CHAMPION TEXT-BOOK ON EMBALMING

REVISED EDITION

MYERS.

Eliab Myers, M.D.

THE CHAMPION TEXT-BOOK ON EMBALMING

A COMPREHENSIVE TREATISE ON THE SCIENCE AND ART OF EMBALMING, GIVING THE LATEST AND MOST SUCCESSFUL METHODS OF TREATMENT, INCLUDING DESCRIPTIVE AND MORBID ANATOMY, PHYSIOLOGY, SANITATION, DISINFECTION, ETC.

BY ELIAB MYERS, M.D.,

LECTURER AND DEMONSTRATOR IN THE MYERS (FORMERLY CHAMPION) COLLEGE OF EMBALMING

FIFTH EDITION

GREATLY ENLARGED AND ALMOST ENTIRELY REWRITTEN

PROFUSELY ILLUSTRATED

BY OVER ONE HUNDRED ENGRAVINGS, HALF-TONES, AND COLORED PLATES

SPRINGFIELD, OHIO:

THE CHAMPION CHEMICAL COMPANY

1908

PREFACE TO THE FIFTH EDITION

The favorable reception with which the first four editions of the CHAMPION TEXTBOOK on Embalming have met in this country, has induced me to spare no exertion to render the fifth edition worthy of the continued confidence of the profession as a guide to the embalmer and as a textbook for the student in the science of embalming.

With this in view the entire work has been brought right up to date. Several chapters have been rewritten, and sufficient new matter added to embody all of the more recent advances in the science of embalming.

It has ever been the ardent desire of the author to make the work a satisfactory and desirable textbook and guide, and he confidently presents this edition as having more claims on the attention of the student and practitioner than previous editions, or any other work on the subject.

E. MYERS.

Springfield, Ohio, January 1, 1908.

PREFACE TO THE FOURTH EDITION.

THE unprecedented exhaustion of three large editions in so short a time has practically demonstrated the esteem in which the Champion Text-Book has been held by the profession.

The period of nearly four years, which has elapsed since the first edition appeared, at the present rate of progress in all the departments of embalming, makes thorough revision and numerous additions necessary to keep up with the times.

In the second and third editions, issued three and two years ago respectively, inadvertencies and errors were corrected, though no attempt was made at general revision.

The work has now been thoroughly revised and almost wholly rewritten, with much new matter added and many new features introduced. The volume is materially increased in size, the type new, the letters and numbers on the plates designating the important parts are enlarged, with a number of new plates added, which is a very necessary and valuable feature. The paper is equal to or even better than that of the former editions.

The thoroughly practical character of the work has been maintained, as far as possible, throughout, as a guide in the operations necessary for the embalming of all kinds of bodies for preservation and disinfection.

In the new matter will be found a Compendium of Practical Questions and Answers, covering all the more important subjects, which will materially aid the student in his comprehension of the same.

The Practical Dictionary will prove convenient and useful in giving definitions of words of an unusual or technical character.

The following books have been especially helpful in the work of revision, in addition to those for which acknowledgment has been made heretofore: "Bacteria and Their Products," Woodhead; "The Principles of Bacteriology," Hueppe; "The Story of the Bacteria," Prudden; "Physiological Chemistry," Novy; Standard Dictionary; Gould's Medical Dictionary, etc.

THE AUTHOR.

SPRINGFIELD, OHIO, October 1, 1900.

PREFACE TO FIRST EDITION.

THE embalmers and funeral directors of this country have made frequent complaints that they were unable to find, in books on embalming heretofore published, such information as they desire on numerous topics of professional inquiry, especially those which have been the subject of recent investigation or introduction.

To meet this confessed demand for a work of more modern character along this line, the preparation of the Champion Text-Book on Embalming was undertaken.

The purpose of the author has been to supply, within the compass of a single volume of moderate size, the information necessary to a full understanding of the subjects belonging properly to the science and art of embalming.

This work is intended both as a text-book for the student and a complete reference book for the embalmer. To meet these ends, we have endeavored to furnish that information which our teaching and long experience in the practice of embalming have suggested to us to be the most needful to the student and practitioner. We have treated of anatomy and physiology to the extent necessary to give a good understanding of the structure and functions of the body, thus laying a sure foundation for the successful study and practice of embalming. After tracing the history of this art from ancient times down through the intervening ages, the most modern, simplest, and best methods have been clearly set forth. Morbid anatomy and the treatment of special diseases, including those which give the embalmer the most trouble, are much more fully considered than in any similar work, thus adding largely to the value of the Text-Book. The best and latest information concerning sanitation, disinfection, infection, and bacteriology, is also set forth in a terse and practical form, while much useful information is given on other subjects.

The very comprehensive Glossary, at the conclusion of the work, cannot but prove helpful to both student and practitioner; while, within the compass of the General Index, has been included every term and subject on which information is likely to be sought.

We have appropriated to our use many important facts found in the works constituting the physician's library, that have a direct bearing upon the subjects of which we treat; but, nevertheless, we have relied chiefly upon our own observations and experiences, especially in the operations and methods of treatment given.

We have made it a rule to write pointedly and briefly, without unnecessary verbiage, or circumlocution, on all subjects treated; and, where it could be done without sacrificing clearness or accuracy, have practiced careful abridgement of the text. As far as possible technical terms have been eliminated. Where it has been necessary to introduce them, they have been placed in the Glossary, with a clear, concise definition.

Our illustrations are of a preëminent character, much superior to any hitherto published in a similar work, and will add greatly to an elucidation of the text and a proper understanding of the methods taught.

We are especially indebted to the works of the following authors in the preparation of this book:

Anatomy:—Gray; Potter.

Physiology:—Flint; Steele; Baldwin; Huxley.

Morbid Anatomy and Pathology:—Flint; Osler; Stille; Bristowe; Aitken; Quain; Green; Peper's System.

Bacteriology and Sanitation:—Sternberg; Abbott; Sykes.

The Author.

Springfield, Ohio, January 1, 1897.

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PART FIRST.

ANATOMY OF THE HUMAN BODY.

INTRODUCTION TO PART FIRST.

ANATOMY is the science of organization. The word "anatomy" properly signifies dissection, but it has been appropriated to the study and knowledge of the apparent properties of organized bodies.

In Part First we treat of the anatomy of the human body, not in its minutia, but, we might say, superficially. We have endeavored to give it in sufficient detail, however, that the student of embalming may understand the matter that follows. He should be familiar with the divisions of the body, its various organs and parts; the location and contents of the cavities; the consistency and composition of the various structures; the different circulations; the structure and position of the arteries and veins, and their relation to each other, and to other parts, for the purpose of raising them when necessary, and also to avoid rupturing or mutilating them while performing operations upon the body.

We also treat of physiology, so that the functions of the different organs and fluids of the body may be understood.

Still, many students of embalming will, no doubt, skim very lightly over this part and even skip some chapters entirely; yet, the real student, who desires to lay deep the foundation for future success, should study every page, for the more he knows about the construction of the body, the better able he will be to care for it, when the last spark of life is finally extinct.

The very excellent anatomical plates, which appear in this part of the work, cannot but be a great aid to the student in the study of anatomy. Many of these are in colors, showing the arteries and veins in contrast, which makes it easy to follow their course, and comprehend their relation. The substitution of large-sized letters and figures, for the smaller and more indistinct ones used in previous editions, to indicate the principal parts, greatly enhances the value of these plates. A careful study of them, in connection with the text, is advised.

CHAPTER I.

OSTEOLOGY.

Osteology is that part of anatomical science that treats of the structure, articulation, development, and use of the bones of the skeleton.

GENERAL DESCRIPTION OF THE BONES.

Number of Bones.—The classified bones of the skeleton in the adult are two hundred in number. The six small bones of the ear; the small sesamoid bones, varying from five to eight, found at the first joint of the thumb and toe; and the Wormian bones, sometimes found in the cranial sutures, are not classified, and are, therefore, not included in the number. The patella (knee=cap) is a typical sesamoid bone, but, being large, and having such an important place in the anatomy of the body, is usually classified among the irregular bones. The teeth are never enumerated among the bones.

The number of bones in youth is greater. The sacrum and coccyx, each a single bone in the adult, are in youth made up respectively of five and four "false vertebræ"; in youth the sternum consists of eight pieces, becoming three in the adult; and the innominate, which in youth is composed of three separate parts, ossifies into a single bone in the adult.

The Distribution of the Bones in the body is as follows: cranium and face, 22; spine, including sacrum and coccyx, 26; ribs, sternum, and os hyoides, 26; upper extremities, 64; lower extremities, 62; total, 200.

The bones are placed in such a position as to bestow individual character upon the body, afford points of connection to the numerous muscles, and give firmness and strength to the entire fabric. In the extremities they are hollow cylinders, and, by their conformation and structure, are admirably calculated to support weight and resist violence. In the head and trunk the bones are flattened and arched for the purpose of protecting cavities and providing an extensive surface for attachment. In some situations they present projections, which serve as levers; in others, smooth grooves, which act as pulleys for the passage of tendons. By their numerous divisions and mutual apposition, the bones are equally adapted to fulfill every movement of the body which may tend to its preservation, or be conducive to its welfare.

Classification of Bones.—The bones are divided into four classes: long, short, flat, and irregular.

The Long Bones are found in the extremities, and consist of a shaft and two extremities. The shaft is cylindrical in form, and the structure is dense and hard, being hollowed out in the interior to form the medullary canal. The extremities are broad and expanded, for the purpose of articulation and for muscular attachment. The texture at the extremities is spongy, with only a thin coating of compact tissue. The long bones are the clavicle, humerus, radius, ulna, femur, tibia, fibula, metacarpal, metatarsal, and phalanges.

The Short Bones.—Where strength and compactness are required, and motion is slight and limited, the part is composed of a number of short bones bound together by ligaments. Their texture is spongy with a thin crust of compact tissue; such are the bones of the carpus and tarsus.

The Flat Bones are adapted to enclose cavities, and afford broad surfaces for the attachment of muscles. They are composed of two thin layers of compact tissue, with an intermediate quantity of cancellous tissue. In the bones of the cranium, the two layers of compact tissue are known as the tables of the skull, and the intermediate cancellous tissue, as diploe.

The flat bones are the occipital, frontal, parietal, nasal, lachrymal, vomer, scapula, innominate, sternum, and ribs.

The Irregular Bones include all the remaining bones. In form they are irregular—in some parts short and thick, in others flat. Their structure is similar to that of other bones, having a dense exterior and a spongy, cancellous interior. They are the vertebra, sacrum, coccyx, temporal, sphenoid, ethmoid, malar, superior and inferior maxillary, palate, turbinate, hyoid, and patella.

The Composition of Bones at maturity is about one part animal or organic matter, consisting of gelatin, vessels, and fat, and about two parts mineral or inorganic matter, consisting of phosphate and carbonate of lime ($62\frac{1}{3}\%$), with fluorid of lime, phosphate of magnesium, sodium, and chlorid of sodium ($4\frac{1}{3}\%$). The proportion varies with age. In youth it is nearly half-and-half, while in old age the mineral is greatly in excess. Heat will remove the animal matter and leave the mineral; dilute muriatic or nitric acid will remove the mineral matter and leave the animal.

Put a bone for a few minutes into a hot fire, and, when carefully removed, it will have the same shape as before, but be much lighter, perfectly white, very brittle, and will easily crumble. The animal or organic part has been burnt out, leaving only the earthy or inorganic. Immerse a long, slender bone for some time in dilute muriatic acid. The bone will retain its original shape, but be lighter in weight, soft, and pliable, so that it can be twisted or tied into a knot. The acid has eaten out the earthy part, but left unaffected the animal.

The Structure of Bones.—Bone is composed of an outer, compact layer, and an inner, cellular or spongy structure. The spongy structure increases in quantity and becomes more porous at the ends of a long bone, while the compact portion increases near the middle, where strength is needed.

Fresh or Living Bone is moist, pinkish in color, and covered with a tough membrane, called the periosteum (*peri,* around; *osteon*, a bone), filled with marrow, and lined with a similar membrane, the endosteum (*en*, in; *osteon*, a bone).

The Lacunæ.—If a thin, transverse section of bone be placed under the microscope, black spots, with lines running in all directions, are seen. These are cavities, called lacunæ, from which radiate small tubes. The lacunæ are arranged in circles around large tubes, called Haversian canals, which serve as passages for the blood=vessels. By means of these canals the blood circulates through the bone=tissue, nourishing it.

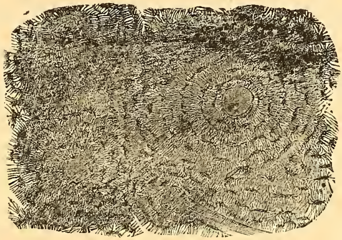

Fig. 1. Lacunæ and Haversian Canals, with tiny tubes or canaliculi radiating from the former, as shown in a thin slice of bone, highly magnified. One Haversian canal is seen lengthwise and three crosswise.

Development of Bone.—The bone=structure does not reach its full development until about the twenty=fifth year. The skeleton of the body in infancy is composed largely of cartilage, which is a white, glistening substance, commonly known as gristle. As age advances, earthy matter is deposited in the cartilage, the bone gradually becoming harder and growing proportionately to other parts of the body. The bones in childhood being tough are not easily fractured, and when broken readily heal again, while those of elderly people are brittle and liable to fracture, and do not easily reunite.

Injury and Repair of Bones.—The proper growth and development of the bones is often hindered by disease or injury. Lack of a proper amount of earthy matter makes the bones soft and allows them to be easily bent out of shape, causing deformity. The breaking of a bone is by no means an infrequent occurrence. When broken the blood oozes out of the fractured ends. This soon becomes a watery fluid, which, in the course of a couple of weeks, thickens to a gristly substance, forming a cement which holds the fractured ends in place. In five or six weeks the broken parts will have reunited, bone matter having been gradually deposited about the fracture. This new formation is larger than the adjacent bone, but the extra matter is gradually absorbed, and often no trace of the injury remains.

BONES OF THE HEAD.

The Bones of the Skull and the Face form a cavity for the protection of the brain. They are immovable, except the lower jaw which is hinged at the back, so as to allow the opening and shutting of the mouth.

The Skull Bones are composed, in general, of two compact plates, with a spongy layer (diploe) between. The outer plates are joined together by notched edges, or sutures, similar to what the carpenter terms dovetailing.

The Cranial Cavity thus formed affords a perfect shelter for the brain. It is oval in shape and adapted to resist pressure. It communicates at the base, through the foramen magnum, with the spinal canal. The cranial cavity and spinal canal together are called the cerebrospinal canal.

BONES OF THE TRUNK.

The Trunk contains the two largest cavities, the chest, or thorax, and abdomen. The principal bones are those of the spine, the ribs, the breast=bone, and the pelvis or hips.

The Spinal Column consists of twenty-four bones, called vertebræ (*verto*, to turn), one placed upon another, between which are placed pads of cartilage. A canal is hollowed out of the column for the protection of the spinal cord. There are projections (processes) at the back and sides, which serve as levers for the attachment of muscles and ligaments. The skull articulates with the spine in a peculiar manner. On the top of the upper vertebra (atlas) are two little hollows (facets), lined with a synovial membrane, which receive the projections on the lower part of the skull, one on either side of the foramen magnum, allowing the head to rock to and fro. The sec-

A
THE BONES

SEVEN PLATES—I -VII

PLATE I.

BONES OF THE SKELETON.

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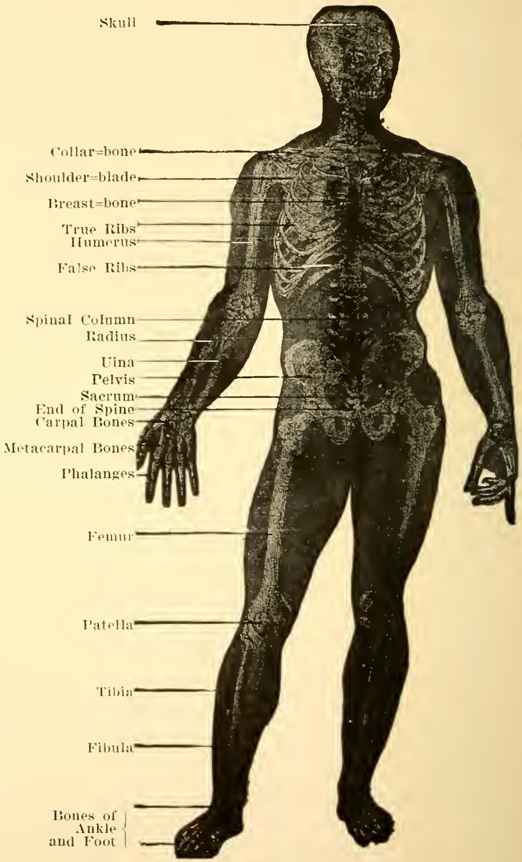

ANALYSIS OF THE HUMAN SKELETON.

- **The Head** (22 bones).
  - 1. Cranium (8 bones).
    - Frontal (forehead).
    - Two Parietal (sides).
    - Two Temporal (temple) bones.
    - Sphenoid (base of skull).
    - Ethmoid (sieve-like bone at root of nose).
    - Occipital (back and base of skull).
  - 2. Face (14 bones).
    - Two Superior Maxillary (upper jaw).
    - Inferior Maxillary (lower jaw).
    - Two Malar (cheek).
    - Two Lachrymal (in orbit of eye).
    - Two Turbinated (scroll-like).
    - Two Nasal (bridge of nose).
    - Vomer (bone between the nostrils).
    - Two Palate.

- **The Trunk** (54 bones).
  - 1. Spinal Column (24 bones).
    - Seven Cervical Vertebræ.
    - Twelve Dorsal Vertebræ.
    - Five Lumbar Vertebræ.
  - 2. Ribs (24 bones).
    - Twenty True Ribs.
    - Four False Ribs.
  - 3. Sternum (breast-bone).
  - 4. Hyoides (bone at root of tongue).
  - 5. Pelvis. (4 bones).
    - Two Innominates.
    - Sacrum.
    - Coccyx.

- **The Extremities** (124 bones).
  - 1. Upper (64 bones).
    - Shoulder............ Scapula. Clavicle.
    - Arm................ Humerus.
    - Forearm............ Ulna. Radius.
    - Hand............... Eight Carpal Bones. Five Metacarpal Bones. Phalanges (14 bones).
  - 2. Lower (60 bones).
    - Thigh.............. Femur.
    - Knee............... Patella.
    - Leg................ Tibia. Fibula.
    - Foot............... Seven Tarsal Bones. Five Metatarsal Bones. Phalanges (14 bones).

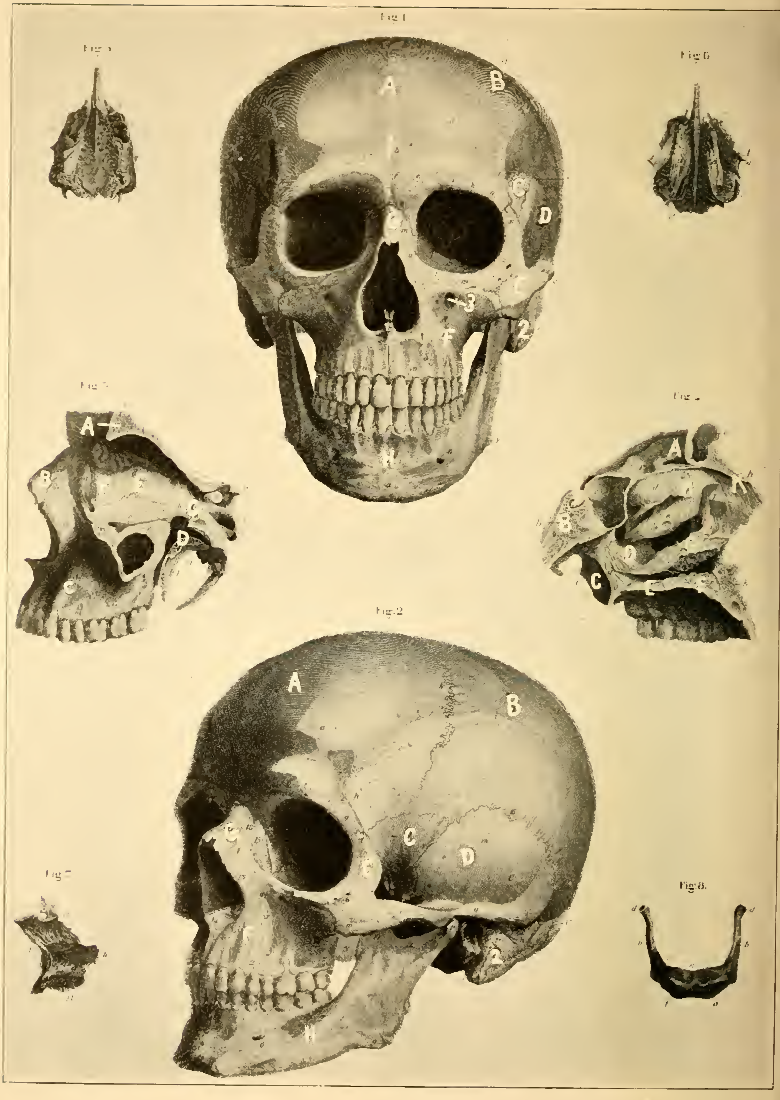
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Fig 8.

PLATE II.

BONES OF HEAD.

Fig 1.—Front View of Cranium.

A. Frontal bone.
B. Parietal bone.
C. Great wing of sphenoid bone.
D. Temporal (temple) bone.
E. Malar (cheek) bone.
F. Superior maxillary (upper jaw).
G. Nasal bone.
H. Inferior maxillary (lower jaw).

1. Frontal suture.
2. Mastoid process.
3. Infraorbital foramen.

Fig. 2.—Side View of Cranium.

A. Frontal bone.
B. Parietal bone.
C. Great wing of sphenoid bone.
D. Temporal (temple) bone.
E. Malar (cheek) bone.
F. Superior maxillary (upper jaw).
G. Nasal bone.
H. Inferior maxillary (lower jaw).

1. Frontal eminence.
2. Mastoid process.

Fig. 3.—Vertical Section of Facial Bones.

Showing inner surface of orbit, antrum highmorianum, and lateral surface of superior maxillary, with portions of sphenoid, temporal, and palate bones posteriorly.

A. Frontal bone.
B. Nasal bone.
C. Superior maxillary.
D. Palate bone.
E. Ethmoid bone.
F. Lachrymal bone.
G. Sphenoid bone.

Fig. 4.—Vertical Section of Facial Bones.

Showing interior and outer wall of nasal cavity, with portions of frontal, ethmoidal, and sphenoidal sinuses.

A. Frontal bone.
B. Sphenoid bone.
C. Pterygoid process.
D. Vertical plate of palate.
E. Horizontal plate of palate.
F. Hard palate.
G. Inferior spongy bone.
H. Nasal plate of ethmoid bone.
K. Nasal bone.

Fig. 5.—Ethmoid Bone—Upper Surface.

Fig. 6.—Ethmoid Bone—Nasal Surface.

Fig. 7.—Palate Bone—Nasal Surface.

Fig. 8.—Hyoid Bone—Anterior Aspect.

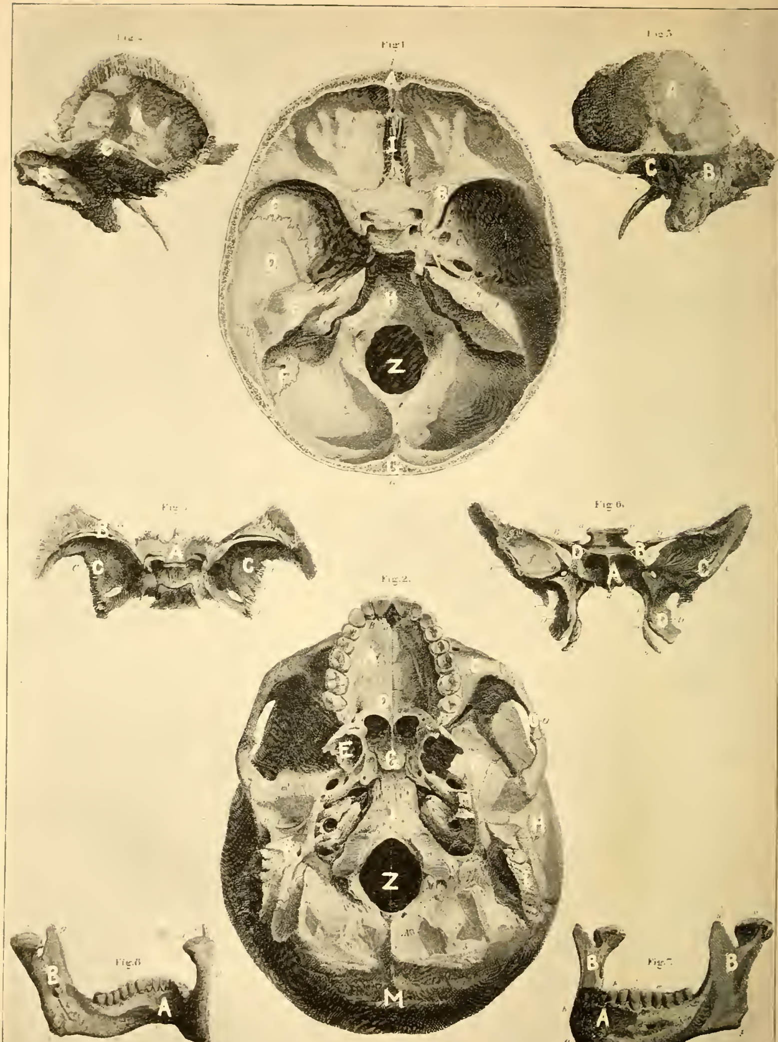
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PLATE III.

BONES OF THE HEAD—(Continued).

Fig. 1.—Base of Skull—Inner Surface.

A. Frontal bone.
B. Lesser wing of sphenoid bone.
C. Greater wing of sphenoid bone.
D. Squamous plate of temporal bone.
E. Petrous portion of temporal bone.
F. Mastoid portion of temporal bone.
G. Occipital bone.
H. Basilar process of occipital bone.
I. Ethmoid bone.
Z. Foramen magnum.

Fig. 2.—Inferior Surface of Cranium—Base of Skull.

A. Bony or hard palate.
C. Superior maxillary.
D. Horizontal plate of palate bone.
E. Pterygoid process of sphenoid bone
F. Greater wing of sphenoid.
G. Vomer.
H. Squamous plate of temporal bone.
I. Mastoid process.
K. Petrous portion of temporal bone
L. Basilar process.
M. Occipital.
O. Zygomatic arch.
Z. Foramen magnum.

Figs. 3 and 4.—Temporal Bone—External Surface (3); Inner Surface (4).

A. Squamous plate.
B. Mastoid portion.
C. Petrous portion.

Figs. 5 and 6.—Sphenoid Bone—Inner Surface (5); Anterior Surface (6).

A. Body.
B. Lesser wings.
C. Greater wings.
D. Pterygoid process (6).

Figs. 7 and 8.—Inferior Maxillary—Outer Surface (7); Inner Surface (8).

A. Body.
B. Ascending ramus.

Fig.

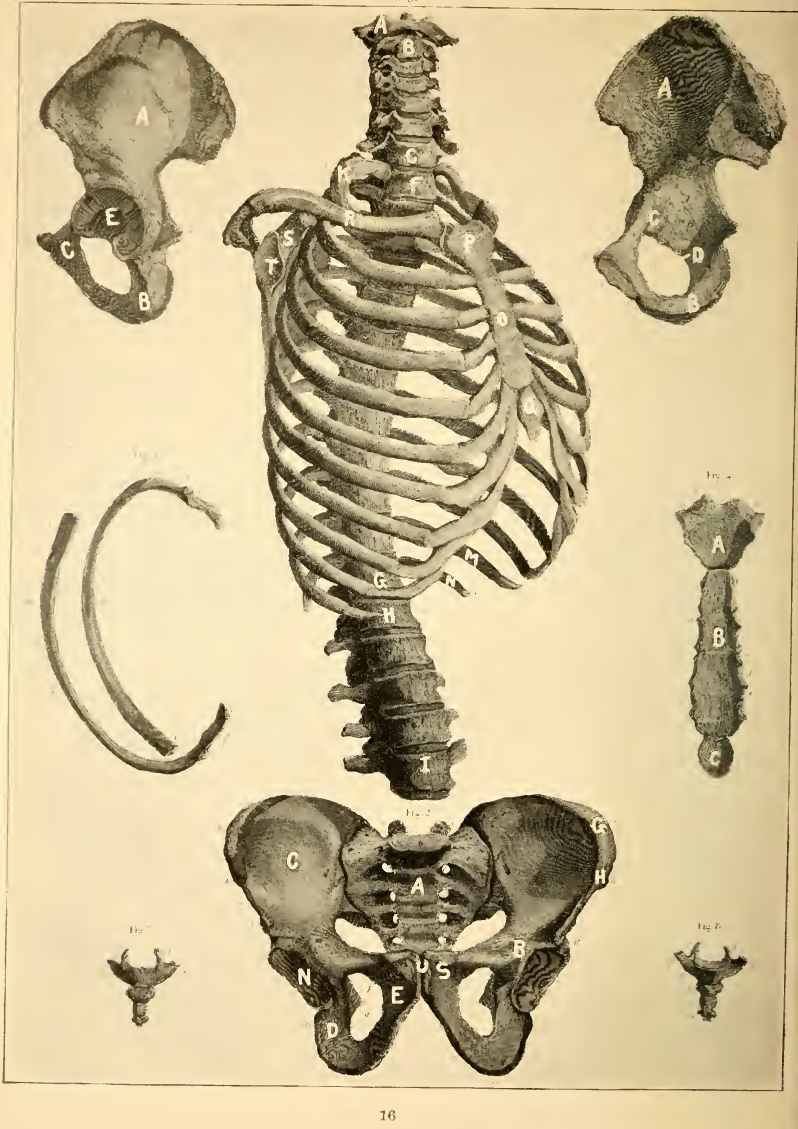

PLATE IV.

BONES OF TRUNK.

Fig. 1.—Spine (Vertebræ), Thorax, Clavicle, and portion of Scapula.

A. Atlas, first veretebra.
B. Axis, second vertebra.
C. Last cervical vertebra.
F. First dorsal vertebra.
G. Last dorsal vertebra.
H. First lumbar vertebra.
I. Last lumbar verteora.
K. First rib.
M. First false or asternal rib.
N. Last floating rib.
O. Body of sternum.
P. Manubrium or first bone of sternum.
Q. Ensiform or xiphoid cartilage.
R. Clavicle.
S. Scapula.
T. Glenoid cavity.

Fig. 2.—Pelvis.

A. Sacrum.
B. Innominatum.
C. Ilium.
D. Ischium.
E. Pubes.
N. Acetabulum.
S. Spine of pubes.
U. Symphysis pubis

Fig. 3.—True or Sternal Ribs.

Fig. 4.—Sternum—Anterior Surface.

A. Manubrium, or first bone.
B. Body or middle portion.
C. Ensiform or xiphoid process.

Fig. 5.—Os Innominatum of Right Side—Inner Surface.

A. Ilium.
B. Ischium.
C. Pubes.
D. Obturator foramen.

Fig. 6.—Os Innominatum of Left Side—Outer Surface

A. Ilium.
B. Ischium.
C. Pubes.
E. Acetabulum.

Figs. 7 and 8.—Os Coccygis—Posterior Surface (7); Anterior and Upper Surfaces (8).

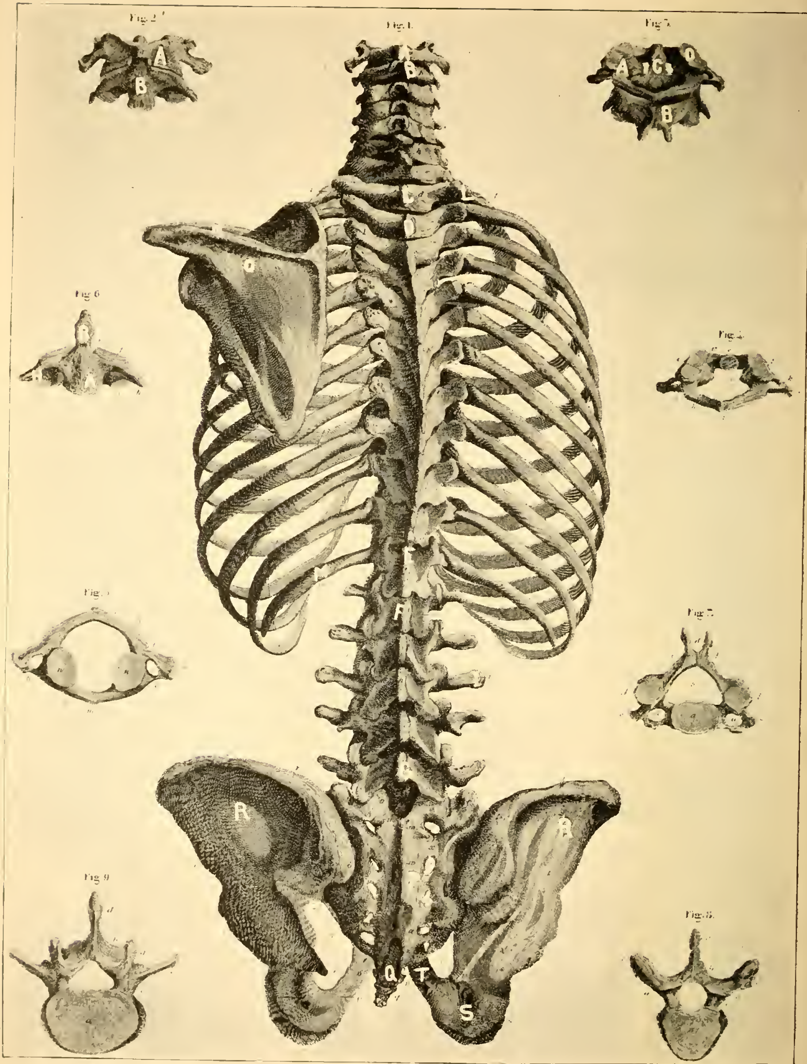
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PLATE V.

BONES OF TRUNK—(Continued).

Fig. 1.—Posterior View of Trunk.

A. Atlas. (See Figs. 2, 3, 4, and 5.)
B. Axis.
C. Last cervical vertebra.
D. First dorsal vertebra.
E. Last dorsal vertebra.
F. First lumbar vertebra.
G. Last lumbar vertebra
I. Transverse processes.
L. First rib.
M. Last rib.
N. Clavicle.
O. Scapula. (See Table VI., Figs 3, 4, and 5.)
P. Sacrum.
Q. Coccyx.
R. Ilia.
S. Ischium.
T. Pubes.

Fig. 2.—Atlas and Axis—Anterior Surface.

A. Atlas.
B. Axis.

Fig. 3.—Atlas and Axis—Posterior Surface.

A. Atlas.
B. Axis.
C. Odontoid process.
D. Articular surface of atlas for occipital condyle.

Figs. 4 and 5.—Atlas—Superior Surface (4); Inferior Surface (5).

Fig. 6.—Axis—Anterior Surface.

A. Body.
B. Odontoid process.
H. Transverse processes.

Fig. 7.—Cervical Vertebra—Superior Surface.

Figs. 8 and 9.—A Dorsal (8); and a Lumbar Vertebra (9)—Superior Surfaces.

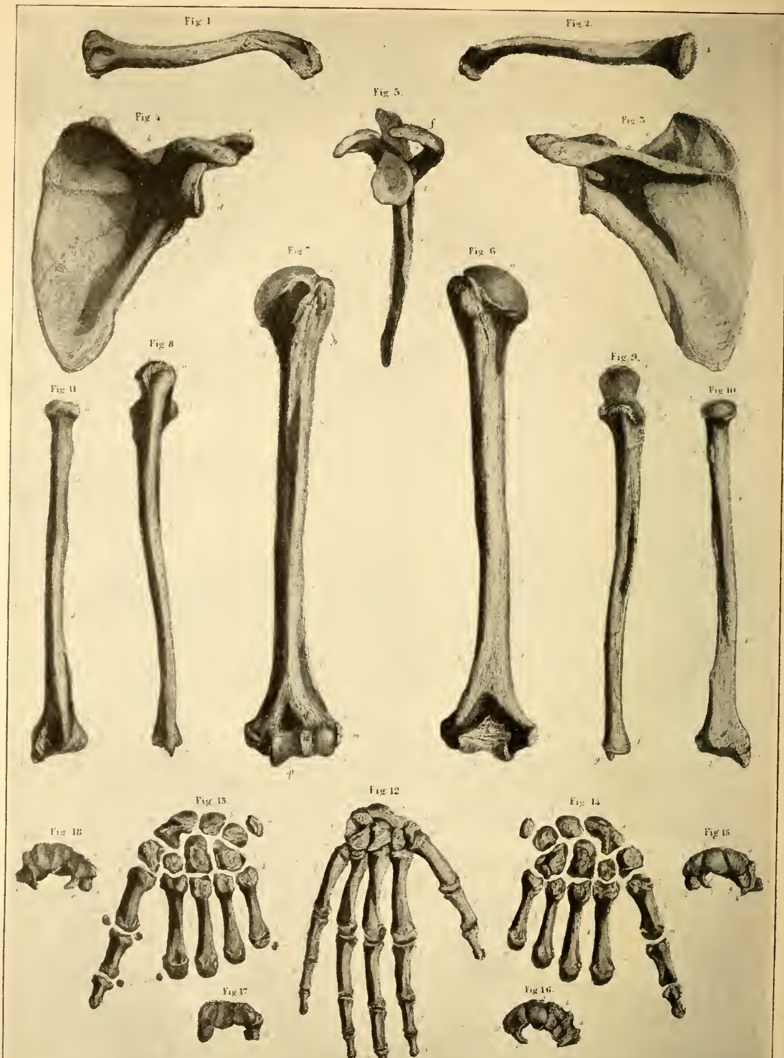
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PLATE VI.

BONES OF UPPER EXTREMITIES.

Figs. 1 and 2.—Clavicle (Left)—Superior Surface (1); Inferior Surface (2).

a. Body.
b. Sternal end.
c. Acromial end.

Fig. 3.—Scapula—Posterior and Outer Surface.

a. Supraspinatus fossa.
b. Infraspinatus fossa.
c. Spine.
d. Acromion process.
e. Articular surface for clavicle.
f. Coracoid process.
o. Neck.
p. Glenoid cavity.

Fig. 4.—Scapula—Internal or Concave Surface.

a. Subscapular fossa.
b. Anterior angle or condyle.
c. Glenoid cavity.
d. Margin or brim of glenoid cavity.
e. Acromion process.
h. Suprascapular notch.
o. Tubercle for origin of triceps muscle.

Fig. 5.—Scapula—Front View of Anterior Margin.

a. Glenoid cavity.
b. Brim of cavity.
c. Anterior margin.
d. Inferior angle.
e. Spine.

Fig. 6.—Humerus (Left)—Posterior View.

a. Head of humerus.
b. Greater Tuberosity.
c. Neck (anatomical).
d. Body.
e. External ridge.
f. Internal ridge.
g. Internal condyle.
h. External condyle.
i. Trochlea.

Fig. 7.—Humerus (Left)—Anterior View.

Figs. 8 and 9.—Ulna—Posterior View (8); Anterior View (9).

a. Olecranon process.
b. Coronoid process.
c. Greater sigmoid notch.

Figs. 10 and 11.—Radius—Anterior View (10); Posterior View (11).

Fig. 12.—Bones of Right Hand—Posterior Surface.

A. Carpus.
B. Metacarpus.
C. Phalanges.

a. Navicular.
b. Lunar.
c. Cuneiform.
d. Trapezium.
e. Trapezoid.
f. Magnum.
g. Unciform.
h-m. Metacarpal bones.
n. Bases of metacarpal bones.
o. Heads of metacarpal bones.
p-t. Phalanges.

Figs. 13 and 14.—Carpus, Metacarpus, and Phalanges of Thumb (Left)—Posterior Surface (13); Anterior Surface (14).

Figs. 15 and 17.—Carpal Bones (Left), First Row—Superior Articular Surface (15); Inferior Surface (17).

a. Navicular.
b. Lunar.
c. Cuneiform.
d. Pisiform.

Figs. 16 and 18.—Carpal Bones (Left), Second Row—Intercarpal Articular Surface (16); Digital Surface (18).

a. Trapezium.
b. Trapezoid.
c. Magnum.
d. Unciform.
e. Hamular process of unciform bone.

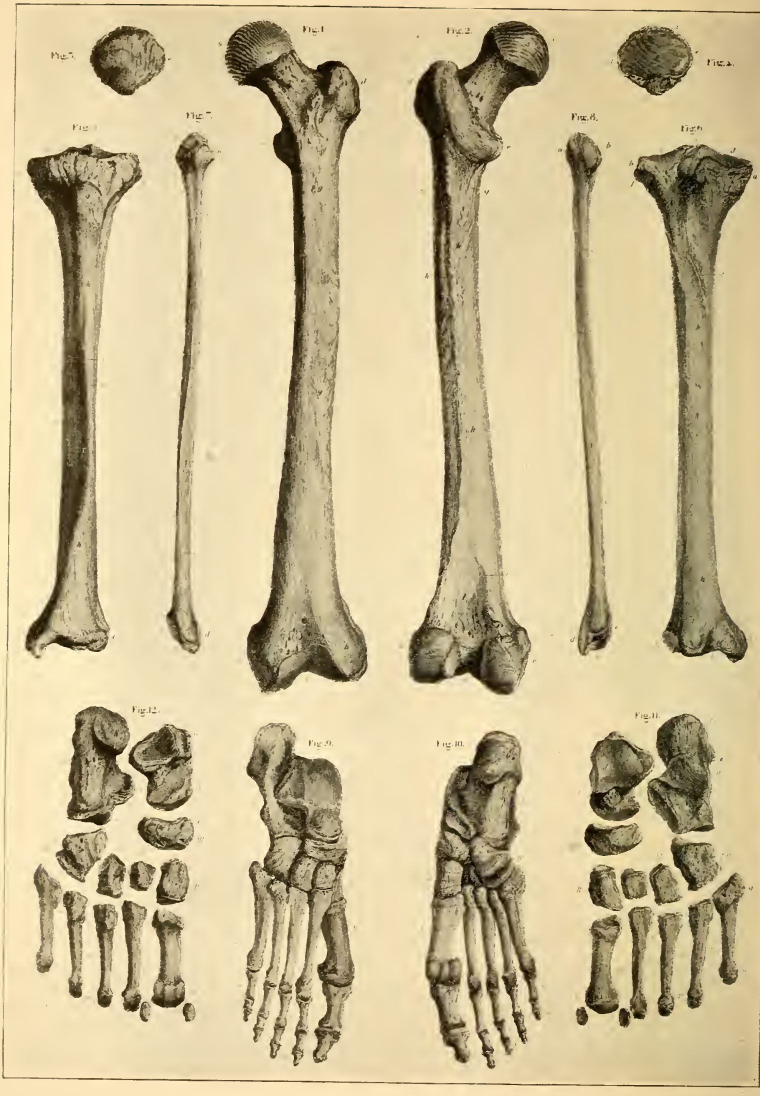
Fig.1.
Fig.2.
Fig.7.
Fig.8.
Fig.12.
Fig.9.
Fig.10.
Fig.11.

PLATE VII.

BONES OF LOWER EXTREMITIES.

Fig. 1.—Femur (Left)—Anterior Surface.

a. Head.
b. Fossa for ligamentum teres.
c. Neck.
d. Trochanter major.
e. Trochanter minor.
f. Anterior Intertrochanterian line.
g. Body.
h. External condyle.
i. Internal condyle.
k. Articular surface for patella.

Fig. 2.—Femur (Left)—Posterior Surface.

a-e. As in Fig. 1.
f. Posterior intertrochanterian line.
g. Superior oblique lines of linea aspera.
h. Linea aspera.
i. Inferior oblique line of linea aspera.
k. Body.
l. Popliteal fossa.
m. External condyle.
n. Internal condyle.
o. Intercondyloid fossa.

Figs. 3 and 4.—Left Patella (Knee-Cap)—Anterior Surface (3); Posterior Surface (4).

Figs. 5 and 6.—Tibia (Left) Anterior and Inner Surfaces (5); Posterior Surface (6).

a. Internal condyle.
b. External condyle.
c. Internal articular surface.
d. External articular surface.
e. Intercondyloid eminence.
f. Articular surface for head of fibula.
l. Articular surface for astragalus.
m. (5). *i.* (6). Internal malleolus.

Figs. 7 and 8.—Fibula (Left)—Anterior Surface (7); Posterior Surface (8).

a. Head.
b. Superior articular surface.
c. Body
d. External malleolus.
e. Tibial surface.
f. Articular surface of astragalus.

Figs 9 and 10.—Bones of Foot (Right)—Upper or Dorsal Surface (9); Inferior or Plantar Surface (10).

a. Astragalus.
b. Os calcis.
c. Navicular.
d, e, f. Cuneiform bones.
g. Cuboid.
h, i. Metatarsal bones.
k, m. First phalanges.
l, n. Second phalanges.
o. Third or ungual phalanges.

Figs. 11 and 12.—Tarsal and Metatarsal Bones (Left)—Upper or Dorsal Surface (11); Under or Plantar Suface (12).

I. Astragalus.
II. Os calcis.
III. Navicular.
IV. Internal cuneiform bone
V. Middle cuneiform bone.
VI. External cuneiform bone.
VII. Cuboid.

n. Metatarsal bones.
o. Bases.
p. Heads.
q. Tuberosity of fifth metatarsal bone.
r. Sesamoid bones of great toe.

ond vertebra (axis) has a peg (odontoid process), which projects through a hole in the atlas, so that when we move the head sidewise, the atlas turns around the peg of the axis. The spinal column serves as a support for the whole body.

The vertebræ are named from the region in which they are located, seven being in the cervical region, twelve in the dorsal, and five in the lumbar. The sacrum and coccyx, which form the terminal bones of the spinal column in the adult, in the child consisted of five and four vertebræ respectively.

The Ribs are twenty-four in number, and are arranged in pairs on each side of the chest. They are also attached to the spine at the back. The upper seven pairs are attached by cartilages to the sternum (breast=bone); the next three pairs are fastened to each other and to the cartilage above; and the last two pairs, the floating ribs, are loose. The long, slender, and arched ribs give lightness and strength, and the cartilages give elasticity to the chest—properties essential to the protection of the organs within, and to freedom of motion in respiration.

The Innominata (nameless), or hip-bones, at the front and the sides, with the sacrum and coccyx at the back, form the pelvic cavity. The hip=bones constitute the pubic arch, being joined by a seam, termed the symphysis pubis. The hip=bone in the young consists of three parts on each side, which unite in adult life to form a single one; but the different parts retain their several names, viz., ilium, ischium, and pubes.

The Extremities are connected to the trunk, and are four in number: two upper, joined to the thorax through the intervention of the shoulder; and two lower, connected with the pelvis. The upper pair, comprising the shoulders, arms, forearms, and hands, are subservient to tact and prehension; the lower pair, comprising the thighs, legs, and feet, to support and locomotion.

BONES OF THE UPPER EXTREMITY.

The Shoulder.—The bones of the shoulder are the clavicle (collar=bone) and the scapula (shoulder=blade). The clavicle is a long bone shaped like the italic *f*. It articulates at one end with the sternum and at the other with the scapula.

The Scapula is a thin, flat, triangular bone, situated on the top and back of the chest, forming the back part of the shoulder.

The Shoulder-Joint.—The humerus, or arm=bone, articulates with the shoulder=blade by a ball=and=socket joint. This consists of a cup=like cavity, the glenoid, in the scapula, and a rounded head of the humerus to fit it, thus affording a free, rotary motion.

The Elbow is formed by the humerus and ulna articulation. The ulna is small at the lower end, while the radius, or large bone of the forearm, on the contrary, is small at its upper end, and large at its lower end, where it forms the wrist=joint.

The Carpus, or wrist, consists of two rows of short bones, one row of which articulates with the radius, forming the wrist=joint, and the other with the metacarpal bones.

The Hand.—The metacarpal bones, or bones of the palm, support the fingers and thumb. Each finger has three bones, while the thumb has two. The first is articulated with the metacarpal bone, the second with the first, and the third with the second. The bones of the fingers and thumb are called phalanges.

BONES OF THE LOWER EXTREMITY.

The Femur, or thigh=bone, is the longest, largest, and strongest bone in the skeleton. It articulates with the hip=bone by a ball=and=socket joint. The acetabulum, a cup=shaped depression, receives the head of the femur, forming a very strong joint.

The Knee-Joint is strengthened and protected by the patella, or knee=cap, the largest sesamoid bone, which is firmly fastened over the joint in the tendon of the quadriceps muscle.

The Tibia, or shin=bone, the largest bone of the leg, articulates with the femur, forming the knee=joint; with the foot, forming the ankle=joint; and with the fibula, the small outside bone of the leg.

The Foot, in general arrangement, is very similar to that of the hand. The several parts of the foot are the tarsus, the metatarsus, and the phalanges. The numerous bones are joined together with cartilages, giving elasticity to the foot in walking. A study of Plates I to VII will give a very good idea of the appearance and relative size of the bones.

Sesamoid Bones are small osseous masses, developed in tendons, which exert a degree of force upon the parts over which they glide. They are enveloped entirely by the fibrous tissue of the tendon in which they exist, except on the side that articulates with the part over which they glide.

Wormian Bones are sometimes found in the cranial sutures, but are not constant in number or size.

The Joints are movable or immovable. The movable joints are covered with a soft, smooth cartilage, which fits so perfectly as to be air tight. It is lined with a thin (synovial) membrane, which secretes a viscid fluid not unlike the white of an egg. This fluid lubricates the joints and prevents friction. The body is the only self=oiling machine in existence. The immovable joints have no synovial membrane. The bones which form the joint are bound together firmly with strong ligaments (from *ligo,* I join), so as to keep them always in apposition.

Articulations are divided into three classes: (1) synarthrosis, immovable; (2) amphiarthrosis, synchondrosis, or symphysis, having limited motion; (3) diarthrosis, having free motion. The latter is divided into gliding joints, ball=and=socket joints, and hinge=joints. The varieties of motion in joints are: flexion, extension, adduction, abduction, rotation, circumduction, and gliding.

The Structures that enter the formation of joints are articular lamella, cartilage, fibro=cartilage, synovial membrane, and ligaments.

Articular Lamella is a layer of compact bone which forms the articular surface, and to which the cartilage is attached; it is white and dense, contains no Haversian canals or canaliculi, and has large lacunæ.

Cartilage is either temporary or permanent. The first forms the original framework of the skeleton, and becomes ossified. Permanent cartilage is not prone to ossification, and is divided into three varieties: (1) articular, covering the ends of bones in joints; (2) costal, forming part of the skeleton; (3) reticular, arranged in lamellæ, or plates, to maintain the shape of certain parts.

Fibro-Cartilage consists of a mixture of white fibrous and cartilaginous tissues, and is flexible, tough, and elastic. It is divided into four groups: (1) interarticular, separating the bones of a joint; (2) connecting, binding bones together; (3) circumferential, deepening cavities; (4) stratiform, lining grooves.

Synovial Membrane is a thin, delicate membrane, resembling serous membrane in structure, forming a short, wide tube, or capsule, and lining the joints and articular surfaces. It secretes a thick, viscid, glairy fluid, called synovia, which acts as a lubricator, preventing friction. Synovial membranes are classified as (1) articular, lubricating joints; (2) bursal, forming closed sacks; (3) vaginal, ensheathing tendone.

The Ligaments, which bind the bones together at the joints, are strong bands of a smooth, silvery-white, fibrous tissue. It is solid and inelastic, softer than cartilage, but harder than membrane. The bond formed is so strong that the bones are sometimes broken without injury to the fastenings. There are a vast number of ligaments in the human body, various in form and office, and each with its own special name.

Poupart's Ligament is the only ligament which calls for a special description. It is attached to the anterior superior spinous process (upper front part of the os innominatum, or hip=bone), and to the center of the pubic arch, forming the upper boundary of Scarpa's triangle, and the division between the abdomen and thigh.

For shape, size, position, and names of ligaments, see Plates VIII to X.

B
THE LIGAMENTS

THREE PLATES—VIII.-X

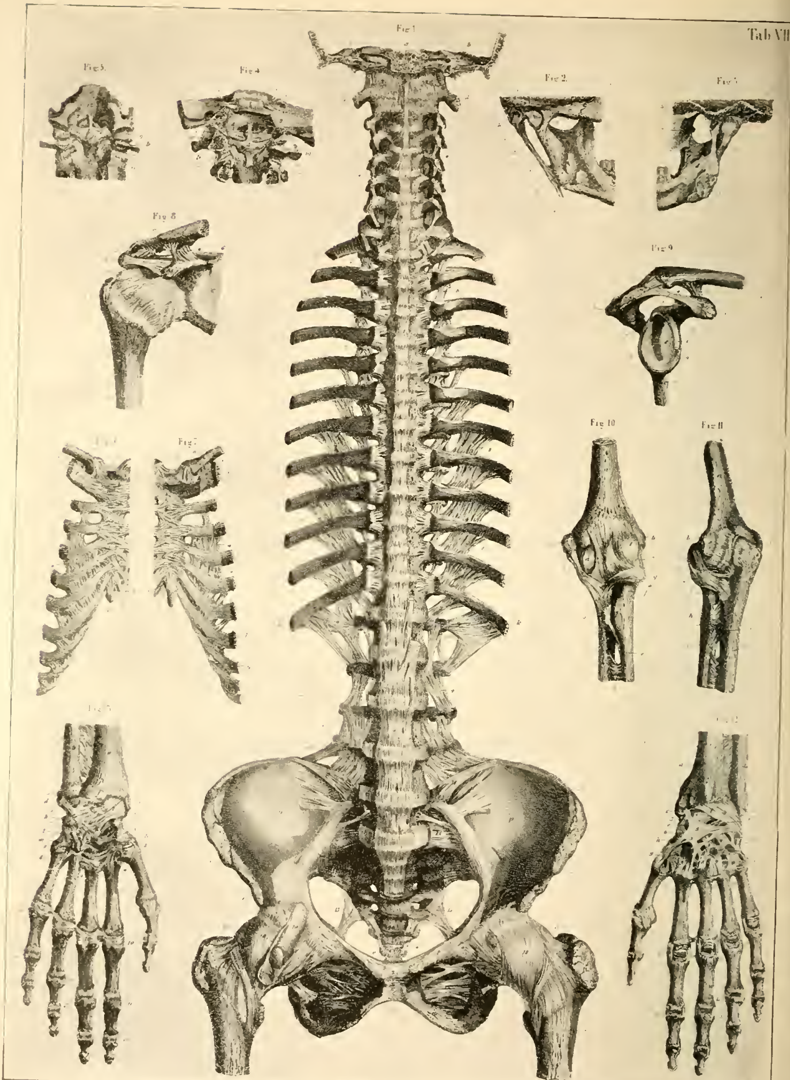
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Fig 1
Fig 2
Fig 4
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Fig 9
Fig 10
Fig 11

PLATE VIII.

LIGAMENTS OF HEAD, TRUNK, AND UPPER EXTREMITIES.

Fig. 1.—Ligaments of the Vertebræ, Sternal End of Ribs, Pelvis, and Iliofemoral Articulation—Anterior Surface.

1. Anterior vertebral ligament.
2. Anterior occipito-atlantoid ligament.
3. Intervertebral fibro cartilage.
4. Intertransverse ligaments.
5. Posterior costovertebral ligaments.
6. Internal costotransverse ligaments.
7. External costotransverse ligaments.
8. Posterior intercostal ligaments.
9. Lumbocostal ligaments.

Figs. 2 and 3.—Ligaments of Right Temporomaxillary Articulation—External Surface (2); Internal Surface (3).

1. Capsular ligament.

Figs. 4 and 5.—Internal Ligaments Connecting Occipital Bone with Axis and of the Articulation between Atlas and Axis—Posterior View, the Posterior Half Arches of these Bones having been removed.

Figs. 6 and 7.—Ligaments of Sternoclavicular and Sternocostal Articulations with Anterior Intercostal Ligaments—Anterior Surface (6); Posterior Surface (7).

FIG 4 and 5
1. Interclavicular ligament.
2. Iternal capsular ligament of sternoclavicular articulation.
3. Rhomboid ligament.
4. 4. Ligamenta coruscantia.
5. Anterior proper sternal ligament.
6. Posterior proper sternal ligament.

Figs. 8 and 9.—Ligaments of Shoulder-Joint and Scapuloclavicular Articulation.

1. Claviculo-acrominal ligament.
2. External capsular ligament of clavicle.
3. Trapezoid ligament.
4. Conoid ligament.
5. Coraco-acrominal ligament.
6. Transverse ligament of scapula.
7. Capsular ligament of shoulder-joint.
8. Tendon of long head of biceps.
9. Glenoid ligament.

Figs. 10 and 11.—Ligaments of Left Elbow-Joint—Anterior Left Surface (10); Posterior Surface (11).

1. Capsular ligament.
2. External lateral ligament.
3. Internal lateral ligament.
4. Orbicular ligament of radius
5. Oblique ligament of radioulnar articulation.
6. Interosseous ligament.

Figs. 12. Ligaments of Left Wrist-Joint and Hand.

1. Interosseous ligament.
2. External lateral ligament.
3. Internal lateral ligament.
4. Posterior radiocarpal ligament.
5. Posterior superficial carpal ligaments.
6. Posterior deep carpal ligaments.
7. Internal lateral ligament of carpus.
8. Proper ligaments of carpus.
9. Dorsal carpometacarpal ligaments.
10, 10. Dorsal ligaments of metacarpal bases.
11, 11. External lateral ligaments of fingers.
12. Internal lateral ligaments of fingers.

Fig. 13.—Ligaments of Left Wrist-Joint and Hand—Anterior Surface.

1. Interosseous ligaments.
2. 3. Anterior radiocarpal ligaments.
4. Lateral radial ligaments.
5. Lateral ulnar ligament.
6. Triangular cartilage.
7. 7. Anterior proper carpal ligaments.
8. 8. Anterior carpometacarpal ligaments.
9. 9. Anterior intermetacarpal ligaments.
10. 11, 12. Ligaments of metacarpophalangeal articulation.

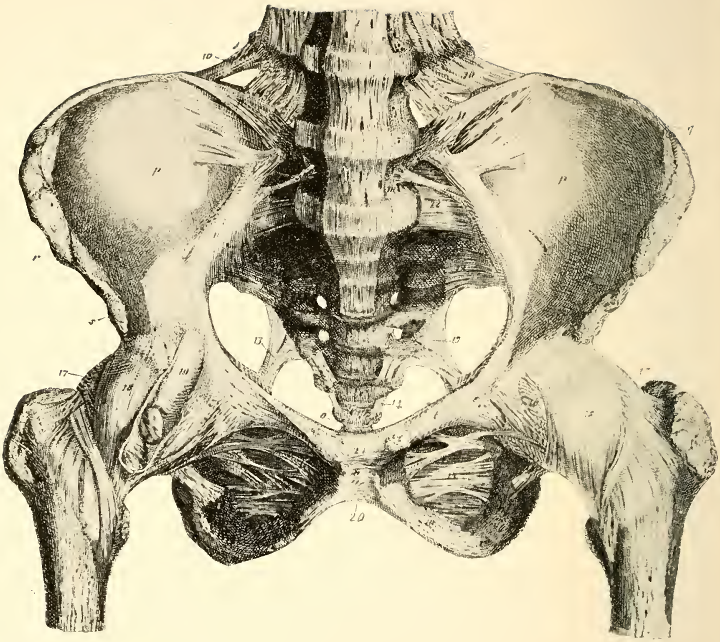
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PLATE IX.

LIGAMENTS OF PELVIS AND ADJOINING ARTICULATIONS.

Fig. 1.—Ligaments of Lower Part of Spine, Pelvis, and Iliofemoral Articulation.

m. Last lumbar vertebra.
n. Sacrum.
o. Coccyx.
p. Ilium.
q. Crest of ilium.
r. Anterior superior spine of ilium.
s. Anterior inferior spine of ilium.
t. Horizontal ramus of pubes.
u. Descending ramus of pubes.
v. Symphysis pubis.
w. Ascending ramus of ischium.
x. Tuber of ischium.
y. Descending ramus of ischium

(For Bones of Pelvis see Plate IV.)

10. Superior iliolumbar ligaments.
11. Inferior iliolumbar ligaments.
12. Anterior iliosacral ligaments.
13. Lesser sciatic ligaments.
14. Anterior sacrococcygeal ligament.
15. Obturator ligaments.

16, 17. Capsular ligaments of hip.
18. Accessory ligaments of hip.
19. Bursa of internal iliac muscle.
20. Subpubic ligament.
21. Interpubic ligament.

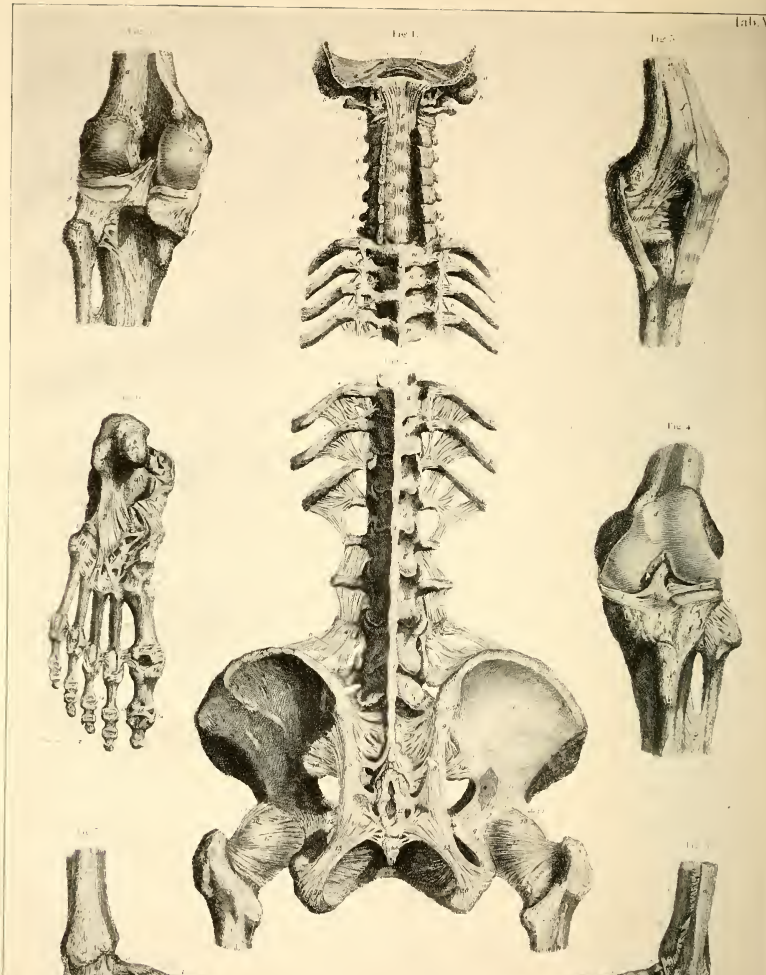
Tab. VII
Fig. 1.
Fig. 4

PLATE X.

LIGAMENTS OF SPINE, PELVIS, AND JOINTS OF LOWER EXTREMITIES.

Fig. 1.—Ligaments of Cervical and Dorsal Vertebræ.

1. Superior attachment of posterior ligament.
2. Apparatus ligamentosus colli (neck).
3. Capsular ligament.
5. Posterior costotransverse ligament.
6. Ligaments of necks of ribs.

Fig. 2.—Dorsal Ligaments of Spinal Column, Pelvis, and Iliofemoral Articulations.

(For bones of pelvis see Plate IV.)

1. Interspinous ligaments.
2. Posterior intercostal ligaments.
3. Lumbocostal ligaments.
4, 5. Transverse ligaments.
6, 7. Iliolumbar ligaments.
8, 9, 10. Iliosacral ligaments.
11. Posterior irregular ligaments.
12. Posterior sacrococcygeal ligaments.
13, 14. Sacrosciatic ligaments.
15. Obturator ligament.
16. Subpubic ligament.
17, 18, 19. Capsular ligaments.

Fig. 3.—Ligaments of Left Knee=Joint.

1. Ligament of patella.
3. Internal lateral ligament.
4. Capsular ligament.

Figs. 4 and 5.—Ligaments of Left Knee=Joint—Internal Anterior View (4); Posterior View (5).

1, 2. Semilunar cartilages.
3, 4. Crucial ligaments.
6. Capsular ligament of head of fibula.
7. Interosseous membrane of leg.

Fig. 6.—Ligaments of Sole of Left Foot.

1. Astragalo=calcanean ligaments.
2. Calcaneo=cuboid ligament.
3. Calcaneo=navicular ligament.
4. Cuboideo=navicular ligament.
5, 6, 7. Cuneiform ligaments.
8, 11. Cuboideo=metatarsal ligaments.
9, 10, 12. Metatarsal ligaments.
13. Fibrocartilaginous sheaths for flexor tendons.
14, 15. Lateral ligaments of phalanges.
16. Crucial ligaments.
17. Intersesamoid ligaments.

Fig. 7.—Ligaments of Left Foot—Internal Surface.

1. Internal lateral or deltoid ligament.
2. Posterior ligament of ankle.
3. Posterior astragalo=calcanean ligament.
4. Plantar calcaneo=cuboid ligament.
5, 6. Navicular ligaments.
7, 8, 9. Naviculo=cuneiform ligaments.
10. Dorsal intercuneiform ligament.
11. Dorsal ligament of base of first metatarsal bone.
12. Plantar ligament.
13. Internal lateral ligaments of toes.

Fig. 8.—Ligaments of Left Foot—External and Dorsal Surfaces.

1. Interosseous membrane of leg.
2. Posterior tibiofibular ligaments.
3, 4. Anterior tibiofibular ligaments.
5, 6, 7. Lateral ligaments of ankle.
8. Tarsal apparatus ligamentosus.
9, 10. Calcaneo=cuboid ligaments.
11, 12, 13. Dorsal navicular ligaments.
14, 15. Dorsal naviculo=cuneiform ligaments.
16. Dorsal intercuneiform ligaments.
17, 18, 19. Dorsal ligaments of tarsus and metatarsus.
20. External lateral ligaments of toes.

CHAPTER II.

THE MUSCLES.

The Muscles are the moving organs of the animal frame. They constitute by their size and number the great bulk of the outer soft tissues of the body, upon which they bestow form and symmetry. In the extremities they are situated around the bones, which they invest and defend, while they form to some of the joints their principal protection. In the trunk they are spread out to enclose the cavities and constitute a defensive wall, capable of yielding to internal pressure, and again returning to its original position. Their color presents the deep=red that is characteristic of flesh, and their form is variously modified to execute the varied range of movements which they are required to effect.

Composition of Muscles.—Muscle is composed of a number of parallel fibers, placed side by side, supported and held together by a delicate web of areolar or cellular tissue, so that, if it were possible to remove the muscular substance, we should have remaining a beautiful, recticular framework, possessing the exact form and size of the muscle without its color and solidity. The fibers are separated by a very elastic, delicate membrane, the sarcolemma, but are bound together into bundles, or fasciculi, by an areolar membrane, or sheath, the internal perimysium. The aggregation of fasciculi constituting a muscle, is in turn bound together by the external perimysium.

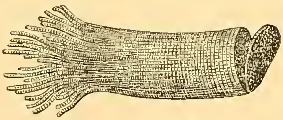

Fig. 2. A Muscle.

Microscopic view, showing the fibrils at one end and the disk or cells of the fiber at the other.

The microscope shows that these fibers are made up of minute filaments (fibrils), and that each fibril is composed of cells arranged like a string of beads. This gives the muscle its striped or striated appearance. The cells are filled with a fluid or semi=fluid mass of living (protoplasmic) matter, which, when separated, appears of a yellowish, sirupy consistence, and is known as the muscle plasma.

Contractility is a peculiar and wonderful property possessed by muscles, resulting from the elastic nature of the muscular tissue. Contraction is effected by an effort of the will, by cold, by certain kinds of irritation, by a sharp blow, etc. When a muscle contracts it becomes shorter and thicker, drawing the ends nearer together. Bending the elbow nicely illustrates this action. The biceps muscle on the front of the arm can be seen and felt to become shorter and thicker as it contracts. Contractility does not always cease at death, as a contraction of the muscles is frequently noticed in certain cold-blooded animals long after the head has been severed from the body.

Kinds of Muscles.—There are two classes of muscles, voluntary and involuntary. The voluntary muscles are those capable of being put in motion by the will, and are composed of reddish fibers. Each one is intended to aid in some movement of the body. All muscles lying on the outside of the skeleton are voluntary. Involuntary muscles, on the other hand, are not capable of being put into action by the will, and are composed of paler fibers, which differ also in shape. Involuntary muscular tissue enters into the formation of the internal organs, as the stomach, intestines, etc. The heart is an involuntary muscle, but its fiber is similar in appearance and structure to those of the voluntary type. The muscles which move the arms, legs, and head are under the control of the will, while the heart beats on day and night. The eyelid combines both classes of muscles, so that we wink constantly, yet we may restrain or accelerate that motion.

Arrangement of Muscles.—The muscles are generally arranged in pairs, one expanding as the other contracts, giving the bone to which they are attached its backward and forward, or other movements.

Grasp the arm tightly above the elbow and bend the forearm; the muscle on the inside (biceps) can be felt as it swells and becomes hard and prominent, while the outside muscle (triceps) relaxes. Straighten the arm, and the conditions are reversed. When the muscles of one side of the face become palsied, those on the opposite side draw the mouth that way.

Modification of Muscles.—Muscles present various modifications in the arrangement of their fibers in relation to their tendinous structure. Sometimes they are completely longitudinal, and terminate at each extremity in tendon, the entire muscle being fusiform in its shape; in other situations they are dispersed like the rays of a fan, converging to a tendinous point, as the temporal, pectoral, gluteal, etc., and constitute a radial muscle. Again they are penniform, converging like the plumes of a pen to one side of the tendon, which runs the whole length of a muscle, as in the peroneal; or bipenniform, converging to both sides of the tendon. In other muscles the fibers pass obliquely from the surface spread out on one side (of a tendinous expansion), to that of another extended on the opposite side, as in the semi-membranous; or they are composed of penniform and bipenniform fasciculi, as in the deltoid, and constitute a compound muscle.

Attachment of Muscles.—Muscles are attached to the periosteum and perichondrium of bone and cartilage, to the subcutaneous, areolar tissue, and to ligaments. The more fixed extremity of a muscle is called the origin, and the more movable, the insertion.

Classification.—The muscles may be arranged in conformity with the general divisions of the body, into those of the head and face, of the neck, of the trunk, of the upper extremities, and of the lower extremities.

The Tendons are white, glistening, fibrous cords, or bands. They vary in length and thickness, are strong and only slightly elastic, have few blood=vessels and nerves, and serve to connect the muscles with the structure on which they act. This union is so firm that, under extreme violence, the bone itself rather breaks than permits of the separation of the tendon from its attachment. The muscular fibers spring from the sides of the tendon, allowing more of them to act upon the bone than if directly attached. This mode of attachment gives strength and elegance.

Aponeuroses are glistening, pearly-white, fibrous membranes, similar in structure and use to the tendons, from which they differ, principally in having a flat form. They are destitute of nerves and blood=vessels, except the thicker ones, which are sparingly supplied with the latter. They are classed as (*a*) aponeuroses of insertion, when at the extremities of muscles, attaching them to the bone; (*b*) aponeuroses of intersection, when they interrupt the continuity of muscle, being continuous on both sides with muscular fibers; (*c*) aponeuroses of investment, when they ensheath the entire limb, or the individual muscle, preventing its displacement. Many aponeuroses serve both for investment and insertion.

Fasciæ (*fascia,* a bandage) are fibro-areolar or aponeurotic laminæ of variable thickness and strength, found in all regions of the body, investing the soft and more delicate structures. They surround and bind together the muscles of the extremities. Fasciæ are divided into superficial, or fibro-areolar, and deep, or aponeurotic.

Superficial Fascia is composed of fibro-areolar tissue and is found immediately beneath the skin over nearly the entire body, varying in thickness in the different parts, being very thick in the groin and very thin on the palms of the hands and soles of the feet. It is composed of two or more layers, between which are found the superficial vessels, nerves, and lymphatics; connects the skin to the sub=jacent parts; facilitates the movements of the skin; serves as a soft and safe re-

C

THE MUSCLES

SEVEN PLATES—XI.-XVII

Tab

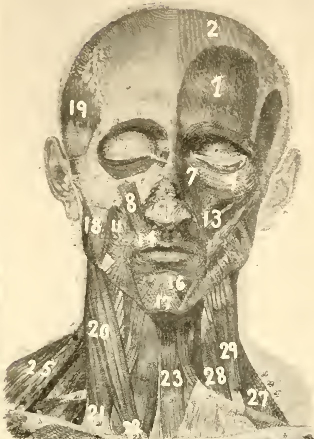

Fig. 4

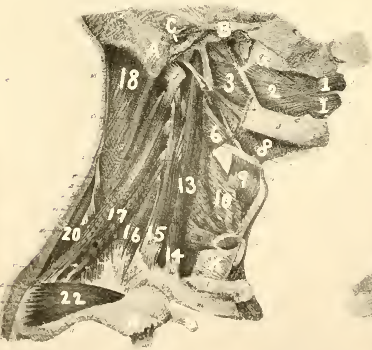

Fig. 5

PLATE XI.

MUSCLES OF HEAD AND NECK.

Fig. 1—Muscles of Face and Neck—Anterior Surfaces.

1. Occipito-frontalis.
2. Tendon of occipito-frontalis.
4. Orbicularis palpebrarum.
7. Levator labii superioris alæque nasi.
8. Levator labii superioris proprius.
11. Levator anguli oris.
13. Buccinator.
14. Orbicularis oris.
16. Quadratus menti.
17. Levator menti.
18. Masseter.
19. Temporal.
20, 21, 22. Sternocleidomastoid.
23. Sternohyoid.
25. Anterior margin of trapezius
27. Levator anguli scapulæ.
28. Scalenus anticus
29. Scalenus medius.

Fig. 2.—Muscles of Neck—Right Side.

D. Mastoid process.
E. Occipital bone.
F. Clavicle.
G. Scapula.
H. Acromion.
I. Coracoid process.
K. First rib.

1. Manubrium.
14. Sternohyoid.
15. Sternothyroid.
16, 17. Omohyoid.
20. Rectus capitis anticus major.
22. Scalenus medius.
23. Levator anguli scapulæ.
24. Splenius capitis.
25. Sternocleidomastoid.
29. Deltoid.

Fig. 3.—Muscles of Neck—Front View.

A. Inferior maxillary.
B. Os hyoides.
D. Thyroid gland.
E. Trachea.
F. Mastoid process.
G. Clavicle.
H. Manubrium sterni.

1, 2. Digastric.
13. Thyrohyoid.
13. Sternohyoid.
15. Omohyoid.
18. Sternothyroid.
19. Scalenus anticus.
20. Scalenus posticus.

Fig. 4.—Deep Muscles of Right Side and Neck.

A. Mastoid process.
B. Zygomatic arch.
C. Meatus auditorius externus
G. Superior maxillary.
K. Trachea.
N. Acromion.
O. Coracoid process.

1, 1. Orbicularis oris.
2. Buccinator.
3. Superior constrictor of pharynx.
6. Middle constrictor of pharynx.
8. Mylohyoid.
9. Thyrohyoid.
10. Inferior constrictor of pharynx.
13. Rectus capitis anticus major.
14, 15, 16. Scaleni.
17. Levator anguli scapulæ.
18. Splenius capitis.
20. Superior rhomboid.
22. Supraspinatus.

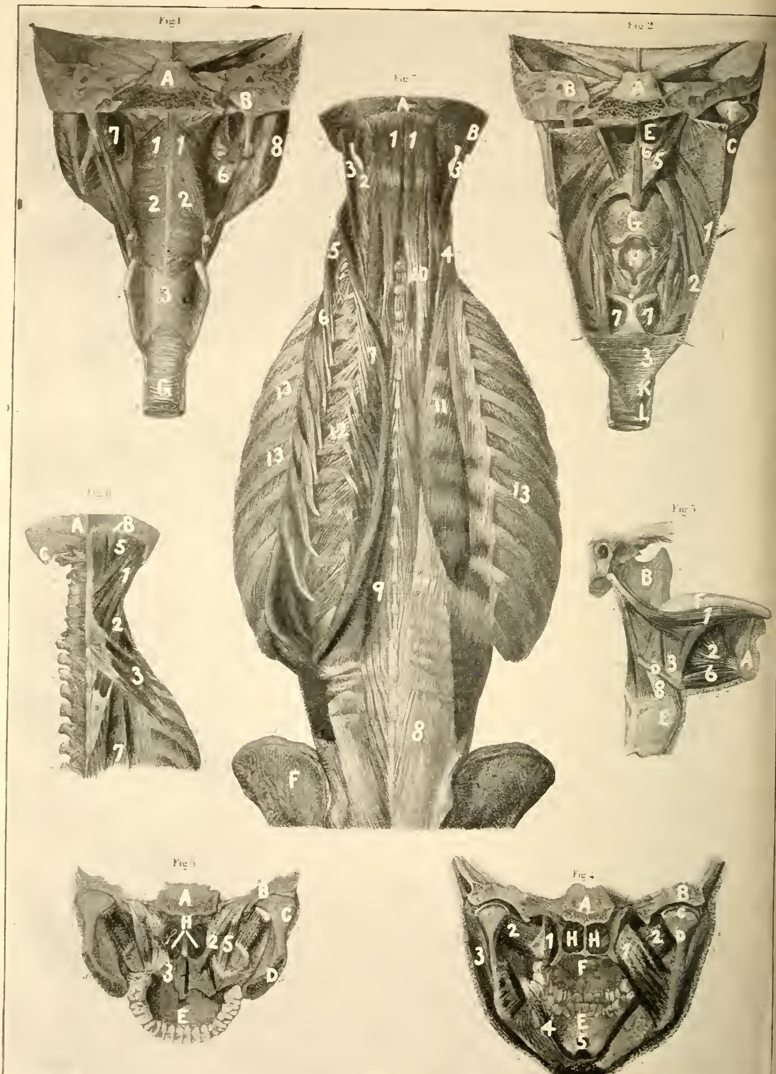
Fig 1
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PLATE XII.

MUSCLES OF POSTERIOR PART OF NECK, TRUNK, PHARYNX, PALATE, LOWER JAW, AND TONGUE.

Fig. 1.—Muscles of Back of Pharynx and Lower Jaw.

A. Basilar process.
B. Petros bone.

1, 2, 3. Constrictors of pharynx.
6. Mylohyoid.

G. Esophagus.

7. Internal pterygoid.
8. Masseter.

Fig. 2.—Muscles of Palate and Throat—Posterior View.

A. Basilar process.
B. Petrous bone.
C. Ramus of lower jaw.
E. Posterior nares.
F. Condyle of lower jaw.

1, 2, 3. Constrictors of pharynx.
5. Levator palati mollis.

G. Base of tongue.
H. Epiglottis.
I. Cricoid cartilage.
K. Esophagus.
L. Trachea.

6. Circumflexus palati mollis.
7. Crico=arytenoideus posticus

Fig. 3.—Muscles of Tongue—Lateral View of Right Side.

A. Body of lower jaw.
B. Ramus of lower jaw.
D. Hyoid bone.

1. Lingualis.
2. Genioglossus.
3. Hyoglossus.

E. Larynx.
F. Tongue.

6. Geniohyoid.
8. Thyrohyoid membrane.

Fig. 4.—Internal Muscles of the Lower Jaw.

A. Body of sphenoid bone.
B. Petrous bone.
C, D, E. Lower jaw.

1. Pterygoideus internus.
2. Pterygoideus externus.
3. Masseter.

F. Hard palate.
H. Posterior nares.

4. Mylohyoideus (divided).
5. Genioglossus (divided).

Fig. 5.—Muscles of Soft Palate.

A. Sphenoid bone.
B. Petros bone.
C. Condyle of inferior maxillary.

2. Levator palati mollis.
3. Circumflexus palati mollis.

D. Ramus of inferior maxillary.
E. Hard palate.
H. Posterior nares.

5. Palatipharyngeus.

Fig. 6.—Muscles of Posterior Surface of Neck and Upper Part of Thorax

A. Occipital bone.
B. Superior semilunar line.

1. Splenius capitis.
2. Splenius colli.

C. Mastoid process.

3. Serratus posticus superior
7. Longissimus dorsi.

Fig. 7.—Deep Muscles of Neck and Back.

A. Occipital bone.
B. Mastoid process.

1. Biventer cervicis.
2. Complexus cervicis.
3. Trachelomastoideus.
4. Transversalis cervicis.
5. Cervicalis ascendens.
6. Lambocostalis.
7. Longissimus dorsi.

F. Ilium.

8. Sacrolumbalis.
9. Spinalis dorsi.
10. Spinalis cervicis.
11. Semispinalis dorsi.
12. Levatores costarum.
13. Intercostals.

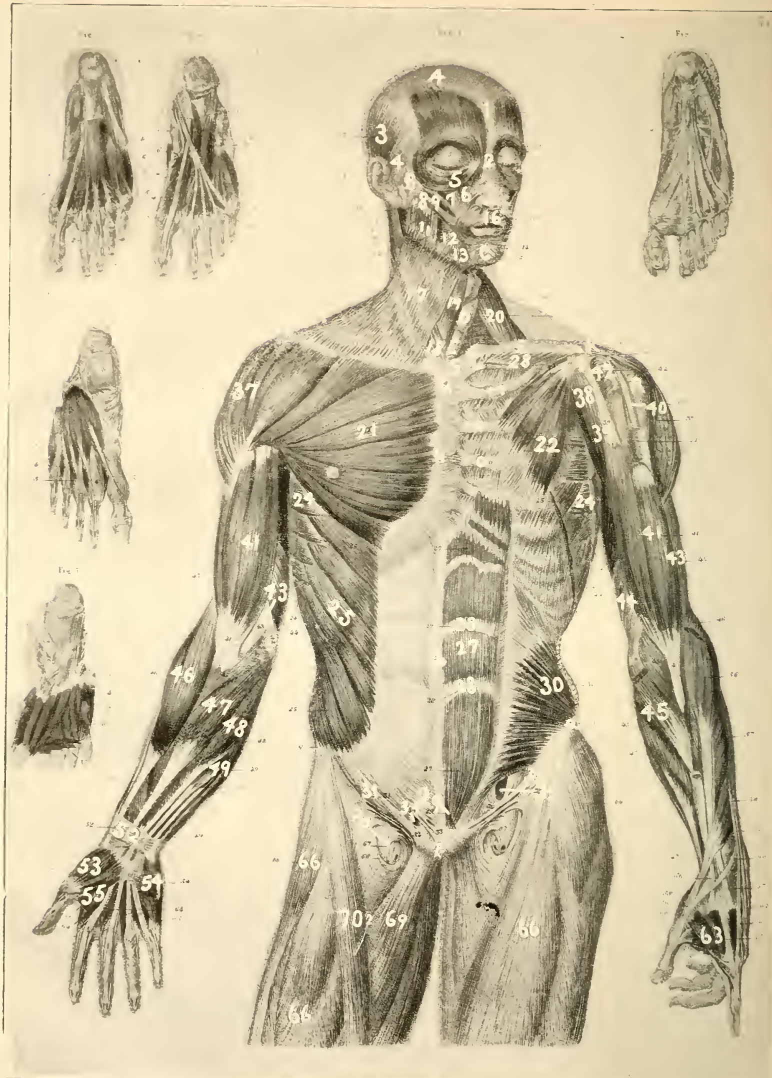

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PLATE XIII.

MUSCLES OF THE TRUNK, ARMS, AND FEET.

Fig. 1.—Muscles of Face, Trunk, Arms, and Upper Part of Thighs—Anterior View.

A. Occipitofrontalis tendon.
B. Malar bone.
C. Inferior maxillary.
D. Thyroid gland.
E. Trachea.
F. Clavicle.
G. Manubrium of sternum.
H. Body of sternum.
I. Coracoid process.
K. Acromion.
L. First rib.
M. Second rib.
N. Third rib.
O. Fourth rib.
P. Symphysis pubis.
Q. Anterior superior spine of ilium.
R. Humerus.
S. Interclavicular ligament.

1. Frontalis.
2. Pyramidalis nasi.
3. Attollens auris.
4. Attrahens auris.
5. Orbicularis palpebrarum.
6. Levator labii superioris alæque nasi with compressor nasi.
7. Levator labii superioris proprius.
8. Zygomaticus minor.
9. Zygomaticus major.
11. Masseter.
12. Buccinator.
13. Triangularis menti.
16. Orbicularis oris.
17. Platysma-myoides.
18. Sternocleidomastoid.
19. Sternohyoid.
20. Scaleni.
21. Pectoralis major.
22. Pectoralis minor.
23. Subclavian.
24. Seratus magnus anticus.
25. External oblique (abdominis).
26. Linea alba.
27. Rectus abdominis.
28. Transverse aponeuroses of rectus abdominis.
29. Pyramidalis abdominis.
30. Obliquis internus.
31. Poupart's ligament.
34, 35. Abdominal rings.
37. Deltoid.
38. Coracobrachialis.
39. Short head of biceps.
40. Long head of biceps.
41. Biceps.
42. Subscapular.
43. Brachialis.
44. Internal head of biceps.
45. Pronator teres.
46. Supinator longus.
47. Flexor carpi radialis.
48. Palmaris longus.
49. Flexor carpi ulnaris.
52. Anterior annular ligament of carpus.
53. Abductor of thumb.
54. Palmaris brevis.
55. Adductor of thumb.
63. Adductor indicis.
64. Lumbricales.
66. Fascia lata femoris.
68. Falciform process of fascia lata.
69. Adductor longus.
70. External femoral ring.
70². Sartorius.

Fig. 2.—Plantar Fascia or Aponeurosis of Right Foot.

Fig. 3.—Plantar Muscles, First Layer—Inferior Surface, Right Foot.

Fig. 4.—Second Layer of Plantar Muscles of Right Foot.

Fig. 5.—Third Layer of Plantar Muscles of Right Foot.

Fig. 6.—Fourth Layer of Dorsal Muscles of Right Foot.

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PLATE XIV.

MUSCLES OF TRUNK, NECK, AND ARMS.

(Posterior View, with some of Anterior Surface.)

Fig 1.—Muscles of Trunk, Upper Part of Thighs, and Arms.

A. Occipitofrontalis tendon.
B. Superior semicircular line of occiput.

H. Crest of ilium.

1. Frontalis.
3. Attollens auris.
4. Retrahentes auris.
5. Attrahens auris.
6. Masseter.
7. Occipitalis.
8, 8, 8. Sternocleidomastoid.
10. Splenius colli.
11. Complexus cervicis.
12. Levator auguli scapulæ.
13. Trapezius.
14. Rhomboideus minor.
15. Rhomboideus major.
16. Latissimus dorsi.
17. Serratus posticus inferior.
22. Obliquus abdominis internus.
23. Gluteus maximus (divided).
24. Gluteus medius.
25. Pyriformis.
26. Gemellus superior.
28. Gemellus inferior.
29. Quadratus femoris.
30. Obturator externus.
31. Vastus externus.
32. Semimembranosus.
33. Adductor magnus.
35. Infraspinatus.
36. Teres minor.
37. Teres major.
38. Deltoid.
39. Triceps brachialis.
40. Long head of triceps.
41. External head of triceps.
42. Internal head of triceps.
43. Anconeus.
45. Supinator longus.
46. Extensor digitorum communis.
47. Extensor carpi ulnaris.
50. Abductor pollicis longus.
52. Flexor digitorum communis.

Fig. 2.—Deep Muscles of Neck—Anterior View.

Fig. 3.—Deep Muscles of Back of Neck.

Fig. 4.—Tendons and Tendinous Sheaths on Posterior Surface of Carpus.

Fig. 5.—Tendons and Tendinous Aponeuroses of Right Wrist and Hand.

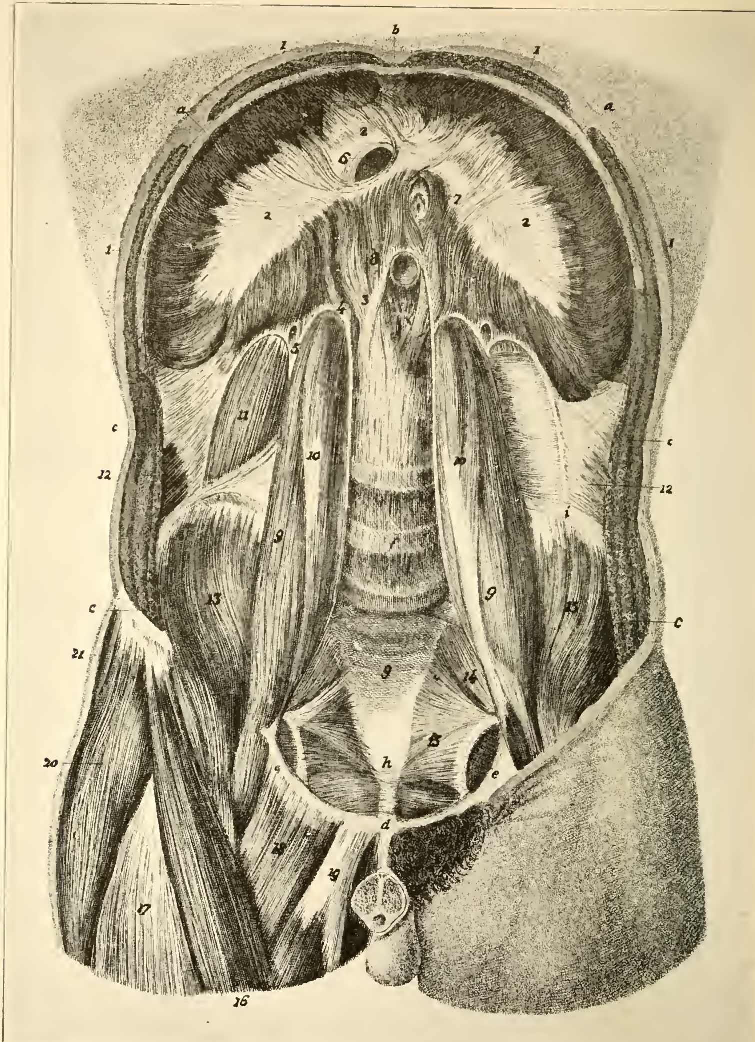

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PLATE XV.

DEEP MUSCLES OF ABDOMEN, DIAPHRAGM, AND PELVIS.

a. Inferior border of thorax.
b. Xiphoid process.
c. Cut edges of oblique and transversalis muscles.
d. Symphysis pubis.
e. Horizontal ramus of pubes.
f. Lumbar vertebræ.
g. Sacrum.
h. Coccyx.
i. Crest of ilium.

1. Costal portion of diaphragm.
2. Tendon of diaphragm.
3. Internal crus of diaphragm.
4. Middle crus of diaphragm.
5. External crus of diaphragm.
6. Opening of vena cava.
7. Esophageal opening.
8. Aortic opening.
9. Psoas major.
10. Psoas minor.
11. Quadratus lumborum.
12. Transversalis and fascia transversalis.
13. Iliacus internus.
14. Pyriformis.
15. Levator ani.
16. Sartorius.
17. Rectus femoris.
18. Pectineus.
19. Adductor longus.
20. Tensor fasciæ latæ.
21. Gluteus medius.


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PLATE XVI.

MUSCLES OF THE ANTERIOR AND EXTERNAL SURFACES OF PELVIS AND LOWER EXTREMITIES.

Fig. 1.—Muscles of Anterior Surface of Lower Extremities.

B. Anterior superiour spinous process.
D. Symphysis pubis.
F. Patella.
G. Tuberosity of tibia.
L. Anterior annular ligament of ankle-joint.

a. Crest of ilium.
c. Trochanter major.
e. Trochanter minor.
h. Tibia.
i. Malleolus internus.
k. Malleolus externus.
m. Fibula.
n. Linea alba.
o. Poupart's ligament.
p. Internal pillar of external abdominal ring.
q. External pillar of external abdominal ring.
r. External abdominal ring.
s. Internal abdominal ring.
t. Posterior boundary of inguinal canal.

1. Obliquis abdominis externus.
2. Transversalis abdominis.
3. Tensor fasciæ latæ.
4. Gluteus medius.
5. Iliacus internus.
6. Psoas major.
7. Pectineus.
8. Sartorius.
9. Adductor longus.
10. Reetus femoris.
11. Tendon of biceps femoris.
12. Ligament of patella.
13. Vastus internus.
14. Vastus externus.
15. Gracilis.
16. Adductor magnus.
17. Tibialis anticus.
18. Extensor longus pollicis pedis.
19. Extensor digitorum communis longus.
20. Peroneus tertius.
21. Peroneus longus et brevis.
23. Gastroenemius.
25. Extensor digitorum eommunis brevis.
28. Soleus.

Fig. 2.—Muscles of External Surface of Right Side of Pelvis and Lower Extremities.

A. Crest of ilium.
B. Anterior superior spine of ilium.
E. Patella.

c. External condyles of knee-joint.
d. Tibia.
f. Anterior annular ligament of ankle.
g. External portion of annular ligament.
h. Tuberosity of fifth metatarsal bone.

1. Tensor fasciæ latæ.
2. Faseia lata.
3. Gluteus medius.
4. Gluteus maximus.
5. Sartorius.
6. Rectus femoris.
7. Vastus externus.
8. Biceps femoris (caput longum).
9. Caput breve bicipitis femoris.
10. Tibialis anticus.
11. Extensordigitorum communislongus.
12. Tendon of Aehilles.
13. Peroneus tertius.
14. Peroneus longus.
16. Sheaths of long and short peroneal tendons.
17. Soleus.
18. Gastroenemius.
20. Extensor digitorum communis brevis.
21. Adductor digiti minimi.

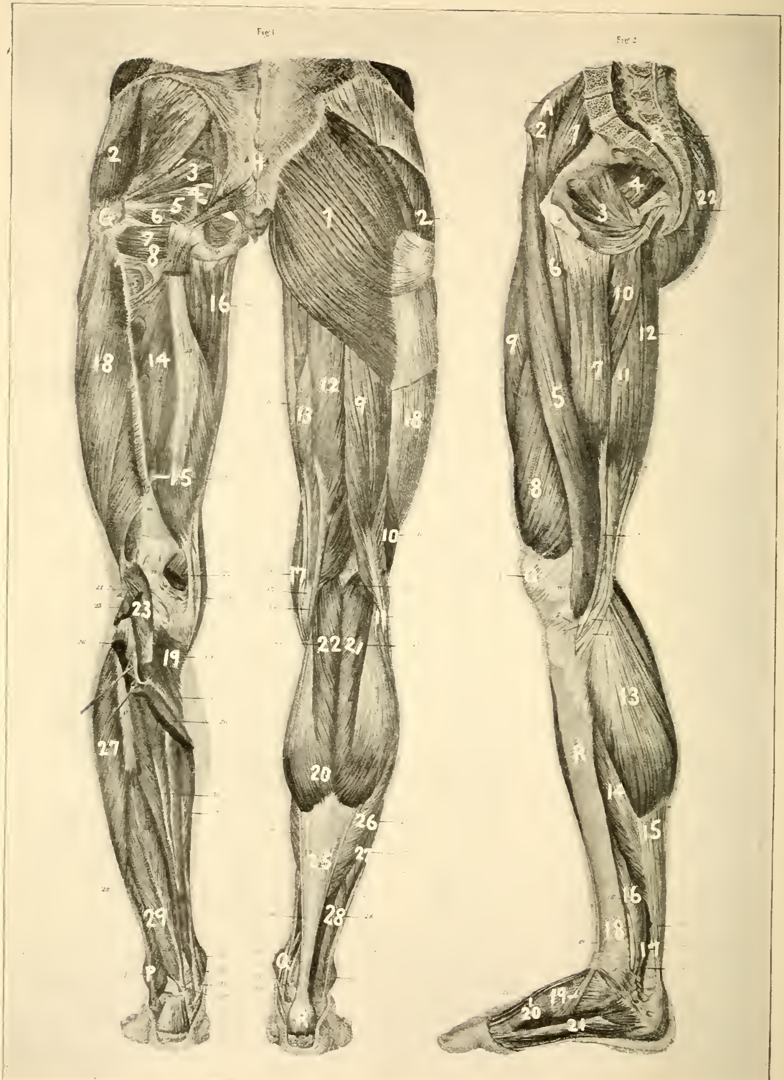


Fig 1
Fig 2

PLATE XVII.

MUSCLES OF THE POSTERIOR AND INNER SURFACES OF PELVIS AND LOWER EXTREMITIES.

Fig. 1.—Muscles of Posterior Surface of Pelvis and Lower Extremities

G. Trochanter major.
H. Sacrum.
P. External malleolus.
Q. Internal malleolus.
R. Tendon of Achilles.

a. Crest of ilium.
b. Ilium.
c. Coccyx.
d. Tuber of ischium.
e. Ascending ramus of ischium.
f. Descending ramus of pubes.
i. Lesser sacrosciatic ligament.
k. Greater sacrosciatic ligament.
l. Linea aspera.
m. Femur.
n. Popliteal fossa.
o. Fibula.
s. Oblique line of tibia.

1. Gluteus maximus.
2. Gluteus medius.
3. Pyriformis.
4. Gemellus superior.
5. Obturator internus.
6. Gemellus inferior.
7. Quadratus femoris.
8. Obturator externus.
9. Long head of biceps femoris.
10. Short head of biceps femoris.
11. Tendon of biceps femoris.
12. Semitendinosus.
13. Semimembranosus.
14. Adductor magnus.
15. Inferior opening of Hunter's canal.
16. Gracilis.
17. Sartorius.
18. Vastus externus.
19. Popliteus.
20. Gastrocnemius.
21. External head of gastrocnemius.
22. Internal head of gastrocnemius.
23. Plantaris.
25. Tendon of Achilles.
26. Soleus.
27. Peroneus longus.
28. Peroneus brevis.
29. Flexor pollicis pedis longus.

Fig. 2.—Muscles of Inner Surface of Pelvis, Thigh, Leg, and Foot

A. Crest of ilium.
B. Sacrum.
E. Symphysis pubis.
Q. Patella.
R. Internal surface of tibia.

c. Coccyx.
d. Linea innominata interna.
m. Ascending ramus of ischium.
n. Anterior sacral foramen.
o. Tuber of ischium.
p. Internal condyles of knee-joint.
s. Internal malleolus.

1. Psoas major.
2. Iliacus internus.
3. Obturator internus.
4. Pyriformis.
5. Sartorius.
6. Adductor longus.
7. Gracilis.
8. Vastus internus.
9. Rectus femoris.
10. Adductor magnus.
11. Semimembranosus.
12. Semitendinosus.
13. Gastrocnemius (internal head).
14. Soleus.
15. Tendon of Achilles.
16. Flexor digitorum communis longus perforans.
17. Flexor pollicis pedis longus.
18. Tibialis posticus.
19. Tendo tibialis antici.
20. Tendo extensoris pollicis pedis longi.
21. Adductor pollicis pedis.
22. Gluteus maximus.

pository for the passage of the cutaneous vessels and nerves; and retains the warmth of the body.

Deep Fascia is a dense, inelastic, unyielding, fibrous membrane, forming sheaths for the muscles, affording them broad surfaces for attachment and binding down the whole in a shapely mass. It consists of shining, parallel, tendinous fibers, connected together by other fibers disposed in a reticular manner. The deep fascia is usually exposed on removal of the superficial, forming a strong investment, which not only binds down the muscles of each region collectively, but gives a separate sheath to each, as well as to the vessels and nerves.

Wonders of the Muscles.—The action of many muscles is required to keep the human body in an upright position. The center of gravity is so high up, and the joints work so easily, that were it not for the muscular action the skeleton would constantly topple over. But for the steadying effect of the muscles of the neck the head would be forced to respond to its tendency to fall forward. The strong muscles of the back restrain the hips' natural forward incline, while the muscles of the calf counteract the pulling forward of the great muscles of the thigh, acting over the knee-cap. So it is with other sets of muscles, all acting so perfectly that they are unthought of until science calls attention to them.

Muscular Sense is useful in many ways. The sensation of weight is felt in lifting an object. Cultivation of this sense enables one to form a very precise estimate of the weight of a body by simply lifting it. Walking is a perilous performance which constant practice alone has made safe. Some authorities define walking as perpetual falling with constant self-recovery. In running we simply incline our bodies more and fall faster.

Development of the Muscles.—Proper exercise develops and improves the muscles, while violent, unguarded exercise is injurious. A muscle remaining entirely idle loses the power to take up the nourishment provided, becomes soft and weak, growing constantly smaller, and finally the muscular tissue almost wholly disappears. Exercise increases the flow of blood to the muscles, promoting their nourishment and stimulating their growth. The large, hard, and strong muscles of men engaged in manual labor, contrasted with the thin and flabby muscles of professional men, who are unaccustomed to exercise, clearly show the effects of exercise. Exercise is essential to the health of the whole body, increasing the circulation and power of breathing, and stimulating every part of the body to a healthy growth. To obtain the best advantage exercise should be regular and systematic, and taken in proper amounts.

Number of Muscles.—There are about five hundred muscles in the human body, each having a special use, and all working together harmoniously and perfectly. Many of the external muscles can be seen and traced on Plates XI to XVII, but beneath these are still larger numbers, many being quite tiny and delicate, too small to be seen with the unaided eye. It is not necessary in a work of this kind to describe all of the muscles—only a few that serve as guides to the arteries and veins which are usually employed in embalming. A brief description is also given of the diaphragm, and of several locations, a knowledge of which is deemed of importance to the embalmer.

The Sternocleidomastoid arises by two heads from the sternum and the inner third of the clavicle, and passes upward and backward to be inserted into the mastoid process of the temporal bone and the superior curved line of the occipital bone, behind the ear. The anterior border serves as a guide to the common carotid artery and internal jugular vein.

The Biceps arises by two heads, the long head from the upper margin of the glenoid cavity, the short head from the apex of the coracoid process of the scapula, and is inserted into the back of the tuberosity of the radius and the fascia of the forearm. The inner border serves as a guide to the brachial artery and basilic vein.

The Sartorius arises from the anterior superior spinous process of the ilium (front part of the hip=bone) and half of the notch below it, and passes obliquely downward and inward, to be inserted into the upper internal surface of the tibia. It is the longest muscle of the body. The inner border serves as a guide to the femoral artery and vein.

The Adductor Longus has its origin in the front surface of the pubic bone, and is inserted in the inner border of the middle third of the femur. It forms the inner boundary of Scarpa's triangle. Its action is to draw the lower extremities together.

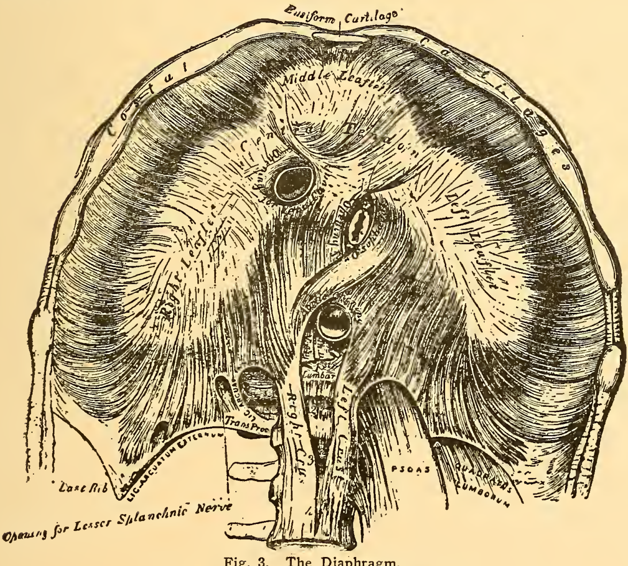


Fig. 3. The Diaphragm,
Showing Under Surface, with Openings, etc.

The Diaphragm (a partition wall) is a thin musculofibrous septum, placed obliquely across the trunk, separating the thorax from the abdomen, and forming the floor of the former cavity and the roof of the latter. It is the great muscle of respiration. It has three openings, the aortic, esophageal, and that of the vena cava, but is impervious to liquids contained in, or injected into, either cavity.

Scarpa's Triangle is situated in the upper front part of the thigh, with the base upward, which is bounded by Poupart's ligament; the outer border is bounded by the sartorius muscle, and the inner by the abductor longus muscle. The femoral artery passes out from the abdomen at the center of the base of the triangle (Poupart's ligament), and extends downward through the center of the triangle to the apex.

Hunter's Canal is the canal through which the femoral vessels pass to the popliteal space. It is formed by the vastus internus muscle and the adductor magnus and longus muscles on either side, and a strong fibrous band passing over from the vastus to the tendons of the adductors.

The Popliteal Space, commonly called the hollow of the knee, occupies the space behind the knee, including the lower third of the thigh and upper fifth of the leg.

Axillary Space.—The axilla (armpit) is a pyramidal space, situated between the upper and lateral part of the chest and the inner side of the arm. It extends from the interval between the two scalene muscles on the first rib to the humerus at the point where the pectoral muscles are inserted.

CHAPTER III.

THE ABSORBENTS.

THE SKIN.

The Skin or Integument (*intego*, to cover) is the first tissue that is incised in cutting into the body. It is a tough, thin, elastic investment, with which the entire surface of the body is covered. Its perfect elasticity adapts it to every motion of the body. The skin surface of an adult of average size is about sixteen square feet. It is not a mere covering, but is an active and important excretory and absorbent organ. Like the joints, it is self-oiling, but for a different reason, namely to preserve its smoothness and delicacy. It also replaces itself as fast as worn out. The skin varies in thickness in different parts of the body, being quite thick where exposed to friction and pressure, as on the soles of the feet and palms of the hands. At the openings of the body, as the mouth, it becomes merged into the mucous membrane.

Structure of the Skin.—The skin consists of two distinct layers, outer and inner, and also a thin middle layer, which is attached to the under surface of the outer layer.

Cuticle, Epidermis, Scarf-skin.—The outer layer is variously called the cuticle (*cuticula*, little skin), epidermis (*epi*, upon; *derma*, skin), and scarf-skin, and is what is commonly styled the skin. It forms a defensive covering to the surface of the true skin; limits the evaporation of watery vapor from the free surface; is the part raised by a blister, and that is detached and slips in a case of so-called "skin=slip." If the soft or middle layer is removed from the under surface the cuticle is perfectly transparent. It neither bleeds nor suffers from heat or cold; neither does it possess blood=vessels. It can be torn or cut without producing hemorrhage or pain.

The cuticle is composed entirely of small, flat cells or scales, which are constantly being shed from the surface in the form of scurf or dandruff, but are constantly being renewed from the cutis or inner layer of the skin. In the usual discolorations the outer layer is not affected, there being no blood=vessels to fill with blood; neither is it stained by any coloring matter.

Corium, Derma, Cutis Vera.—The inner layer is called corium, derma, and cutis vera (true skin), all meaning the same thing. The term "corium," though used to designate the entire layer, is more properly applied to the deeper and principal portion of this layer. It consists of strong, interlacing, fibro=areolar tissue, and merges into the fatty tissue beneath, in which is found an abundance of blood=vessels, nerves, lymphatics, and glands. The superficial or papillary portion of the layer consists of numerous small, highly sensitive, and vascular elevations, the papillæ, which rise perpendicularly from its surface into the rete mucosum. The papillæ form the essential element of the organ of touch; are conical in shape; average about one hundredth of an inch in length; are few, short, and minute on the general surface of the body, where there is slight sensibility, and long, large, and closely aggregated on other parts, where there is great sensitiveness, as in the palmar surface of the hands, the bottom of the feet, etc.

Fig. 4. Section of Skin Magnified

The derma is filled with blood-vessels, the smallest subdivisions of arteries and veins, and with the network of capillaries between them. These capillaries are so small, and lie so closely together, that in puncturing the inner layer with a fine needle, many of them will be ruptured, and, in the living body, blood will ooze from the wound. It is these vessels, with the addition of those in the subcutaneous tissues, that fill with blood, producing the red or dark=bluish discolorations.

Rete Mucosum.—The middle layer is commonly called the soft or pigment layer. The technical name is the rete mucosum. This layer is made up of small grains, forming a pigment, which gives to the skin its color and complexion. This matter varies in color in the different races. In the negro it is almost entirely black; in the European, various shades, from the most pronounced brunette to the lightest blond; in the Malayan, it is of a brownish; in the Mongolian, of a yellowish; and in the American Indian, of a reddish or copper color. In the purest complexion there is some of the pigment. Exposure to the sun readily tans, while the African, living for a time in the secluded forest, or away from the sun, loses much of his normal color.

The rete mucosum softens quickly after death by decomposition, allowing the cuticle to become detached, which will slip if anything comes in contact with it. This is called "skin-slip." It will also become detached in cases of dropsy where the water accumulates, as the cuticle, being extremely compact, will not allow the water to pass through it rapidly.

Uses of the Skin.—As an excretory organ, the skin, removes certain waste material from the body. This process of elimination is produced by the perspiration, or sweat. This office of the skin is a very important one. If the skin were to be covered with a coat of varnish, or other impervious covering, thus preventing sweating, death would soon result. The amount of sweat secreted in a day averages about two pints, varying according to weather, amount of exercise, etc. The sudoriferous or sweat-glands are small tubes, opening in the outside of the skin and coiled up just below the true skin. They cover every portion of the skin, being numerous and important in their office, secreting the perspiration. The skin serves also as an organ of sensation, the nerves conveying the sense of touch, pain, and temperature being situated in it. It assists in the respiratory process, slightly absorbing oxygen, and giving off carbonic acid gas. The skin has, likewise, an absorptive power by which certain substances are carried into the system during life. This power of absorption ceases with death.

The Mucous Membrane is continuous with the skin, beginning where the skin seems to stop, at the external openings of the body, as the mouth, nose, etc., and lines the alimentary canal from the lips to the anus, as well as all the other cavities and canals that have external openings. It is analogous to the skin in structure, consisting of two layers, a deep, fibrous layer, containing blood-vessels, and a superficial, bloodless one, the epithelium. It is, however, much redder than the skin, as is seen in the lips; more sensitive; more liable to bleed; and secretes a tenacious, viscid fluid, the mucus, with which it keeps itself continually moistened. The epithelium is composed of one or more layers of flattened cells, called epithelial cells. The endothelium of the blood=vessels is analogous.

Subcutaneous Tissues.—Immediately underneath the skin, into which it merges, lies the fibro=areolar, cellular or connective tissue, which connects the skin to the subjacent parts. The term "connective" is peculiarly applicable to this tissue, as it is the great connective medium by which the different parts of the body are held together, and is consequently found throughout the body. The terms "cellular" and "areolar," on the other hand, are given because its meshes are easily distended and separated into spaces, or areolæ, which open freely into each other and are easily blown up with air or gas, or permeated by fluid. It thus affords a ready exit for inflammatory or other effused fluids, and for gases. This tissue also enters into the structure of the derma, mucous membrane, tendons, ligaments, etc.

Under the subcutaneous layer of the connective tissue, coextensive with the skin, is the inelastic, superficial fascia, covering and binding together the muscles. Beneath this, and still more closely investing the muscles and vessels, is the deep fascia.

Within the meshes of the areolar, connective tissue is to be found adipose (fatty) tissue, variable in quantity in different parts of the body and very variable in different persons. The fat is contained in tiny cells, of which there is said to be sixty-five millions in a cubic inch of fat. In a fleshy person the adipose tissue is very abundant. Owing to the presence of this fatty tissue in the subcutaneous layer, this layer is sometimes styled the fatty layer.

An understanding of these subcutaneous tissues is of the utmost importance to the embalmer. The skin being made up of compact tissues, liquids and gases, will transude through it very slowly, while they pass through the underlying tissues very freely. Gases and fluids are liable, therefore, to accumulate underneath the skin after death, causing trouble for the embalmer, unless treated properly. Transudation of blood into these tissues frequently causes discoloration. On the other hand, on account of the loose, open character of these subcutaneous tissues, a channel is furnished for the injection of fluid to all parts of the body, chiefly by gravitation, by introducing the needle under the skin.

In general dropsy the water accumulates in the cellular tissue in all cases, to a greater or less extent; in some, only in sufficient quantities to distend the skin enough to remove wrinkles, while in others it will stretch the skin to its fullest extent, enormously increasing the size and weight of the body.

In putrefaction, the accumulation of gas in the areolar tissue beneath the skin causes the extensive bloating that is seen in some cases.

The Hair is but a modified form of the cuticle, and exists on nearly the whole surface of the body, varying in length and size. It forms a protection from heat and cold, and shields the head from blows. The roots of the hairs are imbedded in small opening in the skin, called hair=follicles, which are from one=twelfth to one=fourth of an inch in depth. The outside of a hair is compact and hard, consisting of a layer of colorless scales, which overlie one another like shingles on a roof. The interior is porous and conveys the liquids by which the hair is nourished. It also contains pigmentary matter, upon which the color of the hair depends. The hair and scalp are kept soft and pliable by the oily secretion of the small glands which open into hair follicles, called sebaceous glands. That portion of a hair outside the skin is called the shaft. Each hair grows from a tiny bulb (*papilla*), which is an elevation of the cutis at the bottom of a little hollow of the skin. (See Fig. 4.) The hair is produced from the surface of the bulb, like the cuticle, by the constant formation of new cells at the bottom. When the hair is pulled out, this bulb, if uninjured, will produce a new hair, but once destroyed it will never grow again. Hair grows at the rate of five to seven inches a year.

The popular idea that hair grows after death is due to the shrinking of the skin, allowing the portion of the hair below the surface to project. This is especially noticeable in the beard. It is true that we often hear of hair having grown quite extensively on the head and face of bodies that have been disinterred. If such is the case, scientifically we cannot account for it. There is certainly not enough nutrition left in the parts to produce the growth. The hair, next to the teeth and bones, is the least destructible part of the body, and its color is often preserved after other portions of the body have decayed.

The Nails begin near the tips of the fingers and toes, and consist of two parts, a root and a body. The latter is the part exposed to view, being about four times the length of the root. They protect the tender fingers and toes, and give the power to grasp firmly, and pick up easily, any desired object. The nail is firmly set in a groove (*matrix*) in the cuticle, from which it grows at the root in length and from beneath in thickness. So long as the matrix at the root is uninjured, the nail will be reproduced after an accident.

Like the hair the nail is a mere modified form of the epidermis, its horny appearance and feeling being due to the fact that the scales, or plates, of which it is composed are much harder and more closely packed. It is thrown into ridges which run parallel to each other except at the back part, where they radiate from the center of the root. The whitish, semicircular portion near the root, called the lunula (*lunula*, little moon), owes its different color to the fact that its ridges contain fever blood=vessels and therefore less blood. The thumb nail will grow from the root to its free end in about five months, and the nail of the great toe in twenty months.

THE LYMPHATIC SYSTEM.

The Lymphatics are very delicate, transparent, nerveless vessels which exist beneath the skin and in all the mucous

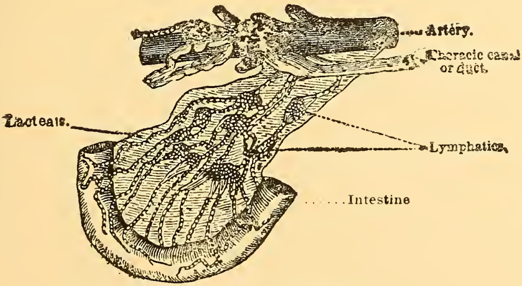


Fig. 5. Section of Mesentery,
Showing Lacteals, Lymphatics, and Thoracic Duct.

membranes. Thus they permeate nearly every portion of the body, being closely interlocked with the blood=capillaries, The parts of the body free from them are the brain, spinal cord, eye=ball, cartilage, tendons, membranes of the ovum, placenta, umbilical cord, nails, cuticle, hair, and bone. They are formed, like arteries and veins, of three coats, and are nourished by nutrient vessels. Like the veins, the lymphatics are provided with valves which permit the matter they convey to flow only one way. Their economy in the human system seems to be to gather up portions of waste matter capable of further use, emptying it, now known as lymph, into the veins, whence it is conveyed to the heart.

The Lacteals, or chyliferous vessels, are small lymphatics, which have their origin in the mucous membrane lining the small intestine. Through them the greater part of the digested food is absorbed from the small intestine and transferred to the circulatory system.

The Villi are delicate, hair-like projections from the lining membrane of the small intestine in which the lacteals have their origin. They are about one=third of an inch in length and vast in number, covering the entire surface of the intestine. Each villus, in addition to its lacteal, possesses an

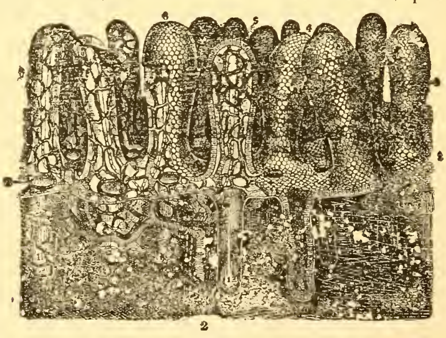


Fig. 6. Mucous Membrane of Ilium, Showing Villi (highly magnified).

1, cellular structure of epithelium; 2, a vein; 3, fibrous layer; 4, villi covered with epithelium; 5, a villus in section; 6, a villus partially uncovered; 7, a villus tripped of epithelium; 9, openings of glands; 10, 11, 12, glands; 13, capillaries.

artery and accompanying vein, with their network of capillaries. The villi, dipping into the digested, liquified food=substance in the intestine, appropriates a liberal portion, which is taken up in the lacteals, where it becomes a milky=white fluid, called chyle. The blood=vessels in the villi also absorb a part of the liquid food.

The Lymphatic Glands are small, hard, pinkish bodies, varying in size from a pinhead to an almond, placed along the course of these absorbent vessels. They are found principally in the mesentery, along the great blood=vessels, in the popliteal space, groin, mediastinum, neck, axilla, and front of the elbow. The lymphatic vessels pass through these glands. They receive their names from the region in which they are situated, as the mediastinal, axillary, etc. In the these glands are formed corpuscles, resembling the white corpuscles of the blood, which are taken up by the stream of lymph as it flows past.

The Thoracic Duct is a tube or canal which commences in the receptaculum chyli, in front of the second lumbar vertebra, passes through the aortic opening in the diaphragm, ascending to the left subclavian vein at its junction with the internal jugular, into which it empties. It is the channel for the lymph and chyle from the whole body, except the right side of the body above and including the convex surface of the liver. Its average length in adults is from fifteen to eighteen inches, and its diameter is about that of a goose=quill, except along the middle part, where it is considerably less. It has three coats and is provided with valves.

The Lymphatic Duct is about an inch in length, terminates in the right subclavian vein at its junction with the internal jugular, and drains the lymphatics of those parts not connected with the thoracic duct.

The Lymph is an alkaline fluid of a thin, colorless, or yellowish appearance. It closely resembles in appearance and composition blood deprived of its red corpuscles and diluted with water. This is the fluid which flows through the lymphatic system.

VISCERAL ANATOMY

THE THREE GREAT CAVITIES

Of the body are the cranial, in the head, and the thoracic and abdominal, in the trunk.

Visceral anatomy treats of the organs contained in these cavities, with their appendages and coverings.

These organs and appendages are called the viscera, or visceral organs; and those of any cavity are called the viscera of that cavity.

The chapters immediately following are devoted, in the main, to the consideration of visceral anatomy.

CHAPTER IV.

THE NERVOUS SYSTEM.

GENERAL DESCRIPTION.

The Nervous System includes the brain, the spinal chord, and the nerves. It is also divided into the cerebrospinal and sympathetic systems. Although distinct from all other systems of the body, the nervous system unites the various parts and organs into one complete, organic whole. It is the medium through which all impressions upon the mind are received and acted upon. The movements of the body and all the processes of life are regulated by it.

Nervous Tissue is composed of two kinds of matter, white and gray, and consists of two different structures, nerve=cells and nerve=fibers. The nerve=cell is the part that is capable of creating nerve=force, while the nerve=fiber acts as conductor of this force. The nerve=cells form the gray matter of the nervous tissue, and are of a pulp=like substance of about the consistency of blanc=mange. The nerve=fibers consist of minute, white, glistening fibers, sometimes as small as one twenty=five=thousandth part of an inch. Every nerve=fiber is connected with a nerve=cell.

The Nerves are white, glistening cords, made up of bundles of nerve=fibers, and penetrate every part of the body. These bundles divide and subdivide as they proceed. They also gather into little masses or nerve=centers, called ganglions (*ganglion*, a knot). These nerve=centers answer to the offices along a telegraph line where messages are sent and received, while the nerves correspond to the wires that carry the messages. Nerves contain two kinds of nerve=fibers, one of which conducts from the nerve=centers to the muscles or organs, and the other from the latter to the nerve=centers. The first are called motor nerves and the latter sensory nerves.

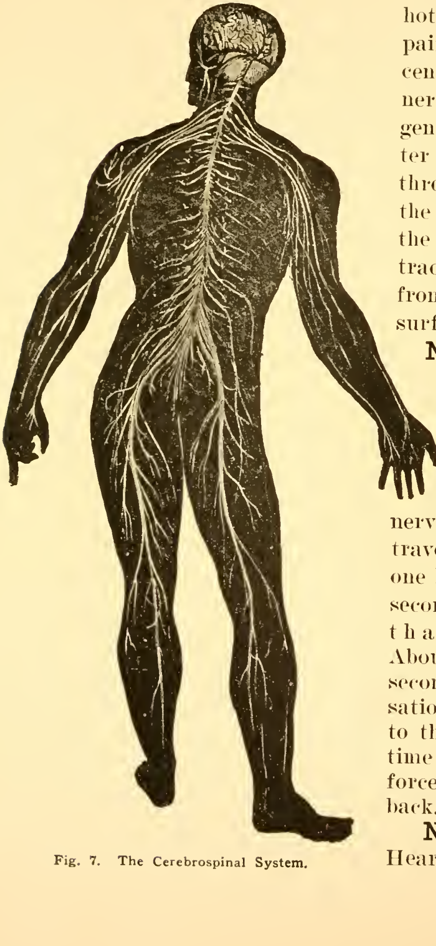


Fig. 7. The Cerebrospinal System.

If you place a finger on a hot stove the sensation of pain travels to the nerve=center through the sensory nerves. A peculiar force is generated in the nerve=center which is conducted through the motor nerves to the muscle which controls the finger, causing it to contract and thus be removed from contact with the hot surface of the stove.

Nerve-Current.—This passing of the sensation to the nerve=center, and of force back to the muscle, constitutes what is called the nerve=current. This current travels at about the rate of one hundred and ten feet a second, being much slower than an electric=current. About one=twentieth of a second is required for a sensation to pass from the foot to the brain, and an equal time is required for the force generated to travel back.

Nerve-Sensations.—Hearing, feeling, tasting, seeing, and smelling are all different kinds of sensations, each with its special nerve-centers which preside over it. There are also several varieties of motor nerves, some coming from centers which preside over the heart and stomach, others over muscles, etc. Certain motor nerves, called vasomotor nerves, are distributed to the walls of the blood-vessels and control the circulation by regulating the size of the blood-vessels, causing them to dilate or contract according to the amount of blood needed.

The Sympathetic System consists of nerves and nerve-centers, or ganglions. There are two chains of ganglions, one on each side of the spinal column, within the body, running the whole length and extending into the chest and abdomen. There are thirty pairs of these ganglions. The sympathetic system of nerves supplies the involuntary muscular tissue, governs all acts of secretion, equalizes the circulation, and controls the nutrition of the body. Nerves from the ganglions are distributed to the mucous membrane and the organs concerned in nutrition—the stomach, liver, intestines, etc. The vasomotor nerves belong to this system. Thus all the organs of the body are bound together with cords of sympathy, so that if one suffers all suffer with it.

The Cerebrospinal System consists of the brain and spinal cord, and the nerves coming from them. This system supplies the greater part of the body with nerves. It presides over sensation, special senses, voluntary motion, intellect, and all movements which characterize different individuals.

THE CRANIAL CAVITY.

The cranial cavity is the smallest of the three large cavities of the body, and contains the brain and its coverings, or meninges—the arachnoid, pia mater, and dura mater.

THE BRAIN.

The Brain is the seat of the mind, and it is the functions which the brain performs that distinguishes man from other animals. Man becomes a conscious, intelligent, responsible being through the action of the brain. The average brain weighs about forty=nine and a half ounces in the adult male and forty=four ounces in the female. It is egg=shaped, soft, and yielding, closely filling the skull cavity. It is surrounded by a delicate double membrane, called the arachnoid, forming a closed sac, and filled, as are also the brain spaces, with a watery liquid. Within the membrane, still more closely investing the brain, is a fine vascular membrane, called the pia mater, which dips down between the convolutions and laminæ and is prolonged into the interior, forming the velum interpositum and choroid plexuses of the fourth ventricle. This tissue receives its blood supply from the internal carotid and vertebral arteries, and so copiously does it bathe the adjacent parts that it is said to use one=fifth of the entire circulation of the body. It is plentifully supplied with lymphatics and nerves. The outermost envelope of the brain is the dura mater, a dense, tough, glistening, fibrous membrane, which lines the interior of the cranium and the spinal column. It separates the various parts of the organs by strong partitions.

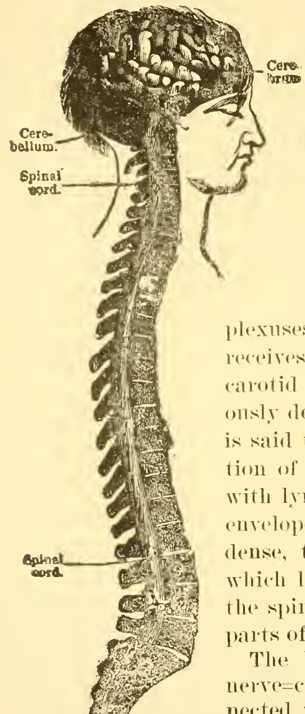


Fig. 8. The Brain and Spinal Cord.

The brain is composed of a number of nerve=centers, or ganglions, which are connected with one another and with the motor and sensory nerves of the system. The brain consists of both white and gray matter, and is divided into three portions, cerebrum, cerebellum, and medulla oblongata.

The Cerebrum (the brain) occupies the front and upper part of the cavity of the cranium, and comprises about seven=eighths of the entire weight of the brain. It is divided into two lateral halves, or hemispheres, right and left, by the great longitudinal fissure, which extends throughout the entire length of the cerebrum, reaching to the base in front and behind, but in the middle it is interrupted by a tranverse commissure of white matter, the corpus callosum, which connects the two hemispheres. In this fissure lodges the falx cerebri. Each hemisphere is divided, by fissures on the under surface of the brain, into three lobes, anterior, middle, and posterior. Thus, we are provided with two brains, as well as hands, feet, eyes, and ears; and one hemisphere has been known to be destroyed in large part without particular injury to the mental powers.

The cerebrum is the center of intelligence and of thought, and is a mass of white fibers, with cells of gray matter on the outside, or lodged here and there in ganglions. The surface is not smooth, except in infancy, but is arranged in large convolutions and sulci, which arrangement very largely increases the surface for the gray matter. This surface has been estimated in some cases to measure as much as six hundred and seventy square inches. Depth and intricacy of these convolutions are characteristic of high mental power. Persons of weak mind are oftentimes said to be lacking in gray matter, while brainy persons are said to possess it in large quantities. When the cerebrum becomes seriously injured or diseased the person is often unable to converse intelligently from an inability to remember words and lack of force to articulate them.

The Cerebellum (a small brain) is situated beneath the posterior lobes of the cerebrum in the inferior occipital fossæ. It is connected by the crura (connecting bands) to the rest of the brain, two to the cerebrum, two to the medulla oblongata, and two blending together in front, forming the pons Varolii. It is about the size of a small fist and weighs about five ounces. In structure it is similar to the cerebrum, being divided into hemispheres, but unlike that portion has parallel ridges, which, letting the gray matter down deep into the white matter within, give it a peculiar appearance, called the arbor=vitæ, or tree of life. This part of the brain is the center for the control of the voluntary muscles, particularly those of locomotion. If it is injured or diseased the power of locomotion is greatly hindered, the muscles not acting as they should. The falx cerebelli projects between the lateral lobes of the cerebellum.

The Medulla Oblongata (*medulla*, marrow; *oblongus*, rather long) is the upper, enlarged part of the spinal cord, extending from the upper border of the atlas to the pons Varolii, and connecting the spinal cord with the various ganglions of the brain. Its anterior surface rests on the basilar groove of the occipital bone, while its posterior surface forms the floor of the fourth ventricle. It is about an inch and a quarter in length and an inch wide, and is composed of a mass of white matter, within which is imbedded a collection of gray matter, or nerve=cells. By connecting the spinal chord with the brain, it serves to conduct the sensation and motor stimulus to and from the brain. Probably its most important function is its entire control over the acts of respiration, and if it is injured or destroyed, breathing ceases and death results. Within the medulla oblongata is also supposed to lie the centers of the vasomotor and cardiac nerves, and nerves of phonation, deglutition, mastication, and expression.

The Spinal Cord is the cylindrical elongated part of the cerebrospinal axis, which is contained in the spinal canal. Its length is usually about sixteen or seventeen inches. It commences at the upper border of the axis and terminates at the lower border of the first lumbar vertebra in the cauda equina. It has two enlargements, one in the cervical region, and one in the lumbar. It is composed of gray matter internally and white matter externally. It gives out thirty=one pairs of

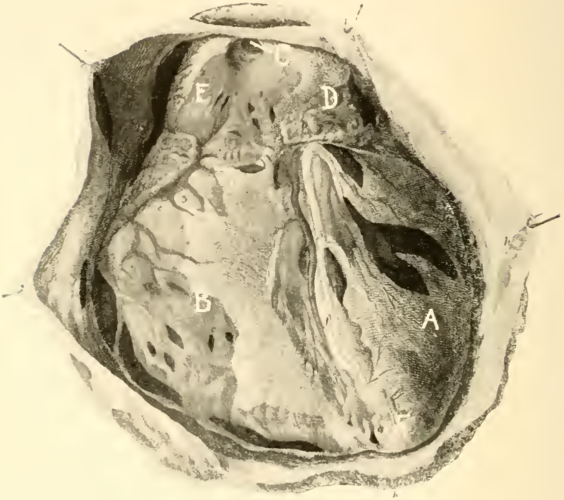
D

THE HEART

TWO PLATES—XVIII.-XIX

PLATE XVIII.

THE HEART, ITS CAVITIES AND VALVES.



Anterior Surface with Pericardial Covering.

A. Left ventricle.
B. Right ventricle.
C. Apex of pericardium.

a. Appendix of right auricle.
b. Appendix of left auricle.
e. Transverse or auriculo-ventricular groove.

1. Pulmonary artery.
3. Right coronary artery.
4. Front branch of left coronary artery.

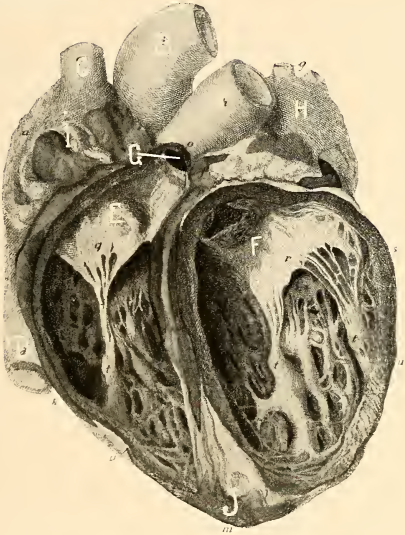
D. Left auricle.
E. Ascending aorta.
F. Apex of heart.

f. Anterior longitudinal sulcus.
h, h, h. Pericardium divided and thrown back.

5. Commencement of great coronary vein.

PLATE XIX.

THE HEART, ITS CAVITIES AND VALVES.—Continued.



Internal Cavities of Ventricles Anterior View.

A. Pulmonary artery.
B. Aorta.
C. Superior vena cava.
D. Inferior vena cava.
E. Right ventricle.

F. Left ventricle.
G. Pulmonary opening.
H. Left auricle.
I. Right auricle.

b. Appendix of right auricle.
f. Appendix of left auricle.
g. Pulmonary veins.
m. Apex of heart.
n. Wall of the ventricles.
o. Opening of pulmonary artery.
p. Opening of aorta.

q. Tricuspid or right auriculo=ventricular valve.
r. Bicuspid or left auriculo=ventricular valve.
s. Tendinous cords.
u Fleshy surface of cut edge of right ventricle.

nerves—eight cervical, twelve dorsal, five lumbar, five sacral, and one coccygeal—which divide and subdivide, going to all parts of the trunk and extremities. Each nerve arises by two roots, the anterior being the motory, and the posterior, the sensory root. These roots soon unite into one sheath, though they preserve their special functions.

The Cranial Nerves, consisting of twelve pairs, arise from the lower part of the brain and medulla oblongata. They are as follows:

1. Olfactory, nerves of smell.
2. Optic, nerves of vision.
3. Motor oculi,
4. Pathetic, } eye=moving nerves.
6. Abducens,

5. Trigeminus (trifacial), nerves of the face, which divide into three branches, going respectively to the upper part of the face, eyes, and nose; to the upper jaw and teeth; and to the lower jaw and mouth, the latter branch becoming the nerve of taste.

7. Facial, nerves of expression.
8. Auditory, nerves of hearing.
9. Glossopharyngeal, nerves of the pharynx, tonsils, etc.
10. Pneumogastric, nerves of the larynx, lungs, liver, stomach, and heart (in part).
11. Accessory, nerves regulating the vocal movements of the larynx.
12. Hypoglossal, nerves giving motion to the tongue.

CHAPTER V.

THE ORGANS OF RESPIRATION.

The Respiratory Organs comprise the respiratory tract, or air-passages, the lungs, and certain muscles which assist in the act of breathing. The respiratory tract consists of the passages of the nose and mouth, the pharynx, larynx, and trachea, or windpipe. All these organs are located above the diaphragm—the great muscle of respiration—chiefly in the neck and thorax.

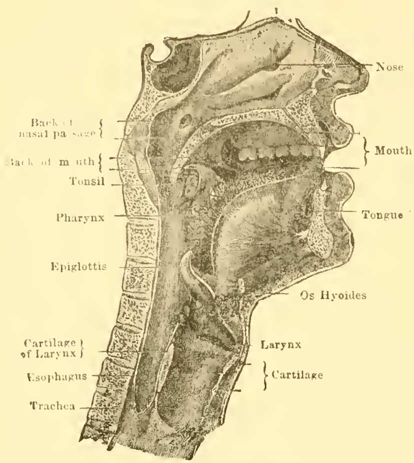


Fig. 9. The Upper Air-Passages.
Sectional view, showing relative positions, connections, and openings.

Mouth and Nose.—The air-passages begin with the mouth and nose. The proper passages for the air to enter in the act of breathing are those of the nose. These passages are lined with a smooth, soft, mucous membrane, the surface of which is greatly increased by the projection into the nasal cavity of peculiarly shaped bones. This mucous membrane is constantly kept moist, thus catching particles of dust from the air as it passes through the nose, and serving to a certain extent in rendering the air moist. The air is slightly warmed, likewise, in passing through these passages. Minute filaments, or cilia, along the air=passages, besides assisting the inward and outward movements of the air, are useful in catching dust and fine particles swept inward with the breath. Although it is possible to breathe through the mouth, it is always better to use the nose for this purpose, as the mouth cannot properly perform this office.

The Pharynx, or Throat, is a musculomembranous sac, conical in form, four and a half inches long, with the base upward and the apex downward, extending from the basilar process of the occipital bone to the lower border of the cricoid cartilage in front, and the bottom of the fifth cervical vertebra behind. It lies behind the nose, mouth, and larynx; that portion behind the nose is known as the nasopharynx, and that behind the mouth, as the oropharynx. It serves as an air=passage to the larynx as well as a food=passage to the esophagus, which is a continuation of the pharynx. (See Fig. 9.) It has seven openings communicating with it—the two posterior nares, from the nose; the two Eustachian tubes, from the middle ears; one from the mouth; one to the larynx; and the terminal opening into the esophagus. The arteries that supply the pharynx are the superior thyroid, ascending pharyngeal, pterygopalatine, and descending palatine.

The Larynx is a musculomembranous, cartilaginous, triangular=shaped box, situated between the root of the tongue and the trachea, into which it merges. It is composed of nine cartilages, which are connected together by ligaments and moved by numerous muscles. There are three single cartilages: the thyroid, cricoid, the epiglottis; and three pairs: the arytenoid, cornicula laryngis, and cuneiform. The thyroid is the largest cartilage, and consists of two lateral lamellæ, which unite at an acute angle in front, forming the prominent projection seen in the front of the neck, called the pomum Adami, or Adam's apple.

Glottis and Epiglottis.—The opening into the larynx from the throat is called the glottis. Just above this opening is a leaf-like portion of fibrocartilage, called the epiglottis (*epi*, upon; *glottis*, tongue), which, during the act of breathing, lies in such a position as to leave the larynx unobstructed. When food or drink is being swallowed, the larynx is drawn up beneath the tongue, and the epiglottis shuts down, closing the glottis and preventing the entrance into the windpipe of any foreign substance. However, should anything enter the larynx by any means, a fit of coughing will result until such substance is dislodged.

Vocal Cords.—The larynx is also called the special organ of the voice, as there are stretched across its upper part, at either side of the glottis, folds of elastic mucous membrane, called the vocal cords, which, by their vibration, due to the passage of air from the lungs, produce sound, or voice. When not in use the vocal cords spread apart, leaving a V-shaped orifice for the passage of the air. On being tightened for use, the edges sometimes approach to within a hundredth part of an inch of each other. The lips, tongue, palate, and teeth assist in the modulation of speech.

THE THORACIC CAVITY.

The Thorax, or Chest, is the smaller and upper of the two main cavities of the trunk. It extends from the neck to the diaphragm; is conical in shape, with the apex above and the base below; is bounded at the back by the spinal column, in front by the sternum, at the side by the ribs, and below by the diaphragm. It contains the lungs, pleuræ, heart, pericardium, aorta, venæ cavæ, trachea, esophagus, and numerous other organs.

The Trachea, or Windpipe, is cylindrical, membrano-cartilaginous tube about four and a half inches in length and one inch in diameter. It begins at the lower border of the larynx, opposite the fifth cervical vertebra, and ends opposite the third dorsal, where it divides into the two bronchi, one for each lung. It is composed of a fibro=elastic membrane, containing from sixteen to twenty C=shaped, stiff, cartilaginous rings, connected by muscular fibers, which keep the

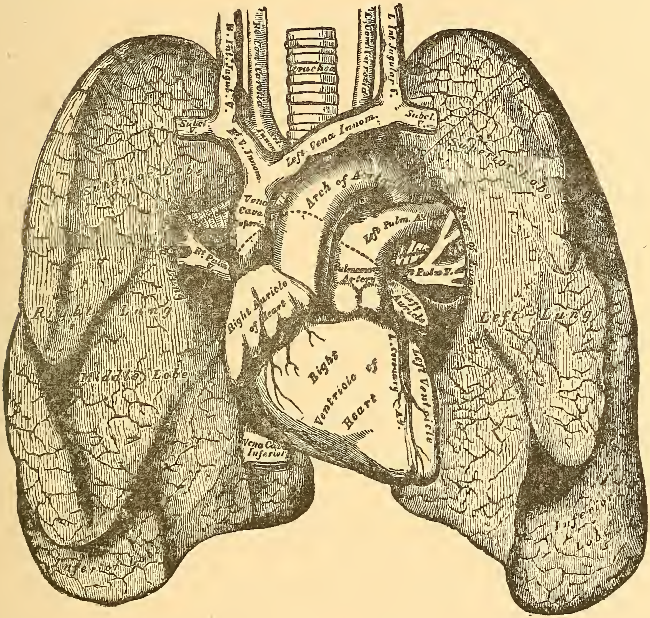


Fig. 10. The Thoracic Viscera.

Showing location and relative position of the heart, lungs, trachea, aortic arch, venæ cavæ, pulmonary vessels, etc.

walls rigid and prevent their collapse during the act of breathing. The openings of the cartilages are behind, where they are attached to the esophagus. The thyroid gland lies at the side and in front of the upper portion of the trachea.

The Bronchi are the right and left divisions of the trachea, which enter the lungs, dividing and subdividing into many bronchial tubes, ramifying all parts of the lungs. The last and most minute subdivisions are called bronchioles. A smooth mucous membrane, which is constantly kept moist by a secretion of mucous, lines the trachea and bronchial tubes throughout, extending with the vessels into all parts of the lungs. The stiff cartilaginous rings, so noticeable in the rough surface of the trachea and bronchi, disappear in the smaller bronchial tubes, so that, while the former are kept constantly open for the free admission of air, the latter are provided with elastic fibers, by which they may be almost closed. The right bronchus is wider, shorter, and more horizontal than the left, is only about one inch in length, and enters the right lung opposite the fourth dorsal vertebra. The left is smaller, more oblique, two inches long, and enters the left lung opposite the fifth dorsal vertebra, about one inch lower than the right. The arteries are the tracheal branches of the inferior thyroid and the bronchial branches of the thoracic aorta. The veins open into the thyroid plexus and the bronchial veins.

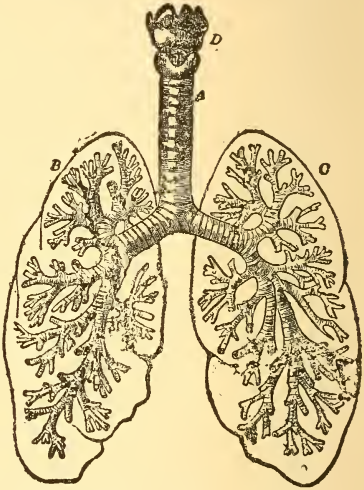


Fig. 11. Larynx, Trachea, and Bronchi.
A, trachea; B, right lung; C, left lung; D, larynx.

The Lungs are the essential organs of respiration; are two in number, one on each side; weigh together about forty=two ounces; and fill the greater part of the thorax. Like many of the organs, they are heavier in the male than in the female. They are separated from each other by the heart and other contents of the mediastinum. Each lung is conical in shape, with the apex extending into the root of the neck about one inch above the first rib, and with the base, which is broad and concave, resting on the diaphragm. A long, deep fissure, penetrating nearly to the root, divides each lung into two lobes, and a lesser fissure subdivides the upper lobe of the right lung. The right lung is larger, heavier (by about an ounce), broader, and shorter than the left. The root of the lung is where the bronchial vessels and nerves, bound together by areolar tissue, enter the lung. The color of the lungs at birth is pinkish=white, which, as age advances, become mottled with slate=colored patches, from the deposits of carbonaceous granules in the areolar tissue of the organ.

Structure of the Lungs.—The lungs are composed of an external serous coat (the pleuræ), covering the entire surface as far as the root; a subserous, elastic, areolar tissue, investing the entire organ and extending inward between the lobules; and the parenchyma, or true lung tissue. The parenchyma is composed of lobules, which, although closely connected together by interlobular, areolar tissue, are quite distinct from each other. The lobules vary in size, those on the surface being large, while those in the interior are smaller. Each lobule consists of several air=cells, arranged around the termination of a bronchiole, and surrounded by plexuses of pulmonary and bronchial arteries and veins, lymphatics, and nerves. The lungs are nourished by the bronchial arteries, and supplied with blood for oxygenation by the pulmonary arteries. The bronchial arteries are derived from the thoracic aorta, and the pulmonary artery, from the irght ventricle of the heart. The bronchial veins open into the vena azygos on the right side and superior intercostal on the left. The pulmonary veins, which carry the oxygenated blood from the lungs to the heart, open by four orifices into the left auricle.

The Pleuræ are two delicate, serous, shut sacs, one surrounding each lung, and deflected or turned back upon itself, so as to line the chest walls. The pleuræ meet for a short space behind the middle of the sternum, at the approximation of the anterior borders of the lungs. The visceral layer invests the lungs as far as the root, while the parietal layer lines the inner surface of the walls of the chest, the diaphragm, and the pericardium. This membrane secretes a thin fluid, which acts as a lubricator, preventing friction between the surface of the lungs and the chest=walls during the act of breathing. The space between the two layers is called the cavity of the pleura.

The Mediastinum is the space between the two pleuræ in the median line of the thorax, extending from the sternum to the vertebral column, and containing all the viscera of the chest, except the lungs, including the heart and pericardium, the large blood=vessels, esophagus, etc. It is divided into the superior mediastinum (upper portion), and the anterior, middle, and posterior mediastinum (lower portion).

CHAPTER VI.

THE DIGESTIVE ORGANS.

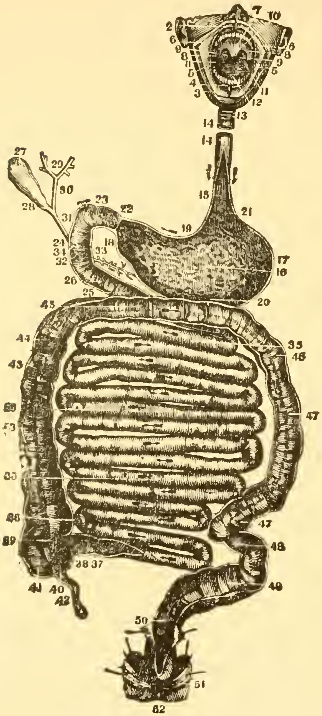
The Organs of Digestion consist of the alimentary canal and accessory organs. All food, before it is in a condition to afford nourishment to the tissues, must undergo a certain process, called digestion. It is while passing through these organs that digestion takes place.

The Alimentary Canal, the chief organ of digestion, is a musculomembranous tube, about twenty=five or thirty feet in length, extending from the mouth to the anus, and lined throughout with mucous membrane. It is divided into different parts, each with its distinctive name and duties. These are the mouth, pharynx, esophagus, stomach, small intestine, and large intestine. The first three lie above the diaphragm, and the others below it. The accessory organs are the tongue, teeth, salivary glands, liver, pancreas, etc.

The Mouth, placed at the commencement of the alimentary canal, is an oval=shaped cavity, formed by the lips, cheeks, jaws, palate, and tongue, in which the mastication of the food takes place. It opens posteriorly into the pharynx by the fauces, and contains the tongue, teeth, hard palate, soft palate, uvula, anterior and posterior pillars of the fauces, tonsils, and the openings of Stenson's and Wharton's ducts and of the ducts of Rivinus.

The Salivary Glands are the parotid, lying below and in front of the external ear, and the submaxillary and sublingual, lying in the corresponding fossæ on the inner surface of the inferior maxillary bone. All of these glands open into the mouth by ducts, and are stimulated to action by the presence of food in the mouth, and by the operation of chewing.

The fluid secreted by these glands is called the saliva. It is mixed with the food during the act of mastication and keeps the interior of the mouth moistened. The saliva is of the



1. Mouth.
2. Hard palate.
3. Lower jaw.
4. Teeth.
5. 5, 6, 6. Mucous membrane.
7. Roof of mouth.
8. 8. Soft palate.
9. 9. Pharynx.
10. Uvula.
11. 11. Tongue.
12. Floor of mouth.
13. Trachea.
14. 14, 15. Esophagus.
16. Stomach.
17. Cardiac end.
18. Pyloric end.
19. Lesser curvature.
20. Greater curvature.
21. Cardiac orifice.
22. Pyloric valve.
23. Beginning of duodenum.
24. Descending duodenum.
25. Ending of duodenum.
26. Transverse duodenum.
27. Gall bladder.
26. Transverse duodenum.
27. Gall bladder.
28. Cystic duct.
29. 30. Hepatic duct.
31. Choledoch duct.
32. Pancreatic opening.
33. Pancreatic duct.
34. Choledoch opening.
35. Jejunum.
36. 36. 36. Ilium.
37. 38. Ending of ilium.
39. Ileocecal valve.
40. 41. Cecum.
42. Vermiform appendix.
43. 43. 44. Ascending colon.
45. Transverse colon.
46. 47. 47. Descending colon.
48. 49. Sigmoid flexure.
50. Rectum.
51. Sphincter muscle.
52. Anus.

Fig. 12. The Alimentary Canal, a Portion of Esophagus Being Removed.

greatest importance in the proper digestion of the food, moistening and softening the food, so that when it enters the stomach the digestive juices there can readily act upon it.

The Tongue is the organ of the special sense of taste. It is situated in the floor of the mouth, in the interval between the two lateral portions of the body of the lower jaw. Its base, or root, is directed backward, and is connected with the hyoid bone by numerous muscles; with the epiglottis by three folds of muscous membrane, which form the glosso=epiglottic ligaments; and with the soft palate and pharynx, by means of the anterior and posterior pillars of the fauces. Its mucous membrane is reflected over the floor of the mouth to the inner surface of the gums, forming in front a fold, the frenum of the tongue. Papillæ cover nearly the entire surface of the dorsum of the tongue, giving it its characteristic roughness. The arteries are the lingual, submental, and ascending pharyngeal.

The Teeth are a very important factor in the scheme of digestion. Their office is to reduce the food to a proper condition as to fineness, so that it can pass through the pharynx and esophagus into the stomach, and there be easily acted upon. This process is called mastication. The teeth, of which there are thirty=two in the complete adult set, sixteen in each jaw, consist of crown, neck, and root. The crown is the part above the gums, and is covered with a white glistening substance, called enamel, which is the hardest substance in the human body. The permanent teeth in each jaw are as follows: four incisor, two canine, four bicuspid, and six molar

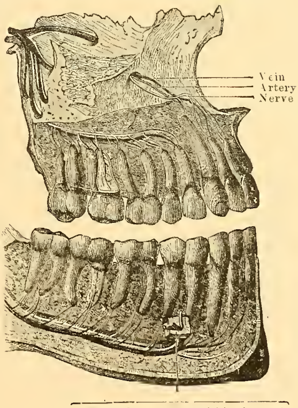


Fig. 13. The Jaws and Teeth.

The Jaws possess the mechanism for grinding the food. The lower jaw being movable, its muscles bring it against the upper jaw, giving it also a sidewise motion. The tongue, lips, and cheeks assist in mastication by keeping the food mass between the teeth.

The Pharynx, which is fully described in the preceding chapter, forms that part of the alimentary canal which lies back of the nose, mouth, and larynx. It has two openings in its lower part, one to the esophagus, into which it emerges, and the other to the larynx. It thus forms an important link in the alimentary canal as well as the respiratory tract.

The Esophagus (gullet) is a musculomembranous canal, about nine inches long, extending from the pharynx, at the lower border of the cricoid cartilage of the larynx, and the fifth cervical vertebra, along the front of the spine, through the posterior mediastinum, passing through the esophageal opening into the abdomen, to the cardiac orifice of the stomach, opposite the ninth dorsal vertebra, where it terminates. It is located in the neck, between the trachea and the vertebral column. Its general direction is vertical. It is the narrowest part of the alimentary canal. The esophageal arteries are chiefly branches from the thoracic aorta. The veins empty into the vena azygos minor.

THE ABDOMINAL CAVITY.

The Abdomen, or Belly, is the largest cavity of the body, extending from the diaphragm to the floor of the pelvis. Though the pelvic cavity is really a part of the general abdominal cavity, it is here considered as a separate cavity. Thus restricted, the abdominal cavity is bounded above by the diaphragm, below by the brim of the pelvis, at the back by the vertebral column and the psoas and quadratus muscles, and in front and at the sides by the transversalis fascia, the lower ribs, and the ilac venter. The muscles forming the boundaries of the cavity are lined upon their inner surface by a layer of fascia, differently arranged, according to the part to which it is attached.

E

THORACIC AND ABDOMINAL VISCERA

WITH THEIR BLOOD-VESSELS

TEN PLATES—XX.-XXIX

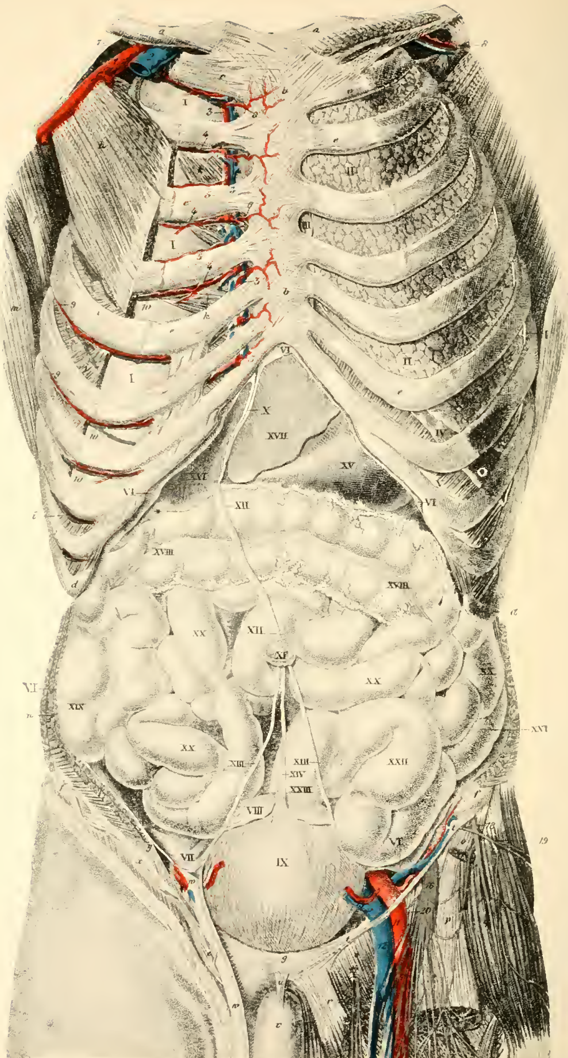

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PLATE XX.

VISCERA OF THORAX, ABDOMEN AND PELVIS (ANTERIOR VIEW).

Thoracic Parietes with Viscera Enclosed (Abdomen and Abdominal Viscera in Natural Position).

I. Costal pleura.
II. Left lung.
III. Anterior mediastinum.
IV. Phrenic pleura.
V. Diaphragm.
VI. Peritoneum.
VII. External inguinal fossa.
VIII. Peritoneal coat of bladder.
IX. Urinary bladder.
X. Suspensory ligament of liver.
XI. Umbilicus.
XII. Round ligament of liver (obliterated umbilical vein).
XIII. Lateral ligaments of bladder (obliterated umbilical arteries).
XIV. Middle ligament of bladder (obliterated urachus).
XV. Stomach.
XVI. Right lobe of liver (with gall-bladder).
XVII. Left lobe of liver (with gall-bladder).
XVIII. Transverse colon.
XIX. Cecum.
XX. Jejunum and ilium.
XXI. Descending colon.
XXII. Sigmoid flexure.
XXIII. Rectum.

a. Clavicle.
b. Sternum.
c. First rib.
d. Tenth rib.
e. Costal cartilages.
f. Ilium
g. Os pubis.

Muscles.

h. Pectoralis minor.
i. Internal intercostal.
k. Triangular of sternum.
l. Subscapular.
m. Latissimus dorsi.
n. Abdominal (oblique external and internal, and transversalis).
o. Sartorius.
p. Rectus femoris.
q. Tensor fasciæ latæ.
r. Adductor femoris longus.
s. Pectineus.
t. Poupart's ligament.
w. Spermatic cord.
x. Divided margin of obliquus externus.
y. Fascia transversalis.
z. Inferior pillar of external abdominal ring (annulus abdominalis).

Blood-Vessels and Nerves.

1. Axillary artery.
2. Axillary vein.
3. Internal mammary artery and vein.
4. Superior anterior intercostal arteries.
5. Inferior anterior intercostal arteries.
6. Sternal branches of internal mammary artery.
7. Brachial plexus.
8. Transverse artery and vein of the scapula, with suprascapular nerve.
9. Posterior intercostal arteries.
10. Intercostal nerves.
11. Crural artery
12. Crural vein.
13. Epigastric artery and veins.
14. Great saphenous vein.
15. Circumflex artery and veins of ilium.
16. Crural nerve.
17. Anterior branch of the obturator nerve.
18. Anterior external cutaneous nerve of the thigh.
19. Cutaneal branch of the iliohypogastric nerve.
20. Lumboinguinal nerve.

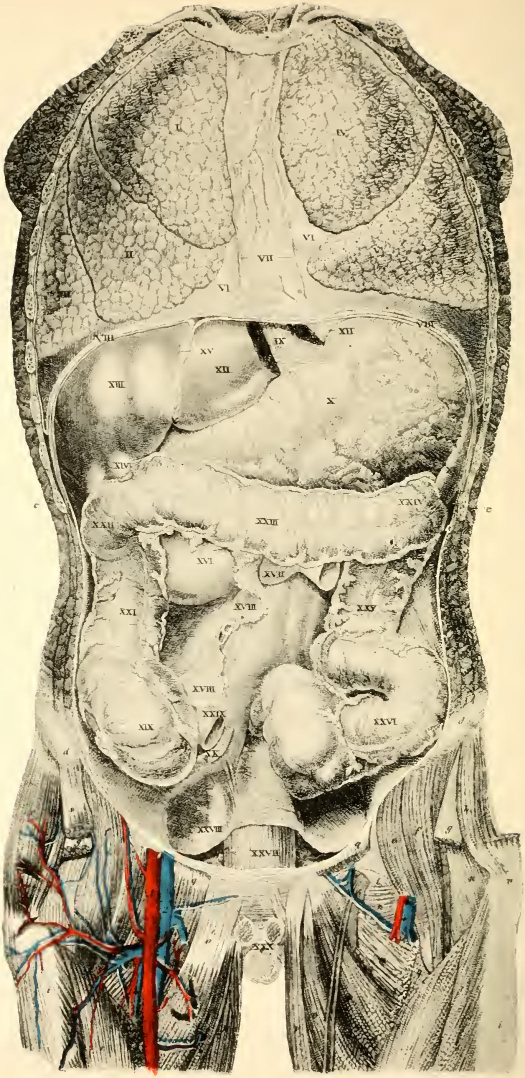
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PLATE XXI.

VISCERA OF THORAX, ABDOMEN AND PELVIS (ANTERIOR VIEW)—Continued.

Lungs, in Position, and Deeper Abdominal Viscera (Small Intestine Being Removed).

I. Superior lobe of right lung.
II. Middle lobe of right lung.
III. Inferior lobe of right lung.
IV. Superior lobe of left lung.
V. Inferior lobe of left lung.
VI. Pleura.
VII. Anterior mediastinal space.
VIII. Diaphragm.
IX. Esophagus.
X. Stomach.
XI. Spleen.
XII. Left lobe of liver (a portion of left extremity being removed).
XIII. Right lobe of liver.
XIV. Gall=bladder.
XV. Suspensory ligament of liver.
XVI. Duodenum.
XVII. Jejunum.
XVIII. Mesentery.
XIX. Cecum.
XX. Vermiform appendix.
XXI. Ascending colon.
XXII. Right flexure of colon.
XXIII. Transverse colon.
XXIV. Left flexure of colon.
XXV. Descending colon.
XXVI. Sigmoid flexure of colon.
XXVII. Rectum.
XXVIII. Peritoneum.
XXIX. Ilium (divided).

a. Clavicle.
b. First rib.
c. Eleventh rib.
d. Crest of ilium.

Muscles.

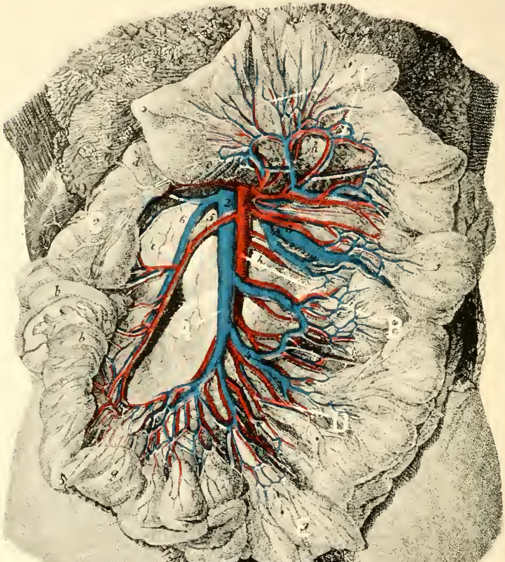
e. Psoas major.
f. Internal iliac.
g. Rectus femoris.
h. Gluteus medius.
i. Vastus externus.
k. External obturator.
l. Obturator ligament.
m. Adductor magnus.
n. Adductor brevis.
o. Adductor longus.
p. Gracilis.
q. Pectineus.
r. Tensor fasciæ latæ.
s. Sartorius.
t. Crural.
u. Neck of femur.
v. Trochanter major.

Arteries and Veins.

1. Crural artery.
2. Crural vein.
3. Superficial epigastric artery and vein.
4. Deep artery and vein of thigh.
5. External circumflex artery and vein of thigh.
6. Obturator nerve.

PLATE XXII.

PRINCIPAL ORGANS OF DIGESTION, WITH DEEPER BLOOD-VESSELS OF ABDOMINAL VISCERA.



Small Intestine (Jejunum and Ilium), Mesenteries, and Mesenteric Vessels.

A.	Superior mesenteric vein.	*D.*	Ileac arteries and veins.
B	Superior mesenteric artery.	*E.*	Ilium.
C.	Ascending colon.	*F.*	Jejunal arteries and veins.
a.	Omentum (raised and thrown back).	*f.*	Jejunum.
b.	Cecum.	*h.*	Mesenteries.
l.	Transverse colon.	*l.*	Right mesocolon.
e.	Commencement of jejunum.		
5.	Ileocolic arteries and veins.	6.	Right colic arteries and veins.

PLATE XXIII.

PRINCIPAL ORGANS OF DIGESTION, WITH DEEPER BLOOD-VESSELS OF ABDOMINAL VISCERA—Continued.

Fig. 1.

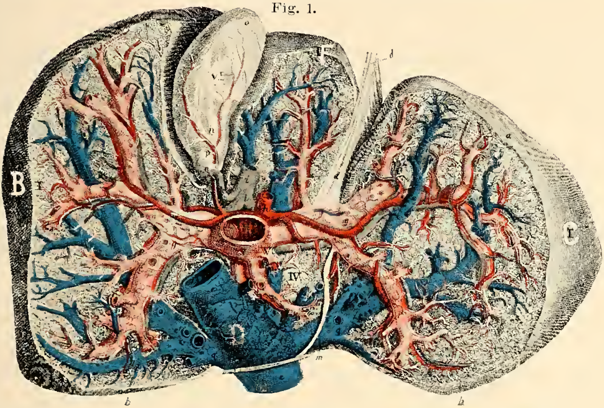


Fig. 1.—Internal Arrangement of Hepatic Blood-Vessels, (Liver Divided Transversely).

A. Gall-bladder.
B. Right lobe.
C. Left lobe.

IV. Lobus Spigelii.

a. Anterior margin.
b. Posterior margin.
c. Suspensory ligament of liver.
d. Round ligament of liver (in fossa umbilicalis).
h. Hepatic artery.
i. Choledoch duct.

D. Inferior vena cava.
E. Portal vein.
F. Lobus quadratus.

V. Porta hepatis.

k. Cystic duct.
l. Hepatic duct.
m. Ductus venosus.
n. Cystic artery.
o. Fundus of gall-bladder
p. Neck of gall-bladder.
q. Hepatic veins.

Fig. 2.

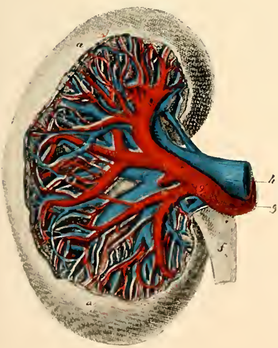
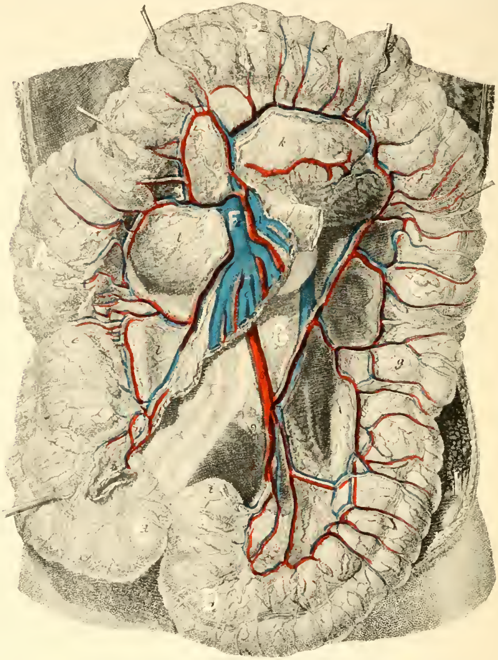


Fig. 2.—Internal Structure of Kidney, with Blood-Vessels and Ducts.

a. Cortical.
b. Pyramid.
c. Mammillary process.
d. Calyx renalis.
e. Pelvis renalis.
f. Ureter.
g. Renal artery.
h. Renal vein.

PLATE XXIV.

PRINCIPAL ORGANS OF DIGESTION, WITH DEEPER BLOOD-VESSELS OF ABDOMINAL VISCERA—Continued.



Large Intestine, with Principal Blood-Vessels.

A. Ascending colon.
B. Transverse colon.
C. Descending colon.
D. Sigmoid flexure.

a. Divided end of jejunum.
b. Divided end of ilium.
i. Commencement of rectum.

1. Superior mesenteric artery.
3. Middle colic artery and vein.
4. Right colic artery and vein.

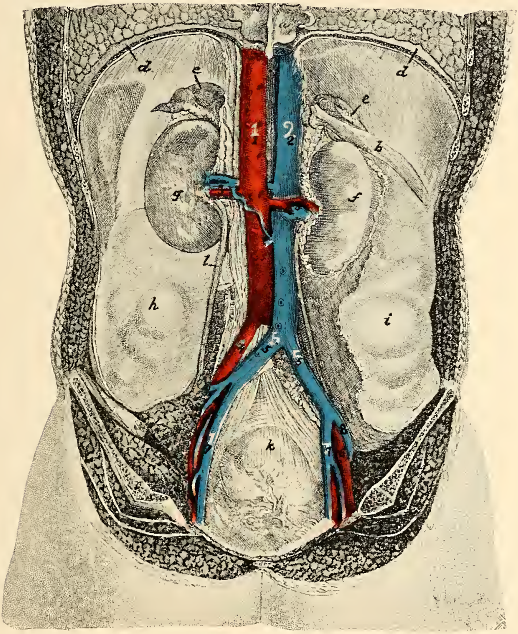
E. Cecum.
F. Superior mesenteric vein.
G. Mesentery.

k. Transverse colon.
l. Right mesocolon.

5. Ileocecal artery and vein
6. Inferior mesenteric artery.

PLATE XXV.

PRINCIPAL ORGANS OF DIGESTION, WITH DEEPER BLOOD-VESSELS OF ABDOMINAL VISCERA—Continued.



View of Posterior Surface of Deep Viscera of Abdomen and Pelvis, with Principal Blood-Vessels.

a. Tenth dorsal vertebra.
b. Last rib.
c. Ilium.
d. Diaphragm.
e. Suprarenal gland.

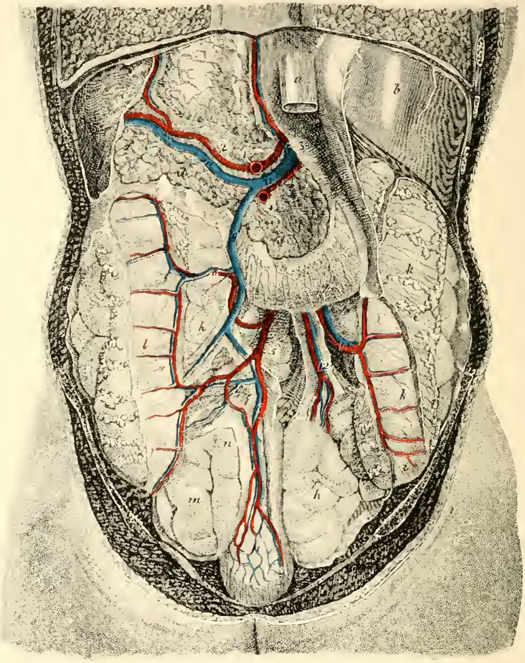
f. Right kidney.
g. Left kidney.
h. Sigmoid flexure of colon.
i. Ascending colon and cecum
k. Rectum.

1. Descending abdominal aorta
2. Inferior vena cava.
3. Renal artery and vein.
4. Common iliac artery.

5. Common iliac vein.
6. Internal iliac artery.
7. Internal iliac vein.
8. External iliac vein.

PLATE XXVI.

PRINCIPAL ORGANS OF DIGESTION, WITH DEEPER BLOOD. VESSELS OF ABDOMINAL VISCERA—Continued.



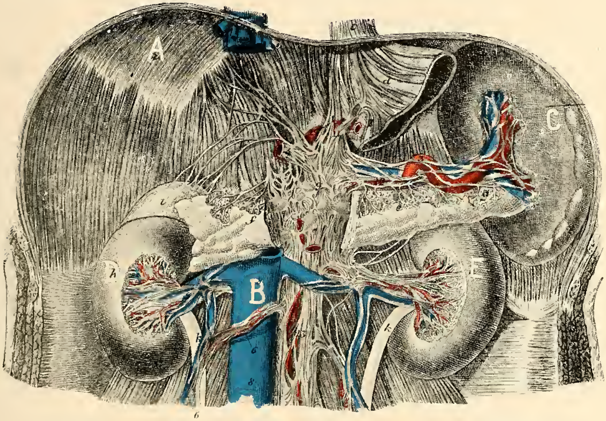
View of Posterior Surface of Superficial Viscera of Abdomen and Blood-Vessels.

a. Inferior vena cava.
b. Liver.
c. Spleen.
d. Pancreas.
e, f. Pancreas.
g. Duodenum.
h. Ileum.
i. Cecum.
k. Ascending colon.
l. Descending colon.
m. Sigmoid flexure of colon.
n. Rectum.

1. Celiac artery.
2. Splenic artery.
3. Hepatic artery.
4. Superior mesenteric artery.
5. Inferior mesenteric artery.
6. Internal hemorrhoidal artery and vein.
7. Left colic artery.
8. Left colic vein.
9. Minor mesenteric vein.
10. Splenic vein.
11. Great mesenteric vein.
12. Iliocolic artery and vein.
13. Right colic artery and vein.

PLATE XXVI.

THORACIC AND ABDOMINAL VISCERA, WITH PRINCIPAL VESSELS, NERVES, AND LYMPHATICS



Posterior View of Solar Plexus and Minor Plexuses, with Some of the Deep Blood-Vessels.

A. Diaphragm.
B, b. Inferior vena cava (with hepatic veins).

c. Esophagus.
d. Stomach divided (with branches of par vagum).
f. Head of pancreas.

2. Right coronary artery.
3. Splenic artery.
4. Hepatic artery (with hepatic plexus).
5. Renal artery and vein.

C. Spleen.
D. Right kidney.
E. Left kidney.

g. Tail of pancreas.
i. Suprarenal gland.
k. Ureters.

6. Internal spermatic artery and vein (with internal spermatic plexus).
7. Superior mesenteric artery.
9. Solar (celiac) plexus.
13. Superior aortic (abdominal) plexus

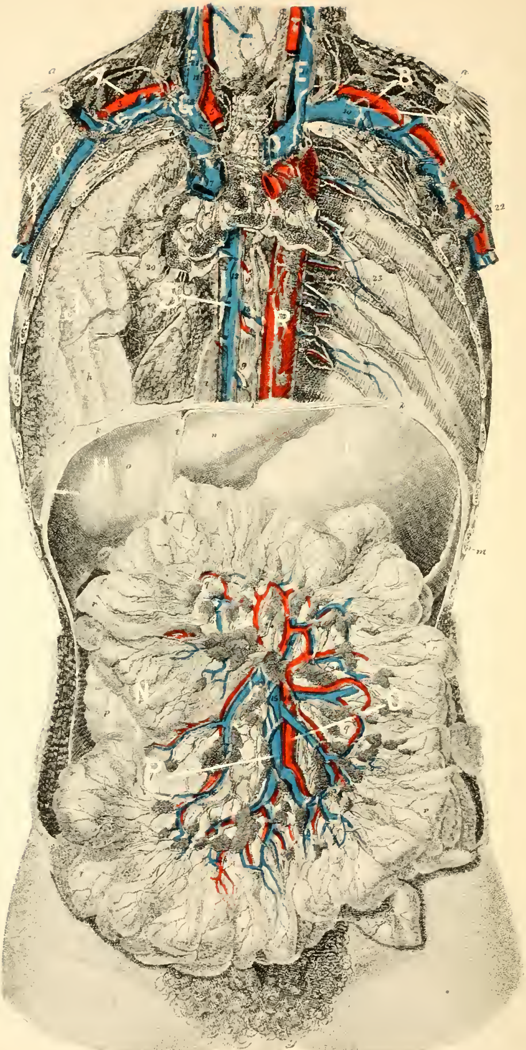

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PLATE XXVIII.

THORACIC AND ABDOMINAL VISCERA, WITH PRINCIPAL VESSELS, NERVES, AND LYMPHATICS—Continued.

Anterior View of the Trunk.

A. Right subclavian artery.
B. Left subclavian artery.
C. Right subclavian vein.
D. Left innominate vein.
E. Left internal jugular.
F. Right internal jugular.
G. Right innominate vein.
H. Right lobe of liver.
I. Left lobe of liver.
J. Right lung.
K. Right axillary artery.
L. Diaphragm.
M. Left subclavian vein.
N. Mesenteries.
O. Superior mesenteric artery.
P. Superior mesenteric vein.
Q. Right axillary vein.
R. Abdominal aorta.
S. Azygos vein.
T. Left common carotid artery.

a. Clavicle.
b. First rib.
c. Thyroid gland.
d. Trachea.
e. Right bronchus.
f. Left bronchus.
g. Dorsal vertebræ.
i. Posterior mediastinum.
k. Edge of diaphragm.
m. Spleen.
p. Ascending colon.
r. Jejunum and ilium.

Arteries and Veins.

1. Arch of aorta.
4. Right common carotid artery.
5. Innominate artery.
6. Intercostal arteries and veins.
7. Superior vena cava.
13. Left lower azygos vein.
15. Great mesenteric vein.
16. Jejunal and ileac arteries and veins.

Ducts and Glands.

17. Thoracic duct.
18. Right (minor) duct.
19. Bronchial glands.
20. Pulmonic glands.
21. Deep jugular glands.
22. Axillary glands.
23. Intercostal glands.
24. Mesentery plexus with mesenteric glands.

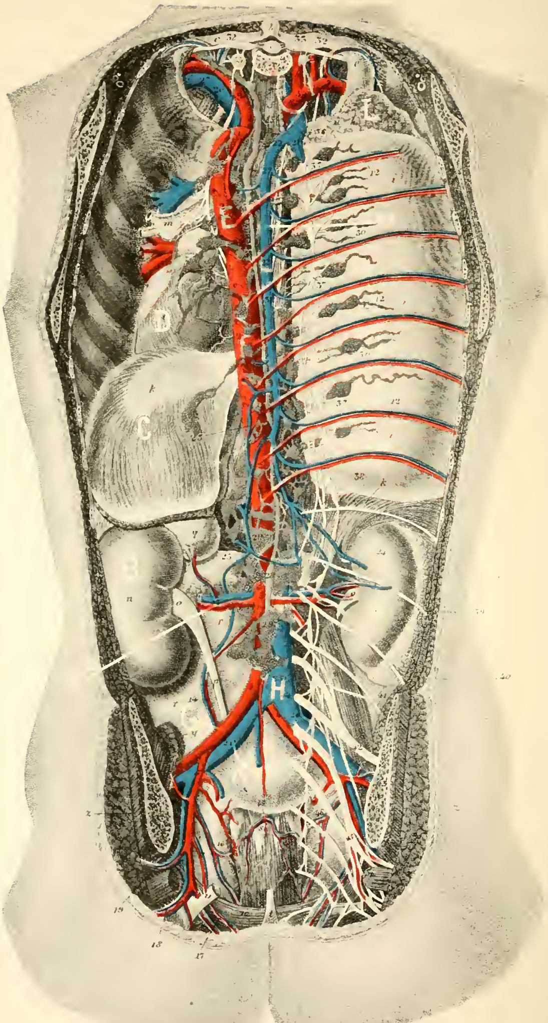


PLATE XXIX.

THORACIC AND ABDOMINAL VISCERA, WITH PRINCIPAL VESSELS, NERVES, AND LYMPHATICS—Continued.

Posterior View of the Trunk.

A. Right kidney.
B. Left kidney.
C. Diaphragm.
D. Heart.
E. Aorta.
G. Left common iliac artery.
H. Ascending vena cava.
H2. Left renal artery.
K. Left common iliac vein.
L. Apex of right lung.
M. Azygos vein.

b. Spinous process of first dorsal vertebra.
c. First rib.
d. Scapula.
e. Spinal cord.
f. Esophagus.
g. Trachea.
i. Parietal layer of pleura.
m. Left bronchus.
o. Pelvis of the kidney.
p. Ureter.
q. Suprarenal gland.
r. Peritoneum.
s. Rectum.
t. External sphincter ani muscle.
u. Levator ani muscle.
v. Great sacrosciatic ligament.
x. Ilium.
y. Psoas major muscle.
z. Gluteus muscle.

7. Sacral median artery and vein.
8. Innominate artery.
9. Subclavian artery.
10. Common carotid artery.
12. Intercostal arteries, veins, and nerves.
18. Ischiadic artery and vein.
19. Superior gluteal artery and vein.
20. Subclavian vein.
21. Superior vena cava.
23. Left lower azygos.
24. Lumbar veins.
30. Intercostal glands.
32. Intercostal nerves.
33. Thoracic ganglions.
37. Thoracic part of sympathetic nerve (with thoracic ganglion).
41. Anterior external cutaneous nerve of thigh.
42. Crural nerve.
44. Lumbar ganglion of sympathetic nerve.
45. Ischiadic plexus.

Abdominal Openings.—The openings in the diaphragm are three in number: the aortic, for the passage of the aorta, vena azygos, and thoracic duct; caval, for the inferior vena cava; and esophageal, for the esophagus and pneumogastric nerves. The other openings in the abdominal walls are the umbilicus, for the transmission (in the fetus) of the umbilical vessels; two femoral openings, or crural rings, for the passage of the femoral vessels; and an opening on either side, for the spermatic cord in the male, and the round ligament in the female.

Abdominal Viscera.—The abdomen contains the greater part of the alimentary canal, some of the accessory organs of digestion, etc. Most of these, as well as the walls of the cavity, are covered by a serous membrane, the peritoneum. The principal contents of the abdomen are as follows:

Stomach.	Gall-Bladder.	Uterus (during pregnancy)
Large Intestine.	Spleen.	Abdominal Aorta.
Small Intestine.	Pancreas.	Inferior Vena Cava.
Appendix Vermiformis.	Kidneys.	Receptaculum Chyli.
Omenta.	Ureters.	Thoracic Duct.
Mesentaries.	Suprarenal Capsules.	Spermatic Vessels.
Liver.	Bladder (when distended).	Solar Plexus, Etc.

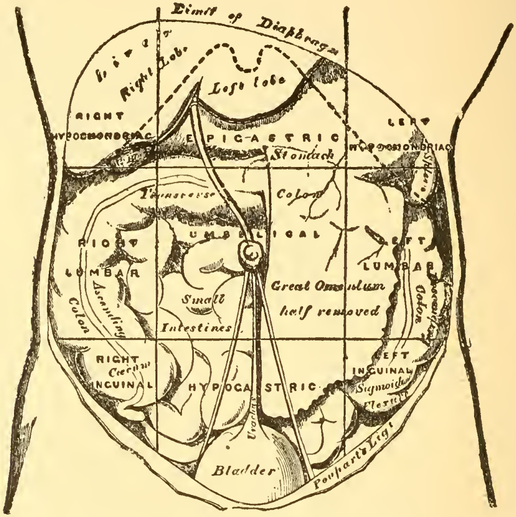
Regions of the Abdomen.—The abdomen, for convenience of description of its viscera, as well as of reference to the morbid condition of the contained parts, is artificially divided into nine regions, by two horizontal lines, one between the cartilages of the ninth ribs and the other between the crests of the ilia, and two vertical lines from the cartilages of the eighth rib on each side to the center of Poupart's ligament. The nine regions thus formed are named as follows:

Right Side.	*Center.*	*Left Side.*
Right Hypochondriac.	Epigastric.	Left Hypochondriac.
Right Lumbar.	Umbilical.	Left Lumbar.
Right Inguinal, or Iliac.	Hypogastric.	Left Inguinal, or Iliac.

The Regional Contents are respectively as follows:

Right Hypochondriac.—Right lobe of liver, gall=bladder, duodenum, pancreas, hepatic flexure of colon, upper part of right kidney, and right suprarenal capsule.

Epigastric.— Right two=thirds of stomach, left lobe and lobus Spigelii of liver, hepatic vessels, celiac axis, solar plexus, pancreas, and parts of aorta, inferior vena cava, azygos veins, and thoracic duct.



Regions of the Abdomen and Their Contents.
The dotted outline shows the edge of the costal cartilages.

Left Hypochondriac.—Splenic end of stomach, spleen, tail of pancreas, splenic flexure of colon, upper half of left kidney, and left suprarenal capsule.

Right Lumbar.—Ascending colon, lower half of right kidney, and part of small intestine.

Umbilical.—Transverse colon, transverse duodenum, part of the great omentum and mesentary, part of jejunum and ileum, and receptaculum chyli.

Left Lumbar.—Descending colon, part of omentum, lower half of left kidney, and part of small intestine.

Right Inguinal.—Right ureter, cecum, appendix vermiformis, and spermatic vessels of that side.

Hypogastric.—Part of small intestine, bladder in children and when distended in adults, and uterus during pregnancy.

Left Inguinal.—Left ureter, spermatic vessels, and sigmoid flexure of colon.

The Stomach, the principal organ of digestion, is pyriform in shape, of musculomembranous structure. It is about twelve inches in length by four inches in average diameter, and, when moderately full, will contain on an average from three to five pints of fluid. It is held in position by the lesser omentum, and is situated diagonally across the upper part of the abdomen, in the epigastric and right and left hypochon-

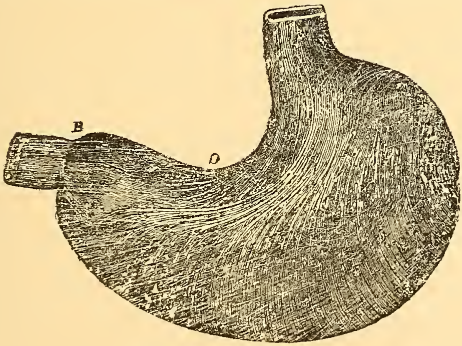


Fig. 15. The Stomach.
A, fundus; B, pylorus; C, lesser curvature; D, greater curvature; E, esophageal opening; F, duodenum.

driac regions, above the transverse colon, and below the liver and diaphragm. The muscular fibers composing the walls of the stomach are arranged in three layers, the first running lengthwise of, the second around, and the other obliquely across, the stomach. When food enters the stomach, the lining membrane, which in rest is of a pinkish color, becomes bright=red from the increased flow of blood to its blood=vessels, and the secretion of gastric juice, the digestive fluid of the stomach, begins. The muscular fibers of the walls are stimulated to action by the presence of food in the stomach, and, by alternate contractions and expansions, give it a sort of motion which causes the contents to roll about in its interior, thoroughly mixing them with the gastric juice. The digested portion of the food is taken up into the circulation, and the remainder passes through the pyloric orifice into the small intestine, where digestion is completed. Stomach digestion requires from one to four hours, according to the condition of the food when received.

The Fundus, or cardiac end, is the left extremity of the stomach. It lies beneath the ribs, in contact with the spleen, to which it is connected by the gastrosplenic omentum.

The Pylorus, or lesser end, lies in contact with the anterior wall of the abdomen, near the end of the cartilage of the right eighth rib. The lesser curvature of the stomach is concave, extends from the esophageal to the pyloric orifice, along the upper border of the organ, and is connected to the liver by the gastro=hepatic omentum, and to the diaphragm by the gastrophrenic ligament. The greater curvature is convex, and extends between the same orifices, along the lower border, and gives attachment to the great omentum. The esophageal orifice is situated between the fundus and the lesser curvature. It is the highest part of the organ, and somewhat funnel=shaped. The pyloric orifice opens into the duodenum, the aperture being guarded by a kind of valve, the pyloric.

The arteries of the stomach are the gastric, arising from the celiac axis, the pyloric and right gastroepiploic branches of the hepatic, and the left gastroepiploic and vasa branches of the splenic artery. Veins terminate in the splenic and portal veins.

The Peptic or Gastric Glands, which secrete the gastric juice, are located in the coating of the stomach, with the mouths opening inward. They are not always simple tubes, being frequently branched; but whether simple or complex, their action is the same. Small rounded cells are formed at the beginning of the tubes and gradually work their way outward to the mouth, where they burst, liberating the gastric juice, a clear, straw=colored liquid, containing pepsin and hydrochloric acid. In the healthy adult about fourteen pints is secreted daily.

The Small Intestine is a convoluted tube, about twenty feet in length, and is the organ in which chylification takes place. When the food enters the small intestine it is a grayish, semi=liquid mass, called chyme. Here it is mixed with pancreatic juice, bile, and intestinal juice, all digestive fluids. The interior membrane is lined with hair=like projections. called villi, which absorb the digested food into the circulatory system. The small intestine has three coats: a muscular, a cellular or submucous, and a mucous. The mucous coat contains the crypts of Lieberkuhn, or simple follicles; Brunner's or duodenal glands; and the solitary glands, situated throughout the intestine, though most numerous at the lower portion of the ileum. They are agminated into twenty to thirty oval patches, named Peyer's patches, situated opposite the mesenteric attachments, some of which are as much as four inches in length. They are most numerous and largest in the ileum. The small intestine is divided into three parts: duodenum, jejunum, and ileum.

The Duodenum is so called from being equal in length to the breadth of twelve fingers (about ten inches). It is the shortest, the widest, and the most fixed part of the small intestine. It is only partially covered by the peritoneum, and has no mesentery. From the pylorus, it ascends obliquely upward and backward two and a half inches to the under surface of the liver, then descends three and a half inches in front of the kidney, and passes four inches transversely across the spine to the left side of the second lumbar vertebra, terminating in the jejunum, where the mesenteric artery crosses the intestine. The ductus communis choledochus and the pancreatic duct open into the descending portion.

The Jejunum (*jejunus*, empty), named from being usually found empty, includes about two=fifths of the remainder of the intestine, its coils lying around the umbilical region.

The Ileum named from its twisted course, comprises the remainder of the small intestine. It lies below the umbilicus, and terminates in the right iliac fossa, at the ileocecal valve.

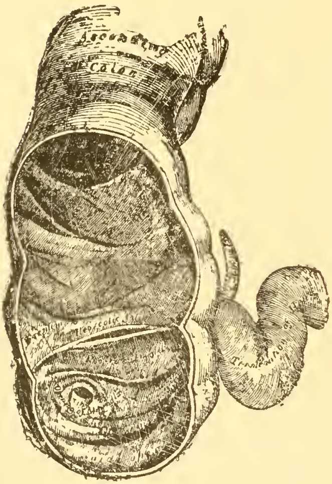


Fig. 16. Beginning of Large Intestine, Showing cecum, colon, appendix, ileocecal valve, etc.

The Large Intestine extends from the termination of the ileum to the anus, and its chief office is the expulsion from the body of the undigested portion of the food. It is about five feet in length, much larger than the small intestine, more fixed in position, and sacculated. In its course it describes an arch, which surrounds the convolutions of the small intestine. It has the same coats as the small intestine, and is divided into the cecum, colon, and rectum.

The Cecum (*cæcus*, blind) is a blind pouch below the entrance to the small intestine, lying in the right iliac fossa. It is the beginning of the large intestine, of which it is the most dilated part, measuring two and one=half inches in diameter. It is two=thirds covered by peritoneum. The ileocecal valve guards the entrance of the small intestine, and when the cecum is distended prevents any reflex into the ileum.

The Appendix Vermiformis is a narrow, worm=like tube, supposed to be the rudiment of the lengthened cecum found in all mammalia, except the orang=outang and wombat. It is about the size of a goose=quill, and is three to six inches long. It is directed backward and upward from the lower part of the cecum, being retained by a fold of the peritoneum.

The Colon extends from the ileum to the rectum, and is divided into the ascending, transverse, and descending colon, and the sigmoid flexure. The ascending colon extends upward to the under surface of the liver, where it forms the hepatic flexure of the colon. The transverse colon crosses the abdomen just below the liver, stomach, and spleen, to the left hypochondrium, where it terminates in the splenic flexure of the colon. The descending colon descends in front of the left kidney to the left iliac fossa.

The Sigmoid Flexure is the narrowest part of the colon, and is curved like the letter S, first upward, then downward, extending from the crest of the left ileum to the sacroiliac synchondrosis.

The Rectum (rectus, straight) is the lower portion of the large intestine, extending from the sigmoid flexure to the anus. It is six or eight inches in length. The lower inch, or inch and a half, has no peritoneal investment. The sphincter ani closes the anus. The glands are the same as in the small intestine, except for the absence of Brunner's glands.

The Liver is the largest glandular organ in the body, weighing from three to four pounds, and measuring transversely about twelve inches, in its anteroposterior diameter about six or seven inches, and in its greatest thickness about three inches. It is intended mainly for the secretion of bile, but effects also important changes in certain constituents of the blood in its passage through the gland. It is situated in the right hypochondrium, and extends across the epigastrium into the left hypochondrium. Its upper surface is convex and its under surface concave. The right extremity of the liver is thick and rounded, while the left side is thin and flattened. Five fissures on the under surface divide it into five lobes: right lobe, left lobe, lubus quadratus, lobus Spigelii, and lobus caudatus. The right and left lobes form the bulk of the liver, the right being about six times the size of the left. Of the three small lobes, the lobus quadratus is the largest, and the lobus caudatas the smallest.

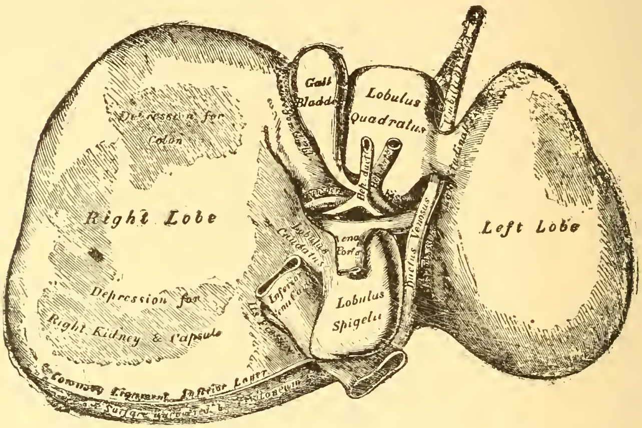


Fig. 17. Under Surface of the Liver, Showing Lobes, Fissures, Vessels, Etc.

The liver is surrounded by a serous or peritoneal covering, folds of which form four ligaments, which attach it to the diaphragm. A fifth ligament, the ligamentum teres, resulting from the obliteration of the umbilical vein, likewise assists in keeping it in position. An inner, fibrous coat also lines the entire organ. The hepatic artery carries nutrition to the liver and its ramifying vessels. The portal vein conveys venous blood, collected from the digesting viscera, to the liver, where it undergoes certain changes, and this superfluous blood is again caught up by the branches of the hepatic veins and discharged into the vena cava.

Hepatic Lobules.—The mass of the liver is composed of small, granular bodies, or lobules, about the size of a millet seed, held together by an extremely fine, areolar tissue, in which are the ramifications of the portal vein, hepatic duct, artery, veins, their branches and capillaries, the lymphatics, and the nerves. Each lobule is composed of a mass of very small spheroidal cells, known as hepatic cells, and plexuses of biliary ducts and other vessels. These cells are the chief agents in the secretion of the bile.

The Bile is a bitter, viscid, golden=brown, or greenish=yellow, liquid, secreted by the liver, and discharged into the duodenum, where it mixes with the chyme, aiding in digestion, chiefly acting on the fats. It is the only secretion of the body taken from the venous blood; but it must be remembered that the blood collected by the portal system differs from ordinary venous blood, as it contains, with the waste materials of the body, portions of partially digested food gathered from the digestive organs. About three pounds of bile is secreted daily; when digestion is not going on, and the opening of the duct into the duodenum is closed, the bile is stored in the gall=bladder, to be discharged when the operation of digestion is again resumed. If a diseased condition of the liver shuts off the supply of bile through the regular channel, the constituents enter the blood direct, causing the disease known as jaundice.

The Biliary Ducts convey the bile to the intestine; they are the hepatic, the cystic, and the ductus communis choledochus. The small branches of the hepatic duct, which have their origin in the substance of the liver, and by their union form this duct, are also called biliary ducts.

The Hepatic Duct leaves the liver in two branches, which unite to form a vessel the size of a quill and one and a half inches long.

The Cystic Duct is the smallest of the three, being one inch long, and conveys the bile to and from the gall=bladder.

The Ductus Communis Choledochus is the largest of the three, is about three inches long, of the size of a goose=quill, and formed by a union of the hepatic and cystic ducts. It enters the duodenum by a common opening with the pancreatic duct.

The Gall-Bladder, the reservoir for the bile, is a conical, pear=shaped sac. three or four inches long, an inch in diameter, holds from an ounce to an ounce and a half, and lies on the under surface of the liver.

The Pancreas (the sweetbread) is a racemose gland, similar in structure to the salivary glands, is about seven inches in length, of a grayish=white color, and situated behind the stomach. It secretes another digestive fluid, called the pancreatic juice. While the bile acts particularly on the fats, the pancreatic juice acts directly on the sugars and starches still undigested. The head of the pancreas extends to the right, occupying a part of the epigastric region; the tail lies above the left kidney, in contact with the lower end of the spleen, and in the left hypochondriac region; and the body lies behind the stomach and transverse colon and in front of the aorta, portal vein, inferior vena cava, splenic vein, and the crura of the diaphragm. The arteries are the great pancreatic and small pancreatics, from the splenic; the superior pancreatico=duodenal, from the hepatic; and the inferior pancreatico=duodenal from the superior mesenteric. The veins open into the splenic and mesenteric veins.

The Pancreatic Duct extends the whole length of the pancreas. It collects the pancreatic juice and carries it to the duodenum, which it enters about three inches below the pylorus, by an opening common to it and the ductus communis choledochus.

The Ductless Glands.—The spleen, thyroid and thymus glands, and suprarenal capsules, constitute the ductless or blood glands.

The Spleen possesses no excretory duct, is oblong, flattened, soft, very brittle, highly vascular, of a dark=bluish=red color, and is situated in the left hypochondriac region, embracing the cardiac end of the stomach. It is about five inches long, three inches wide, and two inches thick. The vessels are the splenic artery, which is large and tortuous, and the splenic vein, which empties into the portal vein.

The Thyroid Gland or Body is a ductless organ, consisting of two lateral, conical lobes, connected across the upper part of the trachea by a narrow transverse portion, called the isthmus. It weighs from one to two ounces and is larger in females than males. Occasionally it becomes enormously enlarged, constituting the disease called bronchocele or goitre. The tissue of this gland is soft, spongy, and of a brownish-red color. Its functions are unknown.

The Thymus Gland is a temporary organ, attaining its full size at the end of the second year, gradually dwindling thereafter, almost disappearing at puberty. It is situated below the thyroid in the neck, being composed of two unequally sized lobes, which occasionally emerge into one mass. It is a pinkish-gray color, soft and lobulated on the surface, and contains in a central cavity (the reservoir of the thymus) a milky fluid.

The Suprarenal Capsules are two small, crescentic-shaped bodies, situated one on each kidney. They are quite large in fetal life, but diminish in adult age. The vessels are the suprarenal branches of the aorta, renal, and inferior phrenic arteries, and the suprarenal vein, which on the right side of the body empties into the inferior vena cava, and on the left, into the left renal vein.

The Kidneys, the largest tubular glands of the body, are located in the lumbar region, behind the peritoneum, one on either side of the vertebral column, and secrete the urine. They are oblong and flattened, about four inches in length, two inches in breadth and an inch in thickness, the left being a little larger, thinner, and higher up than the right. Beds of surrounding fat, the blood-vessels, and the peritoneum cover them and hold them in position. The outer border is convex, and the inner, facing the spinal column, concave. Each kidney in the male adult weighs from four and one-half to six ounces, and in the female one-half ounce less. The substance is dark-red in color, dense in texture, but easily lacerable. The vessels are the renal artery and vein. A deep fissure, the hilum, in the concave border, gives ingress and egress to these vessels, the nerves, the lymphatics, and the ureter.

The Ureters, one on each side, are cylindrical, membraneous tubes, about sixteen or eighteen inches long, which convey the urine from the kidneys to the bladder.

The Peritoneum (to extend around) is a serous membrane, and, like all membranes of this class, is a shut serous sac. Its visceral layer is reflected more or less completely over all the abdominal and pelvic viscera. Its free surface is smooth, moist, and shining. Its attached surface is connected to the viscera and the parietes of the abdomen by the subperitoneal, areolar tissue. In

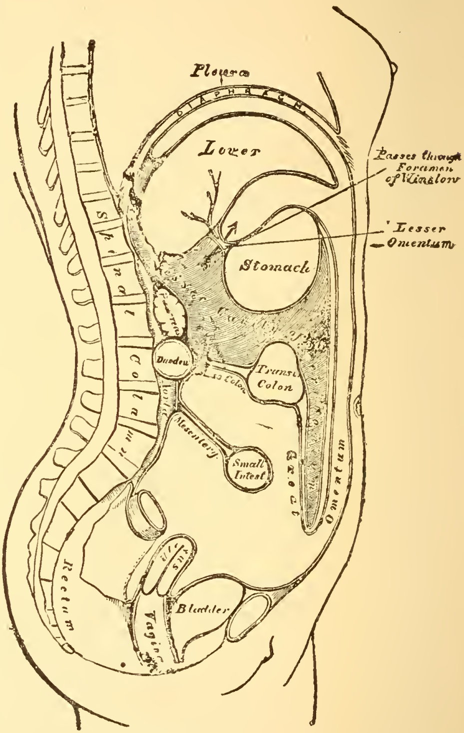


Fig. 18. The Peritoneum.
Vertical section of abdomen, showing its reflections.

the female it is not completely closed, the Fallopian tubes communicating with it by their free extremities, and thus it is continuous with their mucous membrane.

Peritoneal Sacs.—The peritoneum is divided into two sacs, the greater and the lesser. The greater sac extends over the anterior two-thirds of the liver, behind and above the stomach, below, behind, and in front of the great omentum, and below the mesocolon. The lesser sac, or cavity of the great omentum, extends behind and below the liver and stomach, above the mesocolon, and within the great omentum.

The Omenta.—The great (or gastrocolic) omentum consists of four layers of peritoneum, the most anterior and posterior of which belongs to the greater sac and internal to the lesser sac. The two anterior layers descend from the stomach and the spleen, over the small intestine, and then descend as the posterior layers, to enclose the transverse colon.

The lesser (or gastrohepatic) omentum consists of two layers of peritoneum, the upper belonging to the greater sac, the lower to the lesser sac. It extends from the transverse fissure of the liver, to the lesser curvature of the stomach, and contains in its free margin the

Hepatic Artery.	Ductus Communis Choledochus.
Portal Vein.	First Part of the Duodenum.
Lymphatics.	Hepatic Plexus of Nerves.

The gastrosplenic omentum connects the stomach with the spleen, and contains the splenic vessels and the vasa brevia.

The Mesenteries are folds of the peritoneum connecting the various parts of the intestinal canal (except the duodenum) to the abdominal walls. They are the mesentery proper; the mesocecum; the ascending, transverse, descending, and sigmoid mesocolon; and the mesorectum.

THE PELVIC CAVITY.

The Cavity of the Pelvis is a basin-like hollow contained between the pelvic bones, and forms the lower part and outlet of the general abdominal cavity. It contains the bladder, the internal organs of generation in both sexes, and the rectum. The uterus, or womb, in the female, lies in front of the rectum, and behind the bladder. During pregnancy it enlarges until at the latter end of the term, it nearly fills the abdominal cavity.

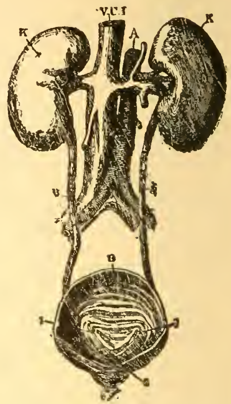


Fig. 19. Kidneys, Bladder, Etc.
K, K, Kidneys; B, bladder; U, U, ureters; A, aorta; V C I, inferior vena cava; 1, 1, opening of ureters; 2, opening of urethra.

The Bladder, the urinary reservoir, is a musculomembranous sac, located in the pelvic cavity. Its shape, position, and relations are greatly influenced by age, sex, and the degree of distension of the organ. During infancy, it is conical in shape, and projects into the hypogastric region. In the adult, when quite empty, it is a small, triangular sac, and, when fully distended, extends into the abdomen, nearly as high as the umbilicus. It is larger in the female than in the male, and, when full, ordinarily contains about a pint. It has four coats and three openings, two for the ureters at the base, and that of the urethra, the channel of discharge, at the neck. Numerous ligaments hold the bladder in position. The vessels are branches of the vesical arteries and the iliac veins.

THE CIRCULATORY SYSTEM.

AN IMPORTANT SYSTEM.

The constant wearing away of the organs and tissues of the body is as unceasingly being repaired by means of the nutriment furnished by the blood. This is carried and distributed by the circulatory system, which is necessarily one of importance.

ORGANS OF CIRCULATION.

The movement of the blood through and to every part of the body is called circulation, and the organs which produce and carry it on are called the organs of circulation. These are the heart and blood-vessels; and the latter are divided, according to the kind of work done, into three classes: arteries, veins and capillaries.

CIRCULATORY SYSTEMS.

The aorta with its branches, the inter-connecting capillaries, and the returning veins, constitute the greater or systemic circulation. The arteries which convey the blood to the lungs, with the veins that return the blood to the heart, and the capillaries between, form the lesser or pulmonary circulation. The portal system of veins is an adjunct of the systemic system. The fetal circulation is that of the unborn child.

In a work on embalming, a careful and thorough study of this wonderful system, which permeates every portion, and almost every tissue, of the body, is most necessary, and its treatment in this work, therefore, is very full.

CHAPTER VII.

THE HEART AND BLD.

THE HEART.

The Heart is a hollow, muscular organ, conical in shape, placed between the lungs in the mediastinal space, and is surrounded by the pericardium. It is placed obliquely in the chest, the base being directed upward and backward to the right, and the apex to the front and left, corresponding to the interspace between the cartilages of the fifth and sixth ribs, one inch to the inner side and two inches below the left nipple. It is placed behind the lower two-thirds of the sternum, and projects farther into the left than into the right side of the chest, extending from the median line about three inches into the left and only one and a half inches into the right side. Its anterior surface is round and convex and formed chiefly by the right ventricle and part of the left. Its posterior surface is flattened and rests upon the diaphragm, and is formed chiefly by the left ventricle.

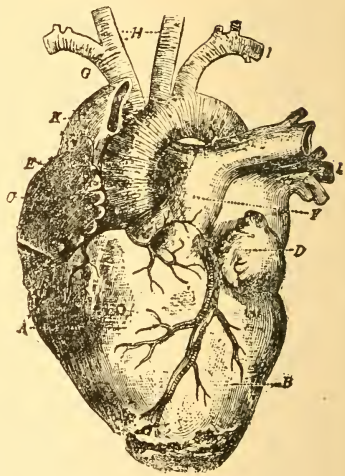


Fig. 20. The Heart and Vessels.
A, right ventricle; B, left ventricle; C, right auricle; D, left auricle; E, arch of aorta; F, pulmonary artery; G, innominate artery; H, common carotids; I, I, subclavians; K, superior vena cava; L, pulmonary veins.

The Pericardium (*peri,* around; *kardia,* heart) is a conical, membranous, closed sac, containing the heart and the roots of the great vessels. It lies behind the sternum and between the pleuræ, its apex upward, its base below, attached to the tendon of the diaphragm. It is a fibroserous membrane, composed of two coats, an inner or serous, and an outer or fibrous, the inner coat being reflected over the heart and vessels. Between the pericardium and the heart there is a small quantity of clear fluid, which acts as a lubricator, allowing the heart to move freely without producing friction.

The Endocardium (*endon,* within; *kardia,* heart) is a serous membrane which lines the cavities of the heart, being continuous with the lining membrane of the great blood-vessels. It also assists by its reduplications in forming the valves. It is smooth and transparent, giving to the inner surface of the heart its glistening appearance.

Heart's Weight and Size.—In the adult the heart is about five inches in length, and three and a half in breadth, and two and a half in thickness, being about the size of one's fist. It weighs from ten to eleven ounces in the male, and from eight to nine in the female. The heart increases in size and weight as age advances, but the increase is less marked in women than in men.

Its Cavities.—The interior of the heart is divided by a longitudinal, muscular septum into two lateral halves, which, from their position, are named the right and left sides. A transverse constriction divides each half into two cavities; the upper cavity on each side is called the auricle, and the lower cavity, the ventricle. There are, therefore, a right and left auricle, and a right and left ventricle. The walls of the ventricles are thick and strong, while those of the auricles are rather thin and less strong. The muscular septum of the heart is complete, no communication existing, after fetal life, between the right and left sides. The right is the venous side of the heart, and receives the venous blood from every portion of the body, through the inferior and superior venæ cavæ and the coronary sinus, into the right auricle. The blood then passes from the right auricle into the right ventricle, and from the right ventricle through the pulmonary artery to the lungs for arterialization. It is returned as arterial blood through the pulmonary veins to the left auricle; from the left auricle it passes into the left ventricle, and from the left ventricle it is carried through the aorta and its divisions to all parts of the body.

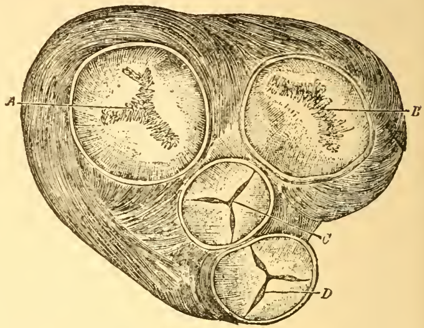


Fig. 21. Valves of the Heart,
Showing fibrous structure, and shape of valves; A, tricuspid; B, bicuspid; C, aortic; D, pulmonary.

The Right Auricle is larger than the left, and when full holds about two fluid ounces. Its walls are about a line (one-twelfth of an inch) in thickness, and are composed of two layers of muscular fibers, which are involuntary in their action. The right auricle consists of a principal cavity and the appendix auriculæ. Two large veins, the superior and inferior venæ cavæ, and the coronary sinus open into the right auricle. The latter is guarded by a valve, while the venæ cavæ are not. The Eustachian valve, which is large in the fetus, and serves to direct the blood through the foramen ovale, is rudimentary in the adult, and is sometimes altogether wanting; it does not prevent the blood from flowing either way through the opening of the inferior vena cava. The auriculo-ventricular opening, communicating with the right ventricle, is oval, about an inch broad, surrounded by a fibrous ring, and is guarded by the tricuspid valve.

The Right Ventricle is conical in form and has a capacity of about two fluid ounces. The walls are three or four lines in thickness, being much stronger than those of the right auricle. The tricuspid valve consist of three triangular segments, connected at their bases with the auriculo=ventricular orifice and by their sides with each other. The opening of the pulmonary artery is at the superior and internal angle of the ventricle, is circular in form, surrounded by a fibrous ring, and is guarded by the semilunar valve, which consists of three half=moonlike segments.

The Left Auricle is smaller than the right, its walls being a line and a half in thickness, and it receives the arterialized blood from the lungs. The openings of the pulmonary veins are generally four in number, sometimes only three, as the two veins from the left lung frequently end in a common opening. These openings are not guarded by valves. The left auriculo-ventricular opening is smaller than the right, and is guarded by the mitral valve.

The Left Ventricle is longer, thicker, and more conical than the right, projecting toward the posterior aspect. The walls are about twice as thick as those of the right ventricle. The aortic opening is small and circular, placed in front, and to the right, of the auriculo-ventricular opening, from which it is separated by one of the segments of the mitral valve. It is surrounded by a fibrous ring and is guarded by the semilunar valve.

Valves of the Heart.—The flow of the blood in only one direction through the heart is affected by a system of valves placed at the openings. Between the auricles and ventricles are the auriculo-ventricular valves. The one on the right side is called the tricuspid valve, because it consists of three folds or flaps of membrane; that on the left side the bicuspid, because made up of two flaps. The latter is also called the mitral valve from a fancied resemblance to a bishop's miter. These valves allow the blood to flow from the auricles to the ventricles, but are so arranged that it cannot flow in the opposite direction. At the opening of the pulmonary artery from the right ventricle is the pulmonary valve, and at the opening of the aorta from the left ventricle is the aortic valve. These two sets of valves, on account of the half-moon shape of their segments (three each), are called semilunar valves. They control the flow of the blood into the arteries, and entirely prevent its regurgitation. Valves are not found at the openings of the venæ cavæ into the right auricle, nor of the pulmonary veins into the left auricle, being unnecessary, as the auricles do not contract with much force. Indeed, the blood would naturally run down into the ventricles whenever the valves between the cavities were opened. Not so the ventricles. It is necessary for them to expel their contents with great force. Especially is this true of the left one, which must send the blood to the extremities, for which duty its strong walls well fit it. The aortic valve prevents the reflow of the blood from the arteries during the expansion or relaxation of the ventricle, and the mitral valve prevents the blood from being forced back into the auricle during the contraction of the ventricle.

Its Movements and Sounds.—The movements of the heart are two, contraction and relaxation. When the heart contracts, its chambers become smaller and the blood is forced from them into the blood-vessels; when it relaxes, or regains its proper size, the chambers are again filled with blood, ready to be sent out into the arteries by the next contraction. The first movement is called systole, and the latter, diastole. The alternation of these movements constitutes the beating of the heart, which is heard so clearly between the fifth and sixth ribs, and can be felt so distinctly at the wrist, where it is known as the pulse.

There are two different sounds occurring alternately with each movement of the heart. The first sound, or that which occurs when the heart contracts, is caused principally by the closing of the valves between the auricles and ventricles. The second sound, or that which occurs when the heart begins to relax, is caused by the closing of the valves at the pulmonary and aortic openings. These sounds have certain characteristics by which it is possible to determine the condition of the valves of the heart, and to tell whether one or more of them is diseased.

The average frequency of the pulse=beat, or heart=contraction, is seventy=two to seventy=six times per minute. It varies, however, in different persons, and in the same person under different conditions. Sudden emotions or sickness cause increase in frequency; it is also more frequent while a person is working than when resting

Its Capacity.—At each contraction of the heart each ventricle forces into the vessels from two to two and one=half ounces of blood. The average amount of blood in the body of the average weight of one hundred and fifty pounds, the conditions being normal, is about fifteen to sixteen pounds. Hence, it will be seen that all the blood in the body passes through the heart in less than two minutes. As the heart is unceasing in its work day and night, the aggregate force exerted by it in twenty=four hours is something stupendous.

THE BLOOD.

The Blood is the liquid by means of which the circulation is effected. It permeates every part of the body except the cuticle, nails, hair, teeth, etc., its office being to carry nutrition to the different tissues of the body. It is the most abundant fluid in the body, comprising about one=tenth of the body's entire weight.

Fig. 22. Blood-Corpuscles.

Composition of Blood.—The blood is composed of a thin, colorless liquid, the plasma, or liquor sanguinis, filled with red disks or cells. These cells are so minute that it takes about thirty=two hundred laid side by side to measure an inch, and about sixteen thousand if laid flatwise.

A microscope shows them to be rounded at the edges with concave sides. There is also a white, globular cell to about every six hundred and sixty-six red ones. The plasma also contains fibrin, albumen, and such mineral substances as iron, lime, magnesia, phosphorus, potash, etc. The blood contains the material for building up every organ. The plasma is rich in mineral matter for the bones, and albumen for the muscles. The red corpuscles contain oxygen, which is so essential to every operation of life. It stimulates to action and tears down all that is worn out. In the latter process it unites with and burns out parts of muscles and other tissues, much as wood is burned. The unburned portion is caught up in the circulation, carried back to the lungs, where it undergoes purification, only to be again sent forth on its mission.

Fig. 23. Blood-Crystals.

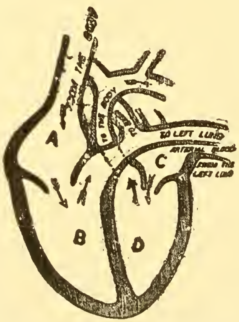


Fig 24. Circulation of Blood.
Sectional view of heart and vessels, showing the course of blood through same.

The Circulation of the Blood is an interesting study. The blood goes from the heart and then returns again to the heart. Starting with the left ventricle the blood is forced through the aorta and its branches to all parts of the body. From the arteries it passes through the capillaries. The second set of capillaries then takes it up and passes it into the veins, and they in turn into either the superior or inferior vena cava, from which it is emptied into the right auricle of the heart. It then passes into the right ventricle, from whence it is sent through the pulmonary artery to the lungs, to be returned through the pulmonary veins to the left auricle, and then to the left ventricle, from which place it started. Blood, when it leaves the left ventricle, and while it is in the arteries, is red in color; when returning through the veins, it is bluish. Arterial blood is pure and contains much oxygen; venous blood is impure, containing much carbonic acid and other waste matter. The blue, impure blood, while passing through the lungs, loses its carbonic acid gas and takes up oxygen, becoming again bright=red in color.

CHAPTER VIII.

THE BLOOD-VESSELS.

THE ARTERIES.

The Arteries are the vessels or canals which convey the blood from the heart to the different parts of the body. They have dense, strong, and very elastic walls. Though generally found empty after death, they still retain their cylindrical shape. Unlike the veins, no valves are found in the course of the arteries, though powerful valves are located at the pulmonary opening in the right ventricle and the aortic opening in the left ventricle. It is on account of the absence of valves, and because found empty after death, that the arteries are chosen by the embalmer for the purpose of injecting the dead body.

The Large Trunks are located generally as far as possible out of harm's way and are commonly found close to the bones, or running through safe passages provided for them. They are usually very straight and take the shortest route to the part of the body to be supplied by them with blood. Some arteries, however, are very tortuous in their course, as the facial and other arteries of the head, to accommodate themselves to the movements of the parts. In their ultimate, minute branchings the arteries connect with the veins through the capillaries.

The Main Artery of the body is the aorta, which starts at the left ventricle of the heart and divides and subdivides into innumerable branches. With each division, these branches become smaller, finally terminating in a network of capillaries. While each branch is smaller than the trunk from which it is derived, the combined area of the branches of an artery is greater than the area of the trunk, and the aggregate area of all the branches far exceeds that of the parent trunk, the aorta.

The arteries are usually named, (*a*) from the part in the body where they are found, as the brachial, popliteal, iliac, etc.; (*b*) from the organ which they supply, as the hepatic, esophageal, mammary, etc.

Arterial Anastomosis.—The arteries communicate freely with each other by anastomosis, or inosculation. This intercommunication is very free among the larger branches, but increases in frequency as the size decreases, being so numerous between the very smallest branches as to form a close network that pervades nearly every tissue of the body. In the extremities, the anastomoses are most frequent and of the largest size around the joints. By anastomoses between arteries, or arterial branches, in the same part of the body, collateral circulation is established in the case of a ligature, or the destruction of a principal artery.

Accompanying Vessels.—The arteries are accompanied by veins, with which they are enclosed generally in a thin, fibro=areolar investment, or sheath. Frequently, an accompanying nerve is enclosed also with the artery. This sheath is formed, usually, by a prolongation of the deep fascia of the part. The included vessels are loosely connected with their sheath by a delicate areolar tissue. Some arteries, as those in the cranium, are not included in sheaths.

Vasa Vasorum.—The walls of all the larger arteries are supplied with blood=vessels, called vasa vasorum (vessels of vessels), which carry nourishment to the external and middle coats, and, according to some authorities, to the inner coat as well. These arise from a branch of the artery, or from a neighboring vessel. Minute veins return the blood from these arterial coats, emptying finally into the venæ cavæ.

Their Coats.—The walls are composed of three coats: internal, or endothelial; middle, or muscular and elastic; external, or cellular and connective. These coats are made up in turn of different layers. The internal coat consists of the endothelium, a layer of flat cells, and the tunica intima, composed of elastic tissue in longitudinal arrangement.

The middle coat is by far the thickest of the three coats, being formed of three fibrous layers, in circular, triangular, and longitudinal arrangement. In the largest arteries this coat is very thick, of a yellowish color, and highly elastic. It diminishes in thickness and elasticity as the arteries become smaller, while the proportion of muscular fiber increases.

The external coat consists mainly of longitudinal, fibrillated, connective tissue, and contains elastic fibers in all but the smallest arteries. In the largest vessels it is thin, but increases in relative thickness, as the size decreases. In medium=sized arteries and larger there are two layers.

The two inner coats are very easily separated from the external by a ligature. If a fine string or thread be tied tightly around the artery and then removed, the external coat will be undivided, while the two interior coats will be found separated in the track of the ligature, and can be easily dissected from the outer coat.

THE VEINS.

The Veins are tubelike vessels that return the blood from the capillaries in the different parts of the body to the heart. They all carry carbonized or venous blood to the right side of the heart, except the pulmonary veins, which convey oxygenated blood to the left side. The portal vein, with the series of veins uniting to form it, is an appendage of the systemic system, and conveys the blood from the viscera of the digestive organs to the liver, from whence it is carried through the hepatic vein to the inferior vena cava.

The veins, like the arteries, are found in nearly every tissue of the body. They have their origin in minute plexuses which communicate with the capillaries. At first exceedingly small, they increase in size and decrease in number as they gradually unite and flow into one another; joining finally to form two large veins, the ascending and descending venæ cavæ, which empty into the right auricle. The veins, like the arteries, are supplied with nutrient vessels, the vasa vasorum.

The veins are larger and more numerous than the arteries; consequently, the capacity of the venous system is much greater than that of the arterial. This is not true, however, of the pulmonary veins.

Venous Anastomosis.—Veins anastomose with each other much more freely than do the arteries, especially in certain regions, as in the cranium, neck, along the spinal column, etc. This communication exists between the larger trunks as well as between the smaller branches.

Venous Coats.—The venous walls are composed of three coats: inner, or serous; middle, or muscular and fibrous; and outer, or connective and areolar. These coats are, with some modifications, analogous to those of the arteries. As they do not receive the direct impulse of the heart, their walls are much thinner and less elastic than those of the arteries; especially is this true of the middle coat. Unlike the arteries, when the veins are empty their walls collapse. Usually the blood remains in the veins for several days after death.

Fig 25. Venous Valves.

Venous Valves.—In the veins, at convenient intervals, are placed strong and perfect valves, which allow the blood to flow through them only in the direction of the heart. Commonly, two valves are found opposite each other, especially in the smaller veins, and in the larger veins at points where other veins join them.

The valves are very numerous in the veins of the extremities, and much more so in the lower, where the blood is conducted against the force of gravity, than in the upper.

Too much standing, or too tight elastics, often cause the veins in the leg to swell, so that the valves cannot work; the veins then become permanently enlarged, or varicosed, and if they burst the bleeding may be profuse and even dangerous.

A number of veins, however, are without valves. These are the venæ cavæ, hepatic, portal, renal, uterine, ovarian, cerebral, spinal, pulmonary, umbilical, and the small veins generally. There are rudimentary valves in the neck through which the blood will pass either way.

Kinds of Veins.—Veins are divided, from their location and structure, into three classes: deep veins, superficial veins, and sinuses.

Deep Veins accompany the arteries, in the same sheath, and are given usually the same names. The secondary arteries, as the radial, ulnar, brachial, etc., have each two veins, one lying on each side of the artery, called venæ comites. The larger veins, as the axillary, subclavian, femoral, etc., have usually only one accompanying vein. The deep veins in the skull and spinal column, the hepatic, and some others, do not accompany arteries.

Superficial or Peripheral Veins are sometimes called cutaneous veins, from the fact that they are found immediately beneath the skin, between layers of superficial fascia. They drain the venous blood from the structures in the outer portions of the body, emptying into deep veins at convenient points.

The Sinuses are venous channels, differing from veins in structure and distribution, but serving the same purpose. The sinuses of the cranium are formed by the separation of the layers of the dura mater and lie in deep grooves. Sinuses are also found along the spinal column and on the outer surface of the heart.

THE CAPILLARIES.

The Capillaries (*capillus,* a hair) are the minute network of vessels formed throughout the tissues of the body between the terminating arteries and the commencing veins. They so blend, however, with the extremities of these two classes of vessels, that it is not an easy matter to tell just where an artery ends and a vein begins. Their diameter is from one three=thousandth to one six=thousandth of an inch. The smallest are those of the brain and mucous membrane of the intestines; the largest, those of the derma and marrow-bones.

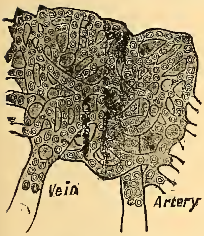


Fig. 26. Capillaries, With a terminating artery and a commencing vein.

Where Found.—They exist in nearly every part of every tissue of the body, and are so closely packed together, that it is impossible to prick the skin with the point of a needle without injuring many of them. They are altogether wanting in the epidermis, and its modified forms, the epithelium and endothelium, in the nails, hair, and teeth, and to a certain extent, in the cartilage. The number of capillaries, and the size of the interspaces, or meshes, determine the degree of vascularity of a part.

By union with each other, the capillaries form a true plexus of vessels of nearly uniform diameter, branching and inosculating in every direction, distributing blood to all parts as necessity demands. They receive the blood from the smallest subdivisions of the arteries, and carry on the work of nourishing and rebuilding the body. They also begin the process of removing the waste matter from the wornout portions of the tissues.

Their Walls, which consist of a transparent, homogeneous membrane, continuous with the innermost layer of the arterial and venous walls, are so thin that their fluid contents readily exude through the delicate membrane, irrigating and nourishing the tissues in which they lie.

CHAPTER IX.

ARTERIES OF THE SYSTEMIC CIRCULATION.

The Aorta, or great artery, is the main trunk of the systemic circulation. It commences at the aortic opening of the left ventricle of the heart, arching backward over the root of the left lung into the posterior part of the thorax, where it descends on the left side of the spinal column, through the aortic opening of the diaphragm, to the fourth lumbar vertebra, where it divides into the right and left common iliac arteries. The aorta is divided into the arch, the thoracic aorta, and the abdominal aorta. The arch is divided into the ascending, transverse, and descending portions. The upper border of the arch is located in the thorax, about an inch below the upper margin of the sternum; the arch ends at the lower border of the fourth dorsal vertebra.

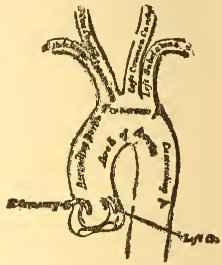


Fig. 27. Plan of Branches of Aortic Arch.

The Branches of the Aorta are as follows:

From the Arch:
- Two Coronary.
- Innominate.
- Left Common Carotid.
- Left Subclavian.

From the Thoracic Aorta:
- Pericardiacs.
- Bronchials.
- Esophageals.
- Twenty Intercostals.
- Posterior Mediastinals.

From the Abdominal Aorta:
- Two Phrenic.
- Celiac Axis { Gastric. Hepatic. Splenic.
- Superior Mesenteric.
- Inferior Mesenteric.
- Two Suprarenal.
- Two Renal.
- Two Spermatic (or Ovarian).
- Eight Lumbar.
- Middle Sacral.

The Coronary Arteries arise from the aorta behind the semilunar valves, and run in the vertical grooves of the heart, to supply the tissues of the heart.

The Innominate arises from the summit of the arch of the aorta, is one and a half inches in length, and divides at the right sternoclavicular articulation into the right common carotid and right subclavian. On the left side these arise directly from the arch of the aorta.

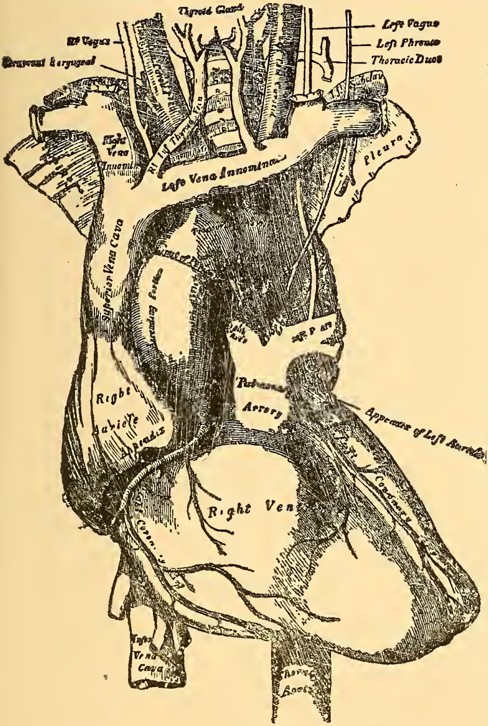


Fig. 28. Arch of Aorta and Its Branches.

The Common Carotid arises on the left side from the aorta, and on the right from the innominate, the left being longer and deeper than the right. Their course is indicated by a line drawn from a point midway between the angle of the lower jaw and the mastoid process to the sternoclavicular articulations. At the lower part of the neck they are separated only by the width of the trachea, and they are each contained in a sheath of the deep cervical fascia with the internal jugular vein externally and the pneumogastric nerve between the artery and vein. They divide at the level of the upper border of the thyroid cartilage into the external and internal carotids.

The External Carotid ascends from its origin to the space between the neck of the ramus of the lower jaw and the external auditory canal, where it divides into the temporal and internal maxillary. It diminishes in size rapidly on account of the number and size of the branches given off. The branches, which supply the tissues of the neck, face, and head, and anastomose freely with those of the opposite side, are as follows:

(1) **The Superior Thyroid,** the first branch, takes a downward course, and supplies the thyroid gland and muscle, larynx, etc.

(2) **The Lingual** supplies the under surface of the tongue.

(3) **The Facial,** the largest branch, ascends obliquely and tortuously forward and upward, and gives off four cervical and six facial branches.

(4) **The Occipital** arises opposite the facial, and courses upward, and its branches anastomose freely with those of the vertebral and deep cervical.

(5) **The Posterior Auricular** supplies the external and internal ear.

(6) **The Ascending Pharyngeal,** the smallest branch, reaches certain muscles and nerves, the pharynx, and dura mater.

(7) **The Temporal,** the smallest of the two terminal branches, is in direction a continuation of the external carotid, and divides into the anterior and posterior temporal, which ramify over the surface of the skull, freely anastomosing with the branches from the opposite side.

(8) **The Internal Maxillary,** the other terminal, passes inward at right angles to the vessel, to supply the deep structures of the face.

The Internal Carotid ascends in front of the transverse processes of the three upper cervical vertebræ, and close to the tonsil, traverses the carotid canal in the temporal bone, and, after passing the anterior clinoid process, and piercing the dura mater, divides into its terminal branches, the anterior and middle cerebral. Its branches are:

F

BLOOD-VESSELS OF HEAD, NECK, ETC.

TWELVE PLATES—XXX.-XLI

PLATE XXX.

BASE AND INTERIOR OF BRAIN, WITH ORIGINS OF NERVES AND BLOOD-VESSELS.

Section at Base of Brain, Showing Origins of Nerves and Arteries.

A. Anterior lobe of cerebrum.
B. Middle lobe of cerebrum.
C. Posterior lobe of cerebrum.
D. Cerebellum (arbor vitæ).
E. Medulla oblongata.

a. Fissure of Sylvius.
b. Longitudinal fissure of cerebrum.
c. Commissure of optic nerves.
d. Tuber cinereum.
e. Corpora mammillaria v. candicantia.
f. Optic tract.
g. Pons Varolii.
h. Crus cerebelli ad pontem.
i. Pyramidal body.
k. Olivary body.

Nerves.

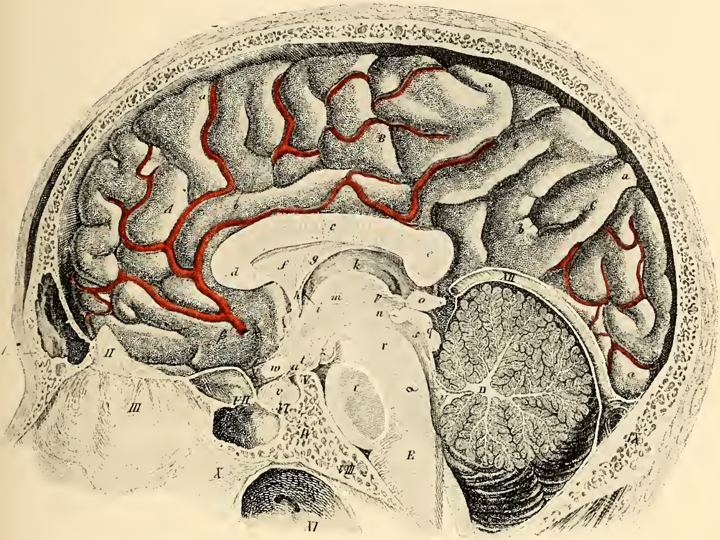
1. Olfactory (first pair).
2. Optic (second pair).
3. Motor oculi (third pair).
4. Pathetic (fourth pair).
5. Trigeminus (fifth pair).
6. Abducens (sixth pair).
7. Facial, portio dura of seventh pair.
8. Auditory, portio mollis of seventh pair.
9. Glossopharyngeal of eighth pair.
10. Pneumogastric of eighth pair.
11. Lingual or hypoglossal (ninth pair).

Arteries.

12. Vertebral.
13. Basilar.
14. Anterior spinal.
15. Posterior inferior cerebellar.
16. Anterior inferior cerebellar.
17. Superior cerebellar.
18. Deep cerebral.
19. Communicating branches (forming with anterior cerebral, internal carotid, and posterior or deep cerebral arteries, the circle of Willis).
20. Internal carotid.
21. Fossæ of Sylvius.
22. Choroid.
23. Corporis callosi.

PLATE XXXI.

BASE AND INTERIOR OF BRAIN, WITH ORIGINS OF NERVES AND BLOOD-VESSELS—(Continued).



Vertical Longitudinal Section of Brain, Cerebrum, and Cerebellum, through Center.

I. Frontal bone and frontal sinus.
II. Crista galli.
III. Perpendicular lamina of ethmoid bone.
IV. Body of sphenoid.
V. Posterior clinoid process.
VI. Sella turcica.

VII. Sphenoidal sinus.
VIII. Basilar part of occipital bone.
IX. Occipital part of occipital bone.
X. Vomer.
XI. Roof of pharynx.
XII. Tentorium cerebelli enclosing straight sinus.

A. Anterior lobe of cerebri.
B. Middle lobe of cerebri.
C. Posterior lobe of cerebri.

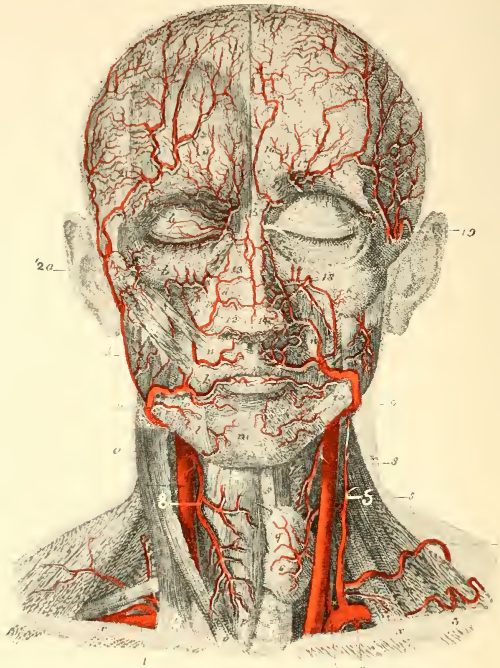
D. Cerebellum (arbor vitæ).
E. Medulla oblongata.

a. Convolutions of cerebrum.
b. Sulci.
c. Corpus callosum.
d. Genu corporis callosi.
e. Splenium corporis callosi.
f. Septum lucidum.
g. Fornix.
h. Anterior crus.
i. Foramen of Monro.
k. Thalamus of optic nerve.
l. Anterior commissure.
m. Soft commissure.
n. Posterior commissure.
o. Pineal gland.

p. Peduncle or crus of pineal gland.
q. Corpora quadrigemina.
r. Pons Varolii.
s. Aqueduct of Sylvius.
t. Tuber cinereum.
u. Infundibulum.
v. Pituitary gland.
w. Commissure of optic nerves.
x. Optic nerve.
y. Fourth ventricle.
z. Corpus mammillare v. candicans.
α. Anterior valve of cerebellum.
β. Artery corporis callosi.

PLATE XXXII.

BLOOD-VESSELS OF HEAD AND NECK.



Arteries of Anterior Surface of Head and Neck.

G. Zygomaticus major muscle.
O. Sternocleidomastoid muscle.

b. Orbicularis palpebarum muscle.
c. Corrugator supercilii muscle.
d. Levator labii superioris alæque nasi.
e. Levator labii superioris proprius.
f. Zygomaticus minor muscle.
h. Masseter muscle.
i. Buccinator muscle.
k. Orbicularis oris muscle.
l. Triangularis menti muscle.

1. Subclavian artery.
5. Ascending cervical.

2. Internal mammary artery.
3. Transverse scapular artery.
4. Transverse artery of neck.
6. Inferior thyroid artery.
9. External maxillary artery.
10. Coronary artery of lower lip.
11. Coronary artery of upper lip.
12. Angular artery.
13. Dorsals of nose.

P. Sternohyoid muscle.
R. Trachea.

m. Quadratus menti muscle.
n. Levator anguli oris muscle.
t. Trapezius muscle.
u. Omohyoid muscle.
v. Scalenus anticus muscle.
w. Scalenus medius muscle.
x. Clavicle.
q. Thyroid gland.
s. Larynx.

7. Common carotid artery.
8. Superior thyroid artery.

14. Alaries of nose.
15. Opthalmic artery.
16. Frontal artery.
17. Supraorbital artery.
18. Infraorbital artery.
19. Deep temporal artery (from internal maxillary).
20. Temporal (superficialis) artery.
21. Frontal branch of temporal artery.

PLATE XXXIII.

BLOOD-VESSELS OF LATERAL SURFACE OF HEAD, FACE, AND NECK.

A. Platysma=myoides muscle.

b. Trapezius muscle.
c. Deltoid muscle.
e. Splenius capitis muscle.
f. Splenius colli muscle.
h. Retrahens auris muscle.
i. Attolens auris muscle.
k. Masseter muscle.
n. Zygomaticus minor muscle.
o. Orbicularis oris muscle.
p. Triangularis menti muscle.

1. External jugular vein.
2. Occipital vein.
4. Internal jugular vein.
5. Anterior facial vein.
10. Frontal vein.

3. Common branch, between external and internal jugular.
6. Labial vein.
8. Temporal vein.

D. Sternocleidomastoid.

q. Quadratus menti muscle.
r. Orbicularis palpebarum muscle.
s. Frontal muscle.
t. Levator labii superioris alæque nasi.
u. Lower jaw.
v. Digastricus maxillæ inferioris.
w. Mylohyoid muscle.
x. Sternohyoid muscle.
y. Omohyoid muscle.

11. External carotid artery.
12. Posterior auricular artery.
13. Temporal (superficial) artery.
18. Frontal artery.

9. Cerebral opthalmic vein.
15. External maxillary artery.
16. Submental artery.
17. Angular artery.

PLATE XXXIV.

ARTERIES OF (RIGHT) SIDE OF NECK.

A. Inferior maxillary.
B. Os hyoides.
F. Trachea.

c. Clavicle.
d. Larynx.
e. Thyroid gland.
g. Acromion process.
h. Mastoid process.
i. Styloid process.
k. Processus transversus atlantis.
l. Digastric muscle (anterior belly).
m. Mylohyoid muscle.
n. Hyoglossus.

1, 2. Right common carotid artery.
3. External carotid artery.
4. Internal carotid artery.
8. Hyoid branch of lingual artery.
9. External maxillary, or facial.
12. Occipital artery.

5. Superior thyroid artery.
6. Superior laryngeal artery.
7. Lingual artery.
10. Ascending palatine artery.
[illegible] Submental artery.

P. Sternocleidomastoid muscle.
R. Scalenus anticus muscle.

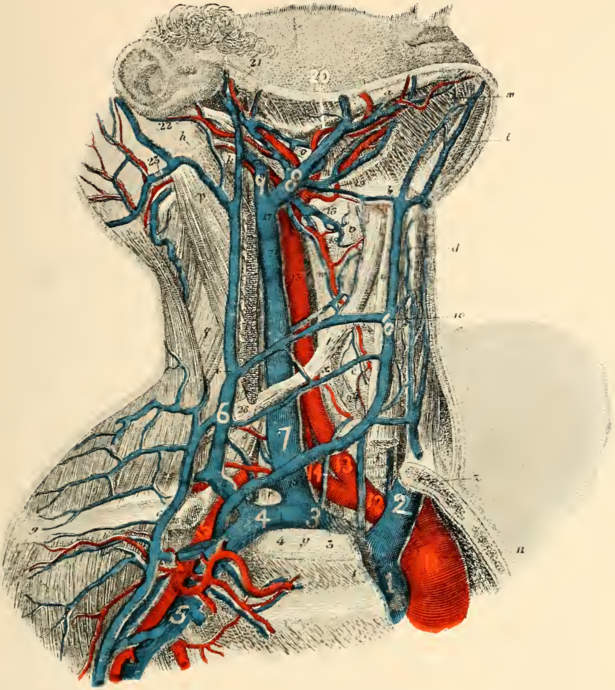
o. Styloglossus muscle.
q. Levator anguli scapulæ muscle.
s. Medius scalenus muscle.
t. Omohyoid muscle.
u. Sternohyoid muscle.
v. Thyrohyoid muscle.
w. Pharynx.
x. Esophagus.
y. Subclavius muscle.
z. Major Pectoralis muscle.

13. Posterior auricular artery.
14. Temporal (superficial) artery.
15. Right subclavian artery.
20. Transversalis colli artery.
22. External thoracic artery.
27. Axillary artery.

16. Trunk of thyrocervical artery.
17. Inferior thyroid artery.
18. Ascending cervical artery.
19. Transversalis humeri artery.

PLATE XXXV.

BLOOD-VESSELS OF (RIGHT) SIDE OF NECK.



a. Inferior maxillary (lower jaw).
b. Os hyoides.
c. Claviele.
d. Larynx.
e. Thyroid gland.
f. Trachea.
g. Acromion proeess.
h. Mastoid proeess.
k. Processus transversus atlantis.
l. Digastric (anterior belly).
m. Mylohyoid musele.
n. Hyoglossus muscle.

o. Styloglossus muscle.
p. Sternocleidomastoid.
q. Levator anguli scapulæ.
r. Sealenus antieus.
s. Sealenus medius.
t. Omohyoid musele.
u. Sternohyoid musele.
v. Thyrohyoid musele.
w. Pharynx.
x. Esophagus.
y. Subelavian muscle.
z. Pectoralis major muscle.

1. Superior vena cava.
2. Left innominate vein.
3. Right innominate vein.
4. Right subclavian vein.
5. Axillary vein.
6. External jugular.
7. Internal jugular.
8. Facial vein.

9. Internal maxillary vein.
10. Anterior jugular.
11. Arch of aorta.
12. Innominate artery.
13. Right common carotid artery.
14. Right subelavian artery.
15. Axillary artery.
20. External, maxillary, or facial artery.

16. External carotid artery.
17. Internal carotid artery.
18. Superior thyroid artery.
19. Lingual artery.
21. Temporal artery.
22. Posterior arieular artery.

23. Occipital artery.
24. Inferior thyroid artery.
25. Transversalis humeri.
26. Transversalis colli.
27. External thoracis.

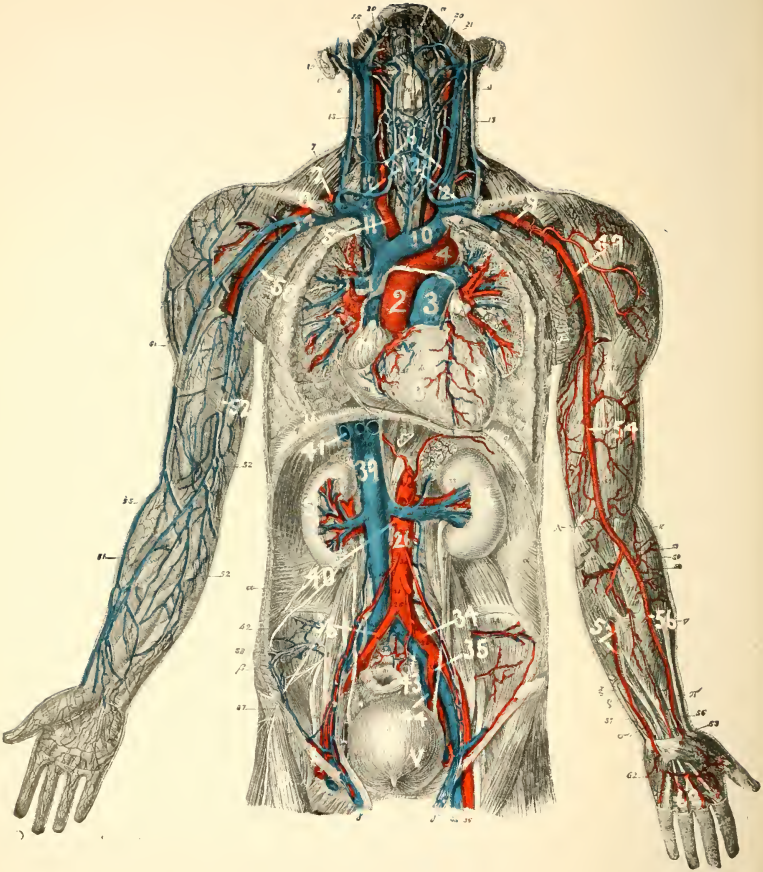


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PLATE XXXVI.

BLOOD-VESSELS OF NECK, TRUNK, AND UPPER EXTREMITIES.

Principal Arteries and Veins of Neck, Thorax, and Arms, with Deep Blood-Vessels of Abdominal Cavity.

D. Sartorius muscle.
E. Poupart's ligament.
I. Lungs.
G. Clavicle.
H. Heart.
M. Right auricle.
N. Left auricle.
O. Right ventricle.
P. Left ventricle.
S, S. Kidneys.
U. Diaphragm.
V. Bladder.

a. Lower jaw.
b. Os hyoid.
c. Larynx.
d. Thyroid gland.
e. Trachea.
f. Esophagus.
h. First rib.
l. Pericardium.
r. Esophagus.
t. Suprarenal capsules.
u. Ureter.
w. Rectum.
y. Quadratus lumborum.
z. Psoas muscle.

α. Transverse abdominal.
β. Internal iliac.
γ. Spermatic cord.
κ. Tendon of biceps of elbow.
λ. Brachialis anticus.
ν. Supinator longus.
ξ. Flexor carpi ulnaris.
π. Flexor pollicis longus.
ρ. Flexor digitorum communis profundus.

Arteries and Vein.

2. Ascending aorta.
3. Pulmonary artery.
4. Arch of aorta.
6. Common carotid artery.
7. Right subclavian artery.
9. Left subclavian artery.
10. Left innominate vein.
11. Right innominate vein.
12. Internal jugular vein.
12^{2}. Subcutaneous vein of neck.
13. Subclavian.
26. Abdominal aorta.
34. Common iliac artery.
35. Internal iliac artery.
36. External iliac artery.
39. Inferior vena cava.
40. Renal vein.
41. Hepatic vein.
43. Common iliac vein.
44. Internal iliac vein.
49. Axillary artery.
50. Axillary vein.
52. Basilic vein.
54. Brachial artery.
56. Radial artery.
57. Ulnar artery.
62. Deep palmar arch.

1. Superior vena cava.
5. Innominate artery.
8. Left common carotid artery.
15. Superior thyroid vein.
17. Inferior thyroid vein.
18. Labial vein.
19. Posterior cephalic vein.
20. Facial (or labial) artery.
21. Anterior facial vein.
23. Pulmonary vein.
24. Anterior branch of left coronary vein of heart.
25. Right coronary artery and vein of heart.
27. Inferior phrenic artery.
28. Celiac axis artery.
29. Superior mesenteric artery.
30. Inferior spermatic artery.
31. Inferior mesenteric artery.
33. Renal artery and vein.
37. Circumflex iliac artery and vein.
38. Iliolumbar artery and vein.
42. Internal spermatic vein.
45. External ilac vein.
46. Middle sacral artery and vein.
51. Cephalic vein.
53. Median vein.
60. Recurrent radial artery.
61. Recurrent ulnar artery.
63. Superficial branch of radial.

PLATE XXXVII.

BLOOD-VESSELS OF (LEFT) SIDE OF HEAD AND FACE.

G. Body of maxillary.

a. Frontal bone.
b. Great wing of sphenoid bone.
c. Superior maxillary.
d. Inner wall of orbit.
e. Malar bone.

f. Inferior maxillary.
h. External pterygoid muscle.
l. Orbicularis oris muscle.
m. Buccinator muscle.

1. Deep temporal artery and vein.
2. Internal jugular vein.
3. Anterior facial arteries and veins.
4. Infraorbital artery and vein.

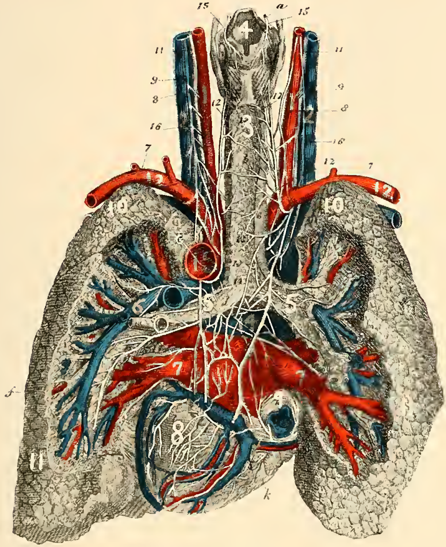
5. Posterior facial arteries and veins.
16. Superior labial artery.
17. Occipital vein.

1. Left common carotid artery.
3. External jugular vein.
7. Occipital artery.
8. Posterior auricular artery and vein.
9. Temporal (superficial) artery.
10. Internal maxillary artery.
13. Posterior alveolar artery and vein.

11. External maxillary artery.
15. Coronaria labii inferioris artery.
16. Coronaria labii superioris artery.
17. Dorsal artery of nose.
18. Angular artery.
19. Cerebral opthalmic artery and vein.
20. Frontal artery and vein.

PLATE XXXVIII.

POSTERIOR SURFACE OF LUNGS AND TRACHEA, WITH THEIR PRINCIPAL ARTERIES, VEINS, AND NERVES.



a, Larynx.
g. Middle lobe of right lung.

1,1. Common carotid arteries.
2,2. Internal jugular veins.
3. Trachea.
4. Glottis.
5. Bronchi.
6. Left pulmonary artery.
7. Pulmonary veins.

2. Great vein of heart.
6. Innominate artery.
10. Superior vena cava.
11. Pneumogastric (vagus) nerve.
12. Recurrent laryngeal branch of pneumogastric nerve.

k. Right ventricle.

8. Left ventricle.
9. Right auricle.
10. Apex of lungs.
11. Lower lobe of lungs.
12,12. Subclavian arteries.
14. Pulmonary artery.
15. Aorta.

13. Recurrent branches of tracheal nerve.
14. Recurrent branches of cardiac nerve.
15. Superior laryngeal nerve.
16. Cardiac branch of sympathetic nerve.
17. Cardiac plexus.

Fig. 1

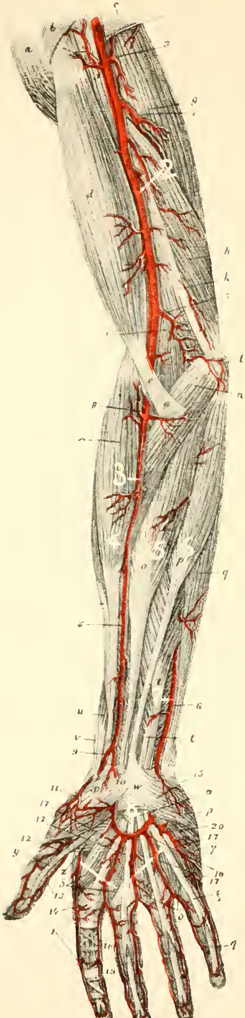


Fig. 2

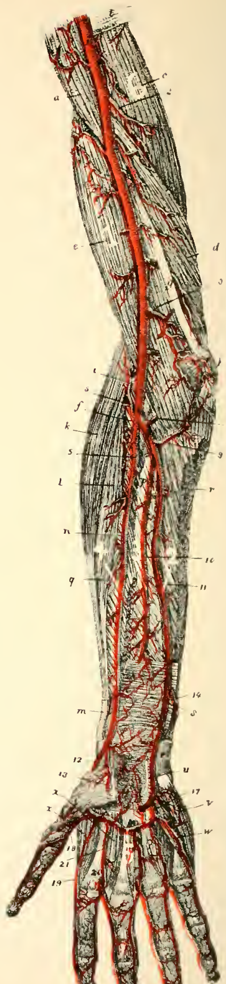


PLATE XXXIX.

ARTERIES OF ANTERIOR SURFACE OF ARM, FOREARM, AND HAND.

Fig. 1.—Superficial Arteries on Internal and Anterior Surface of Arm, Forearm, and Hand.

a. Deltoid muscle.
b. Pectoralis major muscle.
c. Latissimus major muscle.
e. Semilunar fascia of biceps.
f. Coraco=brachialis muscle.
g. Long head of triceps.
h. Short head of triceps.
i. Brachialis anticus muscle.
k. Internal intermuscular ligament.
l. Internal condyle of humerus.
n. Pronator teres muscle.
q. Flexor carpi ulnaris.
r. Extensor carpi radialis longus.
s. Flexor pollicis longus muscle.
t. Flexor digitorum communis sublimis.
u. Abductor pollicis longus muscle.
v. Extensor pollicis brevis muscle.
w. Anterior annular ligament of wrist.
x. Ball of thumb, abductor and flexor brevis pollicis.
y. Tendon of flexor longus pollicis.
z. Abductor pollicis muscle.

1. Biceps muscle.
2. Brachial artery.
3. Radial artery.
4. Supinator longus muscle.
5. Flexor carpi ulnaris muscle.
6. Palmaris longus muscle.
8. Superficial palmar arch.
9. Interosseous arteries.

10. Volar branch of radial artery.
11. Muscular branch to ball of thumb.
12, 13, 14. Branches from princeps pollicis.
17. Common volar digital artery.
18. Volar ulnar artery.
19. Digitalis dorsalis artery.
20. Deep or communicating branch.

Fig. 2.—Deep Arteries of Arm, Forearm, and Hand—Anterior Surface.

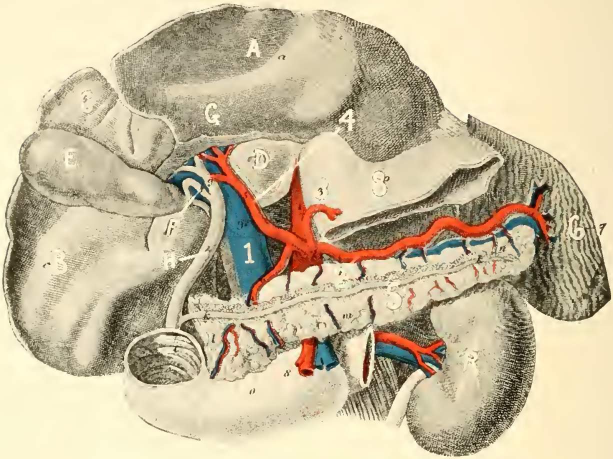
a. Coraco=brachial muscle.
b. Latissimus dorsi muscle.
d. Short head of triceps.
e. Brachialis anticus.
f. Supinator brevis.
g. Internal intermuscular ligament.
h. Internal condyle of humerus.
i. Tendon of biceps (divided).
k. Extensor carpi radialis longus.
l. Extensor carpi radialis brevis.
m. Tendon of long supinator (divided).
n. Radial insertion of pronator teres.
p. Interosseous membrane.
q. Flexor pollicis longus muscle.
r. Flexor muscle (divided).
s. Pronator quadratus muscle.
t. Tendon of flexor carpi ulnaris (divided).
u. Anterior annular ligament (divided).
v. Abductor digiti minimi muscle.
w. Opponens digiti minimi muscle.
x. Interosseous muscle.

1. Biceps muscle.
2. Ulnar artery.
3. Interosseous artery.
4. Radial artery.
5. Deep palmar arch.
6. Triceps muscle.

8. Anterior recurrent ulnar.
9. Posterior recurrent ulnar.
12. Dorsal branch of radial.
13. Superficialis volæ.
14. Dorsal branch of ulnar.
17. Deep branch of ulnar.
18. Princepes pollicis.
19. Indicis radialis.
20. Digitalis communis (divided).
21. Interossæ palmares.

PLATE XL.

THORACIC AND ABDOMINAL VISCERA, WITH PRINCIPAL VESSELS.



Principal Chylopoietic Viscera, Blood=Vessels, and Ducts.

A. Left lobe of liver (under surface).
B. Right lobe of liver.
C. Lobus quadratus of liver.
D. Lobus Spigelii of liver.
E. Gall=bladder.

g. Hepatic duct.
i. Descending part of duodenum, with place of entrance of choledoch duct.

2. Splenic artery.
3. Gastric artery.
4. Hepatic artery.

1. Abdominal aorta.
2. Celiac axis artery.
6. Gastroduodenal arteries.

F. Cystic duct.
G. Lower margin of left lobe of liver.
H. Ductus communis choledochus.
R. Left kidney.

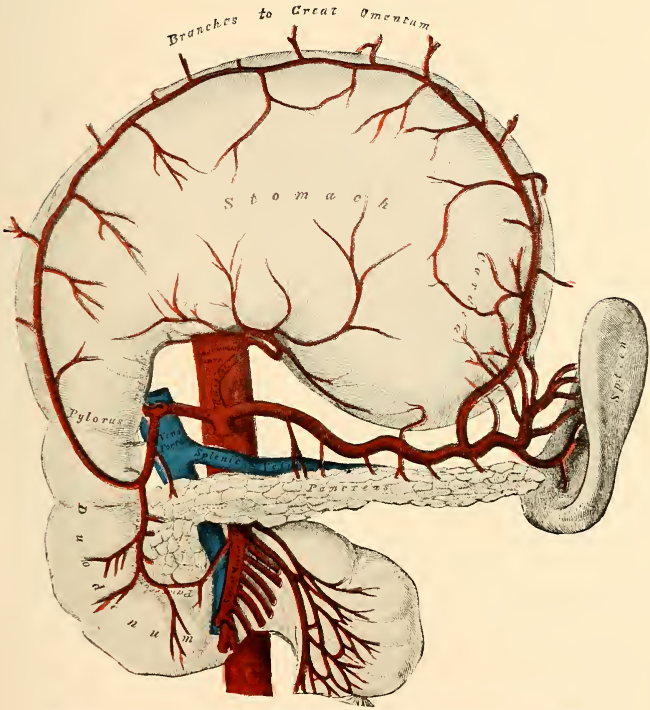
k. Pancreatic duct.
m. Pancreas.
o. Part of duodenum.

5. Pancreas.
6. Spleen.
8. Stomach.

7. Renal artery and vein.
8. Superior mesenteric artery and vein.
9. Portal vein.

PLATE XLI.

CELIAC AXIS AND ITS BRANCHES.



Pancreas, Spleen, and Duodenum in Position, the Stomach Having Been Raised and the Transverse Mesocolon Removed.

(1) **The Tympanic,** supplying the tympanum.

(2) **The Arteriæ Receptaculi,** supplying the walls of the sinuses, the Gasserian ganglion, and the pituitary body.

(3) **The Anterior Meningeal,** supplying the dura mater.

(4) **The Opthalmic,** supplying the eye and its appendages.

(5) **The Posterior Communicating** anastomoses with the posterior cerebral, a branch of the basilar.

(6) **The Anterior Choroid,** supplying the choroid plexus, corpus fimbriatum, etc.

(7) **The Anterior Cerebral** is joined to its fellow by the anterior communicating branch, which is about two lines long.

(8) **The Middle Cerebral,** the largest branch, passes obliquely outward through the fissure of Sylvius, within which it divides into three branches: anterior, median, and posterior.

The Subclavian arises on the left side from the arch of the aorta, and is divided into three portions by the scalenus anticus muscle, the parts being external, posterior, and internal to that muscle. At the outer border of the first rib it becomes the axillary artery. Its branches are about all given off from its first portion. They are the vertebral, thyroid axis, internal mammary, and superior intercostal.

The Vertebral, the first and largest branch, passes up the neck, through the foramina in the transverse processes of six cervical vertebræ, and enters the skull through the foramen magnum. It then passes in front of the medulla oblongata and joins its fellow to form the basilar artery. It gives off two branches in the neck, the lateral spinal and muscular, supplying the spinal column and neck, and four within the cranium, the posterior meningeal, anterior and posterior spinal, and posterior inferior cerebellar, supplying the upper part of the spinal column and back part of the brain.

The Basilar, so named from its position at the base of the skull, is a single trunk formed by the junction of the two vertebral arteries, and ascends from the posterior to the anterior border of the pons Varolii, where it divides into two large branches, the right and left posterior cerebral. The latter arteries and their branches supply adjacent parts of the brain.

The Circle of Willis is an anastomosis at the base of the brain, between the branches of the internal carotid and vertebral arteries, to equalize the cerebral circulation. The two vertebral arteries join to form the basilar, which ends in the two posterior cerebral. These are connected with the internal carotid by the two posterior communicating. The circle is completed by the connection of the two anterior cerebral branches of the internal carotid through the short anterior communicating artery.

The Thyroid Axis is a short, thick trunk, dividing almost immediately into three branches:

(1) **The Inferior Thyroid**, anastomosing with the superior thyroid, and giving of branches: the laryngeal, tracheal, esophageal, muscular, and ascending cervical, which supply those parts respectively.

(2) **The Transversalis Colli**, dividing into two branches, superficial cervical and posterior scapular.

(3) **The Suprascapular**, supplying the superficial tissue of the neck, back of the scapula, and the shoulder=joint.

The Internal Mammary descends along the costal cartilages to the sixth interspace, where it divides into the musculophrenic and superior epigastric, the latter anastomosing with the deep epigastric branch of the external iliac. It gives off branches to the diaphragm, mediastinum, pericardium, sternum, intercostal spaces, etc.

The Superior Intercostal gives off branches to the intercostal spaces, to the posterior spinal muscles, and to the spinal cord.

The Axillary is the continuation of the subclavian, extending from the outer border of the first rib to the lower margin of the axillary space (armpit), where it becomes the brachial. It is deep seated at the beginning, but becomes superficial at its termination. Its seven branches supply the tissues of the thorax, shoulder, and mammary gland.

The Brachial is the continuation of the axillary from the lower border of the armpit to where it divides into the radial and ulnar, which is usually about one=half inch below the bend of the elbow. It is superficial throughout its entire extent, being covered by the integument and deep and superficial fasciæ. Its branches are the superior profunda, nutrient, inferior profunda, anastomotica magna, and muscular, which supply the tissues of the arm. The lower branches, particularly the anastomotica magna, anastomose freely with branches from the radial and ulnar around the elbow both front and back. This anastomosis is of importance to the embalmer when the brachial artery is raised, as that portion of the member below the point of injection is thereby supplied by collateral circulation.

The Radial is one of the divisions of the brachial, extending on the radial side of the forearm, from the bifurcation to the deep palmar arch, and terminates by anastomosing with the superficial palmar arch. Its branches supply the tissues of the radial side of the forearm, wrist, and hand, and inosculate with the branches from the brachial and ulnar arteries.

The Ulnar is the other division of the brachial, along the ulnar side of the forearm. Its branches supply the tissues on the ulnar side of the forearm, wrist, and hand, and anastomose freely with branches of the radial and brachial arteries.

The Superficial Palmar Arch is that part of the ulnar lying in the palm of the hand, and anastomoses with the superficialis volæ from the radial and a branch from the radialis indicis at the root of the thumb. It gives off four digital branches to the sides of the fingers, except the inside of the index finger, which is supplied by the radialis indicis.

The Deep Palmar Arch is formed by the palmar portion of the radial artery anastomosing with the deep or communicating branch of the ulna. It gives off the radialis indicis, palmar interosseous, perforating, and recurrent branches.

The Thoracic Aorta begins at the lower border of the fifth dorsal vertebra, and descends along the left side of the spine to the aortic opening in the diaphragm, where it ends directly in front of the last dorsal vertebra. Its branches are:

(1) **The Pericardiac,** which vary in number and origin, supplying the pericardium.

(2) **The Bronchial,** supplying all the tissues of the lungs. They vary in number and origin, being usually one on the right side and two on the left.

(3) **The Esophageal,** usually four or five in number, supplying the esophagus.

(4) **The Posterior Mediastinals,** supplying the mediastinum.

(5) **The Intercostals,** usually ten in number on each side, dividing into the anterior and posterior branches, and supplying the upper spaces and the spinal cord and tissues of the back.

The Abdominal Aorta descends along the spinal column from the diaphragm to the fourth lumbar vertebra, where it divides into the right and left common iliacs. It diminishes in size rapidly on account of the many large branches given off in its course. Its branches are:

(1) **The Phrenic,** supplying the under surface of the diaphragm.

(2) **The Celiac Axis,** arising near the diaphragm, running forward for half an inch and dividing into the gastric, hepatic, and splenic arteries. (See Plate XLI.)

(a) **The Gastric,** supplying the cardiac end and lesser curvature of the stomach, and the lesser omentum.

(b) **The Hepatic,** supplying the liver, gall=bladder, pyloric end and greater curvature of the stomach, duodenum, and pancreas.

(c) **The Splenic,** supplying the spleen, pancreas, and cardiac end and greater curvature of the stomach. The latter is supplied by the left gastro=epiploic, a principal branch, which, after circling half way around the outer circumfer-

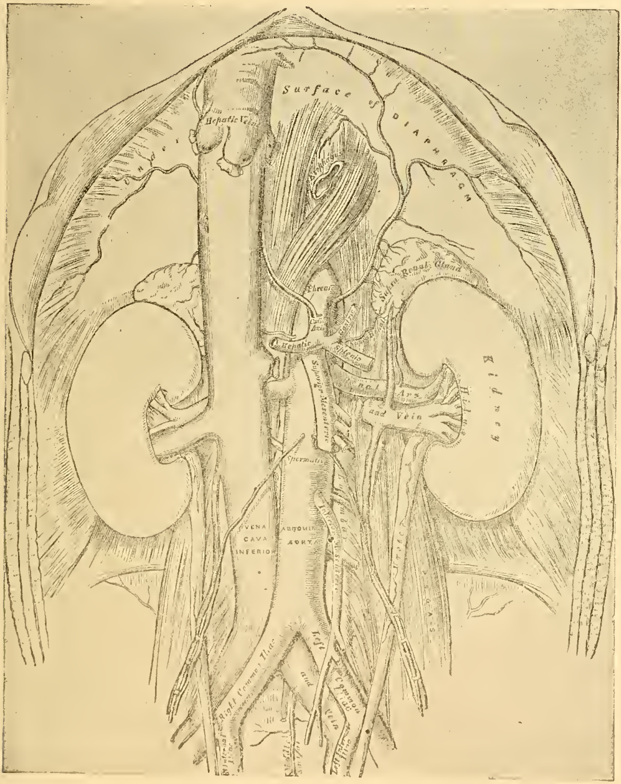


Fig. 29. The Abdominal Aorta and Its Branches.

ence of the stomach, meets and anastomoses with the right gastro=epiploic, from the hepatic artery.

(3) **The Superior Mesenteric,** supplying the small intestine, cecum, and ascending and transverse colon. It arises about one=fourth of an inch below the celiac axis, arching forward and downward to the left, and gives off these branches: inferior pancreatico=duodenal, vasa intestini tenuis, ileocolic, and right and middle colic.

(4) **The Inferior Mesenteric,** supplying the descending colon, sigmoid flexure, and most of the rectum, giving off the following branches: left colic, sigmoid, and superior hemorrhoidal.

(5) **The Suprarenal,** supplying the suprarenal capsules.

(6) **The Renal,** one on each side, supplying the kidneys.

(7) **The Spermatics** (in the male), supplying the testes.

(7a) **The Ovarian** (in the female), supplying the ovaries, uterus, Fallopian tube, and skin of the labia and groin.

(8) **The Lumbar,** usually four on each side, supplying the lumbar vertebræ.

(9) **The Middle Sacral,** arising at the division of the aorta and supplying the sacrum and coccyx.

The Common Iliacs extend from the division of the aorta, at the fourth lumbar vertebræ, to the margin of the pelvis, where they each divide into the external and internal iliacs. They are each about two inches long, the right being somewhat larger than the left. They give off a number of small branches to the peritoneum, psoas muscles, ureters, and surrounding cullular tissue.

The Internal Iliac is a short, thick vessel, about one and a half inches long, extending downward to the upper margin of the sacrosciatic foramen, where it divides into an anterior and posterior branch.

The Anterior Trunk gives off the following branches:

(1) **The Superior Vesical,** distributing branches to the apex and body of the bladder, vas deferens, and ureter. This is that part of the fetal hypogastric artery which remains pervious after birth. The remaining portion dwindles after birth to a fibrous cord, in which condition it continues through life.

(2) **The Middle Vesical** (usually a branch of the above), supplying the base of the bladder and under surface of the seminal vesicles.

(3) **The Inferior Vesical** (in the male), distributing to the bladder, prostate gland, and seminal vesicles.

(4) **The Middle Hemorrhoidal** (usually arising with above), supplying the rectum.

(5) **The Uterine** (in the female), supplying the uterus and broad ligament.

(6) **The Vaginal** (in the female, same as 3), supplying the mucous membrane of the vagina and contiguous part of rectum.

(7) **The Obturator** (sometimes arising from the posterior trunk and sometimes from the epigastric artery), the largest branch, giving off a number of branches within the pelvis and extending through the obturator foramen, dividing into the internal and external branches, which supply the muscles and tissues of the hip.

(8) **The Internal Pudic,** the smallest of the two terminal branches, supplying the external organs of generation.

(9) **The Sciatic,** the other terminal branch, distributing to the muscles of the back part of the pelvis and hip.

The Posterior Trunk (of the internal iliac) gives off three branches:—

(1) **The Iliolumbar,** distributing to muscles in the lower lumbar and iliac regions.

(2) **The Lateral Sacral,** supplying the sacral region.

(3) **The Gluteal,** the largest branch of the internal iliac, and the apparent continuation of the posterior trunk, supplying the gluteus muscles.

The External Iliac is larger in the adult than the internal iliac, and extends in an obliquely downward course, along the inner border of the psoas muscle, from the bifurcation of the common iliac to Poupart's ligament, where it enters the thigh and becomes the femoral artery. Besides a number of small branches to the psoas muscle and neighboring glands, it gives off two branches of considerable size:—

(1) **The Deep Epigastric,** which arises usually a few lines above Poupart's ligament, passes between the peritoneum and the transversalis fascia, to the sheath of the rectus muscle which it perforates, and ascends behind that muscle, to anastomose by numerous branches with the terminal branches of the internal mammary and inferior intercostal.

(2) **The Deep Circumflex Iliac,** which arises opposite the above and ascends obliquely behind Poupart's ligament to the anterior superior spinus process of the ilium, continuing thence along the crest of the ilium. It supplies the internal oblique and transversalis muscles, and other parts, and anastomoses with the iliolumbar, gluteal, lumbar, and deep epigastric.

The Femoral is the continuation of the external iliac. It arises immediately behind Poupart's ligament, passes down the forepart and inner side of the thigh, and terminates at the opening in the adductor magnus muscle, where it becomes the popliteal. Its course corresponds to a line drawn from the center of Poupart's ligament to the inner side of the inner condyle of the femur. It is very superficial in the upper third of the thigh, where it lies in Scarpa's triangle in a strong, fibrous sheath, with the femoral vein on the inside and the anterior crural nerve on the outside. In the middle third it is more deeply seated, being covered by the sartorius muscle in addition to the integument and superficial and deep faciæ, and contained in an aponeurotic canal, called Hunter's canal. The vein now lies on the outer side in close apposition with the artery, with the internal saphenous nerve still more external. The femoral artery gives off seven branches, as follows:

(1) **The Superficial Epigastric,** to the inguinal glands, superficial fascia of the abdomen, and the integument.

(2) **The Superficial Circumflex Iliac,** to the skin over the iliac crest.

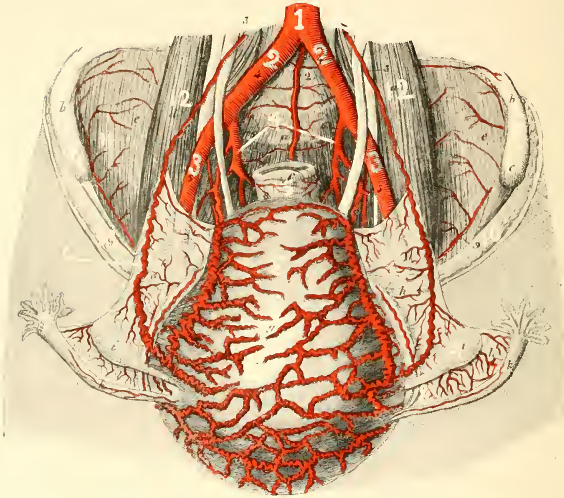
G

BLOOD-VESSELS OF PERINEAL REGIONS AND LOWER EXTREMITIES

FOUR PLATES—XLII.-XLV

PLATE XLII.

BLOOD-VESSELS OF PERINEAL REGIONS.



Arteries of Pelvis and Internal Genital Organs in Female Subject.

a. Sacrum.
b. Crest of ilium.
c. Spina ilii anterior superior.

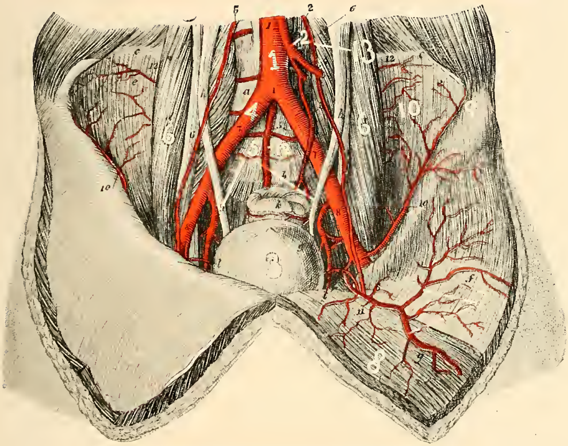
1. Abdominal aorta.
2. Common iliac artery.
3. External iliac artery.
4. Internal iliac artery.
5. Uterine arteries.
6. Internal spermatic arteries.
7. Fimbriated end of Fallopian tube.

g. Uterus.
k. Fallopian tubes.
l. Lateral ligament of uterus.

8. Vessels of the lateral ligament.
9. Ovum, with ovarian ligament.
10. Poupart's ligament.
11. Internal iliac muscle.
12. Psoas magnus muscle.
13. Circumflex iliac artery.
15. Rectum.

PLATE XLIII.

BLOOD-VESSELS OF PERINEAL REGIONS—Continued.



Arteries of Pelvis in Male Subject.

a. Last lumbar vertebra.
b. Sacrum.
c. Crest of ilium.
e. Internal ilac muscle.

f. Transverse abdominal muscle.
g. Rectus abdominis muscle.
k. Rectum.
l. Vas deferens.

1. Abdominal aorta.
2. Inferior mesenteric artery.
3. Bladder.
4. Common iliac artery.
5. Ureters.
6,6. Psoas magnus muscles.
7. Inferior epigastric arteries.

8. Rectus abdominus muscle.
9. Anterior superior spinous process.
10. Internal iliac muscle.
11. Inferior epigastric artery.
12. Middle sacral artery.
13. Internal spermatic artery.

Fig. 1

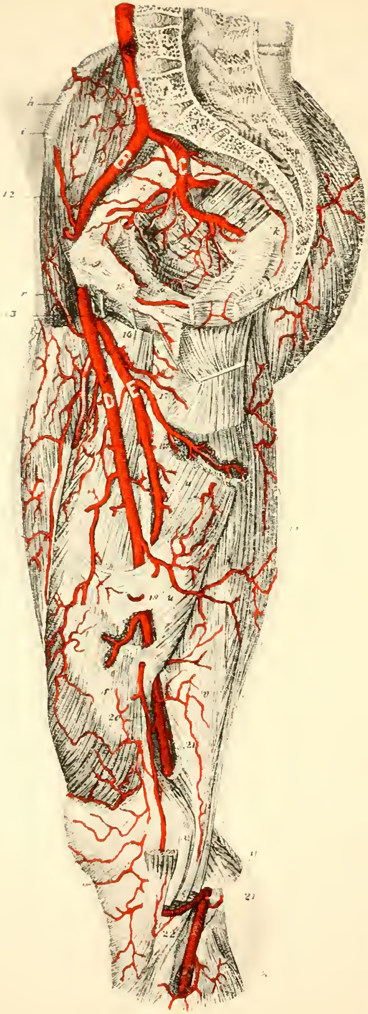


Fig. 2

Fig. 3

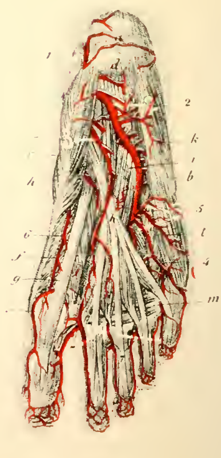


PLATE XLIV.

ARTERIES OF PELVIS AND LOWER EXTREMITIES.

Fig. 1.—Arteries on Internal Surface of Pelvis, Thigh, and Knee of the Right Extremity.

A. Abdominal aorta.
B. External iliac artery.
C. Internal iliac artery.
D. Femoral artery.
E. Profunda femoris.
F. Popliteal artery.
G. Common iliac artery.

c. Spinal canal.
d. Sacrum.
g. Symphysis pubis.
h. Crest of ilium.
i. Anterior superior spine of ilium.
k. Lesser sacrosciatic ligament.
l. Rectum.
m. Internal iliac muscle.
n. Psoas major muscle.
o. Pyriform muscle.
p. Internal obturator muscle.
r. Sartorius muscle.
s. Vastus internus muscle.
t. Rectus femoris muscle.
u. Adductor magnus muscle.
v. Semimembranous muscle.
x. Tendo gracilis.
y. Gastrocnemius (internus) muscle.
z. Soleus muscle.

1. Fourth lumbar vertebra.
2. Fifth lumbar vertebra.
4. Iliolumbar artery.
5. Obturator artery.
10. Middle hemorrhoidal artery.
11. Vesical artery.
12. Circumflex iliac artery.
15. Circumflexa femoris interna.
16. Perforating profunda femoral (1).
17. Perforating profunda femoral (2).
18. Perforating profunda femoral (3).
19. Femoral in Hunter's canal.
20. Anastomotica magna artery.
22. Inferior internal articular of knee.

Fig. 2.—Arteries on Dorsal Surface of Right Foot.

A. Interosseous arteries.
B. Dorsal pedis artery.
C. Os calcis.
D. Astragalus.

c. Navicular bone.
d. Tuber ossis metatarsi (5.)

2. External tarsal artery.
3. Internal tarsal artery.
6. Digital arteries.
8. Communicating branch to deep palmar arch.

Fig. 3.—Plantar Arch of Arteries in Sole of Right Foot.

a. Os calcis.
b. Tuberosities of metatarsal bones.
c. Head of metatarsal bones.
d. Short flexor of foot and toes.
e. Abductor of great toe.
f. Short flexor of great toe.
g. Long flexor of great toe.
h. Long flexor of toes.
i. Accessory muscle.
k. Abductor of the toes (5).
l. Short flexor of toes (5).
m. Transverse of foot.

1. Posterior tibial artery.
2. External plantar artery.
3. Branches of internal plantar.
4. Digital arteries.
5. Communicating branch of deep plantar arch.
6. Plantaris pollicis pedis.
7. Interosseus plantar artery.

Fig. 1

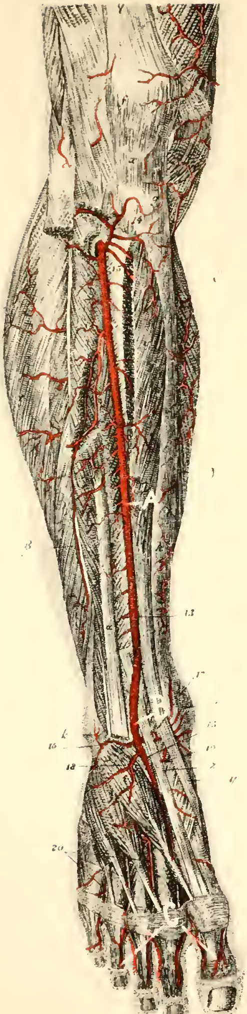
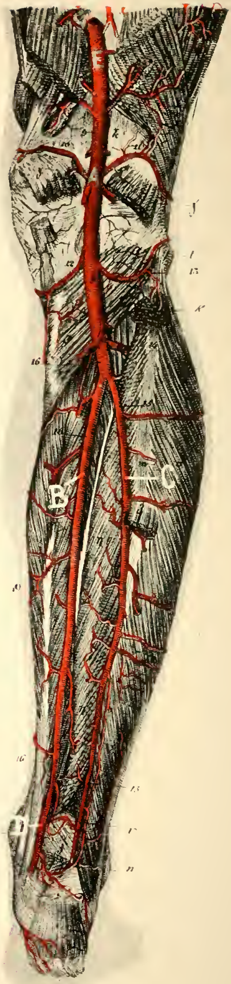


Fig. 2



F. . 3.

PLATE XLV.

ARTERIES OF PELVIS AND LOWER EXTREMITIES—Continued.

Fig. 1.—Arteries on Anterior Surface of Right Leg and Foot.

A. Anterior tibial artery.
B. Point where anterior tibial is usually raised.
C. Digital arteries.

f. Patella.
g. Tuberosity of the tibia.
i. Internal malleolus.
k. External malleolus.
q. Tendo communis extensoris.
x. Ligament of patella.
y. Tibialis anticus muscle.
z. Extensor pollicis pedis longus.

α. Extensor digitorum communis longus.
β. Peroneous tertius muscle.
γ. Soleus muscle.
δ. Gastrocnemius muscle.

14. Recurrent tibial artery.
15. Dorsal artery of foot.
16. External malleolaris artery.
17. Internal malleolaris artery.
18. External tarsal artery.
19. Internal tarsal artery.
20. Interossæ metatarsi dorsalis.

Fig. 2.—Arteries on Posterior Surface of Right Leg.

A. Popliteal artery.
B. Posterior tibial artery.
C. Anterior tibial artery.
D. Posterior tibial at point where usually raised.
E. Femoral artery.

k. Popliteal space.
l. Head of fibula.
m. Fibula.
n. External malleolus.
o. Internal malleolus.
y. Short head of biceps femoris.

β. Popliteus.
γ. Heads of gastrocnemius muscle.
δ. Perineus longus muscle.
ε. Perineus brevis muscle.
ζ. Flexor longus pollicis pedis.
η. Tibialis posticus muscle.
ϑ. Flexor digitorum longus muscle.
ι. Tendon of Achilles.
κ. Soleus muscle.

10. Internal superior articular of knee.
11. External superior articular of knee.
12. Internal inferior articular of knee.
13. External inferior articular of knee.
15. Peroneal of fibula.
17. External posterior malleolar.

Fig. 3.—Deep Arteries in Sole of Right Foot.

A. External plantar artery.
B. Plantar arch.
C. Digitalis pedis plantar.

a. Tuber os calcis.
d. Short flexor of toes.

1. Posterior tibial artery.
3. Internal plantar artery.
4. Tibialis plantaris pollicis pedis.
5. Perforating branches.
7. Interosseous plantar.
9. External plantar of toe.

(3) **The Superficial External Pudic,** to the integument of the lower abdomen, penis and scrotum in the male, and labium in the female.

(4) **The Deep External Pudic,** to the skin of the scrotum and perineum in the male and labium in the female.

(5) **The Profunda Femoris,** called also the deep femoral, is the largest branch. It arises from the back part of the femoral, one to two inches below Poupart's ligament, descends beneath the adductor longus muscle and terminates at the lower third of the back part of the thigh. It gives off the following branches:—

(a) **The External Circumflex,** supplying the muscles at the front of the thigh.

(b) **The Internal Circumflex,** supplying the muscles at the back part of the thigh.

(c) **The Perforating,** usually three in number, piercing the adductor brevis and adductor magnus muscles, which they supply. The terminal branch of the profunda perforates the adductor magnus muscle and is, hence, sometimes called the fourth perforating artery.

(6) **The Muscular Branches,** varying from two to seven, and supplying chiefly the sartorius and vastus internus muscles.

(7) **The Anastomotica Magna,** arising in Hunter's canal, and dividing into a superficial and deep branch, the latter anastomosing around the knee-joint with the superior internal articular and recurrent tibial.

The Popliteal is a continuation of the femoral, and extends downward through the popliteal space behind the knee to the lower border of the popliteal muscle, where it divides into the anterior and posterior tibial. It gives off the following branches: muscular (superior and inferior), cutaneous, superior external and internal articular, azygos articular, and inferior articular (external and internal). These supply the knee-joint and tissues around the knee, and anastomose freely with each other and with other branches above and below the knee.

The Anterior Tibial extends from the division of the popliteal to the front of the ankle=joint, where it becomes the dorsalis pedis. It is superficial in its lower third, lying on the anterior surface of the tibia. Its branches supply the tissues in its course and it gives off the internal and external malleolar at its lower part.

The Dorsalis Pedis extends from the front of the ankle to the first interosseous space, where it terminates in the dorsalis hallucis and communicating. It gives off branches to the outer and front part of the foot and toes.

The Posterior Tibial extends from the division of the popliteal along the back of the tibia to the fossa below the internal malleolus, where it divides into the internal and external plantar. Its branches supply the tissues of the leg, heel, and sole of the foot.

The Internal Plantar passes along the inner side of the foot and great toe.

The External Plantar passes along outward and forward, and at the base of the metatarsal bones it inosculates with the communicating branches from the dorsalis pedis, forming the plantar arch. Its branches supply the muscles on the outer part of the foot, interosseous tissues, the three outer toes, and the outer side of the second toe.

CHAPTER X.

VEINS OF THE SYSTEMIC CIRCULATION.

The Systemic Veins may be classified as: (1) those of the head and neck, upper extremities, and thorax, terminating in the superior vena cava; (2) those of the lower extremities, pelvis, and abdomen, emptying into the inferior vena cava; (3) the cardiac veins, opening directly into the right auricle of the heart.

The Veins of the Head and Neck may be subdivided into four groups: (1) veins of the exterior of the head; (2) veins of the diploe and cranium; (3) sinuses of the dura mater; (4) veins of the neck. (See Plates XXX.—XXXVIII.)

The External Veins of the Head freely anastomose with their fellows of the opposite side and with adjacent branches. The principal ones are:—

(1) **The Facial,** draining the forehead and front of the face, and emptying into the internal jugular.

(2) **The Temporal,** a large vein, commencing by a minute plexus on the side and vertex of the skull, draining the side of the head, and uniting with the internal maxillary to form the temporomaxillary.

(3) **The Internal Maxillary,** receiving branches corresponding to those of the internal maxillary artery.

(4) **The Temporomaxillary,** formed by a union of the last two, descending through the parotid gland between the sternomastoid muscle and the ramus of the jaw, and dividing into two branches, one of which passes inward to join the facial and enters the internal jugular, while the other is joined by the posterior auricular and becomes the external jugular.

(5) **The Posterior Auricular,** descending behind the external ear and receiving the stylomastoid and some tributaries from back of the ear.

(6) **The Occipital,** gathering the blood from the back part of the head.

The Veins of the Diploe are large and capacious, their walls being thin and formed only of epithelium, resting upon a layer of elastic tissue, and presenting at irregular intervals pouch=like dilatations, or culs=de=sac, which serve as reservoirs of the blood.

The Cerebral Veins are remarkable for the extreme thinness of their coats, in consequence of the muscular tissue being wanting, and the absence of valves. They are divided into superficial and deep.

The Superficial Cerebral ramify upon the surface of the brain, being lodged in the sulci between the convolutions. They receive branches from the substance of the brain and terminate in the sinuses.

The Deep Cerebral, or ventricular, two in number, run backward and parallel between the layers of the velum interpositum, pass out of the brain at the great transverse fissure, and unite into one before entering the straight sinus.

The Cerebellar occupy the surface of the cerebellum and are disposed into three sets: superior, terminating in the straight sinus; inferior, terminating in the lateral sinuses; and lateral anterior, terminating in the superior petrosal sinuses.

The Sinuses of the Dura Mater are venous channels analogous to the veins, their outer coat being formed by the dura-mater and the inner by a continuation of the lining membrane of the veins. They are divided into: (1) those at the upper and back part of skull; (2) those at the base of skull. The former are:

(1) **The Superior Longitudinal** occupies the attached margin of the falx cerebri, commencing at the foramen cecum, increasing in size as it runs backward, and opening into the

torcular Herophili. It receives the superior cerebral veins, and numerous veins from the diploe, and dura mater.

(2) **The Inferior Longitudinal** (or inferior longitudinal vein) is contained in the posterior part of the free margin of the falx cerebri, and terminates in the straight sinus.

(3) **The Straight** is situated at the junction of the falx cerebri with the tentorium, is triangular in form, and increases in size as it runs obliquely downward and backward from the termination of the inferior longitudinal to the lateral sinus.

(4) **The Lateral,** right and left, are of large size, situated in the attached margin of the tentorium cerebelli, increase in size as they proceed from behind forward, and empty into the internal jugular veins.

(5) **The Occipital,** generally single, sometimes two, is the smallest of the cranial sinuses. It is situated in the attached margin of the falx cerebelli, and terminates in the torcular Herophili.

The Sinuses of the Base of the Skull, with the lateral sinuses, form a complete circuit. (See Fig. 30.) They are:

(1) **The Cavernous** are vessels of reticular structure, large in size, situated on either side of the sella turcica, extending from the sphenoidal fissure to the apex of the petrous portion of the temporal bone. They receive some cerebral veins and the ophthalmic, a large vein receiving tributaries corresponding to the branches given off by the ophthalmic artery.

(2) **The Circular** is formed by two transverse vessels, connecting the two cavernous sinuses, forming with these a circle around the pituitary body.

(3) **The Transverse** (or basilar) connects the two inferior petrosal and cavernous sinuses, at their junction.

(4) **The Inferior Petrosal** commences in front at the termination of the cavernous sinus and behind joins the lateral sinus, external to the jugular foramen, forming with the lateral sinus the internal jugular vein.

(5) **The Superior Petrosal** is situated along the superior border of the petrous portion of the temporal bone in the front part of the attached margin of the tentorium, and connects the cavernous and lateral sinuses on each side.

The Veins of the Neck, which drain the above, are the four jugulars — external, posterior external, anterior, and internal—and the vertebral.

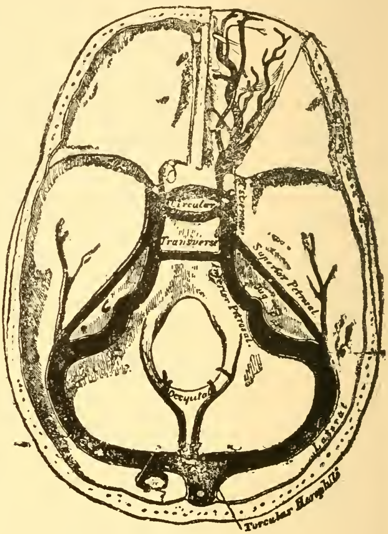


Fig. 30. Sinuses at Base of Brain.

The External Jugular receives the greater part of the blood from the exterior of the cranium and deep parts of the face, being formed by a juncture of the posterior division of the temporomaxillary and posterior auricular. It commences in the substance of the parotid gland, on a level with the angle of the jaw, runs perpendicularly down the neck, crossing the sternocleidomastoid muscle, and terminates in the subclavian, on the outer side, or in front, of the scalenus anticus muscle. It has two pairs of valves, one at its entrance into the subclavian and the other just above the clavicle, which, however, do not prevent the regurgitation of blood or upward flow of fluid. It receives the posterior external jugular, suprascapular, and transverse cervical veins, and sometimes the occipital.

The Posterior External Jugular runs down the back of the neck, opening into the external jugular, just below the middle of its course.

The Anterior Jugular commences near the hyoid bone and drains the front part of the neck, running downward and entering the subclavian near the external jugular.

The Internal Jugular collects the blood from the interior of the cranium, from the superficial parts of the face, and from the neck. It is formed by the junction of the lateral and inferior petrosal sinuses, descends vertically and unites with the subclavian vein at the root of the neck, to form the innominate. In its course down the side of the neck it lies at first on the outside of the internal carotid and then of the common carotid artery. It receives in its course the facial, lingual, pharyngeal, superior and middle thyroid, and the occipital.

The Vertebral commences in the occipital region by numerous small veins from the deep muscles of the upper and back part of the neck, descends by the side of the vertebral artery, and empties into the innominate.

The Veins of the Upper Extremities are superficial and deep. Both sets are supplied with valves, which are more numerous in the deep than in the superficial.

The Superficial Veins lie in the superficial fascia, beginning at the back part of the hand, where they form a more or less complete arch. They are the anterior, posterior, and common ulnar, radial, median, median basilic, median cephalic, basilic, and cephalic. They anastomose freely with each other and with the deep veins.

The Anterior Ulnar commences on the anterior surface on the ulnar side of the hand and wrist and ascends along the inner side of the forearm to the bend of the elbow, where it joins the posterior ulnar to form the common ulnar.

The Posterior Ulnar runs along the posterior surface of the forearm to its juncture with the anterior ulnar.

The Common Ulnar is a short trunk, formed by the union of the two former, and joins with the median basilic to form the basilic. It is sometimes wanting, in which case the anterior and posterior ulnars open separately into the median basilic.

The Radial commences at the back of the thumb and radial side of the hand, communicates with the deep veins of the palm, courses along the side of th forearm, and unites at the bend of the elbow with the median cephalic to form the cephalic.

The Median collects the blood from the superficial structures on the palmar surface of the hand and along the middle line of the forearm. Just below the elbow it receives a branch from the venæ comites of the brachial artery, and immediately divides into the median cephalic and median basilic.

The Median Cephalic is a short vessel which passes outward, joining the radial to form the cephalic.

The Median Basilic is also short, but larger than the above, and passes obliquely inward, joining the common ulnar to form the basilic.

The Basilic is a vein of considerable size, passes upward along the inner side of the biceps muscle, pierces the deep fascia a little below the middle of the arm, ascends in the course of the brachial artery, and joins the venæ comites of that vessel to form the axillary.

The Cephalic ascends on the outer border of the biceps muscle, and terminates in the axillary vein just below the clavicle.

The Deep Veins of the Upper Extremities accompany the arteries, usually as venæ comites, one on either side, and are connected at intervals by short transverse branches. The deep veins inosculate freely with each other and with the superficial branches.

Two Digital Veins accompany each artery along the side of the fingers, uniting at their base and passing along the interosseous spaces in the palm, terminating in the venæ comites of the superficial arch. Branches from these vessels on the ulnar side terminate in the deep ulnar veins. The latter, as they pass in front of the wrist, communicate with the interosseous and superficial veins and at the elbow unite with the deep radial to form the venæ comites of the brachial artery. The interosseous veins accompany the interosseous arteries commencing in front of the wrist and terminating in the venæ comites of the ulnar artery.

The Deep Palmar Veins accompany the deep palmar arch, receive numerous tributaries, communicate with the deep ulnar at the side of the hand, and terminate on the outer side in the venæ comites of the radial artery. The latter continue as the venæ comites of the brachial artery.

The Axillary is of large size, formed by the union of the basilic vein and the venæ comites of the brachial artery, at the lower part of the axillary space, and terminates beneath the clavicle, where it becomes the subclavian. It receives a number of tributaries, the largest being the cephalic, received near its termination. Valves are found in the axillary opposite the lower border of the subscapular muscle and at the termination of the cephalic and subscapular veins.

The Subclavian is the continuation of the axillary, from the outer margin of the first rib to the sternoclavicular articulation, where it unites with the internal jugular to form the innominate. At the angle of this junction the thoracic duct enters on the left side, and the lymphatic duct on the right. It receives the external, anterior, and internal jugulars, and a branch from the cephalic.

The Innominates are two large trunks, one on each side of the root of the neck, formed by juncture of the subclavian and the internal jugular. The right is about one and a half and the left three inches long. They unite below the first rib to form the superior vena cava, and receive the vertebral, internal mammary, inferior thyroid, and superior intercostal; sometimes the left also receives some thymic and pericardiac veins.

The Superior Vena Cava is about three inches long, receives all the blood from the upper half of the body, and terminates in the right auricle of the heart. It is partly covered with the pericardium, and receives the right superior phrenic, vena azygos major, and small pericardiac and mediastinal veins.

The Principal Veins of the Thorax are the

Internal Mammary.	Bronchial.	Right Azygos (Major).
Inferior Thyroid.	Mediastinal.	Left Lower Azygos (Minor).
Superior Intercostals.	Pericardiac.	Left Upper Azygos (Minimus).

The Azygos Veins (see Fig. 31) are the only veins of this region needing particular description. They unite the superior and inferior venæ cavæ, supplying their place in the region behind the heart, where these trunks are wanting.

The Right Azygos begins by a branch from the right lumbar veins, passes through the aortic opening in the diaphragm, and ends in the superior vena cava, having drained nine or ten of the right lower intercostals, the vena azygos minor, the right bronchial, esophageal, mediastinal, and vertebral veins.

The Left Lower Azygos begins by a branch from the left lumbar or renal, passes into the thorax through the left crus of the diaphragm, crosses the vertebral column and ends in the right azygos, having drained four or five lower intercostals.

The Left Upper Azygos, sometimes very small or altogether wanting, receives veins from the intercostal spaces above the left lower azygos; sometimes also the left bronchial.

The Spinal Veins are divided into: (1) those placed on the exterior of the spinal column; (2) those situated on the interior of the spinal column; (3) those of the bodies of the vertebræ; (4) those of the spinal cord. They have no valves and empty into the vertebral and other veins.

The Veins of the Lower Extremities, like those of the upper, are superficial and deep. Valves are more numerous in the veins of the lower than of the upper extremities, and, as in the upper, more numerous in the deep than in the superficial.

The Principal Superficial Veins are the internal or long saphenous and the external or short saphenous.

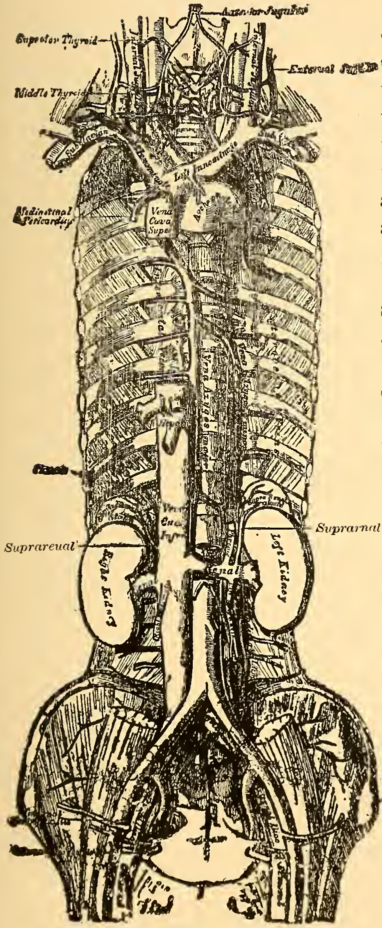


Fig. 31. Venæ Cavæ, Venæ Azygos, Etc.

The Internal Saphenous commences at the inner side of the arch on the dorsum of the foot, ascends in front of the inner malleolus and along the inner side of the leg and thigh, and enters the femoral at the saphenous opening, one and one-half inches below Poupart's ligament. It receives the blood from the superficial branches of the leg and thigh and, at the saphenous opening, the superficial epigastric, superficial circumflex iliac, and external pudic veins. It also communicates with numerous deep veins. The valves vary in number from two to six.

The External Saphenous is formed by the branches from the dorsum and outer side of the foot, and ascends behind the outer malleolus up the middle of the back of the leg, and empties into the popliteal vein. It receives a number of large tributaries from the back part of the leg and communicates at the foot and ankle with the deep veins. It has from three to nine valves, one of which is always near its termination.

The Deep Veins of the Lower Extremities, like those of the upper, accompany the arteries and their branches as venæ comites.

The External and Internal Plantars unite to form the posterior tibial, which accompany the artery, and are joined by the peroneal veins.

The Anterior Tibials are formed by a continuation upward of the venæ comites of the dorsalis pedis artery, which form, by their junction with the posterior tibial, the popliteal.

The Popliteal ascends through the popliteal space to the tendinous aperture in the adductor magnus muscle, where it becomes the femoral. It receives the sural, articular, and external saphenous veins, and has usually four valves.

The Femoral accompanies the femoral artery through the upper two-thirds of the thigh. In the lower part of its course it lies external to the artery; higher up it lies behind it; and beneath Poupart's ligament it lies to the inner side on the same plane. It has four or five valves, and receives numerous muscular tributaries, the profunda femoris, and internal saphenous.

The External Iliac commences at the termination of the femoral beneath the crural arch, and passing upward along the brim of the pelvis, terminates opposite the sacroiliac symphysis, by uniting with the internal iliac to form the common iliac. It receives the epigastric, circumflex iliac, and a small pubic vein. It frequently contains one, and sometimes two, valves.

The Internal Iliac is formed by the venæ comites of the branches of the internal iliac artery (except the umbilical). It receives the blood from the exterior of the pelvis, through the gluteal, sciatic, internal pudic, and obturator veins, and from the organs of the pelvis through the hemorrhoidal and vesicoprostatic plexuses in the male and the uterine and vaginal plexuses in the female.

The Common Iliacs are formed by the junction of the external and internal iliacs, and pass obliquely upward and inward, uniting between the fourth and fifth lumbar vertebræ to form the inferior vena cava. The left is the longer, and receives, in addition to the iliolumbar and lateral sacral received by both, the middle sacral vein.

The Inferior Vena Cava returns the blood to the heart from all parts of the body below the diaphragm. It extends from the juncture of the common iliacs along the front of the spine, on the right side of the aorta, through the tendinous center of the diaphragm, and terminates in the lower and back part of the auricle. At its termination is a valve, the Eustachian, which is large in fetal life, but usually small or altogether wanting in the adult. It receives the

Right and Left Lumbar.	Right Suprarenal.
Right Spermatic.	Right Phrenic.
Right and Left Renal.	Right and Left Hepatic.

The left spermatic, suprarenal, and phrenic usually enter the left renal. The above veins drain the blood from the organs and parts respectively named.

The Cardiac Veins return the blood from the tissues of the heart into the right auricle. They are the great, middle, posterior, anterior, and right cardiac veins, venæ Thebesii, and the coronary sinus. The latter is a dilated portion of the great cardiac (coronary) vein, about an inch in length, and enters the auricle between the inferior vena cava and the auriculo=ventricular aperture, its orifice being guarded by the coronary valve.

CHAPTER XI.

THE OTHER CIRCULATORY SYSTEMS.

THE LESSER OR PULMONARY CIRCULATION.

The Pulmonary System consists of the pulmonary artery, which conveys the carbonated or impure blood from the heart to the lungs, where it undergoes oxygenation; the pulmonary veins, which return the arterial blood to the heart; and the capillaries between.

The Pulmonary Artery, which is the only artery which carries venous blood (except in fetal life), is a short, wide vessel, about two inches long. It arises from the left side of the base of the right ventricle in front of the aorta, passes upward and backward to the under surface of the aortic arch, to which it is attached by a fibrous cord, the remains of the ductus arteriosus of fetal life. At this point it divides into two branches, the right and left pulmonary arteries, which, passing to their respective lungs, again divide, sending a branch to each lobe. Within the lobes these branches divide and subdivide, to ramify throughout the lung tissue and end in the dense network of capillaries. In the lungs the branches of the pulmonary artery are usually above, and in front of, a bronchial tube, with the venous branch below. At the root of the lung the artery is in the middle, with the vein in front and the bronchus behind.

The Pulmonary Veins are the only veins (except the umbilical vein in fetal life) that carry arterial blood. Unlike the veins of the systemic system generally, they are devoid of valves, are only slightly larger than the arteries they attend, and accompany those vessels singly. They originate in the network of capillaries upon the walls of the air=cells, where they are continuous with the ramifications of the smallest branches of the pulmonary artery, and unite to form a single trunk from each lobe. The vein from the middle lobe of the

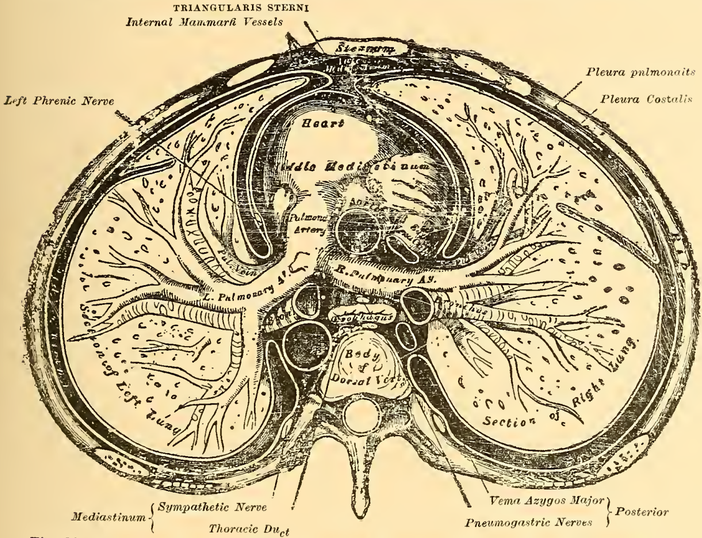


Fig. 32. Transverse Section of Thorax, Showing Pulmonary Vessels, Heart, Lungs, Etc.

right lung usually unites with that from the upper lobe, thus giving two veins from each side; occasionally, the two from the left side enter the auricle by a common opening.

The Pulmonary Capillaries form plexuses which lie immediately beneath the mucous membrane, in the walls and septa of the air=cells and of the intercellular passages. They form a very minute network, the meshes being smaller than the vessels. The walls are very thin, allowing the air to come in contact with the blood within the vessels. The vessels of neighboring lobes are distinct from each other, and do not anastomose.

THE PORTAL SYSTEM OF VEINS.

The Portal System is an appendix of the systemic. It is composed of four large veins, the inferior and superior mesenteric, splenic, and gastric, which carry the blood, together with portions of the digested food, from the digestive viscera. These unite to form a large trunk, the portal vein (vena portæ), extending from the pancreas to the liver, which it enters and ramifies, distributing its blood to every part. The venous blood, after undergoing certain changes in the liver, is again collected by the hepatic veins and emptied into the vena cava.

The Portal Vein is about four inches long, being formed by the junction of the superior mesenteric and splenic, their union taking place in front of the vena cava and behind the upper border of the great end of the pancreas. Passing upward through the right border of the lesser omentum to the under surface of the liver, it enters the transverse fissure, where it is somewhat enlarged, forming the sinus of the portal vein; it then divides into two branches, the right being the larger but shorter. These branches divide and subdivide into still smaller branches which accompany the ramifications of the hepatic artery and hepatic duct throughout the substance of the liver. The portal vein lies behind and between the hepatic duct and artery, the former being to the right and the latter to the left. Filaments of the hepatic plexus of nerves and numerous lymphatics, surrounded by a quantity of loose areolar tissue, accompany these structures.

The Inferior Mesenteric returns the blood from the rectum, sigmoid flexure, and descending colon. It ascends beneath the péritoneum in the lumbar region, passes behind the transverse portion of the duodenum, and the pancreas, and terminates in the splenic vein. Its hemorrhodidal branches inosculate with those of the internal iliac, thus establishing a communication between the portal and general venous systems. Other anastomoses with veins of the systemic system also take place.

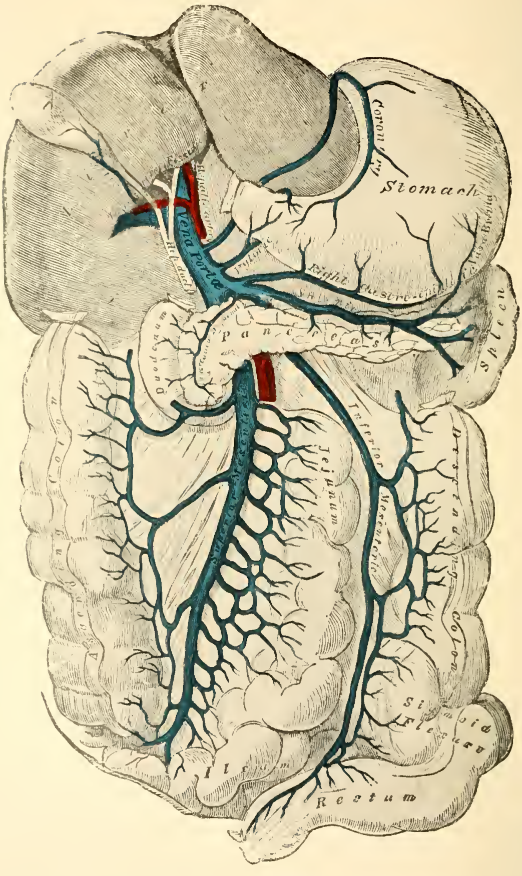
H

PORTAL AND FETAL SYSTEMS

TWO PLATES—XLVI.-XLVII.

PLATE XLVI.

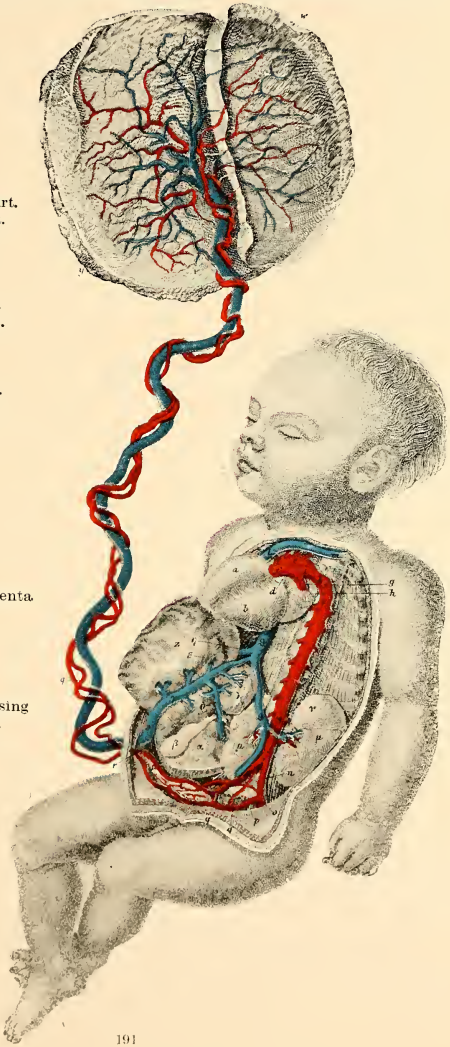
PORTAL SYSTEM OF VEINS.



Portal Vein and Its Branches, Liver, Stomach, Pancreas, Spleen, Portion of Large and Small Intestines in Position (Transverse Colon Removed).

PLATE XLVII.

FETAL CIRCULATION WITH PLACENTA AND UMBILICAL CORD.



a. Right ventricle of heart.
b. Left ventricle of heart.
c. Left auricle of heart.
d. Origin of aorta.
e. Arch of aorta.
f. Pulmonary artery.
g. Left branch (divided).
h. Left pulmonary veins.
i. Ductus arteriosus.
k. Descending aorta.
l. Superior vena cava.
m. Left innominate vein.
n. Common iliac artery.
o. External iliac artery.
p. Internal iliac artery.
q. Umbilical artery.
r. Umbilicus.
s. Umbilical vein.
t. Fundus of bladder.
u. Urachus.
v. Placenta.
w. Amnion.
x. Chorion.
y. Spongy portion of placenta.
z. Left lobe of liver.

α. Right lobe of liver.
β. Gall=bladder.
γ. Umbilical vein.
δ. Portal vein, anastomosing with umbilical vein.
ε. Ductus venosus.
η. Hepatic vein.
ϑ. Inferior vena cava.
ι. Lobus Spigelii.
μ. Kidney.
ν. Suprarenal capsule.

The Superior Mesenteric returns the blood from the small intestine, cecum, and ascending and transverse colon. The large trunk, formed by the union of its numerous branches, ascends along the right side and in front of the corresponding artery, passes in front of the transverse portion of the duodenum, and unites, behind the upper border of the pancreas, with the splenic vein to form the portal vein. Usually the right gastro=epiploic vein empties into the superior mesenteric close to the termination, but in Plate XLV. it opens into the splenic vein.

The Splenic commences by five branches, which return the blood from the substance of the spleen. These form a single vessel which passes from left to right behind the upper border of the pancreas below the artery and terminates at its greater end by uniting at a right angle with the superior mesenteric to form the vena portæ. It is of large size, is not tortuous like the artery, and receives the following additional branches; vasa brevia, left gastro=epiploic, pancreatic branches, pancreatico=duodenal, and inferior mesenteric.

The Gastrics are two in number. The smaller (the pyloric) runs along the lesser curvature of the stomach toward the pyloric end, receives branches from the pylorus and duodenum, and terminates in the vena portæ; the larger (the coronary) begins near the pylorus, runs along the lesser curvature of the stomach toward the esophageal opening, and curves downward and backward between the folds of the lesser omentum to end in the vena portæ.

THE FETAL CIRCULATION.

The Circulation in the Unborn Child is quite different from that in the child after birth. The nutrition of the embryo, though the whole unfolding is extremely complex, is at first of the simplest form, gradually developing by about the fifteenth day into the vitelline circulation, the first stage of the blood=vascular system. Even during this stage the form of circulation is quite simple, being carried on partly within the embryo and partly external to it, in the vascular area of the umbilical vesicle, by means of a tubular heart, from which and to which the blood is carried by two arteries and two veins.

About the fifth week the vitelline circulation develops into the placental circulation, the second stage of the blood=vascular system, and the one with which we have to deal especially under this head. The placental circulation continues until birth, being gradually transformed into the after=birth circulatory system, the third stage. In order to understand better the plan by which the placental circulation is carried on, we will first explain some organs and modifications of organs peculiar to the circulation in fetal life. (See Plate XLVI.)

The Placenta is the organ by which the connection between the fetus and mother is maintained, serving the purposes both of circulation and respiration. It is a soft, spongy, vascular body, adherent to the uterus, and surrounding the fetus, with which it is connected by the umbilical cord. There are, therefore, two parts, the maternal or uterine portion, and the fetal or inner portion. The former is developed from the decidua vera, while the latter is formed out of the villi of the chorion. The maternal portion consists of a number of sinuses formed by an enlargement of the vessels of the uterine wall. These bring the uterine blood into close proximity with the villi of the fetal placenta, which dip into the sinuses. The interchange of fluids necessary for the growth of the fetus and for the depuration of the blood takes place through the walls of the villi, though there is no direct continuity between the maternal and fetal vessels. The fetal vessels form tufts of capillaries, the blood from which is returned by small veins which end in tributaries of the umbilical vein. The maternal arteries open into spaces communicating with a plexus of veins which anastomose freely with each other, and give rise, at the edge of the placenta, to a venous channel, the placental sinus, which runs around its whole circumference. The placenta is detached from the uterus at birth, forming the chief part of the after=birth.

The Foramen Ovale.—In the fetus there is a communicating opening in the septum between the two auricles, called the foramen ovale, which allows the blood to pass from one to the other. It is at first a free, oval opening, but about the middle period of fetal life a fold grows up from the posterior wall of the auricle to form a sort of valve. After birth, as respiration is established, and there remains no longer any need for this short=cut in the circulation, the foramen ovale gradually closes. By about the tenth day the closure is complete and all communication between the two sides of the heart henceforth ceases.

The Eustachian Valve is formed by a semilunar duplicature of the lining membrane of the right auricle, its convex margin being attached to the wall of the inferior vena cava, at its entrance into the auricle. It is large in fetal life and serves to direct the blood from the vena cava on through the foramen ovale into the left auricle. It also prevents the flow of the blood in the opposite direction. The valve dwindles after birth, being commonly small, and sometimes altogether wanting, in the adult, though occasionally it persists in adult life.

The Umbilical or Hypogastric Arteries arise from the internal iliacs, a short distance from their points of origin, ascend along either side of the bladder, pass out of the umbilicus as a part of the umbilical cord, and continue to the placenta, being coiled around the umbilical vein. The name hypogastric is applied usually to the portion within the fetus and umbilical to the portion without. They return the vitiated blood from the fetus to the placenta. At birth the portions extending from the summit of the bladder to the umbilicus contract and ultimately dwindle to solid, fibrous cords, thus continuing through life, while the portions between the bladder and their origin in the internal iliacs, though reduced in size, continue as the superior vesical arteries.

The Umbilical Vein is a large vessel, having its origin in the placenta. It extends along the umbilical cord, enters the abdomen at the umbilicus, and passes upward along the free margin of the suspensory ligament of the liver to its under surface, where it gives off branches to the left lobe and lobi quadratus and Spigelii. At the transverse fissure it divides into two main branches, the larger, after being joined by the portal vein, entering the right lobe, while the smaller, now called the ductus venosus, continues onward and joins the left hepatic vein, as it enters the inferior vena cava. The umbilical vein becomes completely obliterated shortly after birth and continues in adult life as the round ligament of the liver.

The Ductus Arteriosus is a short tube, about half an inch long at birth and the size of a goose-quill. It forms the continuation of the pulmonary artery, and serves to conduct the chief part of the blood from the right ventricle into the descending aorta. The ductus arteriosus begins to contract immediately after respiration is established, becoming completely closed by the tenth day after birth, and remains in adult life as an impervious cord, connecting the pulmonary artery to the aortic arch.

The Ductus Venosus is a short vein, being really a continuation of the umbilical vein from the liver along the longitudinal fissure to the inferior vena cava, which it enters with the left hepatic vein. It continues in adult life as a fibrous cord.

The Unbilical Cord appears about the end of the fifth week after pregnancy. It consists of the coils of the two umbilical arteries and the umbilical vein, united by a gelatinous tissue.

Placental Circulation.—The origin of the blood destined for the nourishment of the fetus, as already explained, is the placenta. From the placenta it is carried to the fetus by the umbilical vein, which enters the fetus at the umbilicus, and passes upward to the under surface of the liver. Here a portion of the blood is supplied to the left, quadratus, and Spigelian lobes. At the transverse fissure the largest portion enters the right lobe, being joined by the portal venous blood. The remainder passes onward through the ductus venosus and enters the inferior vena cava jointly with the blood from the liver delivered by the left hepatic vein. The blood from the umbilical vein, therefore, enters the vena cava in three different ways: a portion enters through the liver and the hepatic veins; a greater quantity passes through the same organs in connection with the portal venous blood; and the smallest part enters direct through the ductus venosus.

In the inferior vena cava this diversified blood is mixed with that being returned from the lower extremities and the abdominal viscera. This blood enters the right auricle, and, guided by the Eustachian valve, passes through the foramen ovale into the left auricle, where it becomes mixed with the small quantity of blood returned by the pulmonary veins. Thence it passes into the left ventricle, and then into the aorta, whence it is distributed almost entirely to the head and upper extremities, a small portion only reaching the descending aorta.

From the head and upper extremities the blood is returned through the superior vena cava to the right auricle. From there it passes into the right ventricle, but little of this current passing through the foramen ovale into the left auricle. From the right ventricle the blood enters the pulmonary artery, but the lungs being solid only a small quantity is distributed to them, the greater part passing through the ductus arteriosus directly into the descending aorta at its commencement. The portion distributed to the lungs is returned by the pulmonary veins to the left auricle, thence to the left ventricle, from which it also passes into the aorta.

The mixed blood in the descending aorta passes downward to supply the lower extremities, the viscera of the abdomen, and the pelvis. The principal portion, however, is conveyed by the umbilical arteries to the placenta, where it undergoes purification, and is fitted for return to, and support of, the fetus.

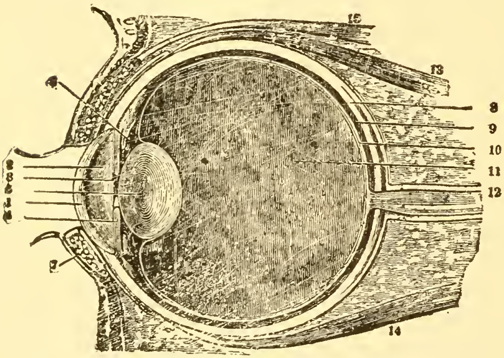
CHAPTER XII.

THE ORGANS OF SPECIAL SENSES.

The organs of the special senses are five in number—those of sight, of hearing, of smell, of taste, and of touch—namely, the eye, the ear, the nose, the tongue, and the skin.

THE EYE.

The Organ of Sight is the eye, which is situated in a bony cavity of the skull (the orbit) protected by the overhanging



1. Cornea.
2. Aqueous humor.
3. Pupil.
4. Iris.
5. Crystalline lens.
6. Ciliary processes.
7. Canal around lens.
8. Sclerotic coat.
9. Choroid coat.
10. Retina.
11. Vitreous humor.
12. Optic nerve.
13. Superior rectus.
14. Inferior rectus.
15. Superior oblique.

Fig. 33. Vertical Section of Eye, Showing Chambers, Tunics, Muscles, Etc.

brow. The position of the eye is such as to insure the most extensive range of vision, and, by the action upon it by numerous muscles, it is capable of being directed to any point.

The Eyeball, the globe of the eye, is spherical in shape and about one inch in diameter. It is imbedded in the fat of the orbit, but is surrounded by a thin, membranous sac which isolates it, so as to allow free movement. The eyeball is composed of several investing tunics, or membranes, and of fluid and solid refracting media, called humors.

The Tunics, or membranes, are three in number: (1) sclerotic and cornea; (2) choroid and iris; (3) retina.

The Sclerotic or outer membrane, (called sclera or sclerotica), is white, tough, dense, and hard, giving form and shape to the eye, and constituting what is known as the white of the eye. It completely surrounds the eyeball, being much thicker behind than in front.

The Cornea is the projecting, transparent portion of the external coat, and forms the front sixth of the globe. Its structure is quite complicated, being made up of four distinct layers.

The Choroid is a thin, highly vascular membrane, of a dark=brown or chocolate color, lying immediately within the sclera. It is pierced behind by the optic nerve and extends as far front as the ciliary ligament. In addition to containing numerous blood=vessels, it absorbs the superfluous light which enters the eye. The ciliary processes, varying in number from sixty to eighty, are formed by the plaiting and folding inward of the various layers of the choroid at its front margin.

The Iris (rainbow) is so called from its varied colors in different persons, which determines the color of the eye. It is a thin colored curtain stretched vertically across the front of the eye, and having a contractile aperture in the center, called the pupil. It is provided with circular and radiating, unstriped muscular fibers, by the action of which the central aperture may be enlarged or diminished. This is an important use of the iris, for by its contraction and expansion the amount of light admitted into the eye is regulated, as all the light reaching the eye enters through the pupil. Too much light irritates the retina. To prevent this the iris contracts, and the pupil becomes smaller. It too little light is received, more light is allowed to enter, by the iris relaxing, and thus allowing the pupil to become larger. The contraction of these fibers, unlike the action of unstriped muscular fibers generally, on account of their peculiar arrangement, is very rapid. The admission of the rays of light through the pupil, which is immediately in front of the crystalline lens, prevents the image which falls upon the retina from being blurred, as would otherwise be the case.

The Retina, the inner and last membrane, is of a delicate structure, and contains a complicated arrangement of nervous tissue, given off from the optic nerve. It is the retina which gives rise to the sensation of sight. The retina never exceeds one=eightieth of an inch in thickness. A lining membrane covers the inner surface. About one=fourth of the outer thickness of the retina is composed of a multitude of colorless, transparent rods, packed side by side, like the seeds in the disk of a sunflower. These rods are interspersed with cones. From the ends of the rods and cones delicate nerve=fibers arise, expanding into glandular bodies. A layer of fine nerve=fibers and gray ganglions, much like the gray matter of the brain, constitutes the interior portion of the retina. From these ganglions emanate filaments which unite with the fibers of the optic nerve. The rods and cones are to the eye what the bristles, otoliths, and Cortian fibers are to the ear.

Chambers of the Eye.—The interior of the eye is divided into three chambers, each filled with a characteristic watery or semifluid substance, termed the humors. These are (1) the aqueous; (2) the vitreous; (3) the crystalline.

The Aqueous Humor is a clear, limpid, alkalin fluid, enclosed in a delicate membrane that fills the anterior chamber of the eye between the cornea and crystalline lens. It is hardly more than water, holding a few organic and saline substances in solution. The iris divides it into two parts, a small portion lying behind that membrane.

The Vitreous Humor, or body, forms about four=fifths of the entire globe, completely filling the cavity of the retina back of the lens. It is a perfectly transparent, albuminous substance, of a jelly=like consistency, enclosed in a structureless, transparent membrane, the hyaloid, which merges at the edge of the crystalline lens into the suspensatory ligament, by which it is attached to the lens.

The Crystalline Lens, or humor, is a transparent, elastic, doubly=convex body, which separates the aqueous and vitreous humors. It is denser, and capable of refracting light more strongly than either of these. It is more convex behind than in front and is kept in place by the suspensory ligament, which, attaches it to the ciliary processes. This ligament being kept tense under ordinary conditions, the front surface of the lens is consequently flattened. The crystalline lens converges the rays of light which enter the eye and brings them to a focus on the retina. When in healthy condition the lens has the power of changing its capacity so as to adapt itself to near and to distant objects.

The Lachrymal Apparatus consists of the lachrymal gland and its excretory ducts. The lachrymal gland is situated in a depression of the bony wall of the orbit, at its outer angle. It is oval in form, about the size of an almond, and its office is to secrete the tears, which flow through small ducts and are spread out upon the eyeball. This secretion is constantly being formed, keeping the eyeball moist, and further assisting in preventing friction between the ball and lids, and also in washing out dust and other foreign matter which find their way into the eye. At the inner angle of the eye is a small basin, called the lachrymal reservoir, which receives the overflow. At either side of this basin are two small canals through which the overplus passes into the nasal duct, which empties into the nose.

Appendages of the Eyes.—The eyelids are folds of skin, which may be drawn over the eyeball, serving as a screen to protect it. They are lined on the inner surface with a very sensitive mucous membrane, which aids in preventing injury to the eye from any irritating substances. The eyelashes, which fringe the eyelids on their free edges, serve as a kind of sieve to exclude dust and other foreign bodies, and also shield the eye from too strong light. An oily substance is secreted by a series of small glands, called the Meibomian glands, located on the inner surface of the eyelids, which act as a lubricator. This substance, covering the edge of the lids, prevents the lids from adhering to each other, and also intercepts the overflow of tears upon the cheek. The conjunctiva is the mucous membrane of the eye. It lines the inner surface of the eyelids and is reflected over the forepart of the sclera and cornea. The inner canthus of the eye is the point for the introduction of the needle in the eye needle process. Six muscles give the eyeball its various motions: four straight, the recti, and two oblique, the obliqui.

THE EAR.

The Organ of Hearing, the ear, is a very complicated and important portion of the human anatomy. It consists of three parts: (1) the external ear; (2) the middle ear; (3) the internal ear.

The External Ear is too conspicuous and well=known to need much description. It is composed of a curiously folded sheet of cartilage, covered with skin, arranged to catch sound. Attached to it are three small muscles, scarcely more than rudimentary in man, but fully developed in many animals, so that the ear can be freely moved. From the outer ear a tube, or canal, called the auditory canal, or external auditory meatus, extends inward about an inch or an inch and a quarter. A thin membrane, called the drum, or membrane of the tympanum, is stretched across the inner end. This membrane is kept soft and elastic by the secretion of a waxy substance, called the ear=wax, or cerumen. Short, stiff hairs spring from the walls of the canal, preventing the entrance of insects and foreign bodies.

The Middle Ear is located just within the drum of the ear, and is a small, irregularly=shaped chamber, or cavity, called the tympanum. Across this chamber hangs a chain of three tiny bones, the auditory ossicles, named respectively: (1) stapes (stirrup); (2) malleus (hammer); (3) incus (anvil). These bones are so very small that they weigh together but a few grains, yet they are covered with periosteum, are supplied with blood=vessels, and articulate with each other by perfect joints, and the joints, in turn, have synovial membranes, cartilages, ligaments, and muscles. The malleus is attached to the drum of the ear, and the stapes to a membrane of the internal ear, while the incus lies between the other two. A thin, delicate membrane separates the middle ear from the internal ear. Opening into the middle ear is a small canal, called the Eustachian tube, which leads to upper part of throat.

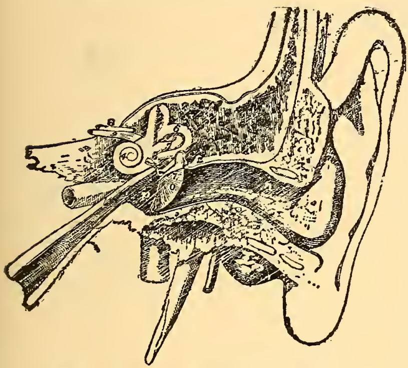


Fig. 34. Sectional View of the Ear.
1, Eustachian tube; n, auditory canal; o, drum; p, tympanum; 1, incus; 2, malleus; 3, stapes; 4, cochlea; 5, 6, 7, semicircular canals; 8, internal auditory meatus.

The Internal Ear is a cavity, very irregular in shape and complicated in structure, hollowed out of the solid bone. From its complex character it is sometimes called the labyrinth. It is made up, in large part, of spiral tubes, which open in front into a sort of court or antechamber, about the size of a grain of wheat, called the vestibule. These spiral tubes consist of three semi=circular canals and the winding stair of the cochlea, or snail=shell, which coils around two and a half times. In the walls of the internal ear are expanded the delicate fibrils of the auditory nerve. The labyrinth is filled with watery fluid, in which floats a little bag containing hair=like bristles, fine sand, and two ear=stones, called otoliths. Within the cochlea are minute tendrils, termed the fibers of Corti, which are regularly arranged, the longest at the bottom and the shortest at the top.

THE NOSE.

The Sense of Smell is seated in the nose, the external portion of which constitutes the most prominent feature of the face. It is composed of cartilage covered with muscles and skin, and joined to the skull by small bones. The nasal passages, or chambers, are situated immediately back, and open at the rear into the pharynx, being lined by a continuation of the mucous membrane of the throat. This membranous lining is supplied with filaments or branches of the olfactory nerve, the nerve of smell, as shown in the accompanying cut. These filaments enter the nasal passages through the cribriform plate of the ethmoid (sieve) bone in the roof. It is through this sieve=bone that the needle is introduced in the nasal needle process. By means of the peculiar property of the olfactory nerves it protects the lungs from the inhalation of deleterious gases and assists the organ of taste in discriminating the properties of food. To properly enjoy this sense the lining membrane of the nose must always be kept in a healthy condition.

Fig. 35. Sectional View of Right Nasal Cavity.

ORGANS OF TASTE AND TOUCH.

The Tongue, the organ of taste, has already been quite fully described in the chapter on "The Digestive Organs" (see p. 91). The sense of taste is located in the papillæ upon the tongue and in the upper part of the palate. A substance, to have taste, must be soluble, as it can only come in contact with the nerve of taste by being absorbed. Taste enables us to distinguish between wholesome and unwholesome foods and drinks. It is in close sympathy with the stomach and often indicates that the stomach will rebel against certain articles of food. By taste, flavors are appreciated, and these, when pleasant, stimulate the flow of the saliva and gastric juice, and thus aid in the digestion of the various foods.

The Skin is the seat of the sense of touch, and because its nerves are spread over the whole body, this is sometimes called the common sense. This sense enables us to appreciate pain, heat, cold, roughness, hardness, and numerous other qualities. The sense of touch is very acute in the tip of the tongue and the tips of the fingers.

CHAPTER XIII.

THE BODY; ITS COMPOSITION AND CHEMISTRY.

WEIGHT OF THE DIFFERENT PARTS.

THE weight of the different parts of the human body of average size (150 pounds) is about as follows:—

	Lbs.	Oz.		Lbs.	Oz.
The skeleton	21	8	Liver	4	1½
Muscles and tendons	77	8	Pancreas	..	3
Skin and subcutaneous fat	16	5	Spleen	..	8½
Brain	3	2½	Thyroid gland and thymus	..	¾
Eyes	..	½	Blood (about ⅛ of body)	17	....
Spinal cord	..	1¼	Heart	..	10¼
Tongue and hyoid bone	..	3	Kidneys	..	10¼
Esophagus	..	1¼	Larynx, trachea, and bronchi	..	2¾
Stomach	..	7	Lungs	2	10¼
Small intestine	1	11½	Unweighed parts	1	12¾
Large intestine	1	1½		—	—
Salivary glands	..	2½	Total	150	00

Another classification is as follows: muscles and their appurtances, 66½ pounds; skeleton, 23 pounds; skin, 10 pounds; fat, 27 pounds; brain, 3 pounds; thoracic viscera, 3½ pounds; abdominal viscera, 10 pounds; blood (estimated amount drained from body), 7 pounds; total 150 pounds. Of the total amount about 86 pounds is water and 64 pounds is solid matter.

THE CHEMICAL CONSTITUENTS.

The chief inorganic, proximate constituent of the human body is water, which, as will be seen from the above classification, amounts to about 57 per cent. of the entire weight of the body. Some authorities make this proportion considerably larger. Next in quantity are calcium phosphates and carbonates; sodium and potassium chlorids; phosphates, and carbonates of soda and potash; phosphates and carbonates of magnesium; fluorid of calcium; and certain compounds containing iron, silica, and manganese, and besides traces of accidental substances, such as copper, lead, and aluminum. To these must be added ammonium, which exists in combination with the urine, and carbonic acid, oxygen, and hydrogen gases.

The percentage of the ultimate elements is as follows:—

Oxygen	72.	Sodium	.1
Hydrogen	9.1	Potassium	.026
Nitrogen	2.5	Iron	.01
Chlorin	.085	Magnesium	.0012
Fluorin	.08	Silica	.0002
Carbon	13.5	Manganese trace	.0000
Phosphorus	1.15		
Calcium	1.3	Total	100.0000
Sulphur	.1476		

The entire body, with its natural moisture, is composed, therefore, of about 84 parts of gaseous elements (the first five named above) to about 16 parts of solid elements. The greater part of the oxygen and hydrogen exists in the state of water, but the drier residue still contains some of the gaseous as well as the solid elements. The solids would consist of the following elements: oxygen, hydrogen, carbon, nitrogen, phosphorus, sulphur, silica, chlorin, fluorin, potassium, sodium, calcium, lithium, magnesium, and iron (manganese, copper, lead), and may be arranged under the heads: proteids, carbohydrates (or amyloids), fats, and minerals. Such a body would lose in 24 hours (in grains): water, 40,-000 nearly 6 lbs.); other matters, 14,500. In the latter would be included: carbon, 4,000; nitrogen, 300; mineral matters, 400.

CHIEF CHEMICAL COMPOUNDS OF THE BODY.

The chief chemical compounds of the body, many of them very complex indeed, are described in the following pages, together with the processes they undergo, either in building up and sustaining life, or in eliminating the waste.

Fats are widely distributed in the human body; indeed, protoplasm always contains some fat, and every cell, therefore, has more or less of these compounds. The fat is stored up, usually, in the subcutaneous areolar tissues and about the abdominal viscera. Fats are neutral compounds, resulting from the union of glycerin, triatomic alcohol, with a mono=basic fatty acid. If the fatty acid is stearic acid, the resulting fat is tri=stearin or stearin. Similarly, with palmitic and oleic acids, the corresponding fats, palmitin and olein, result. Ordinary fats are really mixtures, in variable amounts, of several fats: stearin, palmatin, and olein.

When pure, fats are colorless, tasteless, and odorless, and are insoluble in, and lighter than, water. They are soluble in boiling absolute alcohol, ether, chloroform, and benzol, and are neutral in reaction. As the result of exposure to physical, chemical, or living agents, they are readily divided into their constituent parts, glycerin and fatty acid. Fat taken in as food is not absorbed into the system until it reaches the small intestine, where the pancreatic juice acts upon it. The fatty acid, thus superated, combines with the sodium carbonate present and forms a sodium soap. A small amount of this soap emulsifies a large amount of fat, thus dividing it into very minute globules, in which form it becomes absorbed. Many bacteria exercise a similar fat=splitting action, and, by their activity, fatty acids are formed in the intestines. The bile secretion also aids in the absorption of fat. A part of the fat deposited in the body is derived directly from the fat in the food, and part is formed in the body out of proteins and carbohydrates. The fat deposited in the tissues serves as a reserve to generate heat and energy. The large amount of carbon and hydrogen contained in the fat explains the great quantity of heat generated when fat is oxidized, and the need of an abundance of fat as food in a cold climate.

Carbohydrates comprise those substances which usually contain hydrogen and oxygen in the same proportion as does water (H^2O) and six carbon atoms or a multiple of six. Recent investigations, however, have shown that there may be carbohydrates containing from four to nine or more carbon atoms. Carbohydrates are present in comparatively small amounts in the animal body, either free or as constituents of certain complex proteids. They constitute, however, the greater part of the solids of plants, just as proteids make up the greater part of the solids of animal bodies. They are aldehyde or ketone derivatives of certain alcohols. Carbohydrates are classified as (*a*) mono=saccharides or glycoses, including pentoses, hexoses, (dextrose, laevulose), and rhamnose; (*b*) di=saccharides or saccharoses, as cane=sugar, milk=sugar, maltose, and iso=maltose; (*c*) poly=saccharides; (*d*) mannite; (*e*) inosite. Dextrose or glucose (grape or starch=sugar) is formed during digestion. It is present in small quantity in the blood, and in lesser amount in normal urine. Lactose, (milk=sugar) occurs in the milk of all animals, the amount varying from 3 to 6 per cent. Maltose, another sugar, is formed by the ferments of the saliva, pancreas, and liver. The formation of dextrose precedes that of maltose. Starch, or amylum, is a highly complex carbohydrate, and is converted into and deposited as fat. It is insoluble in cold water. In the presence of chlorid of zinc, and other salts, it swells up and dissolves. On heating with water to 60° to 70°, it swells to a paste, but does not form a true solution. At a higher temperature, it does dissolve, forming soluble starch. Dextrin is the name of a number of compounds that are the first hydration products of starch. Glycogen is found in the liver, and in greater or less amounts in all the animal tissues. It is non=crystallized, white, tasteless powder, present in small amounts in normal blood.

Proteins.—Representatives of this group are found in every living organism. They are present within the cell as an integral part of protoplasm, and are always present in the fluids without the cell. They contain, in addition to carbon, hydrogen, and oxygen, nitrogen and sulphur, and some have phosphorus and iron. The animal organism cannot make protoplasm, hence lives and grows on inorganic nitrogen, sulphur, and phosphorus. These elements are supplied only through the proteins existing ready made in our food. However, not all the members of this group are capable of sustaining life; this is notably true of the albuminoids. Those members are of utility as real food, which, when acted upon by the digestive fluids, yield peptons, which in turn can be reconstructed into serum, albumin, and globulin. The members of this group constitute by far the most complex bodies known to the chemist. Proteins may be classified as (*a*) albuminous bodies, as albumins, globulins, peptons, etc.; (*b*) proteids, or complex albuminous bodies, which on cleavage yield members of the preceding group, as hemoglobins, caseins, mucleins, etc.; (*c*) albuminoids, or albumin=like bodies, as keratins, elastins, etc. Albumin coagulates in a slightly acid or neutral solution, especially in the presence of a neutral salt, as chlorid of sodium. Globulin requires a neutral salt to keep it in solution. Hemoglobin, on heating, decomposes into hematin and globulin. The albumoses are precipitated by chlorid of sodium, and the precipitate, unlike albumin and globulin, dissolves on heating. Peptons are not coagulated by heat.

Saliva is a mixture of the secretions of the parotid, submaxillary, and sublingual glands. The reaction of mixed saliva is usually alkaline, but, on fasting, during the latter part of the night, two or three hours after meals, and after much talking, may become acid; it also becomes acid on standing a few hours, Saliva is more or less viscid and foams readily. Its character varies according to the gland from which mostly derived; the parotid gland yields a fluid secretion, while slimy secretions are given out by the others. In fevers, the diminution or even suppression of the saliva results, causing dryness of the mouth and throat and altered taste; a decrease is also noticed in diabetes, severe diarrhea, and cholera. Potassium iodid, or mercury, produces an abnormally increased flow, know as salivation. An increased flow is also caused by irritant poisons, such as acids and alkalis; by certain foods, as lemons, etc.; by some diseases, especially in inflammatory conditions of the mouth, tonsils, and palate. Salivary calculi, consisting chiefly of calcium carbonate and phosphate, cemented with organic matter, are occasionally deposited in the salivary ducts. The tartar deposited on the teeth has essentially the same composition. These calcium salts are held in solution in the saliva by carbonic acid. On exposure to the air this passes off and the salts are deposited. The amount of saliva secreted in twenty=four hours is 1,400 to 1,500 c. c. (21½ to 23 grs.). The flow is increased after meals and by pilocarpin. The ferment or enzyme present is known as ptyalin, and possesses a diastatic action, converting starch into dextrin, then into iso=maltose and maltose. Eventually glucose forms, probably the result of the action of an inverting ferment. A microscopic examination will show epithelial cells from the mouth and tongue, as well as salivary and mucous corpuscles. Bacteria are always present.

Gastric Juice is the combined product of the cardiac and pyloric glands of the stomach, and normally possesses an intense acid reaction, due to the presence of free hydrochloric acid. It is a watery fluid which filters easily and is not slimy. The contents of the stomach may include (*a*) microscopical constituents, as remains of food, squamous epithelial cells, blood=cells, various micro=organisms, sarcins, yeasts, etc.; (*b*) soluble chemical constituents, as proteolytic enzyme, pepsin, rennin, hydrochloric acid, organic acids, acid phosphates, peptones, etc. The secretion from the pyloric end of the stomach is said to be alkalin and to contain only pepsin, while that from the cardiac end is intensely acid. The hydrochloric acid is derived from the sodium chlorid in the blood, being freed by action of the carbon dioxid, also found in the blood. Hydrochloric acid is an effective germicide, but does not affect the spores. It also stops the diastatic action of ptyalin on starch. Salivary digestion of starch does not necessarily cease when the food reaches the stomach; nor does it follow that all bacteria are destroyed in the stomach. Indeed, the starch conversion will continue until free hydrochloric acid has permeated the entire food=mass in the stomach. If the mass of food is large, or the amount of hydrochloric acid secreted small, this diastatic action may continue for a considerable time after the food reaches the stomach. With the decrease in the quantity of free acid, its inhibiting effect on bacteria is diminished, and, in consequence, the bacterial growth in the stomach may become enormously developed, resulting in various fermentations. The longer food remains in the stomach because of sluggish action, the more marked will such decomposition be. If a sufficient interval is allowed between meals the stomach will undoubtedly disinfect itself.

Pancreatic Juice is a clear, thick, alkaline fluid, rich in solids, and possesses very active ferment properties. It contains at least three distinct ferments, besides albumin, leucin, fats, soap, and salts. These solid constituents make up about 10 per cent. of the secretion. Ingestion of food stimulates the flow; during starvation there is no secretion. Steapsin, one of the ferments, acts upon the neutral fat taken into the body with the food, and splits it up, by hydration or saponification, into free fatty acids and glycerin. However, only a small portion of the fat undergoes the change. The free acids combine with sodium carbonate to form soaps, and the resulting soap solution readily emulsifies the remaining neutral fat, bringing it into a finely divided condition, suitable for absorption. A considerable portion may at times be decomposed into free fatty acids, through the activity of bacteria. The free fatty acids are not absorbed, as such, but appear to be regenerated in the intestinal walls by synthesis, into neutral fat. The cleavage of fats by the pancreatic ferment, and the subsequent emulsification, is necessary to the proper absorption of fat. The second ferment, amylopsin, resembling that of ptyalin of the saliva, acts on starches, splitting up the bodies into dextrin and iso=maltose. The third ferment, trypsin, is proteolytic in its action. This ferment does not exist as such in the substance of the gland, but is represented by a parent=substance, trypsinogen, which is most abundant in from fourteen to eighteen hours after a meal. This zymogen, during the process of secretion, is converted into trypsin. Trypsin, in its purest condition, gives proteid reactions, is soluble in water, and insoluble in alcohol and glycerin.

Bile is a mixture of the secretion of liver cells and of mucin derived from the cells lining the gall=bladder and duct. It is a thick, tenacious fluid, is yellowish, sometimes greenish; is alkalin in reaction; is of a bitter taste; and does not coagulate on heating. In health, about one pint is secreted every twenty=four hours. The secretion is continuous, but variable. A slight obstruction of the bile=duct may lead to retention of the bile; as a result, the bile=constituents are absorbed, and may appear in the urine. Bile contains, as characteristic constituents, certain salts of bile=acids, bile=pigments, and small quantities of lecithin, cholesterin, soap, neutral fat, urea, and salts of calcium, magnesium, iron, and copper. The bile=acids are usually present as sodium salts. A number of bile=pigments are known, but, usually, in normal bile, there are but two, bilirubin and biliverdin. The former is of a reddish=yellow color; the later greenish. The color of bile is due to the predominance of one or the other. The bile=pigments are soluble in alkalis, insoluble in acids, and yield insoluble compounds with calcium and other metals. Bilirubin is slightly soluble in alcohol and in ether, and readily soluble in chloroform. Biliverdin is insoluble in chloroform. Bilirubin, in addition to being in the bile, is met with in bile=stones as a calcium compound, in old blood extravasations (hematoidin), and in urine and tissues during jaundice.

Blood is usually a dark-red, thick, opaque fluid. It consists of red and white corpuscles and plates or crystals suspended in the liquid portion, the plasma. The solid portion may constitute nearly one-half the weight of the blood. The blood of the adult man contains in each milimeter about 5,000,000 red and 7,500 white blood corpuscles, and 250,000 blood plates. That of woman contains about 500,000 red corpuscles less. The blood possesses a distinct alkaline reaction, due, chiefly, to sodium carbonate. This alkalinity is decreased considerably in febrile conditions, diabetic coma, cancer, and after excessive muscular exercise, due to the increased production of acids, which result in the increased disintegration of protein tissues. The average diameter of the red corpuscles in the blood of man is about 1/3200 of an inch. The opacity of the blood is due to the suspended blood-corpuscles. The white corpuscles, or leucocytes, differ considerably in form and size, being larger and lighter than the red cells, and contain from one to four nuclei each. They show ameboid movement. The leucocytes consist largely of the complex proteid, neucleo=histon. The blood=plates are supposed by some to be derived from nuclei, and hence consist chiefly of nuclein. The plasma contains about 8.2 per cent. of solids; of this amount, 6.9 per cent. is due to proteins and 0.87 per cent. to inorganic constituents, such as chlorids, phosphates, and carbonates. There are three albuminous substances contained in the plasma: fibrinogen, serum globulin, and serum albumin. Fibrinogen resembles the globulins, but is distinguished from serum globulin, especially, by its behavior with sodium chlorin, which precipitates it on semi-saturation. Fibrinogen solutions coagulate when heated to 56° or less. The globulins, fibrinogen, and serum globulin make up most of the proteids of the blood. Serum albumin, which is present in plasma, and possibly other proteins of the blood, is made by the epithelial cells of the intestine out of the pepton prepared by the digestive fluids. The pepton made in the stomach and intestine is not absorbed and carried through the body as such, but is regenerated, synthesized, to serum albumin by the cells of the intestinal wall. The blood coming from the intestines does not contain pepton or albumose in solution. Coagulation of the blood takes place in a few minutes after blood is removed from the body, when it clots, forming a solid jelly, consisting of a network of fibrin threads, containing in its meshes the blood=corpuscles and the fluid part of the blood. Finally the clot shrinks, and a light=yellow fluid, called blood=serum, is squeezed out. If the blood. as soon as drawn from the body, is rapidly stirred with the hand, or whipped with a bundle of sticks, glass rods, or wire, the solid clot will not form, but, instead, the hand or stirring rods will be covered with shreds of fibrin or blood=fiber. The resulting fluid is called defibrinated blood; it is blood=serum containing in suspension blood=corpuscles. The fibrin shreds, when washed, are pure white, and resemble, in many respects, the white of an egg. Coagulation, therefore, implies the formation of fibrin. This change is brought about by the action of the fibrin ferment derived from leucocytes, or serum globulin and fibrinogen. The fibrin ferment is apparently a globulin, not a nuclein. It is not present in fresh arterial blood, nor is it present in pepton or histon plasma.

Milk is a secretion of the mammary gland, and is composed of water, casein, globulin, albumin, fats, milk=sugar, and inorganic salts. Its color is due, in part, to suspended fat globules, and in part to the casein held in solution by calcium phosphate. The reaction of milk is usually alkaline or amphoteric, but may be acid. Casein is a complex proteid belonging to the nuclo-albumins. It is insoluble in water, but is dissolved readily in the presence of alkalis. Casein is derived, apparently, from a nucleo=proteid contained in the protoplasm of the cells of the gland. The globulin of milk, or lacto=globulin, is probably identical with serum globulin. The fat is present as an emulsion of fat globules. The sugar present in milk, lactose, is a specific product of the gland=cells and is not directly derived from the blood.

Urea, the chief solid constituent of urine, is the principal form in which waste nitrogen leaves the body. The nitrogen present in the complex proteins, derived from the food and present in the fluids and cells of the body, when disintegration results, passes through a series of successive cleavage products, and eventually appears in the urine as urea, or as other waste nitrogenous substances. The original source of urea is the protein matter of the foods and tissues. The total nitrogen in the food is eliminated by the kidneys within twenty=four hours as waste nitrogen. Some of this waste nitrogen naturally results from the destruction of the tissues of the body, and of hemoglobin. The remainder probably results from the direct breaking down of circulating proteins. The urea, which is made in the liver, is carried by the blood to the kidneys, and there excreted. Since the kidney is the organ eliminating urea, it follows that in structural disease of the kidneys such elimination will be decreased or even suppressed. In that case, urea accumulates in the blood and tissues, and is partially excreted by the sweat, vomit, and intestinal discharges. Poisoning will follow either non-elimination of urea and other waste products, or non-formation of urea. Ammonia is always found in normal urine, not free, but combined as a salt,—chlorid, sulphate, or phosphate.

PART SECOND.

MODERN AND PRESENT EMBALMING.

CHAPTER XIV.

ANCIENT EMBALMING.

We are so accustomed to plume ourselves upon the achievements of this (nineteenth) century, its discoveries and inventions, and its progress in the arts and sciences, that we are often prone to forget its indebtedness to all preceding ages and generations. St. Paul, the great and learned apostle, declared that he was "debtor both to the Greeks and to the Barbarians; both to the wise, and to the unwise." So, likewise, are we of to-day—

"We the heirs of all the ages, in the foremost files of time."

For every age is the inheritor of the wisdom conveyed through the successes and failures of all its predessors, and is enabled, by the proper application of such wisdom, to further its own advancement. Forward is the watchword of Time. The earth does not

"Stand at gaze like Joshua's moon in Ajalon."

Nevertheless, its inhabitants, in their accomplishments, crept before they walked, and walked before they began their grand triumphal march toward great material and intellectual victories—for which march, in these latter days, the music of the spheres themselves seems furnishing the lively quickstep.

In the pride that swells our hearts at the knowledge that we "live and move and have our being," in this age par excellence of all the eons yet emanated from the Deity, this reflection may beget within us a seemly humility. The present age—that contributes to the world such triumphs of the electrician, bacteriologist, and general scientist, to say nothing of corresponding conquests in numberless other fields and pursuits; that, having found the X-ray, proposes to subjugate, therewith, the microbe; that sets no limit to its ambition, and whose bright lexicon contains no such word as "impossible"—has accomplished only that which its forerunners have rendered feasible, when it ceases to speak of "first principles" and presses on to perfection.

In nothing is this tendency to press on toward perfection more clearly demonstrated than in the progress which has been made in the art of embalming. What was, in ancient times, a labor attended with much ceremony, delay, and many drawbacks, becomes, to the thoroughly=equipped scientific operator of to-day, a simple task, accomplished in a brief space of time, by the use of a comparatively small quantity of preservative fluid.

The embalmer does not enter our houses heavily laden with hundred=pound weights of myrrh, aloes, saffron, and cassia. He is not burdened with opobalsam—the resinous exudation called balm of Gilead, yielded by terebinthine evergreens of Asia and Africa—; his assistants are not loaded down with gypsum, or bitumen.

Among the distinctive characteristics of the work of our times are skilled scientific methods and simplicity of detail, which enable us effectually to discard a majority of the cumbersome requisites indispensable to the laborers of bygone ages.

Still, to the forerunner in any field of meritorious performance, is due, of right, that acknowledgment belonging to the pioneer, however convincingly he who comes afterward may be able to say, "And yet show I unto you a more excellent way."

EGYPTIAN METHODS.

It seems peculiarly appropriate that Egypt—that land of mystery—should have been the first, so far as we have knowledge, to embalm the human body after death. Egypt, with its hieroglyphed, cartouched monoliths, mighty pyramidal stairways ascending toward the sky, and grove-shaded temples approached through massive gateways and avenues of sphinxes!

Egypt, the land of beauty, bearing olives, dates, and citron trees; glowing pomegranates and ruddy=hued guavas; perennially green acacias, papyrus reeds that fringe the stream, and gardens sweet with rose and heliotrope!

Reasons for Embalming.—The men who reared Luxor and graved pictoral history on Karnac's walls and lofty pillars, with so lasting, yet so delicate a stroke, must have been beings deeply imbued with sentiments and sympathies of a religious nature. To these feelings, doubtless, may be ascribed their reason for making such an elaborate disposition of the remains of their departed friends. Other assumptions as to the causes from which this custom took its rise have been made, but their credibility fades into insignificance when compared with this. One of these other assumptions is based on the assertion that sanitary expediency was the prompting motive; another, that the periodical overflow of the Nile furnished hindrances to the ordinary form of interment. Still, we cannot but be firmly persuaded that a deeply=rooted religious belief or superstition promoted this endeavor, their aim being to make the best possible provision lying in their power to secure a happy future for those whom they loved.

Herodotus, the Greek historian, tells us the Egyptians were the first people to believe that the soul is immortal. In addition to this faith they held that this immortal tenant of the human frame would never fully abandon its place of habitation so long as the body withstood the ravages of corruption. Embalming but emphasized their idea that if the body be kept free from putrefaction, its immaterial tenant would revisit it from time to time, and return to take up its abode once more at the expiration of a certain period. It was a tenet of their faith, that, after death, the soul was compelled to make the circuit of all forms of animal life—bird, beast, and reptile—, until it had dwelt for a time in each of them. It then passed through earth, air, and water, and after the "circle of necessity" had been completed, returned to its long=

empty tenement and entered in. This journey could not be traveled under 3,000 years, and the embalmer's aim was so to preserve the body, that, when such a period should have elapsed, the home-coming soul would find all things in readiness for its reception.

The lengthy and painstaking preparation bestowed upon the body in the embalming of that day speaks well for the estimate of worth the Egyptians placed on the immortal part of man.

Embalmers of the Medical Fraternity.—It is probable that the embalmers of that period belonged to the medical fraternity, as we read in the fiftieth chapter of Genesis that "the physicians embalmed Israel," the father of Joseph, who died in Egypt. Some writers have objected to this statement on the ground that embalmers were, according to Herodotus, simply persons appointed by law "to exercise this art as their peculiar business." Also, it is so claimed, for the reason that such persons were drawn from the ranks of the priesthood. It is easy to reconcile these objections with the Bible statement when it is remembered that Egyptian physicians were a body of specialists. "So wisely," says Herodotus, "was medicine managed by them, that no doctor was permitted to practice any but his own peculiar branch." The embalmer, even though from priestly ranks, originally must have been compelled to acquire some knowledge of the action of drugs and essences employed in the embalming of the body, upon its organs and tissues. Knowledge of this character may have given him a right to the title of "physician," and license to practice in "his own peculiar branch," as an embalmer.

Selecting the Pattern.—Immediately after death the body of the deceased was brought to the embalmers by his friends. To these friends were displayed wooden models and painted representations of different forms in which mummies were, so to speak, "done up." A favorite style was that of likeness to the god Osiris, who, in addition to other peculiarities, had the beard cut and arranged in a form belonging exclusively to the gods. All who had lived virtuous lives and were accounted worthy of being finally reunited after death with the god from whom they emanated, were entitled to have their bodies preserved in this likeness and to be called by this holy name.

Fig. 36. Mummy, Mummy-cases, and Sarcophagus.

Removing the Brain.—When the pattern was finally agreed upon, and the price to be paid for the service about to be rendered determined, the friends withdrew, leaving the subject in the embalmers' hands. Herodotus says the work was begun by removing the brain, through the nostrils, with a curved iron hook or probe, and that the cavity from which the brain was extracted was then cleansed by an injection of certain astringent drugs with which the skull was filled.

Diodorus does not mention, in his account of the process, the extraction of the brain in this manner; and this statement has met with dissent, on the ground that extraction of the brain through the nostrils would be an exceedingly difficult, if not absolutely impossible, undertaking. That even if it could have been done, the nose must by this means necessarily have been mutilated and the likeness destroyed; whereas we are informed that "so perfectly were all the members preserved, that even the hairs of the eyelids and eyebrows remained undisturbed, and the whole appearance of the person was so unaltered that every feature might be recognized." Gryphius suggests that the brain might have been extracted through a foramen, or orifice, in the back part of the head, near the upper vertebra of the neck. But, as heads indicating this disposition of the brain have not generally been found in mummies, it gives room for still another theory—that of the injection of cedar oil, or some similar tissue-destroying substance, through the nostrils or ear-passages, by way of an artificial canal prepared for it, and the subsequent coming away of the brain in a state of dissolution. The injection of spirituous or aromatic wines could then have acted as cleansing agents, followed by the final injection of melted bitumen, or sweet balsam, which becomes a solid mass, filling the skull, when cold. Many mummy skulls have been found to be full of earthy matter, in place of either of the above, and some to have been prepared with wax and tannin.

While the care of the head was in process in the hands of one embalmer, other necessary features of the work were assigned his assistants.

Incising the Body.—Diodorus says: "First, one, who is denominated the scribe, marks upon the left side of the body, as it lies upon the ground, the extent of the incision which is to be made; then another, who is called *paraschistes* (the dissector), cuts open as much of the flesh as the law permits, with an Ethiopian stone, and immediately runs away, pursued by those who are present, throwing stones at him, amid bitter execrations, as if to cast upon him all the odium of this necessary act."

The stone thus made use of was undoubtedly in the form of a flint knife. It may have been called Ethiopian on account of its black color. Stones used in Egypt for the purpose of cutting were invariably of flint, and were commonly employed by the people. The stone knives found in excavations and tombs, at Thebes and elsewhere, and exhibited in museums of Europe, are of two kinds. One is broad and flat, usually set into some kind of a handle; the other, which is without doubt the knife of the embalmer, is short, pointed, and of razor-like sharpness.

The pursuit of the *paraschistes* already mentioned was probably a religious formality, the people having no real desire to harm him, and he entertaining no actual fear. It indicates, however, that the delicate sentiment which leads modern embalmers to practice their art without spectators, was utterly lacking among these ancient practitioners.

In contradistinction to the odium cast upon this knife-user, was the high esteem in which the embalmers themselves were held. They were associates of the priests, and were permitted free access to the temple, as sacred persons.

Treatment of the Viscera.—Through the hole cut in the side of the dead, the lungs, liver, stomach, spleen, and all the organs, except the heart and the kidneys, were removed from the body. The heart may have been left as the principal organ and source of vital heat, but it is a matter of uncertainty why the kidneys were not removed. Perhaps some religious superstition determined their being left. The body was likewise divested of the entrails. These, and the cavity from which the organs had been removed, were then washed with Phœnician or palm wine and other binding drugs. The entrails were afterward returned to the body, if not otherwise disposed of, which was sometimes the case, through the sacred eye of Osiris, which was placed above the incision.

Ingredients Used.—This being done, the body was repeatedly anointed with oil of cedar. Myrrh, cassia, aloes, and saffron—all fragrant gums and odoriferous spices, with the exception of frankincense, which was consecrated to the worship of their gods—were introduced into the cavity, and the body was sewn up.

After a certain time, the body was swathed in lawn fillets, which were glued together with a kind of very thin gum, and then crusted over with the most exquisite perfumes.

Some historians make no reference to any further preservative process between the use of the aromatics and the binding up of the body in anointed and perfumed linen; but, from others we learn that after the application of the drugs and spices and the sewing up of the ventral incision, came the salting of the body. It was kept in natron or anatron, known to chemistry as potassium nitrate, or salt of niter, and to people in general as saltpeter, an antiseptic used in the curing of meat, for seventy or seventy=two days. This was an arbitrary period to which the embalmers were strictly confined. Upon the expiration of these days, the body was washed and wrapped in linen bandages dipped in oil of myrrh.

Diodorus, who speaks of the actual face of the body being left exposed after restoration, in cartonnage and case, to relatives and friends, is contradicted by Herodotus, who says the features and the whole body were enveloped in wrappings and entirely concealed.

The head was swathed in cloths made fast with flaxen filaments, sometimes of a delicate color. If the body were that of a Pharaoh, or other sacred person, under these filaments were sometimes pushed the stems of lotus buds. The lotus, a name applying to several kinds of water lilies, was a favorite and a sacred flower in Egypt, and was used in religious ceremonies. It appears in hieroglyphics on Egyptian monuments, and entered into their works of art.

Honorable women of high rank were kept for three or four days after death before being delivered to the embalmers.

The Mummy Wrappings.—In passing, it may be interesting to some to learn the exact nature of the mummy wrappings. The words *byssus* and *linon,* used in describing them, indicate that they were linen, not cotton, although cotton cloth was manufactured in Egypt, and dresses of that material were commonly worn. Sometimes, however, these cerecloths were of finely-wrought silk, and have been known to be over one thousand yards in length.

The above was one of the most magnificent styles of embalming, and was used for persons of quality. Its expense amounted to £250, or over $1,200 in American money.

The Cartonnage.—When the usual routine work of embalming had been finished, the mummy was enclosed in a first case, called a cartonnage, or mummy=case. It consisted of many layers of linen, hardened together by a kind of glue, and coated outside with stucco. It was cut according to exact measurements of the mummied body, and made to conform exactly to its shape, by being fitted upon it when damp, and retaining the bent lines imparted in this way, while in the

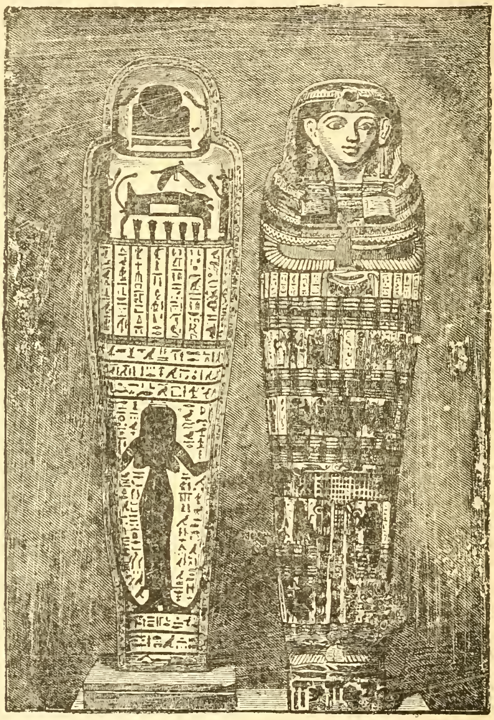


Fig. 37. Inner and Outer Mummy-Cases.

process of drying. It was richly ornamented with a network of bugles, beads, etc., and the pictured face directly over the mummy's face was sometimes overlaid with gold leaf. Three or four other cases, likewise ornamented and gilded, were superimposed upon this cartonnage, and the whole was then inclosed in a sarcophagus of wood or stone, embellished with painting or sculpture. These sarcophagi were often of cedar or a rot-proof wood called gimmis wood. They were of many different shapes, and the shapes of those fashioned in wood differed from those of stone.

Treatment of the Intestines.—The intestines of all persons embalmed by the most expensive process—for none of the first quality were embalmed without the removal of the intestines—were deposited in four vases of alabaster, hard stone, glass, porcelain, or bronze, and these were placed with them in the sarcophagus or tomb. These vases were variously ornamented, usually with the heads of the genii of Amenti. Herodotus does not inform us with reference to what became of the intestines of persons not embalmed as above mentioned. Porphyry says they were thrown into the river. Plutarch gives a similar account and explains the reason for such disposal. He speaks of them as being the cause of all the faults committed by man. The intestines were embalmed in spices, and a separate portion allotted to each of the four vases. In one was contained the large intestine in company with the stomach. In another the small intestine was placed. The lungs and heart, and the gall-bladder and liver, were among the contents of the remaining two.

The most costly of these vases were of oriental alabaster, from ten to twenty inches high, and about one-third of the height in diameter. Each bore an inscription embracing the name of the god the likeness of whose head it bore.

In those instances where the intestines were returned to the body, images in wax of these four genii of Amenti were put into the cavity with them, as guardians of those parts subject to their influence. Sometimes, instead, a metal plate, usually of lead, bearing their images, was substituted. The sacred eye of Osiris was placed over the incision, whether the entrails were returned to the body or placed in the vases.

Sometimes in the higher grade of embalming, the skin of the face itself, as well as, or instead of, the semblance on the cartonnage, was covered with a mask of gold leaf. In other instances, the entire body was so overlaid; sometimes merely the eyelids or the finger nails alone.

Classes of Embalming.—Egyptian embalming may be classified under two general heads: those bodies embalmed with the ventral incision; and those without. Under those embalmed with the incision, are classed bodies prepared with balsamic matter and those preserved by natron only. Balsamic embalming was performed with a mixture of resin and aromatics, or asphaltum and pure bitumen. The first named of these bodies—those filled with resinous matter—became of an olive color, the skin dry and flexible, as if tanned, and adhering to the bones. The features remained as in life. The features of those preserved in natron—simply salted and dried—were completely destroyed, and they became unrecognizable. The hair also fell out and the head became bald. But little care was exercised in the bandaging, which scarcely separated the bodies from the earth in which they were interred.

An Intermediate Grade of embalming, between the most costly and the revolting form above indicated, was the injecting of cedar oil into the abdomen, through the fundament, by means of a syringe. This was done without making a ventral incision, or removing the bowels.

Cedar oil, which possesses heating and drying qualities, also corroded and consumed the substance of the bowels on which it acted. It consumed as well the surplus humidity of the body which brings about putrefaction. Care was taken to prevent this oil's escape while the body was kept in natron during the appointed time. It was then drawn off, bringing with it the bowels upon which it had acted destructively, in a state of dissolution. The natron dissolved the flesh and caused the skin to cling to the bones. The body was then restored to the friends without further attention. This manner of preserving the dead cost about £60, or $300.

When the dead left no estate and the friends were very poor, the body was simply cleansed with an injection of *syrmœa,* and afterward kept salted in the customary manner for the usual seventy days.

If a stranger were found dead in Egypt, the law required that he should be mummified in the most magnificent and expensive manner.

When Embalming Ceased.—It is not positively known when the custom of embalming ceased in Egypt. It has been suggested that it may have been when that land became a Roman province. It is probable that after this time embalming became less universal and gradually fell into disuse, rather than that it was suddenly abandoned. After the sixth century, interest in this disposition of human bodies declined so sensibly that only a few of the more studious and scholarly were informed of the real secret of the art.

A description of Egyptian tombs, with their artistic adornments, the mummy pits with which Egypt is honeycombed, and the funeral customs there observed, would be of interest to the curious inquirer concerning Egyptian antiquities, but such description would form a lengthy article of itself, and does not, strictly speaking, come within the province of this article.

JEWISH METHODS.

The Jews adopted the custom of embalming to some extent, the "manner of the Jews" being to employ "linen clothes with the spices" in winding the body. When Lazarus was resurrected by the Savior's command, "Come forth," he appeared at the aperture of the tomb, "bound hand and foot with grave clothes, and his face was bound about with a napkin." But by whatever process his body may have been prepared for the sepulture, it is evident that his sister Martha did not believe it sufficient to preserve it effectually and with thoroughness; for, when Jesus had said to the bystanders, "Take ye away the stone" that obstructed the mouth of the cave, she had protested, declaring, "Lord, by this time he stinketh, for he hath been dead four days." So hampered was Lazarus by the wrappings in which he was swathed, that, though life had returned to him, he was unable to make use of his renewed vitality until the authoritive mandate, "Loose him, and let him go," had been obeyed.

Like Those of Egypt.—Jacob, who died in Egypt, was probably embalmed after the Egyptians' most expensive and elaborate manner, for Joseph, who "commanded the physicians to embalm his father," was high in the royal favor—"the man whom the king delighted to honor." When Joseph went up to the land of Canaan to bury his father, "with him went up all the servants of Pharoah, the elders of his house, and all the elders of the land of Egypt."

Probably this same form of embalming was used with Joseph, when "he died being an hundred and ten years old; and they embalmed him and he was put in a coffin in Egypt." Before dying, he "took an oath of the children of Israel saying, God will surely visit you, and ye shall carry up my bones from hence."

Wherever the body of Joseph was kept, whether in an apartment of a house, according to the usage of some of the Egyptians, or in a tomb prepared for it, this oath was strictly fulfilled by the descendants of those who made it, nearly two centuries afterward, when the Israelites returned to their own land.

This custom, here referred to, of keeping the mummied body, for a long time, in a place set apart for it in the former home of the person deceased, was sometimes permitted; but some specious reason was usually assigned in excuse for it, as it was considered a very grave thing to deprive one entitled to it of the right of burial. No grief and shame could be more terrible to surviving friends than to have departed dear ones, by a verdict rendered after post=mortem judgment, which was common in Egypt, accounted unworthy of burial.

Embalming the Poor.—The poor among the Jews, those known as the "common people," were embalmed with bitumen, which was a cheap material, easily procured. It was a mineral pitch, found in large quantities on the shores of the Dead Sea, which for this reason was also called the Asphaltic Lake. This lake was located in Palestine, about one hundred miles from Damiata in Egypt, and the bitumen used by the Egyptians came from this place. The body and its envelopes were smeared with this substance "with more or less care and diligence." This bitumen, however, must have possessed considerable preservative power, as sepulchres have been opened in which thousands of bodies deposited in rows, one above another, without coffins, have been kept from decay for centuries, by its use. Coal tar, petroleum, and naphtha are of the same derivation. Mummies prepared by this substances are, of course, black, hard, and shining. The skin appears as if varnished. They are dry, heavy, and without odor.

But the more usual form of embalming among the Jews, appears to have been made use of more to perfume the body and keep at a distance, as long as possible, the disagreeable odor which belongs to death, than with the expectation that it would, for any great length of time, ward off putrefaction. It was simply the binding of spices upon the limbs and body with the usual linen bandages.

In the Time of Christ.—In this manner, at the near approach of the Jewish Sabbath, which must not be defiled by the presence of the unburied victims of the law, Jesus, when taken down from the cross, where he had suffered for the sins of the whole world, was ministered unto by Joseph of Arimathea, a secret disciple, and Nicodemus, who "brought a mixture of myrrh and aloes, about an hundred=pound weight." When the Sabbath was over, very early on the first day of the week, came the faithful women who had loved and followed him, with spices and ointment they had prepared wherewith to anoint him, not knowing that, already, this loving service had been performed by the hand of pious affection.

But even in this simple style, embalming was not, it appears, a prevalent mode of disposing of the dead, among the Jews.

METHODS OF THE ROMANS AND OTHER NATIONS.

Among the Romans.—The funeral rites of the Romans and many other nations embraced embalming in some form. The deceased, after being washed in hot water, sometimes varied with oil, every day for seven days, to revive him in case he was simply in a condition of suspended animation, was "dressed and embalmed with the performance of a variety of singular ceremonies." After this his body was placed on a funeral pile and burnt. The ashes were then gathered in a vase or urn, and deposited in the tomb.

The Babylonians made use of honey in anointing their dead, or immersed them in this viscid fluid.

The Scythians immured the body in a coating of wax.

The Ethiopians washed it over with a sort of plastering called parget.

Among Persians, Assyrians, Etc.—Embalming was practiced also among the Persians, Assyrians, and many other ancient nations.

The Greeks acquired the art through their conquests.

The Guanchos, the original inhabitants of the Canary Islands, probably obtained the custom of embalming their dead from the Atlanteans who inhabited the famous "lost Atlantis," an antediluvian island or continent, which, the ancients asserted, was overwhelmed and swallowed by the "great deep." These islanders coated the body with a liquid composed of a solution of resinous matter in an oil or volatile liquid—a sort of varnish—, after which they wrapped it in goat skin and placed it in a wooden case.

ON THE WESTERN HEMISPHERE.

Among Early Peruvians.—Without doubt, the aborigines of the Western Continent were familiar with the practice of this art. The early Peruvians, we learn from accounts contained in Prescott's "Conquest of Peru," preserved the dead body of the royal Incas by some marvelous process which did not give evidence of foreign applications, and secreted them under mounds of earth and in the interiors of their temples. He presents an ancient picture of these embalmed Peruvian monarchs sitting "natural as life, in the chairs of gold," in the temples of the sun, at Cuzco. They were clothed in their accustomed princely attire. The raven-black or silver-gray of the hair on their bowed heads was still unchanged, and their hands were crossed upon their bosoms in the grim dignity of death.

The Aztecs, a highly civilized race, and one of the most interesting and powerful of the indigenous tribes of America, inhabiting the plateau of Anahuac, later known as Mexico, who were conquered by Cortez in 1519, and whose history has been traced back to the twelfth century, made careful preservation of the bodies of their dead, especially those who could claim royal descent. Aztec legends relate how, after the deluge, seven persons issued from the tomb to which their mummied bodies had been committed, and, in renewed existence, repeopled the earth.

North American Indians.—The art was not unknown among the early North American Indians. Mummies remarkably well preserved have been found among the Flatheads, Dakotas, and Chinooks; and the Florida and Virginia Indians so preserved the bodies of their kings. Quite a number of good mummies have been found in Kentucky caves.

In 1899, the well preserved mummy of a woman and child was found in a cave in the Yosemite Valley, which, on account of its almost giant size (6 feet, 8 inches), and other characteristics, some authorities believe to be a relic of the lost tribe of the stone age, possibly antedating the Christian era 3,000 years.

AMONG EARLY CHRISTIANS.

The Early Christians, for a time, embalmed their dead, according to those forms with which they were familiar in Palestine. No special reason, so far as we have been able to determine, has been given for their abandonment of this ceremony. It may be inferred that they feared, by its continuance, to cast discredit upon the power of God to call together the scattered dust of the body which had returned to its native element, and present it like unto Christ's "own glorious body" on the morning of the resurrection. But, if so, in this they erred. When the Creator stated to Adam, "For dust thou art, and unto dust shalt thou return," he put forth a simple statement of fact; it was not the issuance of a command.

No word was ever spoken by Jesus indicating his disapproval of attempts, with which, as a Jew, he was fully familiar, to preserve the body from decay after death. St. Paul, the greatest of the Christian apostles, inquired of the Corinthians: "What! know ye not that your body is a temple of the Holy Ghost which is in you, which we have of God and ye are not your own?" Men preserve with care, in original grandeur and dignity, the palace where an earthly king has dwelt, and the inn where some mighty man has tarried for a night. Shall they let this temple of the "King of kings" become dishonored so long as preservation is a possibility? Shall they willingly give it over to decay and corruption?

No; let us care for the body, made in God's own image, while we live; and let our friends, in recognition of the temple it has been—of the soul and its Creator—give to it all the deference they can offer, when we shall have passed on to dwell in it no more,

"Until the morning's happier light
Its glory shall restore,
And eyelids that are sealed in death
Shall wake to close no more."

CHAPTER XV.

MODERN EMBALMING.

Great progress has been made in embalming, especially during the present (nineteenth) century, and earlier methods have given way to more modern and enlightened ones. The beginning of these modernized methods was made as early as the seventeenth century, as the following account will show. Which one of the early modern embalmers justly merits the title of father of the present system matters but little, for like every form of advancement, it has had growth and development, and the methods of none of these forerunners have survived, at least in this country; only their investigations led into new channels, resulting ultimately in the prevailing methods.

The processes explained in this chapter are exclusively European.

Dr. Frederic Ruysch, who occupied the chair of anatomy at Amsterdam, Holland, during the closing third of the seventeenth, and early years of the eighteenth, century (1665-1717), was probably the first to practice a successful system of arterial injection, which, however, he used only in preparing specimens for his anatomical work. He did not stop with a simple injection of the arteries, but, after permitting the body to remain for some hours to allow a diffusion of the fluid through the structures, he proceeded to lay open the body as in making a post=mortem examination. The viscera of the chest and abdomen were removed, and the fluid in them sponged out. The organs were then steeped in spirits of wine, replaced, and covered with a preservative solution. He brought his method of preserving dead bodies to such extreme perfection that his specimens were the wonder of his generation, and indeed of later ones. Peter the Great, who was among the distinguished personages to inspect his work, possibly paid the highest compliment to his art by kissing the lifelike lips of a child preserved by the great anatomist, without at first discovering the fact that the lips were those of the dead. Dr. Ruysch's method is said to have preserved the natural color of the body, as well as the form and suppleness of the limbs. He left behind him at his death a large assortment of injected portions of the human body, but no specimen of the body entire. Peter the Great secured a large number of these specimens, which he carried to St. Petersburg. Whether or not the Ruyschian method was as perfect as claimed for it, or whether some of the statements concerning it should be largely discounted, the brilliant anatomist was the first known arterial injector, as well as one of the most skillful of any age. However, he neglected to take the world, or other scientists, into his confidence; hence, but little, if anything, is now known as to the chemicals used by him, or the manner of their injection. His discoveries were, consequently, lost to science. For this reason, others, whose methods were published to the world, have been considered by many as better entitled to the honor naturally accruing from a great discovery.

Dr. William Hunter, an eminent Scottish physician, anatomist, and physiologist of the eighteenth century (1718-1783), is given the credit by many of being the original inventor of the injection method. Unlike Dr. Ruysch he published his plan of injection in minute detail. The artery usually selected by him was the femoral. His solution was composed of oil of turpentine, five pints; Venice turpentine, one pint; oil of lavender, two fluid ounces; oil of rosemary, two fluid ounces; and vermillion. This was forced into the vessel until it reached over the whole body, giving the skin a general reddish appearance. As in Dr. Ruysch's method, complete diffusion of the fluid, through the minute vessels of the body, was secured by leaving the body untouched for a time. The body was then opened, the thoracic and abdominal organs were removed, emptied, and cleaned, their vessels injected with the fluid, and the organs steeped in camphorated spirits of wine. The cavities were washed with the camphorated spirits, the viscera were replaced, and the intervening spaces were filled with a powder composed of camphor, rosin, and niter. This powder was also placed in the mouth, nostrils, and other external cavities, and the body was rubbed over with essential oils of rosemary and lavender. The final operation consisted in placing the body thus prepared in a coffin upon a bed of dry plaster of Paris, put there to extract all moisture from the body. The coffin was then closed for four years, when it was opened. In case desication had not been complete by this time, another bed of the plaster was added.

John Hunter (1728--1793), a younger brother of William, was but little less renowned along the same lines, and also helped greatly to advance the science of embalming, devoting much attention to experiments with various preparations.

Some of the most perfect specimens of modern embalming to be seen to-day are Hunterian, and are found in the museum of the Royal College of Surgeons, London. One is the body of the wife of the eccentric Martin Van Butchell, preserved, some authorities say, by Dr. John Hunter, by the injection of camphorated spirits of wine, etc., into the arteries and veins. Other, and probably more creditable, authorities ascribe the work of preservation to the older brother, and declare that the method used was the same as the one so fully outlined above. Another body preserved in this museum was that of a young woman, who died about 1780, in the Lock Hospital, of consumption.

The Hunterian Method was practiced with or without modification by many succeeding British anatomists. Dr. Matthew Baillie, instead of removing the intestines or other viscera, injected the preserving fluid into the stomach, lungs, and rectum, after having made a complete injection of the arterial system. Dr. Sheldon used as his preservative fluid camphor dissolved in spirits, in the proportion of one ounce of camphor to six of spirits. He removed the viscera, and coated them and the visceral cavities with tar, enveloping the body with a tarred sheet. His method is said to have been successful. Joshua Brooks, the last of the great English anatomists having a distinctive school of anatomy of his own, practiced the Hunterian method with but slight if any alteration.

M. Boudet's Process was a modification of the Egyptian, he being one of the last to follow ancient methods, as well as the first to use corrosive sublimate as a preservative. He embalmed with tan, salt, asphalt, Peruvian bark, camphor, cinnamon, and other aromatics, and corrosive sublimate. He also completely enveloped the body in bandages, varnish being coated over the body and cavities and outer bandage.

M. Franchini's Process consisted of injecting the arteries through the common carotid artery with a solution consisting of eight decigrams of arsenious acid, combined with a small quantity of cinnabar, dissolved in nine kilograms of spirits of wine. By this method bodies could be kept odorless and natural in color for sixty days, after which they began to desiccate, and would mummify so as to last for all time. He had previously used a substance which had to be reduced to a fluid by heat and which became hard when cooled. This was given up for the simpler method outlined above.

Jean Nicholas Gannel (1791--1852), a shrewd and progressive French chemist, introduced a new system of merit in the 30's of this (nineteenth) century. Indeed several methods bear his name, for he used different preparations at different times. He claimed to be able to preserve a body for five or six months by using acetate of alumina, which he obtained by decomposing sulphate of alumina and potash by the action of acetate of lead, using five or six liters of this acetate of alumina of a density of 18° (Beaumi's areometer) to a body. He was also able to preserve a body thirty to sixty days by using a solution of one kilogram of sulphate of alumina to five liters of water. In injecting the body he used one of the carotids, injecting downward. Later he found it necessary to open the abdomen in order to relieve the stomach and bowels of gas. M. Gannal's secret formula, which he claimed contained no arsenic, on being analyzed by a governmental commission, was found to contain that substance. Embalming with arsenious solutions having become common in France in Louis Philippe's time, the government interfered and prohibited the sale of arsenic, and all compositions containing it, for embalming bodies, as well as for several other uses. The further use of M. Gannal's solution was therefore stopped. This prohibited solution was formed by saturating forty liters of water with five hundred grains of arsenious acid, and dissolving therein by heat equal parts of sulphate and acetate of alumina, until the liquid attained a density of 20° (Beaumi's areometer).

Doctor Gannal, of Paris, son of the above, and himself a chemist of no mean note, recently communicated the following concerning his father's method, which is presumedly the system still adhered to by himself:—

"My father found in 1836 that chlorid of aluminum injected into the carotid artery had a remarkably preservative effect. * * * My father's system, which has not been changed, consists in injecting a quantity of the liquid, which marks 32° of density, estimated at ten per cent. of the weight of the body. About half an hour suffices for the injections, and for the rest of the process an hour and a half. After the liquid has been injected into the arteries the body is wrapped in bands of flannel, covered with a sheet and then laid in a leaden coffin. Then four or five liters of various essences are poured over the body, and the coffin is finally soldered up. In this way the remains are absolutely preserved indefinitely."

Doctor Gannal disapproves of the use of a glass plate in the coffin or casket, as he says air will inevitably find its way in, which is not desirable; though he admits that the only result of this exposure to the air is that the body becomes a dry, hard, parchment=like mass. He concludes with a list of distinguished Frenchmen embalmed by his father and himself.

M. Sucquet, in a contest before a board of prominent French physicians, in which MM. Gannal, Dupre, and others participated, won a signal victory for his method, using a non=arsenic preparation. His solution was composed chiefly of chlorid of zinc, which he injected arterially. M. Dupre made use of carbonic and sulphurous gasses, and M. Gannal injected a solution composed of equal parts of the sulphate and the chlorid of alumina, at a density of 34°. Bodies prepared according to these processes in the presence of the board of physicians mentioned, were buried for fourteen months, when they were disinterred in the presence of the same commission. M. Gannal's subject was found to have undergone putrefaction, while the one prepared by M. Sucquet was in an excellent state of preservation. The latter body, on exposure to the air, without showing any signs of putrefaction, dried to a state of hardness little short of that of wood or stone. In consequence of the remarkable success of M. Sacquet's method, it came into extensive use on the contient of Europe and to a considerable extent in this country.

M. Falcony had a desiccatory process which mummified the body, giving it a yellow appearance, but preserving it well, by simply placing the body, without any mutilation or injection, in a bed of dry sawdust to which powdered zinc sulphate had been added. In a paper read before the French academy, he said he found, after careful tests with different salts, zinc sulphate of different degrees of strength, according to the condition of the body, weather, etc., to be the best preservative material; that a gallon would perfectly preserve a body. Bodies so preserved remained flexible for about forty days, after which they began to dry up, though still retaining their natural color. Others practiced this system with remarkable success.

Dr. Chaussier's Method, as given in Thenard's Chemistry, was, in brief, as follows: The body, completely emptied and thoroughly washed, was kept constantly saturated with corrosive sublimate; the salt gradually combined with the flesh, giving it firmness and rendering it imputrescible and incapable of being injured by insects or worms. The author states that he has seen a head prepared in this manner, which had been exposed for several years to the alternation of sun and rain without suffering change, and was easily recognized, though the flesh had become hard as wood.

Franciolla's Method was not greatly different from some of the others given. The formula used by him was as follows: arsenious acid, four ounces; carbonate of potash, two ounces; powdered alum, eight ounces. The acid and potash were dissolved by boiling in three quarts of water, the alum added, and the whole diluted by the addition of water until it made one gallon of the preparation. He opened the abdomen, emptied the stomach and other organs, washed, dried, and injected them; then injected the bronchial tubes by puncturing the trachea. For arterial injection the right common carotid artery was selected, the blood being removed from the veins by puncturing the inferior vena cava, a little below the renal vein, and the jugular vein. The blood was let out of the vena cava before the abdomen was cleansed, and was removed by a sponge or pump. After injecting the head and neck, Franciolla turned the injector downward and continued the injection until completed. Later in his practice he selected the splenic artery for injecting. He poured a solution over the bowels before replacing them; a strong solution of bichromate of potash being sometimes used, though not with the best of satisfaction. He also advocated filling the abdominal and thoracic cavities with a liquid preparation of cornstarch, water, alcohol, and corrosive sublimate, which, after hardening, would prevent the sinking of the parts.

Brunetti, another Italian, used a method, which, it is claimed, reserved bodies so that they resisted decay for hundreds of years, but they became hard as stone and were of course useless for anatomical study. They, however, retained their form and size in a remarkable degree. By this process the circulatory system was thoroughly cleansed by washing for from two to five hours with cold water, until it issued from the body looking clear. Alcohol was then injected to remove the water, and sulphuric ether to carry out of the system all fatty and greasy substances, these operations occupying five to ten hours. Equal time was spent in injecting a strong solution of tannin, after which the body was dried by means of a current of warm air which had been passed over heated chlorid of calcium.

A Method in Vogue in Belgium has proven quite successful, though the process is tedious and requires considerable time for the preparation of the body. The preserving fluid is composed of the following ingredients: one-half pound each of alumina and sulphate of alumina, and one ounce of corrosive sublimate, dissolved in one gallon of water. The body is first thoroughly washed with soap and tepid water to remove every particle which might obstruct the pores of the skin, for the process depends largely upon absorption of the solution through the pores. After the body has been thoroughly dried by the vigorous use of clean towels, the solution is applied externally, keeping the body moist. The application must be renewed from time to time as absorption and evaporation lessen the supply. The theory of this part of the process is to keep the body as nearly as possible completely immersed. The stomach and intestines are removed through an incision in the abdomen and thoroughly cleaned. Blood is withdrawn from the system by opening the inferior vena cava, and the arteries are injected through the abdominal cavity. The diaphragm is punctured and the pleural cavities are filled with a solution of arsenite of soda.

Dr. Tscheirnoff's Method was as interesting as it was thorough, but its necessary expensiveness was fatal to its general use. The multilation of the body, incident to this method, also detracted from its popularity. He first opened the abdomen by making an incision extending from the sternum to the umbilical region, with a short cross incision about midway. This gave a diamond=shaped opening exposing the abdominal viscera. Entrance to the thoracic cavity was gained by carefully cutting the ribs loose from the sternum and turning the latter back over the face. This exposed to view the heart, lungs, and aortal arch. The next step was to displace the bowels and sponge out all fluid or serum found around the intestines. The intestines and other internal organs, whose contents were liable to putrefaction, were emptied, the bladder being vacated through the urinary canal by means of a catheter, after which they were injected with fluid. He then injected the arteries through the descending aorta, which was exposed by moving the small intestine to the right, to be replaced on completion of the operation.

This did not complete the surgical part of the process, for the back of the skull was trepanned, making a two=inch circular hole, through which the brain, or as much of it as could be reached, was removed by means of a long=handled, slender, specially=made spoon. This cavity was filled with a thin paste made by fully saturating a half=gallon of water with alum, and thickening to the proper consistency by the addition of plaster of Paris. The wound was then carefully closed and sewed up. The thoracic and abdominal cavities and their contents were washed and dried and the viscera surrounded with tannic acid. The sternum was then replaced and the wound temporarily closed, and the body completely enveloped in a sheet saturated with fluid, in which condition it was left for twelve hours. The envelop was then removed, the cavities of the thorax and abdomen reopened, and the plaster of Paris and alum paste, mentioned above, was poured over and around the viscera, filling all the space to the level of the ribs. After the paste set tannic acid was sprinkled over the top, the sternum was replaced and the wound carefully and permanently sewed up. The inside of the mouth was filled with cotton saturated with embalming fluid, in order that the face should retain its fullness; the nose=cavity was also filled with paste. The entire body was coated finally with a preparation of Canada balsam and turpentine, which is transparent and excludes the air.

The Florentine Process of embalming, used chiefly for the preservation of subjects for the dissecting table, as described by Dr. Venali, an Italian authority on the subject, was somewhat like Dr. Tscheirnoff's. The abdomen was opened by a transverse incision across the body, the stomach and intestines emptied of any gaseous, liquid, or solid contents, and then injected; the cavity cleaned, sponged, and sprinkled with tannic acid. The thoracic cavity was entered from the abdomen, through the diaphragm, and similarly treated. Arterial injection was made through the femoral artery, the opening being made about eight inches below Poupart's ligament.

A German Process of preservation is given, which, when properly followed, has kept bodies so perfectly that they retained their form, color, and flexibility, so that, after a period of several years even, they made good subjects for purposes of dissection, and were free from offensive smells. The formula for this preserving fluid is as follows: in 3,000 grams of boiling water, dissolve alum, 100 grams; sodium chlorid, 25 grams; potash, 60 grams; arsenic acid, 10 grams. This solution is then cooled and filtered to 10 liters, when four liters of glycerine and one liter of mythlyic alcohol is added. Bodies are injected arterially and saturated with the liquid, 8 or 10 liters being used to a body, according to the size and condition.

Dr. Efisio Marini, a surgeon of Naples, has been attracting no little attention in recent years by his much=vaunted preservative scheme, claimed to rival the best methods of embalming the world has ever seen. According to reports he does not incise, nor does he inject; he simply submits his subject to a series of baths in a liquid, the composition of which he, perhaps wisely, keeps to himself. If these reports are to be believed, decomposition is prevented to the end of time; there is nothing leathery about the appearance of the body; when desired for anatomical purposes, the subject may be made to regain all its primitive freshness; carry the treatment to a further stage, and the subject attains the density, as well as the consistency, of marble, giving the true metallic ring when tapped with a key; a final process will restore the softness, the flexibility, and even the complexion it possessed when alive. As Dr. Marini's method is used almost exclusively for preserving bodies for anatomical purposes, naturally none of his subjects have been reported as reaching this country, so verification of these remarkable claims is not possible.

Embalming but Little Practiced in England.—Singularly enough, while the English, in the latter portion of the eighteenth, and first part of the nineteenth, century, made such wonderful progress in embalming, the art is but little practiced to-day in that country; and then generally for other than natives of Great Britain—especially for Americans. The late Dr. Benjamin Ward Richardson, F. R. C. S., in his work on "The Art of Embalming," published a few years ago, said:—

"Embalming at the present day is, in England, an exceptional process, and when we are called upon to perform it here, it is, in ninety-nine cases out of the hundred, for some one foreign to our country. I have embalmed fifty bodies, but only in two or three instances the bodies of English people, and in these exceptional instances the deceased, although they were born and died in England, had lived the greater part of their lives abroad, and were embalmed in order to be conveyed to friends at a distance, who wished to bury them."

The Sunnyside, of New York, in a recent issue, published the following concerning the condition of bodies embalmed abroad and shipped to this country:—

"**No Good Embalming Done Abroad.**—As an evidence of how limited is the knowledge of embalming in Europe it is stated as a fact, by the New York supply houses, that, with but very few exceptions, all bodies received from Europe are in a revolting condition, unfit to be seen by any of the friends or relatives. The exceptional few cases were those received from H. L. Mills, a London undertaker who graduated from the U. S. School of Embalming, and Beihold Wiesel, Frankfort, Germany, who, by the way, has long been a regular reader of *The Sunnyside*, and a student of the 'Champion Text=Book on Embalming.' Mr. Wiesel, like Mr. Mills, does modern arterial work.

"Bodies have been received in New York for the embalming of which French 'embalmers' charged from $100 to $500 and not a single one has ever been presentable. Most of them were in the worst stages of decomposition rendering an immediate resealing of the casket imperative.

"A few bodies have been received from Egypt and Japan, well preserved, but in a mummified condition. The embalming process had evidently been akin to the ancient Egyptian mode. That is, all the viscera, etc., had been removed and herbs, spices, ointments, and bandages, had been freely used. No bodies embalmed by Dr. Marini's much=vaunted process have reached this country, hence the expert embalmers of New York have had no opportunity of judging his skill. From the foregoing the conclusion is reached that what the foreign world most sadly needs are embalmers using modern, up=to=date American methods. In view of this it is remarkable that there are no foreign undertakers, especially European, progressive enough to study the art and science of American embalmers."

The editor of the above=mentioned journal, in response to an inquiry as to the reliability of this information, emphasizes it as follows:—

"We consider the information in 'No Good Embalming Done Abroad' reliable to this extent, that in New York, at which point nine=tenths of the bodies received from Europe arrive, seldom does the body arrive in a condition that will permit of the casket being open for even an hour. My information was received from several supply house embalmers, who have to handle bodies received from foreign countries. Again, on the arrival of the body of every prominent person, I have asked if the casket had been opened, and about the embalming, and in ninety=nine cases out of one hundred, have been informed that the body had gone to pieces."

However, within the last few years some interest has been developed among British undertakers on the subject of embalming, brought about largely through the introduction of the earlier editions of this work into that country, and the aggressive policy of its publishers.

Two of the papers published in that country in the interest of the undertakers, have more or less vigorously advocated embalming, and whereas one undertaker, a few years ago, claimed to be the only person holding a diploma from an American school of embalming, and was thus supposed to be able to embalm, now quite a number of undertakers advertise to do embalming.

What has been said about the British undertakers does not apply, however, to the profession in its advanced Australian possessions, where embalming is said to be practiced quite extensively.

CHAPTER XVI.

PRESENT METHODS OF EMBALMING.

EMBALMING was made use of by the Ancients, in compliance with religious superstitions that prevailed in the earlier centuries of the world's history. Modern embalming was first practiced as a novelty, but later to preserve bodies, by the students of anatomy. A few bodies are on exhibition in some of the museums of the world, which will prove that the methods followed by the modern surgeons from time to time were successful.

Just when the present methods of embalming were introduced we cannot be certain, but they received their greatest impulse during our Civil War (1861-65), when bodies at the front were embalmed successfully, and shipped many hundreds of miles, requiring a number of days before interment could take place. Since that time great improvements have been made in the methods of embalming, as well as in the instruments and fluids used for the purpose.

The late Dr. Thos. Holmes, of New York, is doubtless justly entitled to the honor of being called the "Father of Embalming" in this country. It was he who embalmed for the Government during the Civil War.

Bodies were formerly embalmed for preservation only, and the operations were merely mechanical; but to=day they are embalmed as a sanitary measure as well, which requires a knowledge of sanitation. Fluids that are used are not only preservative, but strongly disinfectant, for the purpose of disinfecting, as well as preserving the body. It is not absolutely necessary to disinfect all bodies, especially those dying of noninfectious diseases; but as we are not always certain as to the cause of death, to insure positive safety, the operator should disinfect as well as preserve all bodies, whether death was caused by infectious or non=infectious diseases. A disinfectant fluid will preserve as well as disinfect; therefore, no harm will result from the disinfection of all bodies.

It must be remembered that embalming is the filling of a body with fluid for its preservation and disinfection.

The amount of fluid used by most embalmers in the injection of a body is not sufficient to fill all of the tissues. Usually from two to three quarts of fluid are used for embalming all kinds and sizes of bodies, wether they are of a hundred or two hundred pounds weight; whether dying of an ordinary disease or some special disease; whether the temperature is high or low, humid or dry. It matters not what conditions are present, the routine is the same in all bodies. All tissues except osseous—whether solid, semisolid, or liquid—furnish a soil for the growth of bacteria, and the diseased organs in infectious disease are usually filled with the disease-producing bacteria, and should be filled with fluid to prevent their growth or to destroy them. Only such parts of the body as are filled with fluid will be preserved and disinfected; and if too small a quantity is injected to fill the body, then the embalmment will not be complete.

In a great majority of cases, however, nature assists in preserving the body for "the usual length of time"; thus the presence of rigor mortis, or a high, dry, or cold temperature, will retard putrefaction, especially in the more solid of the tissues. When these conditions are present, all that is necessary for the preservation of the body is the injection of a smaller quantity of fluid; but to disinfect a body, and to make preservation certain, in all instances the tissues should be filled thoroughly with fluid. The amount of fluid to make success certain should vary according to the size, disease, and condition of the body, surrounding temperature, etc. While but a gallon of fluid will be required to fill some cases, two or three gallons will be necessary to fill others.

The usual methods by which embalming is accomplished are arterial, cavity, cranial and sub=cutaneous injection, which will be treated separately in the following pages.

REASONS FOR EMBALMING.

Embalming is practiced to=day chiefly for two reasons; namely, that of preservation and that of sanitation.

PRESERVATION AS A REASON.

In performing the "last sad rites" over the dead, the period of mourning prior to interment usually lasts from two to four days, and in case of shipment the time intervening between the death and burial sometimes is prolonged for months.

Previous to the introduction of embalming as practised to-day in this country, the undertaker, or whoever took charge of the funeral, usually had to handle a putrefying mass of animal tissue, sometimes in a horribly corrupt state, and always with more or less putrid odor. Indeed, at the time of the funeral, in such cases, the casket frequently had to be closed and allowed to remain outside of the church or home while the funeral was being held, on account of the putrescent odor. Of course, ice, where used, would, in some cases, modify these results to a certain extent. Sometimes rigor mortis, when well marked, would last for the "usual period of time," preventing putrefaction. But still, in extremely hot weather, this was not sufficient to prevent the commencement of putrefaction.

With the increased demand for more expensive funerals came the demand for better means of preserving the body until the interment could take place. To put a mass of putrefying animal matter into a fine plush casket, or an elegantly finished metallic casket, lined with the finest of fabrics, could not be thought of; therefore, it was necessary to preserve the body until the interment could be made.

Moreover the population of this country is migratory. Families separate more widely than they do in the older countries. One member of a family leaves and goes into a new part of the country, or one may be on a visit to friends in a distant part, and sicken and die; or death may be caused by an accident. In such instances it becomes necessary to ship the remains to friends, maybe a thousand miles distant, taking a period of a week or ten days from the time of death until the interment can take place. In all such cases, it is necessary to prevent putrefaction, and this can be done only by the application of preservatives.

SANITATION AS A REASON.

Sanitation as a reason for embalming is one of very great importance. All bodies dying from infectious diseases should be thoroughly sterilized, or incinerated at once, for the purpose of destroying the germs of contagion and infection. If the body is to be interred, then embalming will be the only safe means by which these micro=organisms can be destroyed.

By the action of the National Baggage Agents' Association, with the aid of enactments of legislatures and boards of health, in many States, it is made incumbent upon every person who ships bodies dying from infectious diseases or who holds public funerals, to embalm them thoroughly, and prepare them in a manner that will prevent dissemination of disease. Health boards in every State, county, city, and town, where such laws are not already in force, should require this. It would lessen the danger in our own, and be a safeguard to future generations, if all bodies, whether to be shipped or not, were disinfected thoroughly.

If interred without disinfection, the spores of the bacteria are not destroyed, and, as they will retain their vitality for a long time in either earth or water, they remain a constant source of danger, Our water supplies may become contaminated by streams running through or near cemeteries, which receive the drainage therefrom, and take up the spores and convey them to any distance, thus spreading the disease.

The occasional changing of cemeteries, and the frequent disinterment and removal of bodies from one burial place to another, are the means often of spreading disease, where disinfection was not effected at the time of burial. Therefore, the thorough embalmment, and consequent disinfection of all bodies is the only safeguard and should be rigorously enforced.

NECESSITY FOR THOROUGH EMBALMMENT

Embalming, as practiced by the majority of undertakers, will not thoroughly sterilize the body, for the reason that the fluid injected does not reach all the tissues, nor does it extend to the abnormal and fecal matter contained in the viscera and within the cavities of the body. Too many employ only the cavity method of treating the body, which, in many cases, with the aid of rigor mortis and an average temperature, will be sufficient to preserve the body for the "usual length of time," but it will not disinfect it.

Again, the artery may be raised at some point and fluid injected, in addition to the operations upon the cavities, and still the body will not be sterilized, because enough fluid has not been used. To thoroughly disinfect a body, a strong disinfectant fluid should be used and in sufficient quantity to fill the capillaries of the entire system; also to fill the lungs, alimentary canal, and pleural and peritoneal sacs.

It will take more fluid for this purpose than is usually injected. Two or three quarts injected into the arteries, and a like amount injected into the cavities, of a body weighing 175 to 200 pounds, is not sufficient. It cannot be stated exactly how much fluid should be injected into a body, but a rule we have followed more recently has been to inject into the arteries a quantity equal to about one-twentieth of the weight of a body of average size. In a smaller body, a little larger proportion might be injected, and in a larger body a little less. This amount will be sufficient to fill the capillaries, and, when the body is in a perfectly relaxed state can be easily injected. If a body is in a rigid condition, or the walls of the arteries are contracted, it will be impossible to inject this amount, but a much greater amount can be injected in some bodies. Frequently, from two to three gallons can be introduced into the arteries of an average-sized body; this quantity will do no harm, unless the fluid is composed of chemicals that will affect the tissues, by causing discoloration.

The Condition, Appearance, and Disease of the body to be embalmed should be be taken into consideration before commencing the operation. If post-mortem contraction of the arteries has taken place and passed off, and the blood has settled into the dependent parts, and no discoloration appears upon the surface, the artery can be raised and the injection of fluid follow at once; but, if the face be discolored, the body should be placed on an incline and blood should be withdrawn from the heart and vessels. This can best be accomplished by alternately withdrawing the blood and injecting fluid. The morbid condition resulting from the disease should be understood, and the parts involved should be injected thoroughly. If gases are present in the cavities they should be removed through the hollow needle and fluid injected before the removal of the needle, for the reason that the fluid should be mixed with the material from which the gas is produced, in order to thoroughly sterilize it.

Sometimes the fluid cannot be injected through the arteries on account of their obstruction by clots, disease of their walls, or extensive mutilation. When this is the case, fluid may be injected hypodermically through the cellular or fatty tissues immediately beneath the skin, over the upper portion of the body. A large amount of fluid can be injected in this manner, which settles downward, gravitating through the tissues, perfectly sterilizing them.

Appearance after Thorough Embalmment.—Changes in the appearance of the surface, owing to the chemicals contained in the fluid that has been injected into the body, will manifest themselves, very likely, within a few hours after death. A lifelike appearance will follow the introduction of some fluids, while a marble=like whiteness, or a brownish or leaden tinge succeeds the use of others. In some bodies none of the above changes occur. These changes will indicate that the fluid is having an effect upon the rete mucosum and dermis only, and not, as some would have you believe, that the body will keep forever. Neither does it indicate, in those bodies where the changes do not take place, that second injection should be resorted to to keep them the "usual length of time." The rule is that ordinary cases do not require a second injection, but occasionally an exception will occur. Very frequently special cases, such as septicemia, consumption, typhoid fever, peritonitis, morphine cases, etc., require a second or even a third injection. Cases to be preserved indefinitely, such as those to be shipped, those to be kept for identification, those to be placed in family vaults, etc., may require a number of injections; but if enough fluid—say about one pint for each twenty pounds weight of body—is injected at the first injection, a second injection will be rarely necessary, if ever.

DEATH.

ITS MODES, SIGNS, AND CHANGES.

CHAPTER XVII.

DEATH: ITS MODES, SIGNS, AND CHANGES.

MODES OF DEATH.

A LITTLE experience in the sick chamber will suffice to teach us that, although all men must die, all do not die in the same manner. In one instance, the thread of existence is suddenly snapped; the passing from life, and apparent health, perhaps, to death, is made in a moment. In another, the process of dissolution is slow and tedious, and we hardly know the instant at which this change is completed. One man may retain possession of his intellectual faculties up to his last breath; another may lie unconscious and insensible to all outward impressions for many hours or days before the solemn change is completed.

In our inquiry and investigation, we seek to ascertain the mechanism and the laws governing these mysterious changes. In this investigation, we need not go into any deep physiological questions respecting conditions that are essential to life. It is sufficient for our purpose to remark that life is inseparably connected with continued circulation of the blood. As long as the circulation continues, life, or organic life at least, remains. When the blood ceases to circulate, death will soon follow. Our inquiry into the different modes of death, therefore, resolves itself into an investigation of the different ways in which the circulation of the blood may finally cease.

There is ample provision made in the construction of the body for maintaining and carrying on the circulation. First, a great hydraulic apparatus is distributed throughout the body, consisting of the heart, arteries, veins, and capillaries. Next, there is a large pneumatic apparatus within the body, consisting of the lungs and respiratory tract. These are worked and regulated by the power which is vested in the nervous system. If either of these systems fail to continue in action the circulation will stop, and life will cease. The functions that these machines respectively perform are called vital functions; consequently, the heart, the lungs, and the brain are called vital organs. If the functions of one of these organs cease, those of the other two will be arrested speedily.

The phenomena of death vary remarkably, according as the interruption begins in the one or in the other of these organs. Bichat describes death as beginning at the head, beginning at the heart, and beginning at the lungs,

Syncope.—For the heart to continue to propel the current of blood, two things are necessary: first, the power of faculty cf contracting; second, a sufficient quantity of blood in its chambers to be moved, and also to stimulate them to contraction. If this proper stimulus is withheld, or is largely deficient, the heart will soon cease to beat. This would indicate, therefore, that there are two ways in which death may be said to begin at the heart: that of death of anemia; and of death by asthenia. Death by anemia is caused by want of due supply of blood to the heart; in death by asthenia there is a total failure of contractile power in that organ. The state of suspended animation common to both of these forms of dying is expressed by the term syncope.

Apnea, Asphyxia.—Death beginning at the lungs is caused by the want of due arterialization of the blood. There are two perfectly distinct modes in which this cause of death may proceed, although the ultimate results are identical: first, when access of air to the lungs is suddenly prevented by the closure of the respiratory tract; second, when the muscles of respiration cease to act as a result of some disease or injury of the brain. The first form results in death by asphyxia; the second form, in death by coma.

The term "asphyxia" properly signifies pulselessness, or want of pulse; but, from long continued use of its current signification, it cannot be restored to its proper meaning without much confusion, although the term "apnea" (privation of breath) would be a much better term to express this mode of death, to which the word asphyxia is so commonly applied.

Air may be prevented from entering the lungs in various ways: by closure of the mouth and nostrils; by submersion of the same openings in some liquid, or in gases, which, though not in themselves poisonous, contain no oxygen; by mechanical obstruction of the larynx or trachea, from within by morsels of food, or from without by hanging; by pressure upon the chest and abdomen, which prevents the movements of the chest, ribs, and diaphragm; by paralysis of the muscles, as from injury or disease of the spinal cord, above the origin of the nerves which supply the muscles of respiration, including the diaphragm; or from a section of the phrenic or intercostal nerves; or by wounds extending through the walls of the thorax, which admit the air freely to the surface of the lungs. It may occur also when both pleuræ become filled with liquid, as in dropsy or large effusions.

If the prevention of air entering the lungs is sudden and complete, certain external phenomena will present themselves: strong contractions of all the muscles concerned in breathing occur; struggling efforts at respiration are made, prompted by the uneasy sensations which every one who has tried how long he can hold his breath has experienced, and which, when unrelieved, soon rises to agony. This extreme distress is transient only, being succeeded by sensations of vertigo, then loss of consciousness and convulsions. In a short time all these phenomena cease, except a few irregular twitches or tremors of the extremities; the muscles relax, but the movements of the heart, and even the pulse at the wrist, still continue for a short time after all other signs of life cease. During this process, which is only of two or three minutes duration, the face becomes flushed and turgid, and then livid and purplish. Even before life is extinct the veins of the head and neck swell and the eyeballs seem to protrude from their sockets.

The internal changes which cause these outward symptoms proceed from the preventing of the chemical alteration, naturally produced in the blood within the capillaries of the pulmonary circulation. The blood, continuing venous, passes at first in considerable quantities into the pulmonary veins, and thence to the left side of the heart and, in turn, to all parts of the body. This venous blood, loaded with carbonic acid, is inadequate to sustain or to excite the functions of the parts it thus reaches.

In the brain, the effect of the unnatural circulation is felt at once and is shown by the convulsions that ensue. The motion of the blood in the pulmonary capillaries is impeded from the first, and its current is retarded gradually until it stagnates altogether. The right cavities of the heart are distended, while the venous congestion becomes general. The blood that passes through the left side of the heart still retains the carbonic acid, and, in a very short time, all the blood in the body is charged with this gas, which results in the enfeeblement of the contractile power of the heart and arteries, and gives the surface of the body that dark=bluish color seen in asphyxiated cases. In this state, even after the heart has ceased to beat, if the cause which excluded the air be removed, and fresh air be readmitted, as by artificial respiration, the venous blood in the pulmonary capillaries undergoes the required change—that is, becomes arterialized—, and begins to pass onward, and, by degrees, the circulation is restored.

When death has occurred from asphyxia, the left side of the heart is found to contain a small quantity of dark blood, while its right chambers are greatly distended, and the lungs, the venæ cavæ, and the whole venous system, are gorged with venous blood.

After sudden death, however caused, the blood seldom coagulates; and the venous congestion, consequent upon rapid apnea, although great at first, will subside in due time, by descending into the dependent portions of the body.

Death by asphyxia is extremely common. It may be produced by anything that will close the glottis, such as edema of the sub=mucous tissues of the larynx, or inflammation or tumefaction of its lining membrane, or the presence in the windpipe and bronchi of what are called false membranes, such as are formed in croup, diphtheria, etc. It may be the result of disease in the substance of the lungs themselves, preventing them from receiving the required amount of air, as in pneumonia and in pulmonary apoplexy; or it may proceed from disorders of the bronchial mucous membrane, the air=passages becoming closed by excessive secretions, as in bronchitis; or from disease of the pleuræ, in which there are extensive effusions, causing pressure upon the lungs; or from diseases of any kind which extend into the thoracic cavity, with like effect.

Coma.—Death beginning at the head ends by paralyzing the respiration and circulation. The nerve=centers situated above the medulla oblongata and pons Varolii are not essential to life, except in so far as animal life, and the possibility of adaptation to surroundings, are concerned. Diseases of the brain, however, are liable to prove fatal by indirect action on the medulla and pons through pressure, extension of inflammation, and the like. Certain poisons, also, whether introduced from without—such as opium and narcotics generally—, or arising within, owing to the elimination of waste products, as in uremia, effect the nerve centers, both cerebral and spinal, and not only produce unconsciousness, or coma, but also paralyze the respiratory and cardiac centers.

In death produced in this manner, the individual lies unconscious, reflex action is abolished, the breathing becomes stertorous, the chest ceases to expand, the blood is no longer aerated, and thenceforward precisely the same internal changes occur as in death by asphyxia.

The differences between the two forms of dying amount to this: in death by asphyxia, the chemical changes of the blood which take place in the lungs cease first, and then the circulation of venous blood through the arteries suspends the sensibility; in death by coma, the sensibility ceases first, and, in consequence of this, the movements of the thorax and the chemical changes of the blood which take place in the lungs, cease also. Therefore the circulation of venous blood through the arteries is in one case the cause, and in the other the effect, of the cessation of animal life. In one case, the circulation ceases because the actions of respiration cease; while, in the other, the failure of the acts of respiration arises from a suspension of the nervous powers.

SIGNS OF DEATH.

It is not always easy to determine when life is extinct. There is no early, single, positive sign to determine whether the solemn change has taken place or not. It requires the combination of a number of signs to determine when the spark of life has become finally extinguished. In apparent death, the functions of the vital organs are reduced to such an extent that life seems to be destroyed. The conditions which most resemble actual death are syncope, asphyxia, and trance—particularly the last—; also to some degree, hibernation, hypnotism, and catalepsy.

Cessation of the Heart's Action.—The most reliable evidence of death is proof of the cessation of the heart's action. This proof is very hard to obtain. If it were possible to cut down to and examine the heart ocularly, the proof would be positive; but, to depend upon external tests and signs, the heart and large vessels being located so deeply, makes it uncertain. Mere pulselessness is no proof, for the heart may still be beating, and the blood may be passing through in such a manner that no contraction of the smaller branches of the arteries will be perceptible to the touch. The ear, placed against the surface of the chest over the heart to gather sounds, cannot be relied upon. The use of the stethoscope, in the hands of a physician or any other expert, and continued for some length of time, may determine whether the heart has ceased to act or not. When the body is in a condition of suspended animation, the heart beats very slowly and feebly; the number of beats may be reduced even to ten or twelve per minute, and the heart action be so feeble that it will require a positive expert to determine that there is any sound whatever.

The application of a tight ligature around a finger or toe has been recommended by Bagnus; when the string has been so applied, if life is extinct and the circulation has ceased entirely, there will be no change in color in the surface of the distal end of the digit, but, if the circulation still continues, it matters not how feebly, the surface of the extremity will sooner or later assume a bluish tint from strangulation of the venous flow.

If the arm is brought out from the body and placed in a dependent position and an artery raised and opened and found empty, it indicates that the heart has ceased to act; if the artery is not empty, whether blood spurts from the wound or not, it would not be proof that either life or death is present.

If cessation of the heart's action is absolutely established, we know positively death is present and no other signs need be considered.

Cessation of Respiration.—Respiration may appear to be suspended, but still may be going on. We may observe the chest very closely and not be able to see the least movement; by placing the hands over the chest the movement may not be felt. The motion of the abdominal wall, that is so constant in the respiratory movement, may appear to have ceased entirely, yet respiration may be going on very slowly and superficially.

If a cold mirror be held before the mouth and nostrils, the moisture in the air coming from the lungs will be condensed on the surface if respiration is going on; if a flock of cotton wool be laid upon the lips and across the nostrils, it will move to and fro if respiration has not ceased; if a cup of water be placed on the chest, the reflection on its surface will move if respiration is still going on. These are all methods well adapted for the detection of respiration.

If the results are all negative, the indications are that respiration has ceased, but still they are not positive. Moisture coming from the body and not from the lungs may condense on the cold mirror in sufficient quantity to be noticeable; the flock of cotton across the lips and nose may be moved by air currents other than those coming from the lungs; a movement of the reflection on the surface of the cup of water may be observed, resulting from shaking of the floor from walking or other causes.

Loss of Vitality.—With the cessation of the circulation, the skin becomes ashy=pale in color, which is due to failure of the blood to remain in the upper surfaces of the body; the tissues lose their elasticity; the tension of the eyeball is reduced; the cornea becomes opaque; the pupils fail to react to light. If life is still present and a bright light is thrown on the pupil, the pupil will contract, and, on its removal, will dilate again. If life be extinct, and the skin is pulled up, it fails to resume its normal position at once, having lost its elasticity; if irritants are applied to the skin they do not cause a vital reaction. If a match or hot iron be applied to the skin, if life is present, a blister will rise and fill in the usual manner; if death is present, the blister will not appear. If the skin is cut or punctured, the wound will remain open, if death is present.

Certain parts may retain their independent vitality after somatic death. The muscles may be made to contract by the application of an electric current two or three hours after death, the muscular energy as yet not having disappeared. In cases of sudden death, or in diseases that produce great shock to the system, contractions of the muscles may take place after death, with sufficient force even to change the entire position of the body, especially in those who die in full muscular vigor.

CHANGES OF DEATH.

The following changes of the body not only indicate death, but aid in fixing the probable time at which death occurred:—

Cooling of the Body.—After death, except under certain special circumstances, as in fatal cases of cholera and yellow fever, the body ceases to be a source of heat=production, and, therefore, is to be looked upon as an inert mass, possessed of a higher temperature than the average medium, which parts with heat according to certain physical laws. The superficial coldness found in collapse, which is due to the cessation of the peripheral circulation, must not be mistaken for cadaveric coldness; for there is still an amount of internal heat after death which has to pass off, and the body, which is cold to the touch before death, may rise in temperature as the internal heat radiates. A thick coating of adipose tissue, a covering of woolen clothing, etc., retards cooling of the body; a high temperature will also retard, while a low temperature will increase, the cooling.

According to Drs. Wilkes and Taylor, if a body, dying of an ordinary disease, is placed in an average temperature in a nude condition, it will cool at a rate of about one degree, F., per hour. If that be the case, and the conditions of temperature are of the average, a body that is found with a surface temperature of eighty degrees will have been dead about eighteen and one=half hours, the natural temperature of the body being ninety=eight and one=half degrees; the difference between eighty and ninety=eight and one=half degrees indicates the period of time that has intervened since death.

Hypostasis, or Post-mortem Discoloration.—The blood gravitates to the dependent parts of the body after death, which gives rise to livid discoloration upon the under surface of the trunk and neck. These discolorations are termed hypostases, and usually occur from eight to ten hours after death. In cases of long=continued sickness, as for instance in the adynamic fevers, the muscular power of the body is so weak that the heart and vessels are unable to force the blood from the dependent portions into the upper parts of the body; failing to keep it all circulating throughout the whole body, it settles and fills the capillaries and small vessels of the under surfaces of the body, even while life is present, causing discolorations. Then, again, post=mortem discolorations may be confounded, in some cases, with ecchymoses, or extravisations of blood; but they differ from ecchymoses in the fact that the blood is contained in the vessels and not extravisated into the tissues, as may be shown by an incision into the skin. If the blood remains in a liquid state, the hypostatic discolorations may be made to disappear by turning the body over. The fact that these discolorations may appear before death, renders hypostasis a sign that cannot of itself be depended upon.

Post-Mortem Staining.—While hypostasis is making its appearance, other changes are taking place in the upper part of the body. The blood undergoes earlier and more rapid change than any of the tissues in the body. The hemoglobin escapes from the red corpuscles of the blood, partly by exudation and partly by the destruction of the corpuscles themselves, and is dissolved in the liquid of the blood, and passes through the walls of the vessels into the surrounding tissues, causing a discoloring, known as post=mortem staining. This is of a uniform, pinkish=red color, and must be distinguished with care from the redness of hyperemia, which appears only in points and layers. This staining may be noticed along the course of the large vessels, as over the ventral regions, and along the external jugulars, the saphenous veins, etc. The amount of discoloring is in proportion to the amount of blood in the veins and the rapidity of its decomposition.

Rigor Mortis.—Arrest of nutrition is accompanied in the muscles by the state of rigidity, known as rigor mortis, or post=mortem or cadaveric rigidity. This rigidity is due to coagulation of the muscle plasma. It comes on after the muscular energy is used up, or, in other words, as soon as the muscle has lost its vitality—that is, when the application of the poles of the battery to the muscle will fail to make it contract. The rigidity usually begins in the muscles of the neck and face, and gradually extends from above downward, so that while the upper parts of the body appear flaccid, the lower extremities are rigid. Putrefaction usually begins in the same region and follows in the same order. As a rule, while rigor mortis is present, putrefaction progresses very slowly. In rare cases, however, putrefaction goes on rapidly in the soft viscera, producing gas sufficient to distend the walls of the abdomen and fill the other cavities, while the muscles remain markedly rigid. Usually, while rigor mortis is present, if fluid is injected into the cavities, preventing the growth of the putrefaction bacteria within, the body can be kept "the usual length of time"; this is the reason for the apparent success of those who do nothing more than cavity embalming. As soon as rigor mortis disappears, the external soft parts of these bodies begin to putrefy.

Rigor mortis takes place in all bodies after death; the muscles become firm and shortened, apparently in a state of chronic contraction. The time of its appearance and its intensity depends on the state of muscular nutrition at the time of death; the greater the store of muscular energy, the longer it is before rigidity sets in and the longer it lasts; on the contrary, the greater the exhaustion of the body, the sooner the rigidity sets in and the sooner it passes off. In persons dying in vigorous health, as by accident, rigor mortis is longer in making its appearance than in those dying from exhausting diseases, as consumption, the adynamic fevers, etc. In cases of full muscular vigor, the rigidity will come on in from one to twelve hours and will last from one to ten days; while in those of exhaustion, it may come on at once and pass off within an hour.

Rigor mortis is not positive as a sign of death, as there is rigidity of the muscles following apparent death, as in cases of asphyxia or trance. If the body is rigid, in a case in which there is a doubt that death is present, the rigidity may be broken up. If it is a case of trance or that of contraction of the muscles following drowning, it is likely to return, especially in case of trance; but if death is actually present it will not return.

Putrefaction is a sure sign of death, but it will not be noticed until two or three days or more have supervened; it cannot be considered, therefore, as an early sign. In an average temperature, the body having died of an ordinary disease, a deep=green color will be noticed in the lower surface of the abdomen externally, and sloughing of the mucous membrane in the throat and pillars of the fauces internally. Putrefaction is treated of fully in the following chapter.

SUMMARY OF THE SIGNS OF DEATH.

It must not be forgotten that somatic death must be differentiated from suspended animation due to trance, asphyxia, profound syncope, hibernation, hypnotism, and catalepsy. For this purpose we have summarized the following signs of death; if a majority, or a large number at least, of these are affirmative, you can rest assured that death is present:—

If death is present—

By placing the ear to the chest over the heart, no sounds will be heard.

On tying a ligature around an extremity, no swelling or discoloration will appear beyond the ligature.

If a cold mirror be held over the mouth, the surface will not become moistened.

If the ear is applied over the lungs, no sounds of respiration will be heard.

If a cup of water is placed on the chest, there will be no movements of rays or ripples on the surface.

If the skin is cut, no blood will flow, nor will the wound close.

If the skin is punctured by a large needle, the wound will not close up.

If heat be applied to the skin, no blister will form.

If ammonia be injected hypodermically, there will be no reddening of the skin.

If the hand of the subject be held to the light, instead of the light showing pink through the inner edges of the fingers, it will be opaque.

The blood sinks in a few hours after death to the most dependent parts, reddening them a livid hue (post=mortem discoloration), while the upper surfaces become very pale.

The eyes will be sunken into the sockets.

The eyeballs will become flattened.

The cornea becomes opaque.

The iris loses its sensibility to light and hangs loosely, rendering the pupil irregular in shape.

The pupil will neither dilate nor contract, if a strong light is held before it.

The eyelid loses its elasticity.

The white, transparent color of the conjunctiva is lost, often becoming black or gray.

Rigor mortis may or may not be present.

The body cools finally to the temperature of the surrounding atmosphere.

If an artery be opened, as a rule, it will be found empty.

If putrefaction is present, all other signs may be ignored.

In conclusion, do not consider from this summarizing that each sign enumerated is a positive indication of death, or that all of them are infallible. But, if a fair number of these signs indicate the presence of death, you are justified in the conclusion that death is really present.

CHAPTER XVIII.

PUTREFACTION: ITS MODIFICATIONS AND PECULIARITIES.

After death has occurred, the tissues of the body undergo various changes as to the color and consistency of the solids, semisolids, and fluids. By these changes, known under the several names of putrefaction, decomposition, decay, etc., due to the presence of bacteria, the tissues are finally resolved into their constituent elements. Putrefaction may occur locally during life, and septic changes may take place to some extent before death. However, the term is not applied, usually, until the changes in color, consistency, and smell are clearly perceptible. Putrefaction may be defined as the separating of the constituent elements of the body, due to the presence and growth of bacteria.

The first external sign of putrefaction is a deep=green color in the surface of the abdomen, beginning in the right iliac region, over the cecum and appendix. This gradually extends until the whole wall of the abdomen is covered. If the larynx and trachea are examined, the mucous membrane will exhibit changes in color and consistency.

Putrefaction takes place first in the soft or less compact tissues; then the fibrous or harder tissues follow, while the most compact tissues, as those of the uterus, resist the final change longest of all. In the course of time, however, all of the tissues are entirely decomposed, becoming detached from the skeleton, which is exposed and gradually falls to pieces.

Putrefaction is effected by micro=organisms, known as saprophytes, or putrefactive bacteria. When rigor mortis passes off, decomposition generally begins. The discolorations that result are due to alterations in the transuded hemoglobin.

The process of putrefaction is accompanied by the generation of gases very offensive to the smell, such as sulphureted hydrogen, nitrogen, carbonic acid, ammonia, etc.

It is impossible to say how long it will take for a body to decompose, as it depends partly on the condition of the body itself, but principally upon temperature, moisture, and exposure. A moist, high temperature, with free exposure, favors rapid putrefaction. A dry, high temperature has a tendency to dry the tissues, and in this way produces mummification instead of putrefaction. Moisture alone tends to produce saponification of the tissues, more particularly of the fatty, causing the formation of a substance known as adipocere, as when the body lies in water or moist earth. (See page 272.)

Putrefaction progresses more rapidly in the air than in the water; while in the earth its progress is much slower than in water. With an average temperature, under ordinary circumstances, putrefaction will appear about the third day. If the temperature be high and moist, it will begin much sooner; if it is extremely high, without moisture, dessication or mummification will result, for the reason that bacteria do not grow or develop in a high temperature unless moisture is present. If a body dies in the high altitudes, where no moisture exists, where there are no dews, where the lands have to be irrigated to produce vegetation, putrefaction will be very slow if it takes place at all. The atmosphere, being so dry, absorbs the moisture from the body so rapidly that the bacteria which exist in the body cannot develop. If the body be placed in the earth in the high altitudes, where the ground is perfectly free from moisture, dessication will result, and the body will be preserved for all time.

At the recent World's Fair in Chicago, there were several mummies from the high table lands of Peru. These, from all appearances, had been buried in a sitting posture, indicating that they were of the aboriginal tribes and that they may have been centuries old. These bodies were not embalmed but were preserved by nature's method. The ancient embalmers seem to have been aided by a very dry atmosphere, as mummies are found only in countries and localities where natural conditions existed that materially aided in dessication or mummification.

Putrefaction is less rapid in a body placed at some depth in the water. This is due, no doubt, to the absence of aerobic bacteria, which exist and grow only where there is plenty of oxygen. However, there are present in the alimentary canal anaerobic bacteria, which develop without free oxygen. The temperature of the water being low, these anaerobic bacteria will slowly produce putrefaction, eliminating gases sufficient to bring the body finally to the surface, where the aerobic bacteria will enter, and putrefaction will progress more rapidly.

In some cases that are placed in the ground, putrefaction will not begin for a long time, while in others it will progress rapidly. In our demonstrations we have noticed the results in a number of different cases. A body that had been placed in a very wet soil, the top of the box resting under two feet of earth, and water entirely covering it, in the month of July, when the temperature was very high, at the end of ten days, had the appearance of what is commonly called a "floater"; putrefaction had progressed to a very great degree. In another case the body had been buried twenty=four hours after death, during the last week in August, in a dry, sandy soil, at a depth of about five feet, and in December, when it was taken up and used for demonstrations, it did not exhibit any signs of putrefaction whatever.

When the body is exposed to the atmosphere in the low altitudes, in passing through its various changes, it will be many months before the soft tissues become entirely disintegrated. The uterus has been found fit for judicial examination nine months after death, in a case where antiseptics had not been used.

It is difficult to state how far putrefaction shall have advanced in a given time, for, under similar conditions apparently, a very great divergence of results have been observed. The necessary conditions for putrefaction are heat and moisture. Putrefaction will not continue in a temperature below freezing; neither in a high temperature where no moisture exists.

ADIPOCERE.

Adipocere (*Adeps*, fat; *cera*, wax) is a substance formed by spontaneous change in dead animal tissues. It somewhat resembles spermaceti in consistency and is of a dull=white or buff color, but it is less crystallin in fracture, the surface being marked by blood=vessels and other textures. When adipocere is formed in damp situations, or in the early stages of its formation, it is soft, and, if rubbed between the fingers, a greasy feeling is communicated. Its odor is peculiar and somewhat disagreeable.

When dissolved in ether, adipocere leaves a delicate, filamentous web. It burns with a blue flame, and white ash results. It is a soap, composed of margaric and oleic acids, combined with ammonia, the fixed alkalis, and alkalin earths. With the age of the specimen, the relative proportion of the latter ingredients varies.

If a recent specimen is examined with the microscope, it is found to be composed of broken down tissues and fatty granules, together with a few acicular scales or crystals. These granules are seen in what was muscular tissue to assume the same arrangement as the muscular filaments, thus having an appearance resembling the early stage of fatty degeneration.

Adipocere was first described long ago. The flesh of animals exposed to moisture or placed in running water will change very readily into adipocere. Dilute alcohol or greatly weakened nitric acid will produce it in abundance, as is seen in the specimen jars of the anatomist. When bodies of men or other animals are buried in peat moss, they are frequently found to have been converted completely into adipocere. When the bodies were moved from the *Cimetiere des innocents*, at Paris, to the Catacombs, in 1786-87, Fourcroy found many of these bodies converted into what he named *adipocire,* which name has since been retained, taking in this country, of course, the Anglicized form. It has been suggested that possibly this substance, formed from the waste flesh of animals, could be adapted to some useful purpose, but the tenacity of the disagreeable odor, and the presence of other difficulties, have interfered very materially, preventing the suggestions from being acted upon.

Chemists differ in opinion in regard to the immediate changes which give origin to adipocere, but when it is considered that after death the tissues are usually resolved into their primary elements by some process, if not by putrefaction, it is possible to perceive that adipocere may be derived, not only from free fat, but from elements of fat existing and obtained from decomposition of their tissues. It may be described as both an educt and product. This opinion is confirmed by the results of the researches of Bauer and Voit, who showed that fatty matter was derived from metamorphosis of albumen in starved animals, to which phosphorous had been administered.

The formation of adipocere has a special interest for the pathologist, who has pointed out that the change is analogous almost to fatty degeneration in the living body, thereby establishing the pathological doctrine that fatty degeneration is the result of retrograde metamorphosis due to defective nutrition. It is this condition that is sometimes supposed by the non=professioned to be petrifaction.

"SKIN-SLIP": ITS CAUSES AND PREVENTION.

Its Causes.—Many embalmers have been led to believe that slipping of the skin is caused by certain fluids used in injecting the arterial system. This is an error needing correction. "Skin=slip" is caused by the putrefactive softening of the rete mucosum. It occurs in all cases where putrefaction has advanced extensively. The early softening is almost exclusively in cases of heart, liver, and kidney diseases, and other morbid changes that result in dropsy, and there is always more or less dropsical effusion into the subcutaneous tissues which transudes into the rete, resulting in putrefactive softening. The general effusion into the subcutaneous and other tissues prevents the fluid from passing through the capillaries, thereby interfering with a proper distribution of the fluid to the skin. Slipping of the skin occurs at times when fluid is used only in the cavities, none being injected into the arteries; under such circumstances the fluid certainly could not produce "skin=slip." No fluid that contains strong antiseptics injected into the vascular system will cause slipping of the skin.

Skin=slip, whether occurring before or after the process of embalming, is due to putrefactive changes. If it occurs after embalmment, it is positive proof that the part or parts have not received fluid, and the rational treatment for such cases is the re-injecting, using enough fluid to fill the parts thoroughly.

Its Prevention.—Cases that die from diseases causing dropsical effusion in the subcutaneous tissues should be handled carefully. A little formaldehyde should be added to the fluid that is injected, say from two to three ounces to each quart of fluid. Formaldehyde hardens the tissues more rapidly and completely than any other known substance. Zinc has a similar effect, but it is not so rapid or powerful in its action. Formaldehyde, having a great affinity for water, will act admirably in this class of cases. It will harden the soft layer of the skin, and, at the same time, destroy the bacteria. A cloth moistened with formaldehyde, placed upon the parts exposed when the skin is slipping, and covered with rubber or oiled silk, or something that will exclude the air, will have a tendency to harden the soft layer. Such treatment will be satisfactory, and is all that is necessary.

CHAPTER XIX.

THE BLOOD: ITS CHARACTERISTICS AND CHANGES.

The Blood is the circulatory fluid, by means of which the nutrition of the body is effected. It carries nourishment to all the tissues (except the cuticle, nails, etc.), and the waste, in the form of carbonic acid, to the lungs, where it is thrown off. It is a fluid, when pure and free from carbonic acid, of a bright=red, or rather, scarlet color (arterial); when impure and full of carbonic acid, of a dull=red or purple color (venous).

The exact proportion of the blood to the entire weight of the body is not known, as it is impossible to gather all the blood in the body. The approximate amount is about one=tenth of the weight of the body, or about fifteen pounds of blood in a body weighing one hundred and fifty pounds.

To the embalmer, the blood is the most important fluid in the body, for the reason that it frequently appears near the surface in the parts exposed, causing a dark=bluish discoloration; it often closes up the channels through which the embalming fluid is conveyed into the tissues; it also decomposes readily, forming gases within the vessels. In many cases it should be removed, and it it a good plan to remove it in all cases, but its property of coagulation after a period of time often prevents this.

Composition of Blood.—The blood is composed partly of a watery substance, called plasma or liquor sanguinis, and partly of red and white corpuscles. The red and white corpuscles constitute a little less than one=half of the mass of the blood. The red corpuscles are about 1/3200 of an inch in diameter and about 1/16000 of an inch in thickness; their color is due to the hemoglobin. White corpuscles (leucocytes) are much larger and less abundant, existing only in the proportion of about one to six hundred and thirty-six of the red corpuscles. The plasma also contains fibrin, albumen, and various mineral substances.

Circulation of Blood.—If reference is made to the anatomy of the heart, arteries, and veins, in Part First, a complete anatomical description of these vessels will be found. This description should be studied until it is comprehended thoroughly, then it will be easy to understand the circulation of the blood.

The blood, in making the complete round of the circulatory system, passes through two circulations, the greater or systemic, and the lesser or pulmonary.

The systemic circulation begins in the left ventricle and ends in the right auricle. The blood passes from the left ventricle, through the aortic opening and the aorta and its branches, to the capillaries in every tissue of the body, where nourishment is given off to, and the waste is received from, the tissues; then it passes through the veins to the right auricle; thence through the right auriculo-ventricular opening into the right ventricle.

The pulmonary circulation begins in the right ventricle and ends at the left auricle. The blood, in making the circuit of this circulation, passes from the right ventricle, through the pulmonary artery and its branches, to the capillaries in the walls of the air-cells, where carbonic acid gas is given off and oxygen is received, purifying it; it then passes through the pulmonary veins to the left auricle; thence through the auriculo-ventricular opening into the left ventricle.

In the above description of the circuit of the blood, it will be seen that venous blood passes through the pulmonary artery, while arterial blood passes through the pulmonary veins in the pulmonary circulation. Except in fetal life, this is the only artery that carries venous blood, and these are the only veins that carry arterial blood.

Coagulation of the Blood.—The blood, while circulating freely in the living body, retains its fluidity; but after death, or when drawn from the vessels and exposed to the air in the proper temperature, it coagulates or sets into a jelly=like

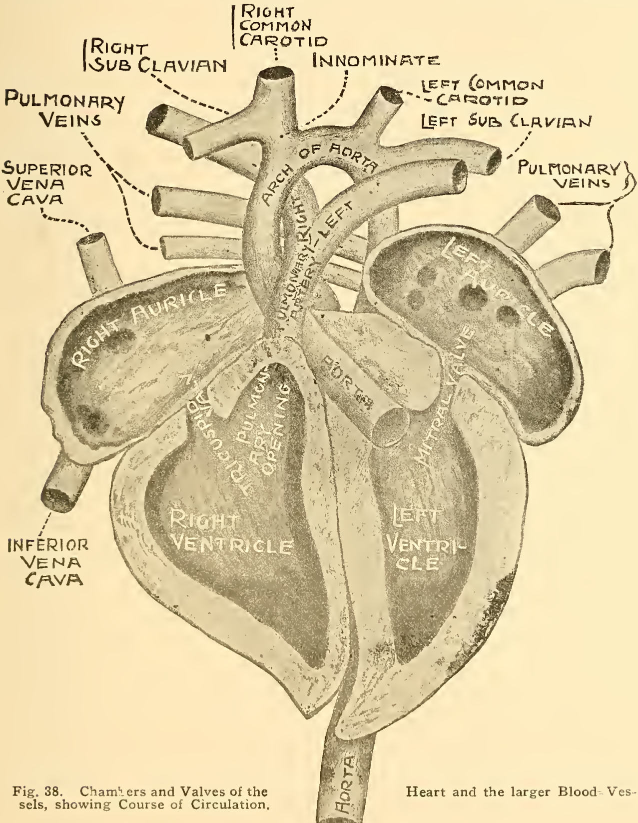


Fig. 38. Chambers and Valves of the Heart and the larger Blood-Vessels, showing Course of Circulation.

mass. This mass will separate, after a time, into a clear, yellowish liquid, called serum, and a semisolid, reddish portion, called the clot or crassamentum. The former is composed of the plasma, minus the fibrin, which has united with, and now binds together, the red and white corpuscles to form the crassamentum.

While in the vessels after death, the blood coagulates very slowly—as a rule, much slower than when removed from the body and exposed to the air. When the blood is perfectly normal and the temperature is high, it will coagulate much quicker than if the body is exposed to a low temperature. Heat increases while cold retards the tendency to coagulation. As a rule, when the blood is in a normal condition and in an ordinary temperature, it coagulates in from twelve to twenty-four hours after death. Therefore, if the blood is to be removed, the operation for removal should take place as soon as possible after life ceases.

After death, the blood is found usually in the veins, the arteries being emptied by post=mortem contraction of their muscular coats, this taking place within an hour or two after death. In the large veins and right side of the heart the coagulation may be firm, while in the smallest or peripheral veins and capillaries it is generally liquid, being seldom found perfectly coagulated. Coagula are sometimes found in the left side of the heart and arteries, but they are much smaller than those found in the right side of the heart and large veins.

The coagulation of blood can be retarded or prevented by the addition of certain chemicals, such as a solution of potash or soda and some of their salts; but practically we cannot make application of these means of liquifying or preventing coagulation, as it is impossible to reach the blood while in the vessels. It is true some have advocated the injection and ejection of solutions of these salts for the purpose of liquefying and removing clots, but that operation is impracticable.

There are other conditions that prevent or retard coagulation. Poison of venomous serpents, narcotics, prussic acid, suffocation, whether by drowning, hanging, or poisonous gases, prevent, while lightning, electricity, blows on the abdomen, cholera, or violent exercise, retard coagulation in the vessels.

There are certain diseases that will accelerate coagulation, such as pneumonia and typhoid fever in their first stages, apoplexy, sudden death in persons of full habit, etc.

Cause of Arteries Being Empty After Death.—As stated, the arteries are usually found empty after death. This condition is due to the tonic contraction of the non=striated muscular fiber in the heart and in the muscular coats of the arteries. The muscular walls of the ventricles and the arteries are the first to lose their irritability, and become rigid and contracted within an hour or two after death, usually remaining in that state for from a few minutes to an hour or two; but in rare cases the walls may continue rigid for twenty=four to thirty=six hours, then become flaccid again. The contraction of the arteries is so great as to produce marked diminution of their caliber. This, no doubt, contributes largely to the passage of the blood from the arteries into the veins, which almost invariably takes place within an hour or two after death. It also frequently prevents a free flow of fluid through the arterial system.

After death, the blood is found in the deep veins and dependent parts of the body. The body should always be placed on an incline, in order to gravitate the blood to the dependent parts of the trunk, thus facilitating its removal. After the body has been embalmed, it should be placed on a level with the head slightly elevated, so that the fluid will remain distributed to all parts of the body.

Circulation of Fluid.—In arterial embalming, fluid is injected into the arteries and capillaries of the systemic circulation. It does not pass through or into the heart when the valves are intact, unless it makes the entire circuit of the systemic and pulmonary circulations, which it is not likely to do, unless a large amount of blood is withdrawn. If the semilunar valve at the aortic opening, and the mitral valve at the auriculo=ventricular opening, are diseased and fail to close the openings, the fluid may regurgitate or take a backward course, through these openings into the ventricle and auricle, thence through the pulmonary veins to the capillaries around the air=cells, and back through the pulmonary artery to the pulmonary opening on the right side of the heart—that is, providing these vessels are empty—but, as above stated, if the valves are intact, no fluid will enter the chambers of the heart or the lungs in this manner except through the coronary vessels.

If the artery is raised at any point in either of the upper extremities, and the body be upon the incline, the fluid will pass through the axillary and subclavian, and on the right side innominate, into the aorta; from there it takes a downward course through the arteries to the most dependent parts, filling them first, and reaching each arterial branch successively, as the level of the fluid rises, supplying all of the tissues, reaching the upper extremities, neck, and head last. After this point is reached, however, it is well to continue the injection until all the capillaries are completely filled, which will be indicated usually by the change of color, the distention of the part or sense of touch or by incising the skin, when fluid may be seen to issue from the incision.

Collateral Circulation.—"The communications between arteries are very free and numerous, and with the diminution in size of the branches, increase in frequency; so that through the medium of the minute ramifications, the entire body may be considered as one uninterrupted circle of inosculations or anastomoses. This increase in frequency of anastomosis in the smaller branches is a provision for counteracting the greater liability to impediment existing in them than in the larger branches. This communication of the arteries is very remarkable where freedom of circulation is of vital importance, as in the Circle of Willis, or in the arteries of the heart. It is also strikingly observed where obstruction is most likely to occur, as in the distribution to the alimentary canal, around joints, and in the hand and foot. On account of this free communication existing everywhere between arterial branches, it is possible for the blood to circulate in every part, even after a ligature has been applied to the main artery. The ramifying branches given off from the artery above the ligature inosculate or anastomose with those given off from the trunk of the vessel below the ligature. These anastomosing branches constitute the *collateral circulation*."

By this it may readily be seen that the collateral circulation is a side circulation, taking the place of a main artery which has been occluded. Now, this very condition arises when we tie in the arterial tube into an artery. We usually tie it in with the nozzle toward the part, or center of the circulation. The fluid is injected toward the heart. If the brachial artery is used, the fluid will soon fill the hand and arm through this collateral circulation, so in every part of the body the same result will follow through the anastomosing of the ramifying branches in every tissue of the body.

"It should be observed that in the division of the artery into two branches, the combined area of the two branches is somewhat greater than that of the single trunk; and if the combined area of all the branches at the periphery or surface of the body were compared with that of the aorta, it would appear that the blood in passing from the aorta into the numerous distributing branches, was flowing through a conical space, of which the aorta might represent the apex and the surface of the body the base. The advantage is sufficiently obvious of this important principle in facilitating the circulation. The increased channel thus provided for the current of blood, serves to compensate for the retarding influence of friction, which results from the distance of the heart, and the divisions of the vessels."

It has been estimated that the blood current at the aortic opening flows at the rate of one mile in 1¼ minutes, while at the peripheries or smaller subdivision of the arteries, its flow is that of a snail's pace: thus we may observe the reason for the large vessels filling so quickly at the beginning of the injection of fluid into the arterial system, which are so apparent in most all instances. The operator should not be misled by the idea that when the large vessels are filled, enough fluid has been injected to fill all the tissues of the body, as the fluid moves so slowly through the smaller subdivisions and capillaries that it takes time and constant pressure to fill all of the smaller branches and subdivisions of the arteries which supply the entire surface of the body.

CHAPTER XX.

ARTERIAL EMBALMING.

RAISING AND INJECTING ARTERIES.

Selection of the Artery.—In the selection of an artery for injection, convenience should govern the operator. If the body is already dressed, the radial or posterior tibial likely will be most convenient, as their use will not necessitate the removal or cutting of the clothing. If blood is to be withdrawn through the vein, then one of the brachials, femorals, axillaries, or carotids should be selected. The common carotid should be avoided on account of the mutilation, leaving an unsightly scar, that may interfere with the wishes of the friends with regard to the dressing of the body. If a large amount of blood is to be withdrawn, the femoral artery and vein should be raised, as they are more dependent when the body is placed on an incline, and consequently more blood can be withdrawn from the femoral vein than from any other. A drainage=tube, sufficiently long to reach above Poupart's ligament as far as the common iliac, is all that is necessary, as there are no valves intervening between the bifurcation of the common iliac and the right auricle. There is no necessity for undue exposure in either sex. To clear the face and neck of blood, the axillary will answer equally as well as the femoral vein.

As far as injection of fluid is concerned, one artery is just as good as another. All arteries are parts of the same channel, branches of the great aorta. No valves exist in any part of their course.

It is believed, quite commonly, that by injecting the femoral artery there is great danger of "flushing the face." This belief is erroneous. Flushing of the face does not result from the injection of the femoral artery unless the arteries are full; then it will be of a bright=red color, except in asphyxia, in which case the blood in both the arteries and the veins will be of a dark=purplish color. When the flush is of a dark=bluish color, it always results from the injection of a vein, except, as stated above, in a case of asphyxia. The internal saphenous vein is mistaken frequently for the femoral artery. It is a superficial vein, usually is found empty, and lies a short distance to the inner side of the femoral artery in Scarpa's triangle. This vein is taken up frequently, not only by the younger members of the profession, but by the older, when the guides are not followed closely. After the arteries are emptied there is no danger of flushing the face from the little blood that remains. This is so diluted, if fluid is injected slowly, that its effect upon the surface will not be noticed.

If post=mortem contraction has not taken place, and the arteries are full, either the operator should wait until they are emptied by the contraction of their walls, or he should place the body upon a high incline, raise the femoral artery, insert the drainage=tube, directing the outer end into a vessel, and allow the blood to drain out of the arteries as much as possible.

Usually it will not be necessary to wash out the arteries, as the blood, especially if liquid, will run out by gravitation. If the blood is coagulated extensively, it will not pass out of the arteries by gravitation, nor can it be washed out. If a small clot occludes the channel, possibly it may be dissolved or forced out by the washing process. To wash out the arteries, raise the brachial artery as well as the femoral, and inject fluid through the former; after the clot is dissolved, the fluid will appear at the opening in the femoral artery. This process only washes out the large channels between the two points of incision.

To Distinguish the Artery.—There is no excuse for making the mistake of injecting a vein instead of an artery, if the location, relation, appearance, and touch of the artery be noted carefully.

An artery is usually constant in its position; it is accompanied by one or two veins—primary arteries by one, secondary by two, called venæ comites,—and sometimes by a nerve; the artery, vein (or veins), and nerve are contained in a common sheath. Arteries, when empty, soon after death, are of a creamy=white color: they retain their cylindrical form, while veins flatten or collapse. Arteries have a firm feel to the touch, while veins are soft and velvety.

A vein that accompanies an artery, if a single one, is constant in its relation to the artery in the various parts of its course. Superficial veins have no sheath, nor are they, as a rule, accompanied by other vessels; they are found within the layers of the superficial fascia. Veins, after death, are usually full of blood, and when full appear bluish; when empty, they are of the same color as the arteries. The superficial veins that are usually mistaken for the arteries—the basilic and internal saphenous—are commonly empty, and are of the same color as the artery.

The nerves are white, inelastic, hard, and dense in structure, and are not hollow like the accompanying vessels.

Raising and Incising the Artery.—To raise an artery at any point, the embalmer should be acquainted with the anatomy of the part as well as the linear and anatomical guides for making the incision. He should be able also to distinguish between an artery, vein, and nerve. In raising an artery, an incision should be made through the skin at the proper place, of sufficient length to expose an inch or more of the artery when it is raised out of the wound; then dissect carefully down through the fat, superficial fascia, and deep fascia, to the sheath of the artery; raise the vessels out of the wound; incise the sheath with the curved=bistoury on the grooved-director, or with the scissors. Cleanse the artery by separating from it the vein (or veins) and nerve, if there be any; then take it upon the end of the finger or the shank of the aneurism=needle or bistoury, and make an incision through the wall, in the direction of its long axis, with the curved=bistoury or scissors.

Never make a diagonal or transverse cut in the artery for the reason that it weakens it, and, if the cut is made too extensive, an artery will break under a small amount of force, resulting from the introduction of the arterial=tube.

An artery may be raised in any part of its course without reference to the collateral circulation, as there is always sufficient collateral circulation to supply the distal end of the artery with plenty of fluid.

The Injection of Fluid.—After the incision of the artery is made, insert an arterial=tube of proper size, with the nozzle toward the heart; pass two threads underneath the artery, tying the artery around the tube with one, leaving the other loose around the distal end of the artery. Then commence the injection of the artery, and when fluid appears at the distal end tie it also.

Fluid should be injected into an artery very slowly and carefully, as rapid or forcible injection may rupture an artery or the capillaries. In cases of consumption, the arteries may be affected or weakened by the disease, the ends being filled with fibrous plugs, and the walls, having been destroyed partly by disease, may give way when force is used. Therefore, in these cases especially, the injection should be made slowly and carefully. The walls of the arteries and capillaries, particularly in the case of old people, are frequently rendered brittle by atheromatous deposits, causing them to rupture easily; or they may be destroyed entirely. In the former case, fluid will pass directly into the tissues in such quantities as to produce a brownish or grayish spot; while in the latter, no fluid will reach the part, and a soft spot will likely result from putrefaction.

If blood still remains in the arteries, rapid injection will force it in volume to the surface, it not having time to mix with the fluid. If its course is through the common carotids, it would cause a flushing of the face and neck of a bright-red color. For these reasons, it is necessary to inject slowly and carefully to have the best results.

The appearance of fluid at the distal end indicates an intact collateral circulation. If the fluid does not appear at the point of incision by the time the other parts of the body have received enough, remove the tube and tie the proximal end, insert the arterial tube into the distal end, and fill that part of the body with fluid.

After removing the arterial=tube from the artery and drainage=tube from the vein (if it has been used for the removal of blood), sew up the wound, and cover with adhesive plaster.

A Second Injection becomes necessary in some cases, enough fluid to preserve and disinfect the body properly not having been injected during the first injection. Sometimes rigor mortis is present, which interferes; in other cases, as in consumption, the arteries are weakened within the lungs and leakage would follow, if sufficient fluid were injected at one time to preserve the tissues; so that it becomes necessary to inject a second time. If the arteries are strong, and the walls of the arteries and tissues are in a perfectly relaxed state, a second injection will not be necessary, as a sufficient amount of fluid can be injected in a single operation to preserve and disinfect the body.

If the case is one in which it is deemed necessary to make a second injection, the arterial=tube should not be removed after the first injection, but, after the removal of the pump, the outer end of the tube should be capped; or, better still, an arterial tube with a cut=off or stop=cock, which is sold to the profession by the different supply houses in the country, should be used. These tubes can be closed by simply turning the cut=off, which makes them much more convenient than capping the ordinary tubes. After waiting several hours, or until the fluid has passed or transuded through the tissues, the cap can be removed, or the cut=off turned, the pump applied, and usually as much fluid injected as in the first injection. After the body has received as much fluid as is thought necessary to preserve and sterilize it, the tube can be removed, and the wound closed in the usual manner.

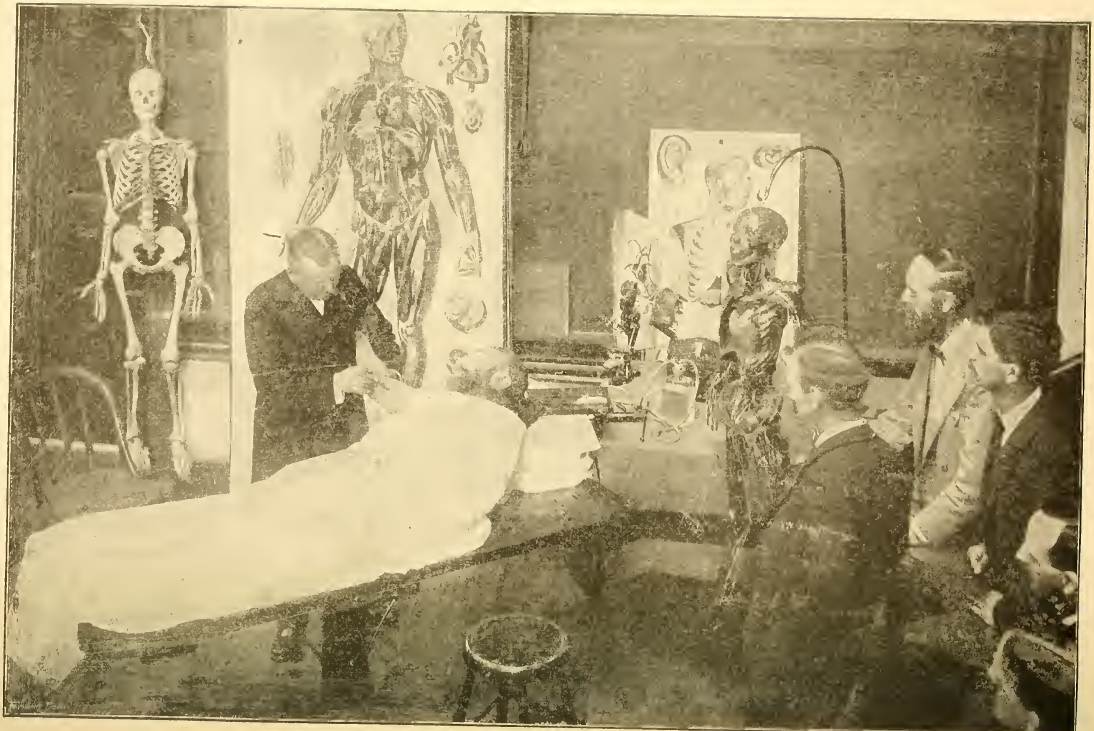


Fig. 39. RAISING THE BRACHIAL ARTERY.

THE BRACHIAL ARTERY AND BASILIC VEIN.

Location.—The brachial artery passes downward through the brachial region, extending from the lower part of the axillary space to the bifurcation at the elbow, along the inner border of the biceps muscle. Anomalies may exist in the artery in this region; instead of dividing at the elbow, it may divide at the lower margin of the axillary space, and descend along the inner border of the muscle as two trunks, each reduced to about half the normal size, in the same sheath, and reunite in the lower part of its course, and then again divide at or below the elbow; or they may continue on through the forearm as the radial and ulnar arteries.

The Linear Guide.—The course of the brachial artery may be marked out by drawing a line from the middle of the axillary space (arm=pit) to the center of the albow, provided the palm of the hand be turned upward. This line will be immediately over the artery, which will be found by cutting through the skin at any point on the line, and dissecting through the subcutaneous tissues toward the center of the arm.

The Anatomical Guide, used for locating the brachial artery, is the inner border of the biceps muscle. The artery lies in the groove between the biceps and triceps muscles, close to the inner border of the biceps. It is not covered by the muscle in any part of its course. It will be found beneath the deep fascia, inclosed in a sheath with the venæ comites and median nerve.

To Raise the Artery, the arm should be brought out from the body to a right angle, and the palm of the hand turned upward. In this position the linear guide will indicate the exact position of the artery, or the inner border of the biceps muscle can be used as the guide. Make an incision through the skin in the middle third of the arm, pushing the fatty or cellular tissue to either side of the cut with the handle of the scalpel; pass the grooved=director underneath the superficial fascia from one end of the incision to the other, pushing the farther end out through the fascia; then cut on the grooved=director, with the sharp=pointed bistoury or scissors, through the superficial fascia. Dissect through the deep fascia in the same manner. The incision through the tissues should be two or three inches in length.

After the deep fascia is divided, the sheath of the vessel will be brought to view. It should be raised upon the handle of the aneurism=needle and opened. The nerve will usually be seen first, the artery lying beneath it, with the accompanying veins attached to either side and in front. These should be separated and the artery brought up out of the incision; place it upon the end of the finger or the shank of the aneurism=needle, and make a cut through the wall in the direction of its long axis with the curved sharp=pointed bistoury or scissors. A double thread should be drawn through, beneath it, one thread being drawn to the upper part of the cut and the other to the lower. The arterial=tube should be inserted into the artery and the artery tied around the tube, the distal end being left open until fluid appears and then tied.

To Raise the Basilic Vein.—If the basilic vein is to be raised at the same time, it will be found lying to the inner side of the artery, within the layers of the superficial fascia. It should be raised and opened in the same manner as the artery; insert the vein=tube, push it through the vein until it reaches the heart and tie the vein around the tube in the same manner as the artery is tied around the arterial=tube. The pump should then be attached to the vein=tube, and all the blood that is possible should be withdrawn; then attach the pump to the arterial=tube, and inject a pint or two of fluid; then pump out blood again as before, continuing alternately pumping out blood and injecting fluid, until all the blood possible is withdrawn, and enough fluid has been injected into the body.

THE FEMORAL ARTERY AND VEIN.

Location.—The femoral artery is situated in the anterior and inner side of the thigh. It extends from Poupart's ligament downward and inward to the upper border of the popliteal space, back of the knee, where it becomes the popliteal artery.

The Linear Guide.—To locate the course of the femoral artery, a line should be drawn from the front of the prominence of the ilium (hip=bone) to the center of the pubic arch. This line indicates Poupart's ligament. A second line should be drawn from the center of Poupart's ligament to the inner side of the knee=joint. The latter line will indicate the course and position of the femoral artery, when the foot is turned out.

The Anatomical Guide is the inner border of the sartorius muscle, which arises from the front part of the hip=bone and passes obliquely downward and inward to be inserted into the upper, internal surface of the tibia, just below the knee=joint. In the upper part of its course the femoral artery passes through Scarpa's triangle, from its base to its apex. The base of the triangle is bounded by Poupart's ligament; the inner side by the adductor longus muscle, and the outer side by the sartorius muscle.

To Raise the Artery, an incision should be made in the lower part of Scarpa's triangle, about two or three inches in length, beginning about two inches below Poupart's ligament, extending the cut downward along the inner border of the sartorius muscle. It is necessary to make the incision near the sartorius muscle, as the artery lies close to the inner border of the muscle in the middle third of the thigh. If the incision were made carelessly, at a little distance from the inner border of the muscle, it would be immediately over the internal saphenous vein, which is large, with rather firm walls, and usually is empty. This vessel can be mistaken easily for the artery, which mistake often occurs, and, when fluid is injected through it, "flushing of the face" results. After the incision is made through the skin, the fat should be scraped to either side by the handle of the scalpel; the grooved=director should be passed beneath the superficial fascia from one end of the incision to the other, and the fascia cut through on the grooved=director with the sharp=pointed curved=bistoury; then the deep fascia should be raised and severed in the same manner. The sheath of the vessels will now be seen, which can be brought to the surface by the hook or finger, and the handle of the instrument placed underneath. The sheath should be opened in the usual manner by the grooved=director and bistoury or scissors.

The artery will be found in front, the vein lying a little to the inner side and back of the artery. The artery should be raised upon the finger or the shank of the arterial=hook or aneurism=needle, and opened with the curved=bistoury or scissors, making the incision in the direction of the long axis of the vessel. Pass threads beneath; insert the arterial=tube with the point towards the heart and tie the artery around it; then attach the pump and begin the injection slowly and carefully. Inject enough fluid to fill the tissues thoroughly. After sufficient fluid has been injected, the tube may be capped, if there is a suspicion that another injection will be necessary. If not, remove the tube, tie the artery, and sew up the incision.

To Raise the Vein.—If it is desired to remove the blood at the same time, the vein can be raised out of the wound, and opened by making a cut in the direction of the long axis, and a silk vein=tube, of sufficient length to reach above Poupart's ligiment as far as the common iliac, inserted and tied in the vein. If the body now be placed in the incline, and the arms extended above the head, the blood will flow by gravitation and the pressure of fluid in the peripheral vessels and capillaries.

THE COMMON CAROTID ARTERY AND INTERNAL JUGULAR VEIN.

The common carotid is the largest artery that is used for embalming purposes. Why it is selected by embalmers we are not able to state, unless it is from a misapprehension. It has no advantages over arteries in other regions. True, it is large in size, but it lies deeper and nearer the parts that are exposed to view, making it possible for the mutilation easily to be seen. Fluid cannot enter the circulation more readily from the neck than it can from the upper or lower extremities. Blood can be withdrawn through the basilic or femoral vein as well as through the jugular. Physicians use the carotid artery for the purpose of injecting heavy or semiliquid solutions. The embalmer uses nothing but thin liquid solutions, which will fill the entire circulation just as easily from other regions. Therefore, there is no reason why the carotid artery should be raised in any case whatever, where the arterial system is intact.

Nearly all arguments favoring the superiority of the common carotid artery in embalming are fallacious and without merit, especially if the usual instruments are used in the operation. It is stated on apparently good authority that the brachial artery should never be selected where the death has been caused by tuberculosis, especially where hemorrhage of the lungs is the immediate cause of death, for the reason that as soon as the pressure rises in the pulmonary circulation, the bronchial arteries are ruptured, and the fluids escape through the mouth and nostrils, etc., and that by injecting downward through the aorta, the lower extremities and abdominal organs may be preserved before the rupture of the pulmonary circulation could occur. Another states that it is the best artery on which to operate, because it is nearer the center of circulation, and that he always gets a better circulation of the fluid; also that if he wishes to withdraw blood from the face, the operator may open the internal jugular vein, thus draining the face to remove discoloration, and that it is possible to inject fluid upward.

All of the above reasons are not sufficient to convince one who understands thoroughly the anatomy and physiology of the circulation that they have any advantage whatever over the operations on the axillary vessels. Surely, fluid enters the aorta as directly when injected into the vessels from the axillary space as it does from any point in the region of the neck. It will enter the lower extremities just the same, and with as much force. It will fill the lower extremities and preserve them without making any more pressure upon the bronchial circulation than if fluid were injected through the common carotid. Practice, as well as common sense, proves it to be the case. As to the better circulation, and the relieving of congestion of the face, the arguments are scarcely worthy of notice. Surely a vein=tube, introduced through an opening in the axillary vein and reaching to the bifurcation of the innominate vein, will cause blood to flow through the internal jugular just as readily, and much more so than if a single internal jugular is opened and the drainage tube pointed upward toward the face. To relieve opposite side the blood would pass through precisely the same vessels.

After considering thoroughly all of the reasons (many of which are not noted above) advanced in favor of the superiority of the vessels in the neck for the operations in embalming, we are yet unable to find any merit whatever in any yet advanced.

Location.—The common carotid artery is situated in the neck, and extends from the upper border of the larynx (Adam's apple) to the junction of the sternum and clavicle (sterno=clavicular articulation). The right arises from the innominate and the left from the arch of the aorta.

The Linear Guide is a line drawn midway between the angle of the lower jaw and the mastoid process behind the ear, down to the junction of the sternum and clavicle. The artery will be found beneath this line.

The Anatomical Guide is the anterior border of the sternocleidomastoid muscle, which arises from the upper end of the sternum and inner end of the clavicle, or collar=bone, crossing upward and a little backward to be inserted into the mastoid process of the temporal bone.

To Raise the Artery, the operator should not make an incision above the clavicle, because of the multilation that results, which cannot easily be hidden from view. The incision should be made through the skin over the front of the clavicle and upper end of the breast=bone, in a transverse direction, about three inches in length in the adult. The skin should be dissected and drawn upward, and the fat scraped from the superficial fascia and tissues beneath. The tendon of the lower end of the sternocleidomastoid muscle should be cut through and the deep fascia severed, when the sheath of the vessel will be brought to view. This should be opened, when the artery will be found on the inner side, the vein on the outer side, and the pneumogastric nerve in the middle. Raise the artery upon the finger or the shank of the aneurism=needle; make an incision with the curved= bistoury or scissors in the direction of its long axis; insert an arterial=tube with its point toward the heart; tie the artery around the tube; commence the injection slowly and carefully. When fluid appears at the distal end, tie it as directed for raising the brachial and femoral arteries. After sufficient fluid has been injected, remove the tube and tie the artery, sew up the wound neatly, and cover with adhesive plaster.

To Raise the Jugular Vein.—If blood is to be withdrawn, the jugular vein should be raised and opened by making an incision in its long axis; insert and tie in a silk vein= tube, pointing it upward, for the purpose of draining the blood from the head and face. If it is desired to remove more blood than is contained in the head, withdraw the vein=tube, insert in the proximal end of the vein, and push it in until the end of the tube passes into the right auricle; tie the vein around the tube, attach the aspirator, and begin aspirating the blood as already directed.

THE RADIAL ARTERY.

Location.—The radial artery extends from the bifurcation of the brachial artery at the elbow to the palm, on the radial side of the arm.

The Anatomical Guide is the groove between the outer edge of the bone and the first prominent tendon of the flexor muscles of the hand and fingers, near the wrist=joint, where the physician takes the pulse=rate. When the hand and arm are extended as far back as possible, this groove is seen extending from the wrist=joint to the elbow. The artery lies in the center of the groove, being superficial near the wrist-joint, becoming deeper in its course toward the elbow. It can be raised easily and no mistake will be made, as no other vessels accompany it, except the venæ comites, which are too small to receive the radial arterial=tube. Its position makes it very convenient for the purpose, when the body is already dressed for burial. At the point where it is usually raised, it lies very superficial, being covered only by the skin, a thin layer of fat, and the superficial and deep fascia.

To Raise the Artery, make an incision along the groove through the skin not more than an inch in length; remove the fat, cut through the fascia on the grooved-director with the sharp=pointed curved=bistoury, raise the vessels, open the sheath, and separate the venæ comites from the artery; make an incision through the wall of the artery in the direction of its long axis, insert the smallest arterial=tube, tie the artery around the tube, leaving the distal end open until fluid appears, when it should be tied. After enough fluid has been injected, remove the arterial=tube, tie the artery, sew up the incision, and cover with adhesive plaster.

THE POSTERIOR AND ANTERIOR TIBIAL ARTERIES.

Either the posterior or anterior tibial artery may be raised for the injection of fluid, for the same reasons that are advanced for using the radial.

Location.—These Arteries extend from the lower border of the popliteal space, one along the posterior, and the other along the anterior, surface of the tibia.

The Guide to the Posterior Tibial is the groove behind and below the inner malleolus (ankle).

To Raise the Artery, the incision should begin on a level with the upper border of the ankle, and extend in a curved line around the border of the malleolus to a distance of about two inches. The fasciæ will be found very thick for the purpose of protection, as the vessel in this part of the body is exposed so greatly. After the fasciæ are opened the artery will be found accompanied by the venæ comites within its sheath. The artery and venæ comites should separated, the artery raised upon the shank of the aneurism=needle, an incision made in the direction of the long axis with the curved=bistoury, the arterial=tube inserted, and the artery tied in the usual manner.

The Guide to the Anterior Tibial is the outer edge of the front of the tibia (shin=bone).

To Raise the Artery, the incision through the skin should begin just above the instep and extend downward a couple of inches, the fasciæ opened, and the tendons drawn to one side. The artery will be found close to the outer side of the bone. The vessels should be raised out of the cut, separated, the artery opened in the direction of its long axis, and the tube inserted and tied.

THE AXILLARY ARTERY.

The axillary artery is the extension of the sub=clavian artery down through the center of the axillary space. It begins at the outer border of the first rib and extends to the lower border of the axilla.

The Linear Guide is a line drawn through the center from the upper to the lower border of the axillary space.

To Raise the Axillary Artery an incision must be made on the above line through the skin superficial and deep fascia. The vein which is superficial at the lower point of the incision may be pushed to one side and the dissection continued through the deep fascia to the artery which lies beneath the vein between several branches of nerves. After separating the nerves, the artery may be raised in the usual manner.

If blood is to be withdrawn, the vein may be opened and large drainage tube inserted, which should be long enough to reach throughout the entire length of the axillary and sub=clavian veins, which have valves along their course nearly to the bifurcation of the innominate.

CHAPTER XXI.

CAVITY EMBALMING.

NECESSITY FOR CAVITY EMBALMING.

THE embalmer cannot exclude cavity embalming and thoroughly disinfect the body. The amount of fluid he injects through the arterial system is only sufficient to disinfect the tissues of the body; he cannot use a sufficient quantity to sterilize the contents of the different subdivisions of the cavities. The physician or anatomist, who embalms for the purpose of dissection, can disinfect the body by injecting a very large amount of fluid into the arterial system. If the embalmer or funeral director were to inject the amount of fluid through the arteries that is necessary to disinfect all of the morbid or effete matter, as well as the normal tissues of the body, the results would usually be disastrous—the features would be distorted, the body would appear unnatural in size, and the complexion would be materially changed, according to the quality or kind of chemicals used in the fluid. The embalmer can only inject a quantity equal to about one-twentieth of the weight of the body into the arterial system, while the anatomist can inject enormous quantities, as he does not care to preserve the features nor the natural color of the body. Therefore, for the embalmer, cavity embalming is a necessary adjunct to arterial embalming.

Disinfecting Effete Matter.—Abnormal material is found, as a rule, in the different serous sacs and in the alimentary canal, especially in the stomach and the intestines, and it is these parts that require special treatment. In consumption, sometimes, a large quantity of abnormal matter is found within the lungs themselves; this should receive treatment by the cavity method. The abnormal matter within the lungs, the material effused into the pleural sacs and peritoneum, and the effete material in the stomach and small and large intestines, cannot be reached by arterial embalming, in the average=sized body, when only four or five quarts of fluid are used. The fluid reaches the walls of the pleural sacs, the peritoneum, the normal tissues of the lungs and the walls of the intestines, but a sufficient quantity does not pass into the contents of either to disinfect the effete or effused material.

The only way that we have yet found to disinfect such matter is to inject a sufficient quantity of fluid directly into the material. This can be done by inserting a hollow=needle at a point from which we can operate without endangering the circulation. Any embalmer can do this if he understands the anatomy of the parts and knows the position of the aorta and its branches. Wounding the smallest subdivision of the arteries and capillaries of the circulation will not injure the arterial system sufficiently to prevent the disinfection of the tissues; it is the wounding of the larger vessels that must be avoided, as this will allow sufficient leakage to prevent the fluid reaching all parts of the body. To inject the usual amount of fluid into the arteries will preserve, in many cases, but will not disinfect. To inject a large amount of fluid into the cavities will often preserve the body for the "usual length of time," but it will not disinfect the whole body. To thoroughly disinfect the body, fluid must be injected into every part, filling all the tissues and the abnormal and effete matter within the body.

The operations of cavity embalming can be performed successfully only by an embalmer who understands the great cavities of the trunk, the location of the visceral organs contained therein, and the great aorta and its branches. We will consider first the thoracic cavity.

THE THORACIC CAVITY.

Its Location and Contents.—The thoracic cavity is the smaller and upper cavity of the trunk. It is conoid in shape, is bounded at the base by the diaphragm, at the apex by the

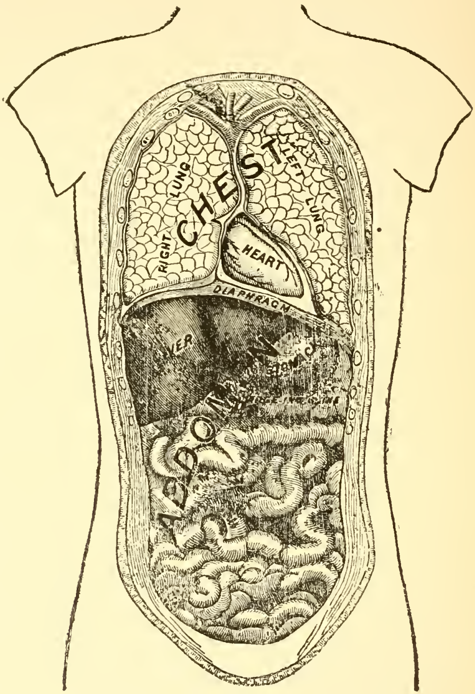


Fig. 41. Thoracic and Abdominal Cavities, showing Relative Position of Internal Organs.

root of the neck, in front by the sternum, at the sides by the ribs, and behind by the vertebral column. It is divided into the right and left sides and the medium space, called the mediastinum, in the center. The right side contains the right lung and pleura; the left side, the left lung and pleura; the mediastinum, the heart, pericardium, thoracic aorta, venæ cavæ, trachea, gullet, and other vessels.

The pleuræ are shut, serous sacs, placed between the lungs and walls of the cavity. They are large enough for one side to envelope the entire surface of the lung, while the other is reflected over the walls of the cavity, which it lines. The spaces between the lungs and the walls of the thorax are within the pleural sac. These spaces are sometimes called pleural cavities.

The pericardium is a shut, serous sac, which envelopes the heart. One wall of the sac is attached to the surface of the heart, while the other hangs loose. The space between the two walls is sometimes called the pericardial cavity.

The serous sacs secrete a fluid called serum. It is of an oily character and moistens the surfaces of the sacs, so that while respiration and the heart's action continue, the surfaces will glide over each other without friction. When these sacs become inflamed, effusions are poured out, filling them to a greater or less extent, making it necessary to remove the effusion, or mix with it a sufficient quantity of fluid to sterilize it, as it forms a good soil for the development of bacteria.

The heart lies diagonally across the mediastinal space, with the base toward the back and right side, into which it extends about one and a half inches, while the apex is directed toward the front and left side, into which it extends three and one=half inches. When in a normal position, the right auricle lies immediately back of the anterior margin of the third intercostal space, through which we direct the needle to reach the auricle, when withdrawing blood from the heart by the direct operation.

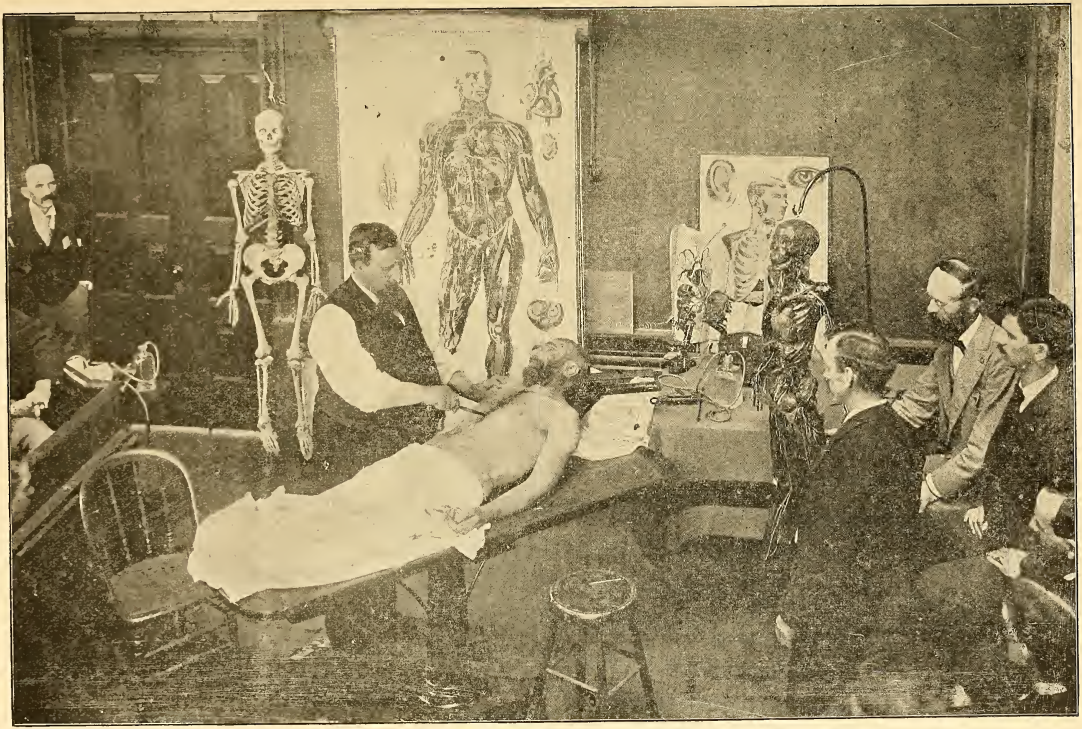
The aorta begins at the left ventricle, extending upward an inch and a half or two inches, then arching over backward to the front and left of the center of the back=bone, to which it is attached, and extends downward in the same position through the diaphragm to the fourth lumbar vertebra. It is this vessel that is wounded usually in the direct operation upon the right auricle of the heart.

The trachea descends from the neck down through the middle space to the root of the lungs. The gullet is immediately behind the trachea, extending downward through the middle space and diaphragm to the stomach. The superior and inferior venæ cavæ enter the right auricle, the former through the upper, and the latter through the lower wall, of the auricle.

To Inject the Pleural Sacs.—The pleural sacs can be treated by inserting the needle at a point immediately over the stomach in the epigastric region and directing it upward and through the diaphragm near its upper border. To treat the right sac, the needle should be directed upward and to the right side through the diaphragm, pressing it downward over the lung to a point as near the back part of the sac as possible. If the pleural sac contains effused matter, this can be pumped out and fluid injected. Enough fluid should be injected to sterilize the material that remains; this, however, will be a matter of conjecture only. The left pleural sac should be treated in a similar manner, but the needle should be directed upward and to the left side.

The pericardium can be reached from the same point by perforating the diaphragm at the lower border of the heart. The contents can be withdrawn and fluid injected.

Fluid injected into these sacs does not preserve the visceral organs. It settles immediately to the back part, while the organs all lie to the front. Unless an unusual amount is injected, it will scarcely reach to the back part of the organs, as there is considerable space to the side and back of the lungs. If the lungs are attached to the front wall of the chest, it will be better to insert the needle between the ribs on either side, at a point four or five inches from the center of the breast-bone, as the operation from the epigastric region will necessitate the passing of the instrument through the lung,



No. 42. BEGINNING A DISSECTION.

which might result in the rupturing of the nutrient vessels conveying the fluid, thus causing leakage. An infant=trocar is sufficiently large to reach the pleural sacs, when the operation is made between the ribs. The effusion, if it is liquid, can be pumped out through the needle before the fluid is injected. The amount of fluid injected will depend, to a great extent, upon the judgment of the operator.

To Inject Fluid into the Lung Cavities.—Cavities in the lungs result from tubercular disease These cavities may be filled with morbid material, such as purulent matter, or broken=down lung=tissue. The arteries leading to these cavities have been destroyed in the general destruction of the tissues during the disease. The ends of the vessels are filled with fibrous plugs. This is nature's method of preventing fatal hemorrhages in these cases. Indeed, in a majority of cases, no hemorrhage occurs during the long continuance of the disease. It is through the nutrient vessels of the lungs (the bronchial arteries) that fluid is conveyed into the normal tissues of the lungs. When fluid is injected into the arterial system, it reaches the walls of the cavities through these vessels, but none enters the cavity to mix with its contents. It then becomes necessary to reach the contents of these cavities through the windpipe, which is composed of the larynx, trachea, and bronchi. The ends of the bronchi are not filled with fibrous plugs as are the arteries. Hence, fluid injected into the windpipe or respiratory tract will reach the cavities and their contents.

Fluid injected into the mouth or nose will pass usually into the lungs, through the respiratory tract, but, in some cases, the glottis, or opening into the larynx, becomes closed by the epiglottis being forced down over the opening by the tongue, which has fallen back into the pharynx or throat. When this condition exists, it is best to use a strong, curved, inflexible nasal=tube; the best are made of steel, and are about ten or twelve inches in length. This can be passed down through the nose and pharynx to the lower margin of the glottis, and the epiglottis be pulled upward and forward, opening the glottis, through which the end of the nasal=tube can be passed. When the nasal=tube has been passed into the larynx in this manner, fluid can be injected into the cavities of the lungs through the trachea and bronchi. A sufficient quantity should be injected to fill the cavities and the whole of the respiratory tract.

If the operator does not succeed in introducing the nasal=tube into the larynx, he should introduce the infant=trocar into the trachea through the notch at the upper end of the sternum or breast=bone. It can be introduced easily at this point, and fluid can be injected in sufficient quantity to fill the cavities in the lungs. The needle should be directed straight back toward the vertebral column, until it passes through the front wall of the trachea. It is an easy matter to tell when the point is within the trachea, as the canal is nearly one inch in diameter.

Gases in the Pleuræ and Pericardium.—Gases frequently accumulate in the pleuræ and pericardium, prior to the general putrefaction of the body. This is due to the presence of putrefactive bacteria in the abnormal matter so often found in them. These materials form very excellent soil for the development of bacteria, and, as soon as death takes place, they begin to grow in such numbers that gas is produced sometimes in great quantities, even sufficient to make pressure upon the large vessels in the mediastinum and right side of the heart, forcing the blood into the superficial veins and capillaries of the surface of the head, neck, and face, causing discoloration. Gas may develop early and rapidly, and pass out through the subcutaneous tissues to the cellular or fat tissue beneath the skin, causing swelling of the neck. When any of these results occur, the cavities should be treated at once, first removing the gas through the hollow=needle.

THE ABDOMINAL CAVITY.

Its Regions.—The abdominal cavity extends from the diaphragm down to the margin of the pelvis. The front wall and

Fig. 43. DISSECTING THE THORACIC AND ABDOMINAL CAVITIES.

sides are formed by the transversalis fascia, lower ribs, and iliac, and the back wall, by the vertebral column. The abdomen is divided, for the purpose of an easy understanding of the location of the different visceral organs contained within the cavity, by certain arbitrary transverse and perpendicular lines, into nine regions. The two transverse lines are drawn from the ninth rib and the crest of the ilium respectively on one side to the same points on the opposite side. The two perpendicular lines are drawn, one on either side, from the anterior end of the eighth rib to the center of Poupart's ligament.

These regions are named the right and left hypochondriac on either side, under the cartilages of the ribs; the epigastric between them, in the middle, above the stomach; the right and left lumbar on either side, between the lower margin of the ribs and the hip=bones; the umbilical between them, in the center; the right and left inguinal or iliac, on either side; and the hypogastric between them, in the middle of the lower part of the abdomen.

Position of Its Contents.—The various visceral organs of the abdomen are located as follows: the liver in the right hypochondriac region; the large end of the stomach and the spleen in the lift hypochondriac; the small end of the stomach across the epigastric region, just below the diaphragm; the kidneys in the right and left lumbar regions; the small intestine in the unbilical and hypogastric regions; the beginning of the large intestine and vermiform appendix in the right iliac region. The large intestine ascends through the right lumbar to the lower surface of the liver, then makes an abrupt turn, crossing transversely through the epigastric region to the spleen, where it makes an abrupt turn, passing downward through the left lumbar region to the margin of the pelvis, through which it passes to the anus.

The peritoneum is a shut, serous sac, the back wall of which is attached to and covers the intestines and other visceral organs, the front wall being deflected to the diaphragm and anterior wall of the abdomen, which it lines throughout. This sac secretes serum for the purpose of oiling the surfaces, so that they will glide past each other without friction. The space between the front wall of the abdomen and the intestines is within the peritoneal sac, and is sometimes called the peritoneal cavity.

The pelvis is a basin=like cavity, forming an outlet to the abdominal cavity. It contains the rectum, bladder, and internal organs of generation. The bladder, when full, extends into the abdomen. The womb, in the female, enlarges during pregnancy so as to extend into the abdominal cavity, which it nearly fills during the latter part of the term.

Organs Requiring Special Treatment. — The organs within the abdominal cavity which require special treatment are the stomach, small and large intestines, and the peritoneum, which extends well down into the pelvis in a cul=de=sac (known as Douglas' cul=de=sac). In the treatment of the organs of this cavity, it is necessary to avoid the multilation of the aorta and its larger branches. The operator should keep in mind the location of the abdominal aorta, and the gastric, splenic, hepatic, renal, mesenteric, and the iliac arteries.

It becomes necessary, frequently, to insert the trocar into the stomach to let off the gas, pump out its contents, and inject fluid. The stomach lies near the diaphragm and can be reached with less danger to the large arteries from a point at the margin of the ribs on the left side, transversely across from the lower point of the breast=bone. The point of the needle should be directed downward and to the left side of the back=bone, until the front wall of the stomach is pierced. From this point, all other parts of the abdominal cavity can be reached through the cavity of the peritoneum.

After the stomach has been treated, the needle should be turned downward and across, through the peritoneal sac, to the organs which require treatment. There is usually a sufficient quantity of gas within the intestines to cause more or less distension of the abdominal walls. When this is the case, it is an easy matter to push a sharp=pointed instrument through the wall of the intestines and remove the gas.

The needle should not be removed, after the gas has escaped, until fluid has been injected into the intestinal canal. If the needle be removed after the gas escapes, it will be impossible to enter the canal subsequently, at the same point or in the vicinity, for the purpose of injecting fluid, as the walls of the canal will collapse. If fluid is injected into the peritoneal cavity, after all the gas has been removed, with the view of sterilizing the contents of the alimentary canal, the operation will be a failure, as fluid thus injected will settle downward through the tissues into the space beneath the intestines, and will not reach the fecal matter contained within the canal. Therefore, fluid should be injected into the intestinal canal after the gas has escaped, and before the needle has been removed, to succeed in mixing it with the contents for sterilization. In fact, whenever gas is removed from any part of the body, fluid should be injected before the needle is withdrawn, as it is not likely that the needle will subsequently enter the same space again.

The pleural and pericardial sacs frequently contain effusions of a dropsical character, or as a result of inflammation. These effusions can be removed by introducing the needle at the same point in the epigastric region from which the stomach is treated. To remove effusions from the peritoneal sac, the needle can be passed downward from the same point through which the stomach was treated, the pump attached, and the effusions pumped out; or a point of entrance may be selected on the median line, above the pubic arch, and the fluid allowed to drain out through the drainage=tube or needle.

The pelvis can be reached through either one of the outlets of the abdomen, through the perineum. or from a puncture through the abdominal wall above the pubic arch.

THE STOMACH.

The stomach, when in position, lies near the diaphragm, in the upper part of the abdominal cavity. It is an organ larger at one end than the other. The larger end is called the splenic end; the smaller, the pyloric end, or the pylorus. It is somewhat oval in shape, and curved upon itself with a large and small curvature. It will hold, when full, ordinarily, from three to five pints. But, as a result of disease, it will vary greatly in size, as for instance by dilatation or by contraction.

Its Dilatation.—The following are some of the causes of dilatation of the stomach: (*a*) anything that will prevent the egress of the digested food into the duodenum, such as cancer, affecting the pylorus, which may obstruct the duodenal opening by the formation of a hard scirrhus ring, or by the projection inward of fungoid growths; (*b*) the narrowing of the pylorus, caused by fibroid thickening, which takes place beneath the mucous membrane, or even thickening of the mucous membrane itself, or by a single ulcer near the pylorus, or by the cicatrix of a healed ulcer; (*c*) pressure of tumors upon the pylorus or duodenum externally, preventing the contents of the stomach passing into the duodenum; (*d*) displacement of the stomach by adhesions or by the pylorus being dragged down out of its usual place; (*e*) or, dilatation from paralysis, as a result of injury to the splanchnic nerves, etc.

In cases of this kind, when the abdomen is laid open, the stomach is found to be greatly increased in size. Often it appears to fill the whole abdominal cavity. The greater curvature will be below the umbilicus; in extreme cases it will be even as low as the pubes. When the stomach is opened, it is found filled, partially or wholly, with a dark fluid, the amount of which is sometimes enormous. The wrinkles are effaced entirely by the constant stretching, and the mucous membrane presents a level surface, which is generally more or less softened by the acid contents after death. In cases in which the dilatation is very great, and the stomach is filled with enormous quantities of the material as described, there will be dilatation of the abdomen also.

Its Contraction.—We sometimes have atrophy of the stomach. The walls become thin and smooth, especially the mucous membrane, which adheres to the adjacent coats. The size of the organ is materially diminished. Sometimes the stomach is collapsed by pressure, and is found in a position very high in the abdomen; while at other times it is dragged downward by adhesions, and will be found in a position much lower than normal.

It is not always easy for the embalmer to locate the organ, especially when it is nearly or entirely empty. It will be an easy matter to puncture the stomach with the hollow=needle, if dilated either chronically or by gases formed within. But, if small and collapsed and pressed up against the diaphragm, there will be no certainty in the operation through the abdominal wall, although in about ninety=five per cent. of the cases, it can be punctured by inserting the needle immediately over the normal location. Remember, this should be done near the margin of the ribs on the left side, at a point transversely across from the tip of the breast=bone. The stomach should always be punctured, as well as the small and large intestines, to relieve the pressure formed by gases, to prevent purging.

CHAPTER XXII.

CRANIAL EMBALMING—SO=CALLED NEEDLE PROCESSES.

THE EYE PROCESS.

EMBALMING by the needle process was first introduced by the late Benjamin Ward Richardson, of London, England, in 1884. He introduced a small needle through the inner canthus of the eye, and passed it along the inner wall to the point of the socket, through one of the foramina in that part of the orbit, into the spaces beneath the brain, called the subarachnoid spaces, through which he injected fluid into the circulation.

In 1891, F. A. Sullivan, who was then teaching embalming in this country, taught the eye process, and claimed it as his own method, giving no credit whatever to Dr. Richardson, to whom all credit for the so=called needle processes should be accorded.

The Operation.—The body should be placed in an elevated position on the embalming board. A small embalming=needle, about six inches in length, known as the eye=trocar, should be introduced at the inner corner of the eye, directing its course along the inner wall of the orbit, through the small foramen at the point of the socket, into the cranial cavity, to a distance of about four or five inches. The injector should be attached to the needle, and the injection should be begun very slowly and without force. After a few minutes the rapidity can be slightly increased. From two to four pints can be injected in this manner, in from twenty to thirty minutes.

The only objection to this method is, that an accident may occur if too much force is used at the beginning of the operation, or, if the needle is withdrawn too soon, fluid may regurgitate and fill the loose tissues behind the eye and push if forward. If this result should obtain, it is no serious matter, as the fluid will disappear after a short period of time, by absorption and gravitation, and allow the eye to settle back into its place. To prevent such a result, however, be careful to inject slowly and use the least force at the beginning of the injection, and after the injection is finished, allow the needle to remain in position for a period of five to ten minutes before removal. Do not lower the body until after the needle is removed.

This method includes all the science that there is in embalming through the cerebrospinal cavity.

THE BARNES PROCESS.

The introduction of the needle through the foramen magnum into the cerebral cavity was recommended by Dr. Barnes, of Chicago, in 1893. When the needle is thus introduced, it reaches the subarachnoid spaces from the back part, while by the eye process it reaches them through the front part. When fluid is introduced by the needle, therefore, whether through the foramen magnum or through the orbit, it reaches the same spaces, and is distributed to the tissues of the body, in precisely the same manner.

The Operation.—To introduce the needle through the foramen magnum, it is necessary to incline the head to one side; then bend it downward to the chest; draw a line from the angle of the lower jaw, straight around the neck, and a second line from the mastoid process to the center of the clavicle or collarbone; the lines will cross just back of, and a little below, the lobe of the ear. Introduce the needle on the first line one inch behind the point where the second line crosses the first, directing the needle upward and inward toward the opposite eyebrow, when the needle will enter the cavity.

Dr. Barnes claims that this method of introducing the needle constitutes the most scientific process of embalming that has been introduced since embalming began. Whether it does or not, we will not question.

THE NASAL PROCESS.

The introduction of the needle through the cribriform plate of the ethmoid or sieve bone at the root of the nose can be accomplished as readily and easily as by either of the other methods. It can be passed through, also at the suture between the ethmoid and sphenoid bones, a little distance back of the sieve bone. At either point but little pressure will be required, and, when the needle penetrates the cranial cavity, it will reach the same space as when introduced through either the orbit or the foramen magnum. This method requires no special position of the head or of the body, and any amount of force that the operator may exert can be used in injecting the fluid; it will neither bulge the eye nor disfigure in any other manner.

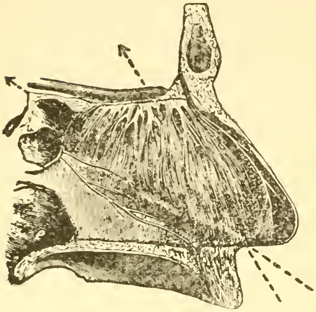


Fig. 44. Section of Nose, Showing inclination of trocar in the Nasal Process.

The Operation.—Place the body upon the embalming board in the usual position. Introduce the needle through either one of the anterior nares, directing it upward between the turbinated bones and along the side of the septum until it reaches the sphenoid bone, which is back of the ethmoid; then bring the point of the needle forward, pressing slightly against the bone, and when it reaches the suture between these bones it will pass through readily; or, bring it still further forward, when it will reach the cribriform plate of the ethmoid bone, through which it will pass with ease. After the needle is introduced in this manner, the injector should be attached and fluid injected.

The fluid will pass into the circulation as readily, when introduced in this manner, as it will by either of the methods before mentioned; distribution of fluid is just the same. It passes into the subarachnoid spaces, filling the area between the coverings of the brain and spinal cord. The fluid reaches the vascular system by exudation through the walls of the smallest arteries, veins, and capillaries in the coverings of the brain and spinal cord, especially the pia mater or vascular membrane. A portion of the fluid may pass into the sinuses through the walls. We have injected, in this manner, two quarts of fluid in eighteen minutes; in another case, a pint in a minute and a half; in another, a pint in three minutes. In some cases, a large amount of fluid can be injected; in others, a small amount; and, in still others, none at all.

The results obtained by these processes are not constant; therefore, we would not recommend any one of the needle processes to take the place of arterial embalming. As an auxiliary, they certainly have their place among other methods of embalming. In giving the treatment for special cases, we point out where the needle processes can be used to advantage.

EMBALMING THROUGH SOFT TISSUES ON OUTSIDE OF SKELETON.

In some cases, on account of the mutilation or destruction of the arteries, it is impossible to inject fluid through the arterial system into the tissues of the body. It is true, in many cases, that arteries that are mutilated may be tied and fluid injected just as well as if no mutilation existed, but in cases of extensive mutilation from accident, and in post=mortem cases, there will be leakage, on account of the anastomoses, that it is impossible to control. To preserve these parts, therefore, it becomes necessary to introduce fluid into the tissues through other channels than the arteries.

The Operation.—The fluid can be injected directly into the parts through a hollow=needle. The needle that is employed in treating the cavities, or the infant=trocar, can be used for this purpose. The needle should be inserted in the top of the upper center of the part which it is desired to treat, passing it through the skin into the cellular tissue beneath, when the fluid can be injected very easily. The needle should be passed over the upper surface of all the tissues that require fluid, pointing it in all directions, and injecting sufficient fluid to sterilize the tissues beneath. To preserve the upper extremities, the needle can be inserted through the skin on the top of the arm and fore=arm, at a number of points between the wrist and shoulder. The lower extremities and the trunk can be treated in a similar manner.

Fluid thus injected will settle downward through the tissues by gravitation. Large amounts of fluid can be injected in this way. In an average=sized body, in which the cellular tissue was filled to a considerable extent with gas, we have injected three gallons of fluid by this method.

In the treatment of "floaters," the injection of fluid into the subcutaneous tissues is very essential. The fluid introduced thus will destroy the bacteria within the tissues, and the needle, as well as the perforation through the skin after the needle is removed, forms an exit through which the gas will pass out more rapidly.

If the face and neck are in a natural condition, when the arteries of the trunk have been destroyed extensively, as in a post=mortem case, or as the result of an accident, do not inject fluid under the skin in these parts, but use one of the needle processes. After the fluid appears at the open end of the veins and arteries, showing that the blood is all washed out, a cord may be tied tightly around the root of the neck, which will strangulate the vessels so that fluid may be injected in sufficient quantity to fill the capillaries of the head, face, and neck, which will preserve the parts and retain their natural appearance.

The embalmer should be acquainted with all the methods of introducing fluid into the tissues, so that, when called to a case, he will be ready to use whatever method is necessary, in that particular case, to preserve and disinfect the body.

CHAPTER XXIII.

REMOVAL OF THE BLOOD.

Reasons for Its Removal.—Blood should be removed from the venous side of the vascular system, for several reasons. This removal will relieve congestion of the superficial or peripheral vessels of the head, face, and neck, in a body that is full of blood, thereby removing the discoloration. It will free the tissues from an excess of blood, which is a material in which putrefaction takes place quickly, decreasing the chance of preservation, and giving rise to post=mortem discoloration and post=mortem staining.

It is not necessary to withdraw blood in all cases, but it is certainly a good practice to withdraw it whenever it can be done. The greater the quantity of blood extracted from the body, the less likelihood there will be of discolorations and early putrefaction. More blood can be withdrawn, and the most satisfactory results will follow, if the operation of withdrawal of blood is performed alternately with that of the injection of fluid into the arteries, whether the withdrawal be by the direct operation upon the heart or through one of the veins.

The Methods of removing the blood from the body are three: first, by the direct operation upon the heart; second, by aspiration through the basilic vein; third, by drainage through the femoral or jugular vein.

From the Heart Direct.—To remove blood from the heart direct, a cardiac=needle and an aspirator are required. An ordinary hollow=needle or trocar may be used, but the cardiac=needle is better, as it is less likely to become closed by clots. It should be very sharp, six or more inches in length, and of fair caliber. The arrow=pointed and diamond=pointed

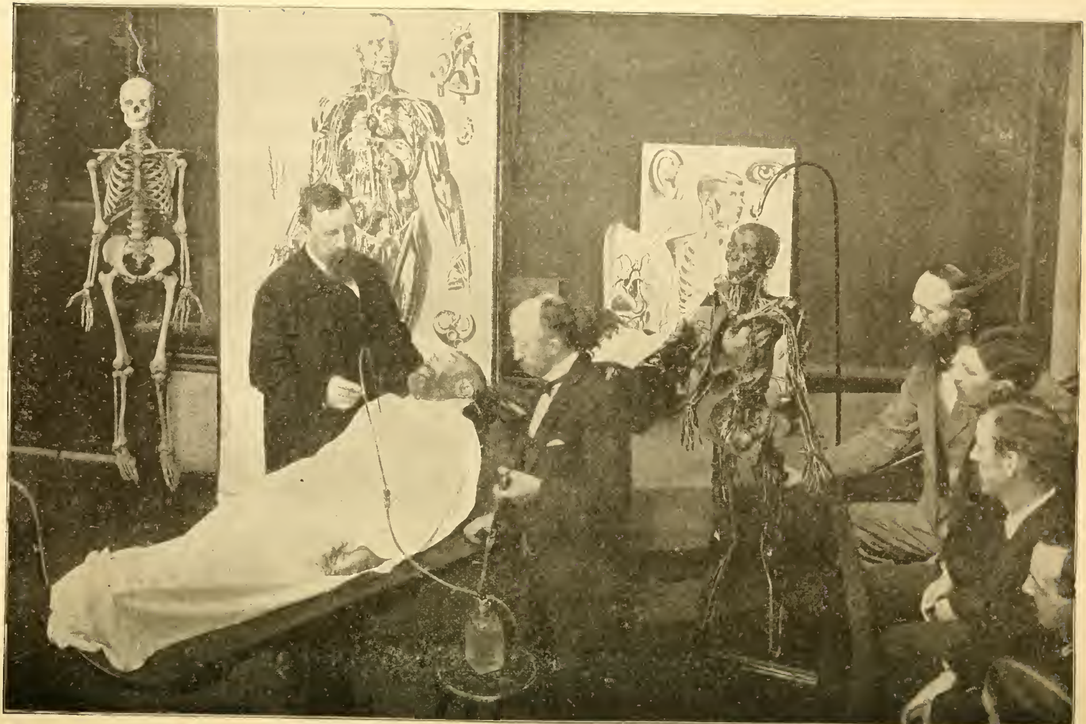


Fig. 45. ASPIRATING BLOOD FROM THE HEART.

needles are excellent for the purpose, as they will pass directly through the heart, without a tendency to turn to one side, as is likely to be the case with the pen=pointed needle.

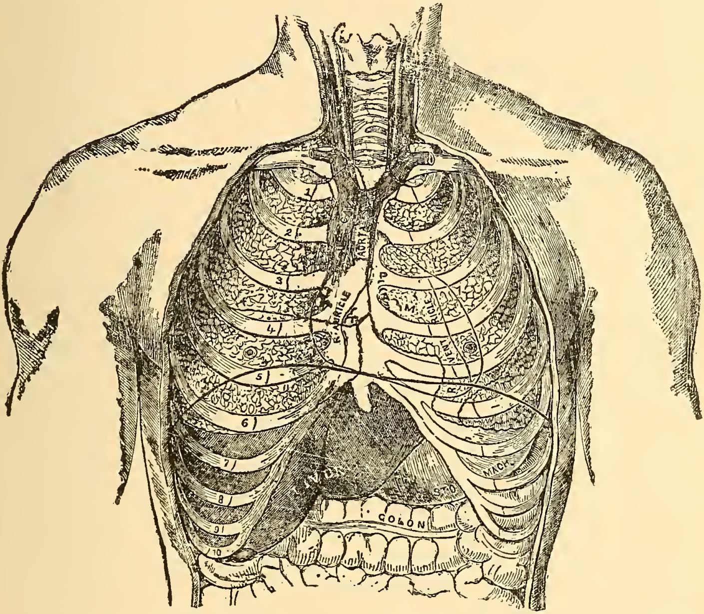


Fig. 46. Front View of the Thorax.

The ribs and sternum are represented in relation to the lungs, heart, and other internal organs. M, mitral valve; T, tricuspid valve; A. aortic semilunar valves; P, pulmonary semilunar valves; x, point for introduction of needle in the direct operation.

To reach the right auricle of the heart, the needle should be introduced at a point immediately to the right of the margin of the breast=bone, in the third intercostal space, which will be found in the adult about four inches below the upper end of the breast=bone. (See Fig. 46.) The needle should be directed backward toward the right of the center of the back=bone, to the depth of about four inches, or until the point of the needle touches the spinal column, when it will have entered the right auricle. Never direct the point toward the center, much less to the left side of the center, of the back=bone. The surface of the front part of the body of the dorsal vertebra is round, and, if the point of the needle should be pushed through the auricle, it would strike the vertebra, and be deflected to the left and pierce the thoracic aorta, which lies in front, and to the left, of the center of the back=bone, to which it is attached. To wound the aorta thus would be to destroy the circulation. Therefore, it is very important to give the needle its proper inclination.

In many cases, especially if one has had experience in tapping the heart in this manner, it is possible to determine when the needle passes through the wall of the auricle, but it is not the case at all times. When it is the case, the needle need not be pushed so deep as to wound the aorta. But there is no certainty, and we should not rely on imaginary depth alone.

The needle can be pushed through to the right side of the back=bone, or entirely to the back wall of the cavity on the right side of the back=bone, without injury to the circulation, and then be withdrawn again until the slotted portion of the needle is found to be in the cavity of the auricle. This is indicated by blood appearing in the vacuum in the bottle, when the pump is operated. It matters not if the needle passes entirely through the auricle, which it will do if it is pushed against the right front of the back=bone, as only a little blood will escape, which will amount to nothing. If blood does escape in this manner, it can be pumped from the mediastinal space, if found necessary.

After the needle has been introduced, place the body high on the incline and raise the arms over the head, for the purpose of gravitating the blood toward the heart; attach the aspirator and withdraw the needle slowly and carefully a short distance until the slotted portion enters the cavity, when blood will begin to flow. Allow the needle to remain in this position as long as the flow continues; when it ceases, push the needle in a little farther, then withdraw it again to its former position, which operation will aid in the removal of clots—if there are any—in the slots of the instrument.

To remove the blood from the lower extremities, the position of the body must be reversed, as blood can only be removed from the body by the aid of gravitation, or while the mouth of the tube, or the point of the needle, is immersed in the fluid. The cavities of the heart are not filled by the pressure of the air, as is the vacuum produced in the common pump, but by the force of gravity.

When the heart is emptied, and no more blood can be withdrawn, the injection of fluid through the artery should begin, and an amount of fluid equal to or greater than the amount of blood withdrawn, should be injected; then more blood should be pumped from the heart, and fluid injected into the artery alternately, until sufficient fluid is injected to fill the capillaries.

Another Method.—The needle may be introduced through the anterior wall of the abdomen, at the point through which the cavities are injected, and directed upward toward the heart through the diaphragm and into the right ventricle. By this operation, blood can be withdrawn just as well as from the right auricle, but there is greater danger of wounding the aorta or the valves at the aortic opening. Moreover, as the heart is rather pendulous in its position, it is easily moved to the right or left of its usual location, and thus the puncturing of the right ventricle is made more uncertain.

Too much care cannot be exercised in the introduction of the needle, because of the large vessels that are found in this region. To wound the aorta, or any of the large arteries, is to destroy the circulation, so that fluid cannot reach the tissues of the body through these channels. Therefore on account of the great danger of destroying the circulation, this method of piercing the heart is not recommended.

Through the Basilic Vein.—To remove the blood through the basilic vein, will require an aspirator and a silk vein-tube, of proper caliber to enter the vein, and long enough to reach the innominate vein. This method of removing the blood is made use of, generally, when the brachial artery is raised. Raise and incise the vein as already directed; insert the vein-tube, and pass it through until the end of the tube reaches the innominate vein; then tie the vein around the tube, attach the pump and begin the aspiration of blood. Remove all the blood that is possible; then begin the injection of fluid, and continue alternately aspirating blood and injecting fluid until no more blood can be removed.

It makes no difference which basilic vein is used. It is true the curve is more gradual in the left than in the right, but if the right is used, the tube will enter the innominate vein just as well.

Through the Femoral Vein. — To remove the blood through the femoral vein, there will be needed a drainage-tube, or silk vein-tube, of sufficient length to reach above Poupart's ligament as far as the common iliac, and allow six or eight inches to remain out of the wound, so that the blood can be directed into a conveniently-placed vessel. It should be of large caliber, say No. 14 or No. 16 in size, and twelve to fifteen inches in length. The advantage of withdrawing blood through the femoral vein, besides the convenience in raising it at the same time the femoral artery is raised, is that by its use pumping the blood is not usually required. There are no valves in the ascending vena cava, or in the common iliac vein, to prevent the flow of the blood from the heart, and if the blood is sufficiently thin to run, and there are no clots intervening, it will pass out through the draining-tube by gravitation, and by the pressure upon the peripheral veins of the fluid that is being injected, at the same time, through the artery. The body should be placed on a high incline, say from forty to fifty degrees. The arms may be held in an upright position by an assistant, when blood will begin to flow. Then commence the injection of the fluid through the femoral artery. As the fluid begins to press upon the tissues and capillaries, the blood will flow more freely, and the use of the aspirator will not be required —that is, if the blood is perfectly thin or liquid.

If the blood is thick, or if it is full of coagula, it may be necessary to attach the aspirator. But, in the great majority of cases, if the body is placed high enough on the incline, the aspirator will not be necessary.

Through the Jugular Vein.—If the common carotid is raised, the internal jugular may be used for the purpose of withdrawing the blood. By inserting the tube into the jugular vein toward the base of the skull, the blood will drain out. If the tube is turned and entered toward the heart, the aspirator will have to be used.

Every operator should be prepared to withdraw blood either by the direct method from the heart, or through a vein, because he will fail sometimes in one operation and may be successful in the other. Therefore, if the basilic vein is raised, and the operator fails to get blood, he should try the direct operation upon the heart; or, if he should fail by the direct operation, he should then raise the basilic or some other vein, and endeavor to withdraw blood.

Sometimes the heart may be lying in an abnormal position, and it will be impossible to withdraw blood from the right auricle by the direct operation; in such a case, it will be necessary to use one of the veins.

The direct operation through the third intercostal space is the simplest and quickest method of withdrawing blood from the body. If the directions for introducing the needle are followed carefully, there will be no danger of wounding or mutilating the arterial system, and as much blood can be withdrawn in this manner as through either of the veins.

Circulation Not Destroyed by Tapping the Heart.— Objection has been made to the direct operation on the heart, by some embalmers, who raise the point that the circulation is destroyed thereby, and that arterial embalming, therefore, would be noneffective. The point is not well taken. The right auricle being the only part wounded, the fluid would have to make the entire circuit of the circulatory system before it could escape from the wound. (See "Circulation of Fluid," page 279.) The valves of the heart act just the same after death as before. During life they prevent the backward flow of the blood, and after death they prevent the flow of the fluid into the heart. Therefore, fluid does not enter the left cavities of the heart at all, unless the aortic valves are injured or destroyed; nor does it enter the right cavities unless it has made the entire circuit of the systemic circulation; that is, at least, through the coronary vessels.

However, the heart may be occupying abnormal position, as a result of effusion into one of the pleural sacs, or some other disease. In this case the left side of the heart (or the aorta, for that matter) may be injured by the needle. Injury even to the left auricle or left ventricle would not destroy the circulation sufficiently to interfere with arterial embalming, unless the aortic valves were destroyed. Wounding the aorta, as already stated, would destroy the circulation of fluid.

CHAPTER XXIV.

DISCOLORATIONS AND THEIR REMOVAL.

Discolorations take place in all bodies sooner or later after death, as a result of putrefactive or other changes. The surface of the body becomes changed to a deep=green color, due to putrefaction; or it may become a dark=blue color, owing to the blood settling into certain parts; or it may become flushed, due to the injection of fluid into the arteries before they are empty, or to the injection of a vein instead of an artery. It matters not what the cause may be, the desire of the embalmer is to remove these discolorations from the parts that are exposed to view when it can be done. These exposed parts may be involved to a greater or less extent; the whole surface of the body may be discolored, or a mere spot may be changed. The head, neck, and face may be of a dark=bluish color, resulting from the position of the body after death, the head being allowed to lie lower or more dependent than the trunk, causing the blood to gravitate towards it. The same discolorations of the surface will result from the forming of gases in the thoracic and abdominal cavities in such quantities as to cause pressure upon the large veins and right side of the heart, sufficient to force the blood into the head, face, and neck. The capillaries and small vessels in the skin and subcutaneous tissues in these parts are very greatly distended with the venous blood, causing the dark=bluish discolorations.

Venous Congestion.—The body should be placed on a high inclined position, and blood should be withdrawn by one of the methods described in the previous chapter. If the discoloration is caused by the pressure of gas within the thoracic and abdominal cavities, the gas should be removed at once, and the body allowed to remain on the incline, until all the blood will have gravitated to the trunk and dependent portions of the body.

If the blood is less fluid than normal, thus interfering with its passage through the veins, or if it has become coagulated in the large vessels and right side of the heart, and still remains fluid in the peripheral veins and capillaries, it may be aided in its gravitation by spreading a damp cloth over the face and rubbing the hand downward over the surface toward the heart. This should be continued for some length of time, or, until the discoloration entirely disappears. The cloth will protect the surface, preventing the skin from slipping, which occurs in some cases when the hand is rubbed over the bare surface.

If the above method fails, place a mixture of fine ice and salt over the surface, with a thin cloth intervening between the ice and skin, and wrap the whole with a woolen blanket or cloth to exclude the air and external heat; allow the mixture to remain until the surface is frozen from one=eighth to one=fourth of an inch in depth. Cold retards or prevents the coagulation of blood, and if the surface is frozen, it removes the blood from the surface by pressure. (For "Ice Mixture" see page 328.) Never make use of hot applications, as they increase the tendency of the blood to coagulate, and will in no way assist in its removal. It is said that the needle operations aid in removing blood when other means fail. No doubt, good results will follow their use if the blood is not firmly coagulated, but if it is, they can do no good, as blood that has become thoroughly coagulated in the vessels, cannot be removed by any means that are known.

If the blood is firmly coagulated in the small veins and capillaries of the surface, there is nothing that will remove the discoloration. In time, it will be modified, becoming of a reddish cast, and finally of a dull=red color, owing to the escape by transudation through the tissues of the carbonic acid gas in the blood; the hemoglobin or coloring matter of the blood remains, which gives it the reddish appearance.

Cold applications, hot applications, rubbing the surface, or working with it in any manner, will have no effect upon the discoloration after the blood is coagulated firmly in the capillaries. In many cases of discoloration, the results of treatment are very unsatisfactory.

Even when the blood is quite thin and is carried downward by gravitation, the rims of the ears, in many cases, will remain full of blood, presenting the usual discoloration. An instrument, known as the leecher, has been recommended for its removal, by scarifying the posterior surface of the ear and removing the blood by suction. The operation is scarcely necessary for the reason that, if the rim of the ear is turned upward, the blood will gravitate through the vessels and enter the larger veins at the base of the ear and be carried off by gravitation.

"Flushing of the Face."—Discoloration caused by the injection of an artery when it is full of blood, or the injection of a vein by mistake for an artery, usually cannot be removed. If the flush is noticed at once, before the capillaries are dilated to a great extent—there not having been much blood forced into them—it will be possible to remove it by withdrawing the blood through the vessel through which the injection has taken place. This may be aided by pressure upon the surface, and rubbing with the hand. If the capillaries are distended fully, by the injection of sufficient fluid to fill the vessels thoroughly, and the fluid has been allowed to remain for some length of time, it will be impossible to remove the flush; the effect can only be modified by the use of powder or tints.

Post-Mortem Discoloration, or Hypostasis, is due to the presence of blood near the surface in the back and dependent parts of the body, especially of the trunk. The blood remains in the vessels which are filled to distension, and is not transuded into the surrounding tissues as in bruises and ecchymoses. This discoloration can be removed only by turning the body upon the face, when the blood will gravitate to the front part of the body or trunk. This method, however, is never practised, as its removal is not necessary, the back part of the body not being exposed to view. It is only when the discolorations appear on the fingers or rims of the ears that it becomes necessary to remove them. This can be done by raising the rim of the ear and elevating the ends of the fingers, when the blood will gravitate to other parts.

Post-Mortem Staining is a bright-red discoloration, which is seen frequently along the course of the superficial veins over the ventral region and extremities and sometimes in the face. This takes place usually about eight or ten hours after death. It is due to putrefactive or other changes that take place in the blood. The red corpuscles being reduced, the hemoglobin is eliminated into the liquor sanguinis, or watery portion of the blood, where it is dissolved thoroughly, when it passes out through the walls of the capillaries and vessels into the surrounding tissues, producing a continuous bright=red color, which can be seen through the skin. The hemoglobin, or red coloring matter of the blood, is a permanent color and cannot be removed by any bleaching process that is known. It is just as impossible to remove post=mortem staining as it is to remove the normal color of the negro's skin.

Brownish or Greenish Spots, which appear occasionally under the eyes, along the nose, and at the corners of the mouth, are caused, usually, by putrefactive changes in the blood=vessels and capillaries, or by destruction of the circulation in the part, due to embolism in young people and atheroma in old people, either of which prevents the fluid from reaching the parts. These spots may be removed by injecting hypodermically a bleeching solution, using just enough fluid to reach the circumference of the discoloration.

Bruises and Ecchymoses are spots caused by blood exudations, due to rupture of the capillaries near the surface. The walls of the capillaries being destroyed, the blood passes out into the tissues and no channels remain through which the blood can gravitate to the dependent parts. These parts are usually of a dark=blue color, but after a time they will change to a dull=red color, due to the transudation of the carbonic acid gas that the venous blood contains. Spots of this kind may be covered with flesh=tints; they cannot be removed by the application of bleachers.

Discoloration Caused by Biliverdin usually takes place during life. It is caused by the blood taking up the bile in the liver, when the usual channel of exit is obstructed, and carrying it to the tissues of the body. It stains all the tissues, including the skin and conjunctiva (mucous membrane of the eye) a yellowish or brownish color. A similar discoloration will result in certain diseases, such as Bright's disease, cancer, consumption, etc., or may be due to chemical changes in the pigment or tissues of the skin itself. These stainings cannot be removed; the color is permanent and unbleachable. The injection of a good bleaching fluid through the arteries sometimes will modify the appearance, but will not remove the discoloration entirely. The best effect can be secured by placing the body, after it has been embalmed thoroughly, in a darkened room, and have artificial light reflected upon it. If this is done properly the case can be made to look almost perfectly natural in color and appearance.

Bleachers and Fluids Not Effective.—So=called bleachers and fluids, used on the face in the usual manner, serve no purpose whatever, unless it be to destroy odors. Fluid thus placed on the outside of the body does not penetrate or pass into the tissues. The skin is a very compact tissue, and, if penetration should take place at all, it would be very slowly. Tissues of the body are composed of about two=thirds water and one=third solid matter. The air on the outside of the body is much dryer than the tissues of the body, even when the humidity is great. The air, therefore, takes up the moisture, leaving the chemicals within the meshes of the cloth, absorbent cotton, or linetine, or upon the surface of the body, none of the chemicals having penetrated through the skin into tissues beneath.

To make the application of fluids or bleachers effective at all, they should be covered with rubber, oiled silk, or some other fabric which is impervious to air. But even then, absorption would take place so slowly that its effect would be very limited.

It is advisable not to apply fluids or bleachers upon the outside of the body, as they will do little, if any, good, while they have a tendency to soil the clothing and other fine fabrics which may be placed upon or around the body.

The Ice Mixture.—The following is the formula for removing discoloration by the blood when it is not coagulated firmly in the capillaries and small superficial veins:

℞ Finely powdered ice........three parts.
Common salt ....one part.
Mix.

Place the mixture about two inches thick, between two thin muslin cloths, and apply to the affected part; then cover with a blanket or thick towels to exclude the air. The application can be removed in from two to four hours, or when the discoloration has disappeared.

CHAPTER XXV.

GASES: THEIR PRODUCTION AND ELIMINATION.

An erroneous idea prevails among a great majority of embalmers as to the production and elimination of gases that are found in the body after death. It is supposed by them that these gases are produced by some chemical reaction, and that they are destroyed by the fluids that are used for the preservation and disinfection of the body.

What They Are.—First, what are these gases? They are merely some of the elements of which the body is composed, set free by the action of the putrefactive bacteria, and recombined in the form of sulphurated hydrogen, carbonic acid, ammonia, etc. They are not destroyed by the fluid that is injected for the purpose of preservation and disinfection; the fluid only destroys the odor. During their production, the gases transude rapidly through the tissues into the cellular tissue beneath the skin, and slowly through the skin itself, which causes the body to swell in proportion of the amount of gas produced. If the production of these gases is stopped, in time they will be eliminated from the body by the above process.

Where Found.—Gases may be found in the peritoneal cavity, for instance, from several causes; first, escape from the alimentary canal through a perforation in the peritoneal wall; second, transudation through the intestinal wall into the peritoneum; third, decomposition of materials within the peritoneal sac. Gas may be found in all parts of the peritoneal cavity, or it may be limited to a small space by the adhesion of the walls of the peritoneum. More or less gas is always found in the alimentary canal. It may be found in the small intestine in small quantities, or in the large intestine alone. There may be an amount in the large intestine sufficient to distend the walls of the abdominal cavity to their greatest extent.

Gases are produced within the thoracic cavity, especially in the pleural and pericardial sacs, due to the decomposition of their abnormal contents, as when they are filled with more or less solid, semisolid, or liquid matter. Gases are formed sometimes within the lungs, the result of putrefaction of the lung substance, as in cases of pneumonia, tuberculosis, gangrene, etc.

Gas may be formed in the pelvic cavity, or in the spaces behind the peritoneum in the abdominal cavity, as a result of decomposition, or the presence of a large amount of purulent matter in abscesses, or in the subperitoneal, connective tissue. Gas may be formed in the bladder, resulting from decomposition of material within it, sufficient to distend the abdominal walls.

If gases are present in these several locations, and are still being developed without interference, they will transude through the tissues, finally getting into the fatty or cellular tissue, especially the layer between the skin and superficial fascia, bloating the body, as is seen in the "floater," or in any other body in which putrefaction has been going on for some time.

How Eliminated.—As stated before, these gases are not destroyed by the introduction of fluid into the body—it is impossible to destroy them with anything. But, by the injection of fluid into the parts affected, the putrefactive bacteria are destroyed and no more gas is produced. Fluid injected into the arteries will not reach the contents of the several cavities of the organs mentioned; it only reaches the walls of the cavities which are filled with capillaries. The morbid material contained within these several cavities can only be reached by the hollow=needle, through which the gases can escape and sufficient fluid be injected to sterilize the contents thoroughly. Fluid is mixed with the contents of these cavities for the purpose, as stated before, of destroying the bacteria which are present, and to assist in the elimination of the gas by the direct connection of the cavity with the surface of the body through the opening made by the needle. Gases that are not eliminated in this manner transude through the deeper tissues into the cellular tissue, thence slowly through the skin itself, until finally the body will be reduced to its normal size. The elimination of gas through the skin can be assisted greatly by making a number of punctures through the skin over the parts which are swollen.

Odors that accompany the gases eliminated from the body should be destroyed by deodorizers. Most of the fluids that are sold for the purpose of preserving and disinfecting the body will also destroy the odors that accompany the gases.

PURGING AND ITS TREATMENT.

The definition of purging is a diarrhea or dysentery; preternatural evacuation of the intestines; looseness of the bowels. Purging also means to cleanse, clean, or purify, by separating or carrying off whatever is impure, heterogeneous, foreign, or superfluous. The term, as understood by the embalmer, also includes the after=death evacuation from the mouth and nose, and it is this phase which more especially interests him.

There are two kinds of purging from the mouth and nose. One comes from the stomach through the upper end of the alimentary canal, and the other comes from the lungs through the respiratory tract. The purge from the former is a brownish, coffee=ground=like material, while that from the latter is a bloody, frothy mixture.

Purging from the Stomach.—In purging from the stomach, the contents, which consist largely of animal and vegetable matter, undergo a chemical or putrefactive change, liquifying the substance, and producing gas. The gas thus produced finally distends the walls of the stomach and makes its escape through the gullet, mouth, and nose. At the same time gases are produced in the intestines by the putrefactive changes taking place in the contents, especially in the large intestine. The gas thus formed fills the intestines, dilating the canal sufficiently to fill the entire abdominal cavity, pressing the stomach against the diaphragm with enough force to cause the contents to escape through the upper end of the alimentary canal. The purged matter has a very strong and peculiar odor. At times the quantity is enormous, and, unless the gas be removed, the clothing and everything around the body will be soiled, and a very unpleasant odor will permeate the room.

Treatment.—In the treatment of a case of purging from the stomach, it is necessary to remove the gas from both the stomach and intestines. The hollow=needle should be introduced into the stomach through the abdominal wall at a point in the epigastrium over that organ. The point of the needle should be directed to the left side of the back=bone at such a distance that it will not wound the great aorta. The gas should be allowed to escape through the needle and rubber tubing into a bottle containing fluid which will destroy the odor. After all the gas has escaped from the stomach, and before the needle is removed, fluid should be injected, as frequently it will be impossible to enter that organ again with the needle. Then the needle should be withdrawn and directed downward through the space between the peritoneal walls and through the wall of the large intestine, from which the gas will escape through the needle. Before the needle is withdrawn, inject fluid in sufficient quantity to sterilize the contents of the intestines. Gas should be removed from all parts of the abdominal cavity. The operator should always bear in mind that when gas escapes fluid should be injected before the removal of the needle. When the gas is removed and fluid injected, as directed, no further purging will follow.

Purging from the Lungs.—Purging of a red, frothy character, through the respiratory tract, comes from the lungs. Sometimes, in a case of drowning, it is produced by the presence of bacteria, which can easily be checked by the introduction of fluid into the lungs, through the respiratory tract. In case of consumption, it will give way immediately on the injection of fluid directly through the windpipe, but in cases of pneumonia in the second stage, it frequently becomes very obstinate. The reason for this obstinacy is that no fluid can reach the diseased lung, either through the nutrient arteries, or by way of the respiratory tract. The lung, having filled the entire side of the cavity of the thorax, making pressure upon the arteries and capillaries of the nutrient circulation and upon the bronchi, which are filled to a certain extent by a bloody mucous, renders it impossible for fluid to enter the diseased portion of the lung. This being the case, the bacteria of putrefaction will begin to develop sooner or later within the diseased portion of the lung, causing liquefication of the lung substance and the formation of gas. The gas will force the liquefied matter, with more or less froth, which is in the bronchi of the normal portion, out through the respiratory tract, and it will finally appear at the mouth and nose as bloody, frothy purge.

Treatment.—The usual methods of treatment, that have been recommended, are the turning of the body over and making pressure over the chest and up against the diaphragm to force this matter from the cavity, and then to inject fluid into the respiratory tract; to repeat this a number of times, if the case be obstinate; also, to close up the respiratory tract, in order to keep the purge from passing out through the windpipe, either by introducing cotton or some other substance into the glottis, or by tying a tape around the windpipe.

Such treatment is not successful, as it will not arrest the growth of bacteria in the lungs, and consequently will not stop the production of gas. If the gas cannot pass out through the respiratory tract it will transude through the tissues into the cellular or fat tissue beneath the skin, causing a swelling of the surface in the neck and upper portion of the body. The bacteria must be destroyed to stop the production of gas. To accomplish this, the portion of the lung which is involved should be mutilated with the knife, which should be passed through the front wall of the chest between the ribs into the diseased lung; then the hollow-needle should be introduced, and fluid injected into all parts of the diseased lung. This can be done a few hours after the body has been embalmed without destroying the effects of arterial embalming.

Usually such treatment is successful. If all parts are not reached and gas is still formed, it will pass out through the openings made by the knife and hollow-needle. If necessary, the treatment can be repeated in the course of a few hours.

PART THIRD.

MORBID ANATOMY AND TREATMENT OF SPECIAL DISEASES.

INTRODUCTION TO PART THIRD.

Morbid (or Pathological) Anatomy treats of the changes produced by disease in the solids and fluids of the body, as in the tissues, skin, blood, secretions, etc. It also shows what effusions are to be found in the several cavities—as blood-serum, purulent matter, etc.—and the effects wrought on the various organs.

The morbid changes which take place in the different organs and tissues, as a result of the many diseases that human flesh is heir to, are scarcely understood by the embalmer. In many cases his knowledge of the real condition is very slight indeed. There is nothing more essential in the practise of embalming than to understand which organs and tissues are affected, and what are their condition at death.

In Part Third we have endeavored to place before our readers, in as plain language as possible, the morbid anatomy of certain diseases, with the proper mode of treatment of the body dying from each. Only the most important diseases, and those whose treatment is likely to give the embalmer the most trouble, are thus considered.

We show which organs and tissues are affected by complication and otherwise, so that the embalmer may know where to look for, and how to reach, all diseased tissues, for the purpose of destroying the bacteria of infection and putrefaction, and of preserving the parts, and thereby have no "failures."

These diseases are considered under a somewhat arbitrary, though more or less logical, classification. In the first class are included diseases which affect the circulation in such a manner as to make it impossible or difficult to get a good arterial circulation of fluid, some of which conditions are present in various other diseases, the description of which follow.

CHAPTER XXVI.

DISEASES AFFECTING THE VASCULAR SYSTEM.

DISEASES OF THE ARTERIES WEAKENING THE WALLS AND CAUSING ANEURISMS.

To fully understand this subject, it is very important, in studying the morbid process to which arteries are subject, to keep in mind the following anatomical facts: the blood=stream, as it passes through the arteries, glides over the surface of the endothelium (the layer of the flattened cells); outside of this layer is the tunica intima, composed of elastic tissue in longitudinal arrangement; the endothelium and the tunica intima together constitute the internal coat; still more external is the middle or muscular coat, composed of a fibrous arrangement in circular, triangular, and longitudinal manner, and, in the larger arteries, mixed with elastic tissue; outside of all is the external coat, consisting of longitudinal, fibrilated, connective tissue.

Acute inflammation of the artery affects only a limited portion of the vessel, and leads occasionally to ulceration. In some cases, this has arisen from the irritation caused by an embolus (clot), which, becoming detached from the cardiac valve, has blocked a distant artery. Sometimes there will be softening and swelling of the arterial coats in circumscribed spots, which become flabby and inelastic, and ultimately bulge outward and form aneurisms. This condition is the great cause of aneurism in hard=working young men.

Chronic inflammation of the arteries is so infrequent that it is scarcely worth noticing, unless as a precursor of the disease known as atheroma.

Atheromatous disease is met with oftener than any other, and is much more serious. It presents three tolerably well=defined stages. In the first stage, if the vessel is slit open, grayish patches, which thicken the lining membrane, are noticed. These patches seem to lie on the surface of the membrane, but this appearance is deceptive. They lie underneath the endothelium, which is not affected at all in the beginning of the morbid process. Indeed, the material of which the patches are formed is really situated external to the tunica intima, between that and the middle coat. It is half cartilaginous in consistence, and is formed by the rapid, abnormal multiplication of the deep cells of the tunica intima, the new growth pushing up this tunic with its endothelium on the inner side, and so causing the bulging into the interior of the vessel. It seems to be in the nature of an inflammatory change—that is, it consists in the throwing out of cellular elements in consequence of some influence which has excited them to unnatural growth.

In the second stage, the cellular elements, of which the new growth is composed, undergo the process of fatty degeneration, and, in consequence, become yellowish in appearance and pasty in consistence. It was the paste=like appearance of the mass that gained for it the designation of atheroma (meal). In this stage, it frequently happens that the whole of the internal coat with its endothelium is involved in the softening, and gives way under the pressure of the blood, leaving an excavation, the contents being literally washed out. The floor of this excavation is formed by the middle and external coats of the artery. When this is the case, the blood insinuates itself between the coats of the vessel, which, being weakened by the removal of the internal coat, yields to the pressure of blood, and a sacculated aneurism is originated. Cerebral vessels, probably on account of the thinness of the walls, are liable to rupture when they are the seat of aneurisms. Sometimes, the diseased coronary artery has given away, filling the pericardium with blood.

Occasionally, however, the pasty mass, instead of being washed away, becomes the seat of calciferous (lime) deposits. This is known as the third stage. The appearance of the vessel, in which the atheromatous disease has reached this stage, is very striking. Plates, which present to the naked eye the appearance, but do not show the structure of bone, are observed at intervals in the walls of the vessel, with their sharp points projecting into the interior of the vessel. In the aorta it is not uncommon to find such plates an inch long and half an inch broad, and in the smaller arteries the calcific matter forms a ring around the vessel. In the latter the calcareous particles appear to be deposited in the patch while it is still firm, so that the second stage is not marked.

Atheromatous disease sometimes invades the aorta, while the small vessels are not affected; or, on the other hand, the small vessels may be the seat of the calcific change and the large vessels be healthy. Occasionally, the disease is limited to a few vessels. Next to the aorta, the arteries of the lower extremities are prone to this form of arteritis (inflammation of the arteries). The dangers to which an atheromatous state of the vessels exposes a person in whom it exists are various. The stream of blood is retarded by the projection of the new growth into the vessel, and still more by the destruction of the elasticity of its coats. Hence, the failure in the nutrition of the organ, which depends for its supply of blood on the diseased vessel, will follow. This is said to be the cause of cerebral softening.

Arteries have been occluded completely by the deposit of fibrin on the spiculated edges of the calcareous plates. This is one of the causes of senile gangrene. The plugging of distant vessels by emboli, at times, results from the detachment of such fibrinous clots and the washing away of the atheromatous material. Rigidity of the larger arteries, from the atheromatous change, is likewise one of the most frequent causes of hypertrophy (enlargement) of the left ventricle of the heart, in which increased work is caused by the destruction of the elasticity of the vessels. Anasarca of the lower extremities may occur in elderly men from the plugging of the vessels, or it may result from dilatation and weakening of the left ventricle, thereby weakening the blood=current.

When a number of these atheromatous spots have washed out, the distant vessels may fill up with debris, which has a yellowish=white appearance, causing occlusion sufficient to prevent the flow of fluid. In one case, in following up a dissection, it was noticed that a number of points in the aorta were diseased in this manner. One dissecting aneurism was present, while other points seemed to have been washed out. In some rare cases of dropsy there have been noticed a substance composed of white plates in the arteries in sufficient quantity to impede the flow of fluid. This is due, presumably, to the separation of the solid and semisolid portions of the blood from the liquor sanguinis, hemoglobin being absent. It is a grayish=white color. This has been mistaken, by some, for the atheromatous deposits.

Treatment.—The use of great force in the injection of fluid, in cases of this kind, may produce disastrous results. If it is kept in mind that the aorta is the vessel most frequently diseased, and that the injection of fluid can be accomplished with very little force, the results will be satisfactory, provided the aneurisms that are present are not burst. If undue pressure is use, these aneurisms, or weakened walls of the vessel, will undoubtedly give way, when it will be impossible to fill the arteries and capillaries. In a case where such results obtain, fluid must be injected beneath the skin into the cellular tissue in all parts of the body. Fill the cavities thoroughly. Treated in this manner, preservation and disinfection can be accomplished.

DISEASES OF THE HEART AND BLOOD-VESSELS AFFECTING THE CIRCULATION.

In the embalment of a body it is not always easy to get an arterial circulation; in fact, in a number of cases, it is impossible to get an arterial circulation at all. It is not always owing to the contraction of the arteries, or to the presence of blood=clot, but is frequently the result of disease of the heart, arteries, veins, or capillaries.

First, the heart is liable to organic disease, either of its propelling muscular walls, its regulating valves, or its controlling nervous system. It will be found that disease of any of these parts of the cardiac apparatus, affects its several functions. Thus, disease of the walls of the heart affects the force or pressure; disease of the valves disturbs the distribution or quantiy of blood in the several parts of the circulation.

Second, disease of the arteries interferes with the quantity of blood transmitted through them, and produces disturbances of distribution or pressure.

Third, when the capillary walls are degenerated or ruptured, or their channels are blocked as a result of embolism or thrombosis in the arteries or veins, nutrition is disturbed in various ways.

Lastly, the veins may be the seat of a variety of lesions, which prevent the return of blood and lead to hemorrhage or dropsy.

The pressure of blood within the circulation may be either increased or diminished, or irregularly distributed. The most marked instance of increased pressure is seen in simple hypertrophy of the left ventricle without valvular disease, especially if the hypertrophy be associated with increased peripheral resistance, as observed in chronic Bright's disease. In the arteries there is fullness, elongation, thickening, and atheroma, with their results. The pulse is full and strong, and the capillaries are distended and may be ruptured, hemorrhage being the result.

Diminished pressure of the circulation is more common, and is seen in dilatation, with thickening of the cardiac walls, and in atrophy, with fatty degeneration. The effects of diminished pressure within the circulation generally are the reverse of those of increased pressure: the arteries are comparatively empty and small; the pulse is weak, small, and irregular; the cavities are supplied insufficiently with blood; the surfaces are anemic, or passively congested; and the various functions are discharged feebly; the backward pressure within the veins, on the contrary, is increased; the blood tends to accumulate within them; the walls are dilated; the valves are disorganized; and passive congestion, thrombosis, dropsy, and chronic inflammation are the frequent results.

The quantity of blood distributed in hypertrophy of the heart is large, while in atrophy the quantity is less and the pulse is wiery. The most frequent disturbance observed is irregularity of distribution. This condition generally affects the pressure and quantity together, and may affect the one more than the other. Irregular distribution of blood and pressure is present more markedly in valvular imperfection, and is seen also in obstruction of the arteries, and other allied conditions, especially of the aorta. In the parts of the circulation and in the organs situated behind the seat of the disease, irregularity of the distribution of blood and of pressure is a manifested form of dilatation, such as enlargement and engorgement of the heart, congested and associated changes of the lungs and abdominal viscera, of hemorrhage, and of various exudations and effusions, whether as edema, dropsy, or catarrh. On the other hand, the portions of the circulatory apparatus beyond the seat of the disease are underfilled and undersized. The organs are deprived of a sufficient supply of blood, and anemia, with its further consequences, is the result.

In cases of hypertrophy without valvular disease, accompanied by disease of the arteries, capillaries, and veins, there is liable to be ecchymoses (blood=spots) on the surface. These discolorations are the result of the blood breaking through the walls of the capillaries into the cellular and connective tissues, producing bluish or reddish spots.

Treatment.—In case of thinness of the walls of the heart and of the arteries and capillaries, we are liable to have rupture during the injection of fluid. Therefore, in all cases, and in case of the aged especially, fluid should be injected very slowly and without force, as, frequently, if force is used, rupture will follow, and the entire destruction of the circulatory flow of fluid will result. Indeed, in some cases, it will be impossible to inject fluid through the arteries with sufficient force to reach the capillaries in the tissues, without causing rupture. In cases of rupture resulting from the injection of fluid, and in those cases where sufficient force cannot be used to reach the capillaries, the fluid should be injected into the tissues direct through the hollow=needle. The cavities can be treated in the usual manner. Ecchymoses cannot be removed by bleachers applied to the surface, or by hypodermic injections. If they appear on the parts that are exposed to view, as the face, neck, and backs of the hands, they should be covered with flesh tints, or powder.

VALVULAR DISEASES OF THE HEART.

Valvular lesions of the heart are situated, generally, in the left side, at the mitral and aortic openings. Lesions on the right side are comparatively rare. The valves are frequently thickened and contracted; or, they may be encumbered simply with vegetations of greater or less size, without being incapacitated for the performance of their functions. Sometimes they are rendered more or less rigid by the deposit of calcareous matter. The aortic and mitral valves may become enlarged and thickened sufficiently to almost close the orifices; or they may become atrophied, rendering them liable to rupture or perforation. Enlargement of the heart follows either of the above conditions. When the aortic valve is diseased sufficiently to interfere with, or prevent, perfect closure of the aortic orifice, fluid, when injected into the arteries, will enter the left side of the heart; and, in tapping the heart, if the left side be perforated by the trocar, a partial destruction of the circulation will result, and the fluid will fail to permeate a part, at least, of the tissues. The lungs may become involved, resulting in edema, hemorrhages, or pulmonary apoplexy. Dropsy of the serous sacs, or general dropsy, may be present. Death may have been caused by heart failure or by apoplexy. The face and upper surfaces of the body are congested and edematous, rendering the removal of blood necessary.

Treatment.—When the semilunar valve, which guards the aortic opening, is diseased in such a manner as to prevent the closure of the orifice, fluid, when injected into the arterial system, will pass into the left ventricle. If the mitral valve, which guards the opening between the left auricle and left ventricle, is diseased at the same time, the fluid will pass on into the left auricle. In withdrawing blood from the heart by the direct operation; when the above valves are diseased, great care should be taken not to wound the left side of the heart. If the septum between the right and left sides of the heart is wounded, the circulation of fluid will be destroyed.

A less dangerous method of withdrawing blood from the heart, under these circumstances would be through the basilic or the femoral vein, as the heart may be moved out of its normal position by an effusion into one or the other pleural sac; for instance, if the heart be forced a little to the right side by an effusion into the left pleural sac, it would cause the operator, if not aware of the abnormal position, to wound the left side. Death may have been caused by asphyxia, due to edema of the glottis, hydropericardium, or pulmonary congestion, resulting in congestion of the face and neck, on account of which the blood must be removed at once.

Dropsical effusions almost always occur in valvular disease of the heart; sometimes they are limited to the serous cavities only, but more frequently anasarca, or general dropsy, is the result. The water should be removed from the serous cavities by the use of the aspirator, and from the cellular tissue, especially in the extremities, by the rubber bandage; then fluid, containing a little formalin, should be injected into the arteries in sufficient quantity to fill the capillaries of the skin, which will harden the pigment layer, preventing "skin slip." The cavities should be filled in the usual manner. Fluid should be injected into the lungs through the respiratory tract; then place the body upon the level with the head slightly elevated.

CHAPTER XXVII.

INFECTIOUS AND CONTAGIOUS DISEASES.

SCARLATINA—SCARLET FEVER.

Scarlet fever is an acute infectious disease. Infection with the specific scarlatinal poison occurs almost always by contagion, which takes place very readily. There seems to be no doubt that the disease is transmitted by objects which the patient has touched, such as linen, clothing, furniture, toys, etc. Even persons who have been with the sick may be the means of transmitting the disease, the poison, having attached itself to the meshes of the garments while moist, will be detached easily on becoming dry, and be received through one of the various channels by those coming into contact. In England it has been thought that the contagion might be carried by milk.

Scarlatinal poison is destroyed with great difficulty. It keeps its contagious powers for months. In some cases it is very hard to point out the source of the contagion. The tenacity of the scarlatinal poison may well explain the reason. The disease may be communicated as late as the end of the desquamative period. The details as to the manner of contagion are yet unknown. Statements have been made repeatedly about the presence of bacteria in the blood and in the tissues of scarlet fever patients, but the specific poison of scarlet fever has probably never been observed, though the disease has been repeatedly produced in healthy persons through inoculation.

The predisposition to scarlet fever is far less usual than to measles or smallpox. Frequently, where there are several children in the family, only one or two are sick, while the rest escape, although equally exposed. The liability to the disease is greatly diminished as age increases, although adults are sometimes affected. Between the ages of two and ten years is the period when the majority of the patients are affected. It is very rare in the first year of life. Children with fresh wounds, either accidental or surgical, especially are liable to scarlet fever. One attack of the disease renders the person immune, as very few are attacked a second time, so that after the disease is over, an immunity from contagion is enjoyed, but there are exceptions to this rule.

Scarlet fever is met with in every part of the globe. Sporadic cases in the large towns are found at almost all times, while in the autumn, from time to time, there are more or less extensive epidemics in one place or another. There is considerable variation in the different epidemics of scarlet fever. Sometimes it prevails in a very mild form, with few deaths, and at other times it prevails in a more severe and grave form, and many deaths result.

This disease being contagious, especially among children of the ages of two to ten years, children of that age should be kept away from the patient. The patient should be isolated, and all persons, except the nurse, should be kept out of the room. Indeed, the nurse should not be allowed to come in contact with others, as the poison which is liable to attach itself to the clothing, hair, hands, and underneath the nails of the nurse, are liable to be the source of contagion. We might say that there are cases of so-called puerperal scarlatina, resulting from the entrance into the system of the scarlatinal poison through the excoriations or wounds caused by the passage of the child through the female genital organs. In these cases following childbirth, death may result, and carelessly the scarlatina may be overlooked, supposing it to be a case of septicemia. In cases of septicemia there is an eruption on the surface, due to the septicemic condition. Therefore, the scarlatinal eruption may be mistaken for the eruption of septicemia. If there is any doubt, be very careful not to expose any one to the contagion. To be on the safe side, treat the case as one of scarlatina.

The kidneys are affected frequently in scarlatina, and this is usually a dangerous complication. Ordinarily, there is found in the urine a tract of albumen, and in rare cases the quantity of albumen may be considerable. There is a changed appearance of the urine in some cases, and the microscope reveals but few abnormal constituents. In genuine scarlatina, nephritis rarely ever developes before the end of the second week or the beginning of the third. Sometimes it begins even later. It may follow the severest case or the mildest. The severity of the disease seems, therefore, not to be essential. In case of nephritis, general dropsy follows, and frequently death occurs. It may occur from extensive ascites, or hydrothorax, or it may result from uremic poisoning. In some cases cardiac failure may be strongly developed.

Treatment.—In cases dying after desquamation has already taken place, if the body is treated properly, and the room thoroughly fumigated, there will be no danger in exposing the body; it need only be known as a case of Bright's disease or acute nephritis. The body may be shipped without danger to others, without the usual means of protection required in cases of infectious diseases. Of course, if desquamation is not complete, it must be treated precisely as a case dying earlier in the disease.

Cases dying before desquamation should be embalmed thoroughly, as all infectious cases should be, not for the purpose of exposing them to view, but as a sanitary measure. As stated above, the bacteria are very tenacious and hard to destroy. From experience and investigation we know that these bacteria will resist the effects of water, cold, freezing, earth, etc., retaining the power of development for a long period of time. To place a body dying from scarlatina in the ground without first destroying these bacteria, or scarlatinal poison, exposes future generations to a source of dissemination, at least.

In preparing the body, first remove the clothing, rendering the body nude. Inject fluid into the arteries until sufficient has been injected to fill the capillaries thoroughly; fill the cavities thoroughly; fill the cavities and external openings; wash the body with hot water and soap, and also with strong disinfectant fluid. Allow the body to remain upon the board; close and seal all the doors and windows, making the compartment as nearly air-tight as possible; then disinfect the room by the use of formaldehyde gas. After thorough disinfection, dress the body and place in the coffin or casket, and remove for burial. If it is to be shipped, follow the rule adopted by the General Baggage Masters' Association in preparing bodies for shipment.

DIPHTHERIA.

Diphtheria is an acute infectious disease, caused by an infectious bacillus. It is highly contagious, and the malignant form is a very grave disease, with a high mortality rate. It is principally a disease of childhood, although no age is entirely exempt. Occasionally an adult becomes infected. It is characterized by a false-membrane in the throat, nose, and other parts of the mucous surfaces. The fauces are usually the only parts covered with the false membrane. Although a constitutional disease, the morbid changes are apparently not very great.

Fig. 47.
Bacillus Diphtheriæ, from colony upon an agar plate, 24 hours old. X 1000. From a photo micrograph by Fränkel and Pfeiffer.

The disease is endemic in our large cities, and, at certain periods of the year, becomes epidemic. Diphtheria seems to have increased in our large cities in the last few years, while other contagious diseases have diminished. The disease seems to be specially virulent in country districts where it has prevailed.

Diphtheria is highly contagious, and readily communicated from one person to another. The bacilli may be received from the false membrane or discharges from the patient; from the secretions from the nose and throat of convalescents, in which virulent bacilli persist; from healthy persons who have been in contact with others having virulent germs on their persons or clothing.

Diphtheria is specially fatal to physicians and nurses, and may be to the embalmer, if due care is not exercised. The particularly dangerous period to the physicians or nurse is while examining and swabbing the throat, for the patient may cough mucus and pieces of the false membrane into the face and mouth of the physician or nurse. The virus is found in the room of the patient, and is hard to remove; it also attaches itself to the bedding and clothing. Osler says: "A majority of the cases die of faucial or laryngeal disease. The exudation may occur in the mouth and cover the inner surfaces of the cheeks; it may extend beyond the lips on to the skin."

The exudation varies in amount in different cases. The tonsils and pillars of the fauces are covered with pale membrane. In fatal cases the exudation is much more extensive, involving the uvula, the soft palate, the posterior nares, and the pharynx. The parts are covered with a dense false membrane, which adheres firmly in places, and in others begins to separate. In the most severe cases there is a gangrenous condition of the parts. The false membrane is of a gray or dirty=greenish color. There may be sloughing of the tonsils and palate, and the erosions may be deep enough in the tonsils to open the carotid artery, or a false aneurism may be produced in the deep tissues of the neck. The nose may be filled completely by the false membrane, which may extend through the Eustachian tube into the middle ear and into the conjunctiva.

In cases where the larynx becomes involved—so=called laryngeal diphtheria—the pharyngeal exudation may be very extensive, but in many cases it is slight upon the tonsils and fauces, and abundant upon the epiglottis and the largnx, which may be closed entirely by the pseudomembrane. The exudation may extend into the trachea and into the larger bronchi. The lymphatic glands of the neck are enlarged, and there is general infiltration of the tissues; the salivary glands may be enlarged. The false membrane extends, in rare instances, to the esophagus and the stomach. While the infectious or diphtheretic bacilli are limited to the false membrane, the whole body is impregnated with a virulent poison.

Treatment.—In the treatment of diphtheretic cases the embalmer should be extremely careful. The blood is very poisonous, and, if he should wound himself, or receive the least particle of the blood through an abrasion, death would result most likely from blood poisoning. Therefore, in handling or operating on these cases, the embalmer should wear gloves, or some other protection should be used on the hands to cover abrasions; these may exist without the knowledge of the operator. He should also dress himself in a suit of old clothes—a suit used only in handling infected bodies. He should cover his head with a rubber cap, and also wear a rubber coat fitting closely around the neck and reaching to the feet. Rubber, having no meshes, can be cleaned easily.

The body should be undressed and placed upon the board; then washed with a solution of bichlorid of mercury, and a strong disinfecting fluid should be injected in the nose and mouth, filling the trachea and lungs. Raise an artery at some convenient point and fill the tissues with fluid. Inject about one pint of fluid for every twenty pounds of weight of the body—that is, if a body weighs 150 to 160 pounds, inject at least one gallon of fluid to fill the capillaries, rather more than less than that quantity. Remember that the tissues must be filled to insure disinfection. After injecting the arteries, fill the cavities thoroughly. Then inject again into the nose, mouth, throat, and lungs, and fill all the openings of the body with pledgets of absorbent cotton soaked in fluid.

The room should now be closed tightly and disinfected thoroughly with formaldehyde gas or sulphur fumes. After the room and body have been disinfected in this manner, the body may be dressed for burial. If the body is to be shipped, it should be wrapped in cotton at least one inch in thickness, protected by a roller or many=tailed bandage, and the whole wrapped in a sheet wet with a strong solution of mercuric chlorid, and then placed in a hermetically=sealed coffin, casket, or box.

TYPHOID FEVER.

Typhoid fever is an acute infectious disease, caused by the presence of the typhoid bacilli. They are found in the alimentary canal, principally in the lower part of the small intestine.

If death results early in the disease, the body will not be much emaciated; the pallor will not be so great on account of the thickness of the blood, caused by excessive perspiration and diarrhea, and the bluish color of the tissue, resulting from the loss of the liquid portion of the blood. The body, at this stage, will not be hard to preserve; rigor mortis being well marked, it will keep usually, without the use of fluid, for two or three days in ordinary weather; but the body should be disinfected as one dying in a later stage, on account of the presence of the typhoid bacilli.

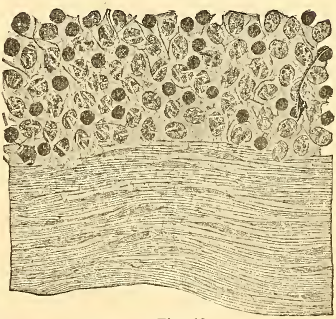


Fig. 48.
Section through wall of intestine showing invasion by typhoid bacilli, X 950 (Baumgarten).

If death occurs later in the disease, say at any time after three or four weeks, the pallor will be much greater. Rigor mortis will not be so well marked. In fact, it will come on and pass off, when the body is extremely emaciated, within the hour.

In cutting down into the different cavities of the body, the tissues will be found light in color, the blood very thin, and there will be a hypostatic congestion in both lungs; the posterior part of the lungs will be quite solid. Hypostatic congestion will be found in the dependent parts of the body, even before death. The small intestine will be found to be denuded of mucous membrane in patches two or three inches in length. Peyer's patches and the solitary glands will be sloughed off and cleansed, showing deep ulceration.

Fig. 49.
Bacillus Typhi Abdominalis (Typhus bacillus), from single gelatin colony, X 1000. From a photomicrograph by Sternberg.

In many cases the contents of the small intestine will be of a pea=soup=like=green material, filled with typhoid bacilli and putrefactive bacteria. This matter is very poisonous; if the least particle is taken into the stomach, it will produce the disease. A very small quantity of this matter may get into the clothing, and, when it becomes dry and is brushed off, it may be carried by the air and deposited on such material as is taken into the stomach, such as cold food or the water we drink; therefore, it is very necessary to be extremely careful in handling bodies of this kind.

The ulcerations may be deep enough to have perforated the walls of the intestines, and the contents, containing more or less undigested food, may be found in the peritoneal cavity; the spleen may be found from two to five times its usual size, or its capsule may have burst, and a great quantity of blood may have escaped into the peritoneal sac. The kidneys and liver may be found affected more or less; the large and small intestines will be filled with gas in all cases.

Treatment.—When the embalmer is called to embalm a case dying from typhoid fever, it is not only his duty to preserve the case, but to disinfect it thoroughly. If the body is to be shipped, it must be disinfected to meet the requirements of the shipping authorities of this country, and must be prepared specially, according to the rules adopted by the General Baggage Masters' Association.

It is necessary to disinfect the body, even if it is not to be shipped, for the protection of the community. If a public funeral is to be held, the body should be disinfected thoroughly, to prevent the dissemination of the disease. If the body should be buried without being disinfected properly, the spores of the bacteria will remain dormant within the grave for a long period of time, as earth does not seem to destroy them. Under these circumstances, if the body should be disinterred for removal at any time, the spores may be thrown out on the surface and be carried away by the wind, or washed into the streams; or they may be washed out of the grave through the drainage from the cemetery, and be carried into the larger streams, which form source of the water supplies to the inhabitants along their course. In this manner, the disease is no doubt frequently disseminated. Therefore, all bodies dying from typhoid fever should be disinfected in a thorough manner before burial.

To treat a case of typhoid fever, the body should be taken from the bed, the clothing removed, and the body washed with a strong disinfectant solution, as well as soap and water. The washable material that was used on the bed, with the clothing upon the body, should be rolled up closely and placed in a wash boiler of water and boiled for at least an hour. After the body has been carefully washed, it should be embalmed.

If the abdomen is distended with gas to a great extent, it will be better to treat this cavity before raising an artery. If it is not distended with gas, an artery may be raised first and fluid injected into the arterial system.

To operate on the abdominal cavity, an atmospheric pump, with complete tubing, and a hollow=needle of about ten or twelve inches in length, are necessary. Connect the needle with the tubing, place the goose-neck loosely in the bottle, already filled with fluid. Do not push the cork into the neck but let it lie upon the rim, so as to allow the gas to pass out freely; then introduce the needle at the proper point in the epigastric region (as described in the chapter on "Cavity Embalming"), pushing the needle downward until the stomach is reached, always keeping in mind the location of the abdominal aorta and its large branches. The gas in the stomach will pass out through the needle and tubing into the bottle containing the fluid, through which it will pass, destroying the odor and any bacteria it may contain, and then escape through the neck of the bottle. This will be indicated by bubbles forming on the surface of the fluid. After all the gas has escaped, before removing the needle, the goose=neck should be pushed tightly into the bottle, and fluid should be pumped into that part of the cavity from which the gas escaped.

From the same point of introduction, the needle may be pushed through the peritoneal sac into other parts of the abdominal cavity that contain gas. When the needle enters these parts, the goose=neck should be loosened from the neck of the bottle as before. After the gas has escaped, the goose=neck should be tightened again in the bottle and fluid should be injected before the needle is removed. Inject the canals and cavities in this manner successively, filling each, until all the gas is removed, and all parts of the abdominal cavity have received fluid. This should be done for the purpose of mixing the fluid with the contents of the alimentary canal and other parts of the cavities.

If all the gas is removed from these cavities before the fluid is injected, it will be impossible to introduce the needle again into the several cavities that had contained gas, on account of their walls collapsing, and fluid injected would be received only by the peritoneal sac and would settle down through its walls into the tissues beneath. It is necessary that fluid should be mixed with the contents of the intestinal canal and other organs of the body, and to do this the fluid must be injected after the gas escapes, before the removal of the needle.

After the abdominal cavity has been relieved of the gas and fluid injected, the needle should be turned upward through the front border of the diaphragm, and the serous sacs in the thoracic cavities should be treated, as directed in the chapter on "Cavity Embalming." Fluid should be injected through the respiratory tract to reach the congested part of the lung, and, if persistent purging from the lungs should follow in twenty=four to thirty=six hours after death, the needle, should be inserted through the front wall of the thoracic cavity, into the diseased portion of the lung, the part mutilated as much as possible, and fluid injected in large quantities. This will destroy the bacteria that are contained within the diseased portion of the lung, and purging will cease.

After the cavities have been treated properly, an artery should be selected and raised for the purpose of arterial embalming. If blood is withdrawn, it should be sterilized by a solution of chlorid of lime, about five or six ounces to the gallon.

If a body is treated in this manner, and enough fluid is used, there will be no danger of the dissemination of the disease.

TYPHUS FEVER.

Known Also as Hospital, Jail, Camp, and Ship Fever.

Typhus fever is an acute infectious disease, entirely distinct from typhoid fever, with which it was formerly confounded. The similarity of the two diseases, which caused the assumption of similar names, consists in a number of complications which may appear in both diseases. An essential difference, however, which exists in the whole course of the disease, is the intestinal lesion, which is characteristic of typhoid fever, but is never seen in typhus fever. Another, the chief distinction between the two affections, is the inability to find the bacillus, which causes the typhoid, in the typhus case.

We have not been able yet to determine the pathogenic bacteria that causes typhus fever. We have much less information as to the way in which the affection occurs, than in relation to typhoid fever. Several microbes have been described in connection with the disease, such as streptobacilli, diplococci, and ascomycetes, but the question still remains open for investigation. The disease is rare at present. Epidemics are infrequent, although sporadic cases occur from time to time in the centers of large population.

Typhus fever is a most highly contagious affection; even the doctors and nurses in attendance on the sick are almost invariably attacked. It is a very grave disease, and a large percentage of those attacked die. Clothes and bedding retain the poison for a long time. Emaciation is not very apparent, unless the case is protracted, through the intercurrence of complications, when it may reach an extreme degree. Rigor mortis is not well marked and usually lasts but a short time. Hypostasis occurs rapidly, and putrefaction begins soon after death. The only constant lesion noticed in this disease is the profoundly changed condition of the blood, which is dark in color and very fluid. If clots exist at all they are large and soft and easily broken down. The amount of fibrin and the number of red corpuscles are diminished, but the number of white corpuscles is increased.

Treatment.—In treating a case of typhus fever, it must always be remembered that it is infectious and highly contagious; therefore, the dress should be one in which the germ is not so likely to be carried, as that described under the directions for the handling of infectious cases. The body should be laid upon the board and washed with a strong disinfectant; an artery should be raised and fluid injected in sufficient quantity to fill the tissues; the cavities should be filled in the usual manner. No special treatment can be given, as it is not known what parts of the body are infested with the specific micro=organisms of the disease. If the body is to be shipped, it should be wrapped in cotton, as directed in the rules for the shipment of bodies.

MEASLES.

Measles is an acute infectious disease, characterized by coryza and a peculiar red eruption. It is a disease of childhood, but adults are liable to the infection when unprotected. Adults are attacked more frequently by measles than by scarlet fever. Within the first few months of infantile life there is less liability of attack, although infants two or three weeks old may have the disease. Both sexes are affected equally. The contagion is communicated by the breath and by the secretions, those of the nose being the most dangerous. The disease can be conveyed in the clothing, especially when secretions from the nose come in contact with the meshes.

Death rarely results from measles alone, but complications produce many fatalities among children. There is no characteristic post=mortem appearance in any of the tissues. In the bronchi the mucous membrane indicates a catarrhal condition, death usually resulting from pneumonia, capillary bronchitis, or other complications in the lungs. The post=mortem condition is referable to those diseases. There is an invariable swollen condition of the bronchial glands. Pleuritic effusions, as a result of pleurisy, may occur in some cases. Sometimes, later on, there may be a tubercular invasion, which will produce the same condition that is found in tuberculosis. There is a congested condition of the mucous membrane of the stomach and small intestines. Peyer's patches or glands may be swollen and congested to a very considerable extent.

Treatment.—In the treatment of measles the complication producing death must be considered. If it be pneumonia, or consumption, or any other disease of the lungs, the treatment recommended for the disease should govern the operator;

otherwise, the body should be injected very thoroughly and the tissues and cavities filled with fluid with a view to disinfection. If the body is to be shipped it must be prepared according to the shipping rules governing the same. For burial in the local cemeteries, the rules as laid down by the health board in the locality where the death occurs should govern.

TUBERCULOSIS—CONSUMPTION.

Consumption (tuberculosis) is one of the most wide-spread and deadly diseases known. A larger percentage of deaths is due to this disease than to any other. It is an acute infectious disease, due to the presence of tubercular bacilli. It prevails in all climates and altitudes. Usually in the high altitudes it is longer in developing, due to the absence of moisture or damp atmosphere. It is true deaths occur frequently in the higher altitudes, but this is the result usually of persons seeking higher altitudes for the purpose of being cured. The disease having almost run its course, but little of the lung remaining, it is impossible for them to live in an atmosphere so rarified.

Fig. 50.
Bacillus Tuberculosis in giant cell, X 1000. From photomicrograph made at the Army Medical Museum, Washington, by Gray.

Morbid changes take place very frequently in the larynx, trachea, and bronchi. Tubercles commonly develop first in the upper part of both lungs; sometimes only in one. Their development is always, in a greater or less degree, associated with other morbid changes of the lungs, such as congestion and edema of the lungs, bronchial catarrh, pneumonia, etc.

Cavities from the size of a pea to the size of an orange are found usually throughout the lungs. Sometimes they are large enough to involve the whole lung; pus from these cavities frequently escapes into the pleura or into the abdominal cavity. There is always a complication of pleurisy with effusion of serum or suppurative matter into the pleural cavities. Sometimes this may be a straw=colored liquid, having the consistency almost of water; at other times it may be heavy pus; and at still other times a plastic effusion which adheres to the parietal walls of the pleura. Extensive pleuritic effusions may be found, causing the lung to adhere to the front or side of the chest. Very extensive morbid changes sometimes take place in the mesenteries, peritoneum, intestines, and other organs. Sometimes there is ulceration of the intestines, abscesses of the mesenteries, circumscribed or general peritonitis, abscesses of the liver, kidneys, etc.

In children frequently the serous membrane of the brain is affected, and in tubercular diathesis, often rickets, or necrosis of the vertebra, or softening of the bones in general, is present.

Treatment.—In the treatment of the disease, it must be remembered that preservation is not all, but disinfection must be considered as well, as the inhalation, or taking into the system, of these tubercular bacilli will result, in many cases, in tuberculosis; especially when a condition of the system prevails in which the tubercular bacilli may grow.

To stamp out the disease, it is highly necessary that every case dying of tuberculosis should be disinfected thoroughly, as the spores will remain alive in a body placed in the ground, even after putrefaction has taken place, and be ready for development when they reach the proper soil. This can result from the disinterment of bodies that have been buried, or from outlets from graves in cemeteries, through sewers or ditches that carry the water, filled with these bacilli, into streams which assist in forming the water supplies of our larger cities.

The fluid, which is injected through the arterial system, reaches the lungs, when they are not diseased, by means of the bronchial arteries, which are branches of the thoracic aorta; but in the case of consumption these arteries usually are destroyed or closed with fibrous plugs. Consequently, in many cases, fluid will not reach these cavities. The only positive evidence of fluid having reached the lungs is when it appears at the mouth or nostrils, which usually is the result of these plugs being forced out, or of the rupture of the wall of the artery in some part of the cavity. When such is the case, it is possible to complete the injection through the arterial system by closing the glottis. This can be done by the introduction of a tampon or tampons of cotton through the nose or mouth, into the pharynx, for the purpose of closing the glottis. When this is accomplished, the injection may be proceeded with, and when the cavities are filled with fluid, the leakage will not interfere further with the injection through the arteries.

If the fluid does not appear at the nose or mouth, during the injection of fluid through the arteries, it will be necessary to inject fluid through the trachea into the cavities of the lungs, filling the lungs full. The operation should be repeated, especially in warm weather, in a few hours. The pleural cavities should be emptied by pumping them out and then filling them with fluid. Gases should be removed from the abdominal cavity and fluid injected in large quantities into the intestinal canal and peritoneum.

A body treated in the above manner with a good disinfecting fluid, will be both preserved and disinfected.

TUBERCULAR MENINGITIS.

Tuberculosis of the meninges is nearly always a secondary affection. It follows existing tubercular disease of some other organ. The inner covering of the brain (pia mater) is singled out most frequently for the secondary infection by the tubercular bacilli. The path of these bacilli traverse to reach the pia mater is not known, unless it be by the circulation. The original tubercular disease would undoubtedly end in death, the meningitis merely terminating life more quickly. Again, the primary trouble may not be noticed at all, or it may have long since appeared to have been arrested, so that the meningitis may appear to be a primary disease. It most frequently follows pulmonary tuberculosis, coming on as a complication in very advanced cases. It may follow tubercular pleurisy, but tubercular pleurisy is usually a sequel of pulmonary affection.

Strumpell, in his "Text=book of Medicine," says:—

"In children, and sometimes in adults, the virus may be carried to the meninges from cheesy, tubercular, bronchial, or mesenteric glands, or from tubercular or fungous disease of the bones or joints. Another danger to adults is tubercular disease of the genito=urinary apparatus. It should also be noticed that a single large tubercle in the brain may lead to miliary tuberculosis of the meninges. In short, we see that it is not impossible for any tubercular infiltration, wherever situated, to communicate infection either to the meninges alone, or simultaneously to them and many other organs."

In tubercular meningitis the pia mater is the membrane that is affected. Sometimes, the tubercules are very abundant and the inflammatory exudation comparatively scanty; and in other cases the inflammation is considerable, although but few tubercles can be found. The turbercles are found usually in greatest number along the course of the large blood=vessels, chiefly in the furrows and clefts of the surface of the brain, in the fissure of Sylvius, the pons, medulla, and the cerebellum. Often the regions supplied by one or more arteries are affected more than other parts. This, no doubt, is due to the infection being carried by the circulation. There is, in the region involved, a gelatin=like exudation which varies in amount. Sometimes it is purulent in character; sometimes hemorrhages in the pia mater will give it a bloody appearance.

Usually the brain is flattened from the pressure of the exudation. In some cases, the space all around the brain is filled, rendering it impossible to introduce fluid into the cranial cavity. Sometimes the brain substance itself is involved in inflammatory changes, and capillary hemorrhages are found. The ventricles and subarachnoid spaces are filled with a serous effusion. The spinal cord, in the majority of cases, is involved. The coverings around the cord are inflamed, resulting in the effusion of serous liquid, making pressure upon the vessels which supply the cord.

Treatment.—In these cases, it frequently is impossible to reach the parts with fluid by the injection of the arterial system. The effusion of serous matter into the cerebrospinal canal is so extensive that it makes pressure upon all the vessels and capillaries that supply the viscera that are involved. The injection of fluid through the cranial cavity by one of the needle processes, seems to be the only means of treatment. Of course, in cases of small effusions, where the pressure is not so great, the injection of fluid through the circulatory system will be successful. As has been stated above, many other organs are affected at the same time. Therefore, it is necessary to inject a sufficient quantity of fluid to fill every tissue in the body, and, to do this, the arteries should be filled in the usual manner, in addition to the needle operation, unless enough fluid is injected by the latter process. Usually too little fluid is injected by the cranial operations to fill the entire body. For shipment, these cases must be disinfected just the same as a case that dies of pulmonary tuberculosis; it must be prepared by covering with cotton and the roller bandage for the prevention of the escape of the bacteria.

SCROFULA.

Tuberculosis of the Lymphatic Glands.

Scrofula is a tubercular disease, and is produced by bacteria that are similar to, if not identical with, the tubercular bacilli. Formerly it was thought that adenitis was essentially different from tuberculosis, although the final cause of death is usually tuberculosis of the lungs. It is true, when the bacilli are limited to the glands of the lymphatic system, the disease is very chronic. The tendency is a return to health. Tissue cells finally destroy the tubercles that are present. If the bronchial glands and those situated near the lungs are involved, after a time acute tuberculosis occurs. If the mesenteric glands are attacked, peritonitis, either general or circumscribed, will be a complication.

Treatment.—When the physician's certificate gives as a cause of death scrofula, or chronic or tubercular adenitis, the case should be understood as tuberculosis, and should be treated in all respects as tuberculosis of the lungs. The body should be prepared for shipment in the same manner, as the danger of dissemination is equally as great. In preparing these cases, if the glands of the neck, or other parts of the body near the surface, are filled with pus, it should be let out and the parts sterilized thoroughly. If they are open, forming ulcers, they should be washed out, filled with hardening compound, and covered with lintine or absorbent cotton, and a piece of muslin or other white fabric. The body should be injected through the arterial system, and the cavities filled in the usual manner.

CEREBROSPINAL MENINGITIS—SPOTTED FEVER.

Cerebrospinal meningitis is an acute infectious disease, occuring in epidemics, and sometimes sporadically. It is characterized by inflammation of the cerebrospinal meninges. It prevails in almost all parts of this country. This disease is not directly contagious, and probably is not transmitted by clothing or excretions. The nature of the virus is not yet understood. There is a lance=shaped coccus found in the meningeal exudations, in many cases, very similar to the pneumococcus. There may be no characteristic changes in malignant cases, or the patient may die before the occurrence of exudation. The meninges of the brain and spinal cord are inflamed in well=marked cases.

Osler gives the following description of the morbid changes, which were found in a case in Montreal, in which death occurred about the fifth day, which he states, gives a good idea of the condition in this disease:—

"The brain contained an excessive amount of blood. The dural sinuses and all the veins and arteries were engorged. Some of the veins of the pia were as large as goose=quills. On the cortex there was much lymph beneath the arachnoid on either side of the longitudinal fissure—more on the right than on the left hemisphere. At the base there was a purulent exudate about the chiasm and inner parts of the Sylvian fissure, but none on the pons or medulla. There was no lymph on the course of the middle cerebral artery. The ventricles contained serous exudate, the walls were not softened. The gray matter of the brain was doubly congested, but presented no other hemorrhages, spots, or softening. In the spinal cord, the veins of the pia mater were engorged. On the posterior surface, from the cervical enlargement to the cauda equina, was a thick layer of grayish=yellow, lympho=purulent exudation, which in places produced an irregular bulging of the arachnoid membrane. There were no changes in the thoracic or abdominal viscera.

"This picture corresponds closely with five other cases which I have examined. In one case, however, the amount of exudation in the hemispheres was large and the convolutions were covered with a thick, creamy pus. Foci of hemorrhage and of encephalitis occur in some cases. The formation of abcesses has been occasionally described. The involvement of the ventricles is less than in tuberculous meningitis. In the cases which I have seen, the exudation, as is usual in the secondary meningeal inflammation, was most apparent on the cortex. The exudation may extend along the lymph sheaths of the cranial nerves, particularly the auditory and the optic. In long standing cases the inflammatory processes appear more chronic. There are thickening and adhesion of the membranes, areas of cortical softening or of atrophy, and in some cases hydrocephalus. The changes in the other organs are those associated with fever. In the malignant cases there may be hemorrhages into the skin and on the serous membranes. Pneumonia, pleurisy, endocarditis, dysentery, and nephritis have been described. The spleen varies in size according to the period of the disease at which death has occurred. When the fever has been intense, it is enlarged."

As will be seen by the above=described morbid condition the arachnoid membrane, and almost all other parts of the brain and spinal cord, will be filled by exudation. The vessels, both arteries and veins, are enlarged. As is stated, the veins of the pia mater are sometimes as large as goose= quills, due to the presence of blood, showing that pressure upon the capillaries is due to a great amount of the natural and exuded liquids of the body, preventing the fluid from reaching the different organs.

Treatment.—The injection of fluid into the arterial system fails to reach and fill the viscera within the cerebrospinal canal. In all other parts of the body the different tissues will be filled, except when there are complications of pleurisy and pneumonia. In these latter cases, fluid will be prevented from reaching the tissue of the lung, as in the ordinary cases of penumonia and pleurisy. As in cases of pleurisy, the aim must be to relieve the pleural sacs of the exudation within them. Pericarditis is a frequent complication, and when present the heart sac or pericardium must be relieved of its contents. In cases where the lungs are inflamed (pneumonia), the area of the lung that is inflamed should be treated as a simple case of pneumonia. That is, if persistent purging from the lungs be present, the diseased lung should be mutilated and fluid injected, as in the treatment of obstinate purging from the lungs in pneumonia. Failure of the fluid to enter the viscera of the cerebrospinal canal, frequently gives more or less trouble. The exudation being filled with bacteria, gases are formed which are annoying for the time being at least; but if the arterial system and capillaries are filled thoroughly, and the body is kept in a recumbent position, in time, fluid will enter the cerebrospinal canal in sufficient quantity to destroy the bacteria by the penetration of the disinfecting chemicals.

CHAPTER XXVIII.

INFECTIOUS AND CONTAGIOUS DISEASES—Continued.

SMALLPOX.

Smallpox has been known for centuries, although formerly it was confounded with other diseases. It is an acute infectious disease, characterized by an eruption upon the surface of the body. Smallpox is one of the most virulent of contagious diseases, and persons exposed, if unprotected by vaccination or a previous invasion of the disease, almost invariably are attacked by it.

It is produced probably by a specific micro=organism, though the same obscurity hangs over its cause as over those of many other diseases of the zymotic class, such as measles, scarlatina, etc. While, however, the causes of these two latter diseases seem still active, there is every probability that that of smallpox has subsided, and that now this disease has no other source than human contagion.

The poisonous material of smallpox is given out from the mucous and cutaneous surfaces of the patient, especially from the lungs and skin, and from the exhalations, the secretions, the excretions, the matter in the vesicles and pustules, and the scabs. These all contain the noxious germs of the disease, which may attach themselves to bed=clothes, and especially to woolen, felt, and cotton articles. Such stuffs retain the specific poison for a very long, but undetermined, period, just as the hat, coat, and cap, worn in the dissecting room, retain the peculiar odor of the place for a long time. It is not yet determined at what period the poison is generated by the patient's person—whether during the primary fever, or not until after the eruption has appeared—, but it is secreted probably during the primary fever.

In general, it may be stated that the poison is most powerful when it is most manifest to the sense of smell; that the dried crusts of the pustules or scabs possess a contagious quality and retain it for a long time; and that it is unsafe for a susceptible person to be in the same room, or in the same house, with the disease. The dead body of a variolated person is equally infectious, and students, who have been near it, when brought into the dissecting room, have in consequence fallen ill with the disease. The infecting distance, therefore, must be many yards around the patient's room.

Treatment.—Embalming for preservation should not be considered at all, but the body should be embalmed and disinfected thoroughly as a sanitary measure.

Every embalmer should be an immune to smallpox. He cannot tell at what moment he may be called into a case, even in the most remote parts of the country. Persons sometimes contract the disease at a very distant part of the country from the place where it develops. The disease may progress and death may result without even the knowledge of the physician. This occurs frequently. Therefore, every embalmer should be prepared to handle these cases. If the operator has not been vaccinated or if not recently, he should be vaccinated at once, on being called to the case.

The embalmer should always dress himself in clothing which is free from meshes or pores—something with a smooth surface, as rubber. A rubber coat, extending from the neck, around which it should fit snugly, to the shoes, is preferable. This should be closely and evenly buttoned from top to bottom. The head, including the hair, should be covered with a cap made of the same material; the mustache and whiskers should be shaved from the face, and the hands covered with some protecting substance, or by rubber gloves.

Upon his arrival at the death chamber, he should place the body upon the board, raise an artery, and inject a large quantity of fluid; also, wrap a sheet, immersed in bichlorid of mercury solution (1:1000 or 1:500), around the body; then place the body in a coffin or casket, bury it at once, and disinfect the room.

A better method would be: After the body has been embalmed, close the doors and windows, sealing all cracks, and disinfect the room and contents with formaldehyde gas or sulphur, either of which, when properly used, will penetrate every part of the room. This should be done according to the methods described in the chapter on "Disinfecting Rooms." After the room containing the body has been disinfected thoroughly, wrap the body in a sheet which has been moistened with bichlorid of mercury solution (1:1000 or 1:500); then place it in a coffin or casket, and deliver to the cemetery for burial.

CHOLERA, ASIATIC.

Asiatic cholera is an infectious disease, produced by the comma bacillus of Koch, or spirillum chorleræ Asiaticæ. The comma bacillus was discovered by Koch in 1884 in the excreta of cholera patients and in the intestinal canals of bodies having recently died of cholera. The researches of Koch, made in India and Egypt, and those made by various bacteriologists since that time, in different parts of the world, show that the comma bacillus is present always in the intestinal contents of cholera patients during the height of the disease, and that it is not found in the intestinal contents of those suffering from other diseases, nor persons in perfect health.

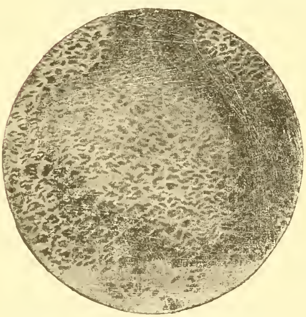


Fig. 51. Spirillum Choleræ Asiaticæ. [*comma bacillus*]
From a culture upon starched linen at end of 24 hours, X 1000. From a photomicrograph by Frankel and Pfeiffer.

The disease is characterized by violent vomiting and purging with rice=water evacuations, cramps, prostration, collapse, and other striking symptoms. It runs a rapidly fatal course, and is capable of being communicated to others through the dejecta of patients suffering from the disease. These bacilli are disseminated most commonly among a community, and taken into the system, by means of drinking water, or by anything swallowed, which has been contaminated by the excretions from a patient suffering with cholera. In a dried state, the bacilli in cholera excreta may be carried in clothing to any point or distance, where the disease may be communicated, as they retain their vitality for a long period of time, only requiring a "proper soil in which to grow."

The appearance is very characteristic after death in collapse of cholera. The whole body has a shrunken aspect and a grayish or leaden pallor, which contrasts with the livid hue of the lips, eyelids, ears, abdomen, back, fingers, and toes. The eyes are sunken deeply in their sockets; the nose is bent and sharp; the temples are hollow; the skin clings tightly to the bones; the tissues of the body are hard and dry, and, owing to the wasting of the soft parts, the muscles stand out prominently; decomposition takes place very slowly on account of the absence of moisture; rigor mortis is marked and persistent.

The occurrence of muscular contraction after death is a very notable phenomenon. It may occur spontaneously, or it may be excited mechanically. A case is reported by Eichhorst in which the fibers of the biceps muscle were noticed to move tremulously, and then the entire muscle contracted, causing flexion of the forearm, three hours after death. Even the fingers performed movements like those made in piano playing. The lower jaw moves in some cases, causing the mouth to open and shut.

Barlow reports a case as follows:—

"The patient was a strong man; the course of his attack was rapid, and he suffered most cruelly from cramps. Within two minutes of his ceasing to breathe, muscular contractions began, becoming more and more numerous. The lower extremities were first affected. Not only were the sartorius, rectus, vasti, and other muscles thrown into violent, spasmodic movements, but the limbs were rotated forcibly, and the toes were frequently bent. The motions ceased and returned; they varied also; now one muscle moved, now many. Quite as remarkable were the movements of the arm; the deltoid and biceps were peculiarly influenced; occasionally the forearm was flexed upon the arm— flexed completely—and when I straightened it, which I did several times, its position was recovered instantly. The fingers and thumbs were now and then contracted, and at times the thumbs were separately moved. The fibers of the pectoral muscles were often in full action; distinct bundles of them were seen at intervals beneath the skin. After I had taken leave of the body, the nurse was horrified by a movement of the lower jaw, which was followed by others, and I thought for a moment that the man was alive. The facial muscles became generally affected, and at length all was still."

These movements vary from slight trembling to powerful contraction of the muscle. Cases have been known to turn completely on the side, by a strange and forcible combination of muscular contractions. These phenomena are not peculiar to cholera only. In cases of yellow fever they have been observed as well. In both diseases they occur when the cases are severe and rapidly fatal, and the patient is robust, with great muscular energy. Stilla says:—

"On opening the abdominal cavity of persons who have died in collapse of cholera, one is struck by the general pink or rose tint of the peritoneal coat of the intestines. It is produced by a repletion of the minute branches of the portal venous system. Sometimes the color of the peritoneum is rendered very dark by the pitchy blood contained in the veins. The stomach generally has a thin, partially transparent liquid of a greenish or grayish color. The intestinal canal is, in a majority of cases, partially filled with liquid which has the aspect of turbid serum, more or less mixed with the previous contents of the bowel, if death has taken place very rapidly, but otherwise it is almost colorless. In the more prolonged cases the contents at the upper part of the bowel are less liquid and are darker in color."

The comma bacilli are found in the intestinal contents, especially in the lower part of the small intestine, when death occurs at the height of the disease, and also in the diarrheal discharges; when the discharges become fecal or more solid, the bacilli disappear.

Treatment.—Preservation of bodies dying from this disease should not be considered at all. A thorough embalmment is necessary only as a sanitary measure. Disinfection of the body should be complete—internally as well as externally. First remove all clothing from the body and place it upon the board. Then pour a first=class disinfecting fluid into the mouth and nostrils. Raise an artery and fill the circulation with fluid, forcing in all that can be gotten into it. Then fill the intestinal canal and cavities of the chest and abdomen as full as possible. Soak a sheet in the fluid and wind it around the body, covering every portion. By this treatment the bacilli will be destroyed in a short time, rendering dissemination impossible.

All bodies dying from infectious diseases should be embalmed thoroughly, as directed elsewhere, if interment is to take place, as otherwise the bacteria may get into our water supplies by some means; or necessary disinterment may follow at some future time, greatly endangering a community. The above measures, or cremation, should be enforced by our health boards in these cases.

YELLOW FEVER.

Yellow fever is a specific infectious disease, so named from the yellow color of the skin which appears in the advanced stages of the severe forms of the disease and in the dead body. The infectious germ peculiar to this disease has not yet been determined, although it is supposed to exist in the intestinal contents. It does not originate in country districts, but is peculiarly a disease of dense population. It prevails in cities, on the shores of the ocean, along the large rivers, and on ships. It does not prevail in a hot, dry, nor in a cold, climate.

It matters not how violent the disease may be at any place, yellow fever will be arrested on the morning of a heavy frost or freeze. It seems that a hot, moist temperature is essential to its existence.

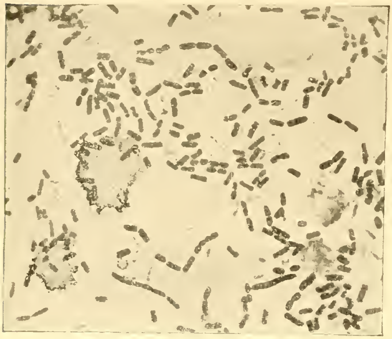


Fig. 52. Bacillus Cadaveris.
Smear preparation from liver of yellow fever cadaver, kept 48 hours in antiseptic wrapping. From a photomicrograph (Sternberg).

In cases dying from yellow fever, the features frequently are bloated; the skin of the face and upper portion of the body is of a golden=yellow color, while the dependent parts present a mottled, purple and yellow, ecchymosed appearance. On section of the muscle a large amount of dark fluid blood escapes, which on exposure becomes bright scarlet. Putrefactive changes may take place early, sometimes appearing to begin before death. However, in some cases, especially in those stricken with the disease while in full muscular vigor, when the disease is severe and rapidly fatal, peculiar muscular phenomena take place, similar to those of cholera.

Dr. Dowler, of New Orleans, reports a case, as follows:—

"Not long after the cessation of respiration the left hand was carried by a regular motion to the throat, and then to the crown of the head; the right arm followed the same route on the right side; the left arm was then carried back to the throat, and thence to the breast, reversing all of its original motions, and finally the right arm did exactly the same things."

All the vital organs and other viscera of the different cavities are affected more or less. The blood is altered in color and consistency. The secretions are changed. Bile is always absent from the intestinal contents. There is extreme congestion of the dependent portions of the lungs.

Treatment.—When death occurs from yellow fever, the body should be embalmed thoroughly, to destroy the contagion. Disinfection of the body should be very complete both internally and externally. After removing the clothing from the body, it should be placed on the board; then fill the mouth, nostrils, and other openings of the body with a strong disinfectant fluid; wash the body with the same; raise an artery at some point and inject sufficient fluid to fill every part of the body; fill the alimentary canal and the thoracic and abdominal cavities. If enough fluid is injected, and the body is treated as directed above, there will be no danger of disseminating the disease. Incineration, however, would be the best method of disposing of bodies dying of the disease. Fire is the best disinfectant; it will positively destroy all germs.

BUBONIC PLAGUE.

Bubonic plague is a specific infectious disease of very great virulence, which runs a very rapid course, and is characterized by adenitis (buboes), carbuncles, and frequently by hemorrhages.

The disease dates from a very early period in the Christian era, about the second century. Between the sixth and seventeenth centuries epidemics of varying severity occurred in Europe. The most disastrous was the famous "black death," which occurred in the fourteenth century. It extended all over Europe and destroyed about one=fourth of the population. During the great plague of London in the seventeenth century (1665), it caused the death of about seventy thousand people. In later years it has been confined almost exclusively to Turkey and Southern Russia.

Recently, interest has been aroused in the disease by its prevalence in Eastern Asia, the South Sea Islands, and India. In September of 1896, in Bombay, it began and developed gradually for about three months, maintaining a great intensity for about three months, and then slowly declined for about the same length of time. In the nine months twenty thousand or more people died. It broke out again in Bombay during 1898, and at the present time is spreading to points near our own country; some cases have developed even in one of our new possessions, Hawaii.

This disease is caused by a specific organism, a bacillus discovered by Kitasato, which has been studied carefully by Versin and by others. The bacillus pestis bubonicæ is found in the blood and in the organs of the body; also in the dust and soil of houses in which the patients have lived. Flies and fleas die from the disease and may convey the infection. Diseased animals, such as rats, mice, and dogs, will convey the plague to healthy ones.

It prevails most frequently throughout the hot season, although it may break out during the coldest of weather. No age is exempt from the disease. It prevails chiefly among the poorer classes, in the slums, and where hygienic conditions are at fault in the great cities. The disease has not the extreme contagiousness of smallpox or scarlet fever, although it may be communicated from one person to another through the air. The virus very readily attaches itself to houses, clothing, and bedding.

To prevent the spread of the disease, general hygienic measures should be carried out. There should be a proper receptacle for sewerage, a pure water supply, the cleansing and disinfection of houses, and the isolation of those who have the disease. Rooms should be disinfected thoroughly by the use of formaldehyde gas, all evacuations of the sick should be mixed with the milk of lime. The bodies of those who die of the disease should be embalmed very thoroughly, and buried; or, better still, cremated.

Treatment.—Bodies dying from this disease should not be buried unless thoroughly embalmed, as the bacteria will live a long time in the earth. Indeed, there is much in favor of the view that the plague is a soil=disease, the virus of which, like that of anthrax and tetanus, resides permanently in the soil of the affected district, so that, if the body were not embalmed and should be disinterred years hence, there would be great danger of disseminating the disease. Embalming for preservation should not be considered at all. These bodies should be embalmed as a sanitary measure only and should be filled thoroughly with a very strong disinfectant fluid. They cannot be shipped under the rules adopted for the transportation of bodies.

TETANUS—LOCKJAW.

Tetanus Neonatorum.

Tetanus is an infectious disease, characterized by tonic spasms of the muscles, with marked exacerbations. The poison is produced by the tetanus bacilli, which are found in earth and in putrefying fluids. Tetanus usually follows a wound; it prevails more extensively in some localities than in others.

Fig. 53. Bacillus Tetani.
From an agar culture, X 1,000. Photomicrograph by Frankel and Pfeiffer.

It seems to be epidemic among new=born children, when it is usually called tetanus neonatorum. It is due, no doubt, to the sloughing off of the umbilical cord, when infected clothing or sponges are used for cleaning.

Tetanus is less frequent in temperate than in hot climates, and in the Caucasian than in the colored race. Tetanus neonatorum, especially, is more frequent among the colored races than in the white.

Tetanus, in a majority of cases, follows an injury which may be of the most trifling character. It is more frequently a result of punctured or contused, than of incised, wounds, and most frequently follows wounds of the hands and feet.

Lesions in the spinal cord or brain are not characteristic. Congestion has been found in different parts of the cord and brain with perivascular exudations and granular changes in the nerve=cells. The condition of the wound varies. If the nerve is injured, it is reddened and swollen. Inflammatory results have been noticed usually in the umbilicus in tetanus neonatorum.

The bacillus that causes the disease—a spore=producing anaerobic—will grow without the presence of oxygen. They multiply, usually in the seat of the wound, where alone the toxic matter is formed. The bacteria do not invade the blood and organs of the body. The poison that is formed in the wound is absorbed and carried throughout the body by the circulation, producing its effects upon the brain, spinal cord, and the nervous system in general.

Treatment.—The treatment of a case dying from tetanus, or tetanus neonatorum, should be the same as for an ordinary case, there being no lesion or morbid material that requires treatment of a special character. The surface may be of a bluish color, cyanosed, due to the extreme muscular contraction, making pressure upon the vessels, even to the extent of mutilating the peripheral veins and capillaries. The body should be placed high on the incline and the blood removed, either by the direct operation on the heart or through one of the veins.

ANTHRAX—SPLENIC FEVER.

Wool-Sorters' Disease—Rag-Pickers' Disease.

Anthrax is an acute infectious disease caused by the bacillus anthrasis. The disease is wide=spread among animals, especially sheep and cattle. In man it is only the result of accidental inoculation with the virus, or it may occur sporadically. In Europe and in Asia it is much more prevalent than in America. Among sheep in certain parts of Europe, and among herds of cattle in Russia and Siberia, its ravages are not equalled by any other plague. It is a rare disease in this country. The disease, no doubt, is conveyed by a direct inoculation in animals, as by the sting or bite of insects, or by feeding upon the carcases of those animals that have died of the disease, or, more commonly, by feeding in pastures in which the germs have been preserved. These may come to the surface, having been propagated in buried carcasses of infected animals, in several ways—the ground may be turned, as in cultivating the field, or the earth=worm may bring the germs to the surface. Certain fields or farms may be infected for a long period of time.

Fig. 54. Bacillus Anthracis. From cellular tissue of inoculated mouse; stained with gentian violet, X 1,000. Photomicrograph by Frankel and Pfeiffer.

The disease in man is always the result of infection, either through the skin and intestines, or, in rare instances, through the lungs. Persons whose occupations bring them into contact with animals, such as shepherds, butchers, and those who work in hair and wool, are the ones usually affected. The diseases known as wool=sorters' and rag=pickers' diseases are produced by anthrax infection, by ulceration, or inoculation in their occupation.

Surgeons sometimes become infected from treating animals having the disease, or from making autopsy on same. The case is reported of Dr. John J. Smith, a veterinary surgeon of Chambersburg, Pennsylvania, who, on August 25, 1899, made an autopsy on some stock which had mysteriously died in a near=by town. The disease was found to be anthrax. Dr. Smith also attended other infected stock, but, being aware of the horrible nature of the disease to man and beast, took proper sanitary precautions. Nevertheless, nine days later, an eruption appeared on his hands, which he at once pronounced anthrax. Physicians were called immediately, who gave every care possible to the case, performing an operation. The victim, however, grew rapidly worse, his body became badly swollen, he fell into an unconscious state, and, on the fifth day, died.

Anthrax, if it is external, usually affects the hands, arms, or face, being produced by inoculation, which occurs through an abrasion. The points of inoculation, during the course of the disease, change considerably, but finally at death, as a rule, the surface is covered with scabs; the glands are swollen; sometimes, in the more malignant form, there is gangrene in the parts, which may have involved a considerable surface. The head and face are involved most frequently in those who die from anthrax, especially affecting the parts which are exposed, producing a very unpleasant appearance.

In internal anthrax, the mucous membrane of the stomach and intestines is affected variously: the spleen is enlarged; the blood is dark and remains fluid for a long time after death; sometimes the anthrax bacilli are found in the blood; sometimes the lungs and pleura are inflamed to a considerable extent.

Treatment.—On account of the deadly nature of anthrax, the embalmer, when called to handle a case of this kind, cannot be too careful, both in its treatment and in taking every precaution possible against becoming infected himself.

The body should be placed on the board on the incline, and, if blood is withdrawn by the direct operation on the heart, or through one of the veins, it should be sterilized thoroughly, by mixing it with a strong disinfectant. An artery should be raised and fluid injected to fill the tissues completely; fluid should then be injected through the alimentary canal in sufficient quantity to sterilize the contents; also, the spleen should be treated by injecting a large amount of fluid around it. The peritoneum should be filled at the same time. As the lungs and pleura are involved frequently, fluid should be injected through the respiratory tract, filling the lungs and tract completely; also, fluid should be injected in the pleural sacs in sufficient quantity to sterilize their contents. A body dying from anthrax should be disinfected very thoroughly, as the germs are very tenacious. The face should be washed carefully with a good disinfecting fluid, and powder and tints be used to give it as near a normal appearance as possible.

SYPHILIS.

Syphilis is a specific infectious disease, communicable by contact of the poison with a breach of the surface, or by hereditary transmission. Syphilis is characterized by a period of incubation and (except in cases of inheritance) by certain changes in the seat of infection, and in the proximate lymphatic glands. These are followed by eruptions on the skin and mucous membrane, and sometimes by lesions of the deeper tissues and viscera. Frequently burrowing abscesses, involving much tissue, are found in the peritoneum, groins, neck, and other parts of the body. Septicemia may be the cause of death. The visceral organs may become a putrid mass. The sources of infection are very numerous. Whenever the poison comes in contact with a broken surface, it may be absorbed and general infection follow.

Instances of syphilis being conveyed quite independently of sexual relations are very common. The disease may spread by kissing, infectious syphilitic lesions being quite common around the lips and in the mouth. Medical men not infrequently contract the disease by examining or operating on syphilitic cases.

Treatment.—In handling a case of syphilis, the hands should be covered by some tenacious disinfecting salve. A preparation known as "hand protector" is a very good one. It should be rubbed over the hands and under the finger nails; or rubber gloves should be worn over the hands, to prevent the matter from ulcerated glands and chancres entering any abrasion that might be in the skin. Ulcers should be washed out with fluid and covered with "hardening compound," or some similar preparation. The arteries should be raised and fluid injected to fill every part of the body. The cavities should then be treated in the usual manner. The external openings of the body, especially the mouth and nose, should be filled with fluid, and pledgets of absorbent cotton, soaked in fluid, should be introduced into the nostrils and the mouth.

SYPHILITIC DISEASE OF THE LUNGS.

In syphilitic disease of the lungs much uncertainty exists as to the effects which may be produced in connection with the lungs, but there is no doubt that specific lesions in these organs occur, occasionally at least, though they may be less frequent than in any other viscus. They are met with, usually, in advanced cases of acquired syphilis, when the signs of the disease are markedly developed in other parts. The lungs are involved, occasionally, in congenital syphilis. A predisposition to syphilitic disease is supposed to occur in tubercular or scrofulous diathesis. Gummata constitute the most certain and unquestionable lesions of syphilis of the lungs, but they are rare. They vary in number from one to many. In the latter case they are disseminated throughout the entire lung, but have a predilection for the deeper parts of the organ.

These growths usually vary in size from a pea to a walnut, but they may reach much larger dimensions. They are rounded in shape and generally well defined, and found surrounded with a fibrous capsule. In the earlier stages, gummata in the lungs appear on section grayish or brownish=red, firm and dry in consistence; but later on, they tend to degenerate and become more or less gaseous and less consistent, and they may even break down in the center so as to form cavities. The disease may involve, in a chronic form, the interstitial or connective tissue, resulting in fibroid infiltra tion of the pulmonary tissue. The affected parts are much indurated, and the bronchi in the region which is involved become more or less dilated.

Various parts of the lungs may be affected, but the disease appears to have a preference for the base and roots of the lungs. The fibroid infiltration may become the seat of ulceration or gangrene. One lung may be affected throughout, while the other is quite free from disease. The lung that is involved may be enlarged, even to the extent that its surface is marked by the ribs. On section, it presents a white or yellowish color, being more or less bloodless, and little or no fluid can be pressed from the surface. Careful examination reveals minute bands of fibrous tissue running in all directions. Microscopic examination reveals a thickening of the walls of the minute bronchioles, due to the fibrilated tissue, which undergoes degenerative changes. The vessels also become thicker, and ultimately obliterated, destroying the channels through which the blood reaches the lungs, and also destroying the means of injecting fluid into the diseased tissue. Even the bronchial tubes or their subdivisions may be affected by syphilitic disease, their submucous tissue, and occasionally their deep structure, becoming involved. Ulceration may take place, followed by cicatrization, and lead to the thickening of their walls, narrowing or completely closing these channels.

Treatment.—In cases of this kind, we may expect to find other organs affected. If the liver, spleen, pancreas, kidneys, and other organs of the abdomen are involved, direct operations upon them should be resorted to in the embalming of a subject dying from syphilitic disorders, especially where the disease has been extremely chronic. In the lungs, the bronchial and other arteries are obliterated, or partially destroyed, and in some cases the bronchial tubes are closed, so that it will require the introduction of the hollow=needle into the diseased substance to fill the mass with fluid. Putrefaction may take place in the tissue, on account of the absence of fluid, resulting from occlusion of the vessels through which fluid is usually carried to the lungs.

In handling these cases, if there are any abrasions or minute cuts upon the hands of the operator, they should be covered with gloves or an antiseptic paste, sufficiently tenacious to cover and fill the abrasions, should be used, so that inoculation cannot take place. Carelessness in this respect has been the cause frequently of inoculation. Not only may the disease be contracted in this manner, but the absorption of the poison may produce blood poisoning of the severest type

CHAPTER XXIX.

DISEASES AFFECTING THE BLOOD.

SEPTICEMIA—BLOOD POISON.

Septicemia usually follows injuries, surgical operations, childbirth, carbuncles, burns, scalds, dissection wounds, etc. The morbid conditions resulting from septicemia recently have been studied very carefully, and the characteristic lesions have been found, particularly in the blood and in the alimentary canal. The rapid putrefaction of the body after death is the most prominent manifestation of the disease. Rigor mortis comes on and passes off almost instantly. Indeed, sometimes it can scarcely be detected. Usually the embalmer is not called in until a period of time has elapsed after death, and, even if he were present, rigor mortis would be so slight and of such short duration that it would escape his notice entirely.

Davaine has defined septicemia to be the "putrefaction of the living body," because, in many cases, putrefaction is going on in the neighborhood of the wound prior to death.

When septicemia originates in an external wound, putrefaction goes on rapidly, in the vicinity of the wound, after death occurs. The blood does not coagulate; only a few imperfect, deep=black=colored clots are found after death; the presence of this blood in the soft tissues greatly hastens putrefaction. Generally putrefaction goes on most rapidly in the dependent portions of the body and along the course of the large veins, especially those filled with blood.

Watson says:—

"It has also been observed that putrefaction in the human cadaver begins much sooner and progresses much more rapidly under similar circumstances when the death has been produced by this disease than when it has occurred from any other cause."

"Furthermore, this rapid decomposition is not limited to the internal organs, but may frequently be strongly marked on the surface of the body after a lapse of a few hours."

Blood taken from such a body usually is acid in its reaction, and always gives off a peculiar, putrefactive odor. In the study of the blood with the microscope, it has been shown that the blood, as well as the various organs of the body dying from this disease, contains a great number of the rod=bacteria. These bacteria are in every part of the body, being carried there by the blood.

Cases dying of septicemia are very hard to preserve. Indeed, we have known cases dying several days after parturition to decompose very extensively within the period of twelve hours, the body swelling to its greatest distention, the features being almost entirely obliterated, the neck swelling out even with the face, and the putrefactive odor filling the apartment, indicating that putrefaction had progressed to a very great degree.

The blood is not in the same condition in all cases of blood poisoning. In one case the blood is found, under microscopic examination, to be perfectly normal, while in another, it is filled with rod=bacteria. In the former cases, abscesses may be found in all the tissues of the body, especially in the lungs, pleural membranes, and other soft tissues.

Treatment.—It is highly important, in these cases, to remove at once all of the blood, or as much of it as is possible. It is better to raise the femoral vein for this purpose. Place the body on an incline, having an assistant raise the arms to cause the blood to descend to the lower part of the body. Open the vein and introduce and tie the vein=tube, which should be long enough to reach above Poupart's ligament as far as the common iliac vein, the outer end being directed into a conveniently=placed receptacle. Then raise the artery and insert the arterial=tube in the usual manner and begin the injection of fluid. The blood, being very thin, will drain out through the tube without the aid of the pump, gravity being sufficient. Inject the fluid slowly and carefully, while the blood is running, continuing the injection until the arteries and capillaries are filled, or until the embalming fluid appears at the outer end of the vein=tube. Then remove the gas that may have formed within the thoracic and abdominal cavities, and fill them, including the alimentary canal, with fluid. The arterial=tube should be capped and left tied in the artery, so that in due time more fluid may be injected.

Many of the fluids that are used for embalming purposes have a tendency, after so large an amount has been injected into the tissues, to change or discolor the skin. Even if it is known that such a discoloration will take place, it is far better to discolor the surface than to allow putrefaction to continue.

PYEMIA.

Pyemia is caused by the entrance of septic products into the blood, and is characterized by clots or emboli, and the consequent occurrence therein of patches of congestion, inflammation, suppuration, or gangrene. It is caused, usually, by some one of the following conditions: injuries, surgical operations, burns, scalds, carbuncles, dissection wounds, puerpural fever, etc.

The external appearance of the body after death varies greatly. In some cases the skin will be found to be of a dark=orange or icteric tinge, and in other cases it will be pale or anemic in appearance. Sometimes, black or yellow spots, produced by the effusion of blood into the areolar or fat tissue, exist on the surface of the body, and the edges of the wounds are generally of a dull=yellow color. Great emaciation follows a long continuance of the disease. Rigor mortis usually is well marked and will last for some hours. In the cellular tissue there is diffuse suppuration, forming a thin and unhealthy pus, which is liable to burrow. Sometimes suppuration takes place beneath the fascia of the tendons and muscles. In fact, suppuration or gangrene may be found in any part of the body, but most frequently the lungs and pleuræ are involved. The pleural cavities may contain a large amount of purulent matter, and large abscesses may be found in the lungs, and even gangrene may be present. Abscesses may be found in the liver, kidneys, and spleen. Pus will be found frequently on the surface, and in the Haversian canals of the bones; it also forms, at times, in the joints. Pyemic blood is usually normal, but it may contain the rod=bacteria; in the latter case the disease might be termed septopyemia.

Treatment.—In cases where the blood does not contain the rod=bacteria, putrefaction will not follow as quickly as in septicemia, but the treatment must be just as thorough, because, when rigor mortis passes off, putrefaction will be very rapid. In those cases where rod=bacteria are found in the blood, and the blood has that peculiar, putrefactive smell, the treatment should be heroic, and should follow as soon after death as possible. This is best done by raising the femoral vein and artery, which can be done through the same incision. Fluid can be injected through the femoral artery, and, the femoral vein being the most dependent, more blood can be withdrawn through it than through any other. A short vein=tube, sufficiently long to pass beyond Poupart's ligament as far as the common iliac, is all that is needed. It should be introduced into the vein and tied, directing the outer end into a vessel. The blood in these cases is as thin as water and will escape without the use of the atmospheric pump, gravity being sufficient. The injection of fluid can be begun at once. Enough fluid should be injected to fill every tissue of the body. The introduction of fluid will cause the blood to flow more freely by making pressure upon the capillaries and smaller veins and the peripheral portions of the circulation.

It will be well to inject enough fluid to make the entire circuit of the circulation. Fill the alimentary canal with fluid; also the peritoneal, pleural, and pericardial sacs. Enough fluid should be injected through the trachea to reach the abscesses within the lungs. Before proceeding to inject the body, remove all gases from the several cavities; in some cases it will be well to pump out and refill the cavities. Occasionally a second injection of the arterial system, may be necessary.

ERYSIPELAS.

Erysipelas is an inflammation of the skin, caused by the presence of a specific micrococcus. It is characterized by redness, swelling, and pain. It spreads over a large portion of the skin from the points of its origin. There are two varieties commonly recognized—the idiopathic and the traumatic. The latter follows a wound of the skin. It is known as a surgical disease, and usually is treated of in surgical works under the head of traumatic erysipelas. Puerperal erysipelas—that which follows childbirth—results from the injuries to the female genital organs during parturition. Erysipelas sometimes occurs in a new=born infant, having its origin in the navel or in the small anal fissures.

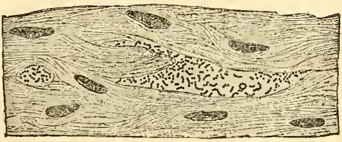


Fig. 55.

Section from margin of an erysipelatous inflammation showing streptococci, in lymph spaces, X 900. From a photograph by Koch.

The so=called idiopathic erysipelas appears almost exclusively in the face, or at least spreads from that point. It frequently extends to the scalp and the trunk, covering a large portion of the surface. It is supposed that idiopathic erysipelas is different from the traumatic variety, but it is a question whether or not it is essentially so. There are good reasons for supposing that idiopathic erysipelas is really traumatic in every case, the origin of which is due to injuries to the skin or mucous membrane, which may be overlooked on account of their small size. For example, we see cases, and many of them, in which erysipelas takes its origin in the excoriations on the borders of the nostrils, or on the nose, or in the fissure of the lobe of the ear; and quite frequently coryza precedes erysipelas, in which case, the first inflammatory swelling of the skin is at the nose. Probably nasal catarrh causes slight abrasions of the mucous membrane, and these furnish a point for the entrance of the infectious bacteria.

Such cases suggest the possibility that the infection may take place in some other manner than that mentioned above. Fehliesen has demonstrated the characteristic chain=forming micrococcus in the lymphatic vessels of the serous canaliculi, of the diseased portion of the skin. This micrococcus is distinguished by its peculiar behavior in pure gelatin cultures, and invariably causes erysipelas in rabbits and human beings that are inoculated with it.

In some cases the subcutaneous, connective tissue is involved as well as the skin, causing suppuration of the areolar tissue. It is soft and boggy and in a state of moist gangrene. Even the deep parts of the connective tissue, as of the pelvis and mediastinal tissue, may be involved. The disease may have extended to the mucous membrane of the fauces, uvula, and bronchi or lungs, which may slough off, and death may be caused by edema of the glottis, by asphyxia, or by the development of pyemia.

Treatment.—Traumatic erysipelas is considered peculiarly contagious. Persons handling these cases should be careful to disinfect themselves thoroughly, cleansing the nails, hair, whiskers, and exposed surfaces, before visiting living cases upon which surgical operations have recently been performed, or women in childbirth. Gloves should be worn, or some antiseptic should be used, to prevent the absorption of the poison through the erosions or small abrasions on the hands. Indeed great care should be taken in the handling of these cases, as the poisonous matter is absorbed easily, and may result in blood=poisoning or erysipelas, which is very dangerous.

The body should be injected carefully through the arterial system and the cavities should be well filled. The gangrenous portions should be washed thoroughly with hot water, followed by application of a strong disinfecting or dessicating powder, which, if properly made, will thoroughly disinfect the external parts, and will also dry and harden them, leaving no odor. If the face and other surfaces that are exposed to view have been involved in the disease, there is no way to make them look natural. A little powder and the different pigments, judiciously used, may be beneficial, and add to the appearance.

The body should remain in the room, if possible, until fumigation of the apartment has been effected. Sulphur fumes or formaldehyde gas should be used for the disinfection of the room. First, close and seal all the windows and doors, making the room practically air=tight; then follow the directions given for fumigating rooms.

PURPURA.

Purpura is a disease in which circumscribed effusions of blood take place in the soft layer of the skin and connective tissue, due to rupture of the capillaries of the inner layer. Hemorrhages of this character have been seen as early as the third day after birth and at all periods of life. Women seem to be attacked more frequently than men. They may accompany the most various diseases of the general system. They are observed frequently in Bright's disease and in valvular disease of the heart. They occur in phthisis, acute rheumatism, cirrhosis of the liver, leukemia, and in many other diseases. They have been seen to follow severe frights; also sudden destruction of the peripheral vessels, as in severe coughing and epilepsy. Purpuric spots may follow the use of chloral in excessive doses, or of iodid of potassium in specially susceptible individuals.

The rete mucosum and the papillary layer of the cutis are the chief seat of the hemorrhage in purpura. Owing to the rupture of the capillaries over a small area, the blood finds its way into the meshes of the connective tissue and fills the interspaces between the hair=follicles and the ducts which traverse these parts; also, it finds its way into the network of the soft layer. Absorption of the serum takes place, and changes occur also in the coloring matter, which is set free from the red=corpuscles, producing various tints of blue, green, and yellow, until, if life continues, it is completely absorbed; if death takes place at this stage, these tints will remain in the skin.

Very large extravasations of the blood may result in a long=continued or even permanent discoloration of the spot. Similar effusions to those in the skin are found internally, in the the severer cases, beneath the mucous membranes of the canals; but in these parts they are not seen after death and their presence will make no difference to the embalmer. If a post=mortem examination is held, extensive extravasations will be seen in the pleural, pericardial, and peritoneal sacs, and sometimes in the arachnoid membrane of the brain. They will occur also in the muscles, in the periosteum, and even in the bones, as well as beneath the conjunctiva and in the retina.

Purpura seems to depend on an alteration in the nutrition of the coats of the blood=vessels, which results in weakness and their inability to stand the strain of arterial pressure, so that they rupture; or, on alterations in the blood itself; or, on both causes combined. These spots are seen, most frequently, on the feet and legs and on other dependent parts, such as the back of the patient, if he has been in a recumbent position, or where arterial pressure is intensified by gravity.

Embolism and thrombosis have been suggested as an explanation of some cases. These discolorations consist of isolated spots, whose color varies from bright=red to a livid or dark=purplish=red; if the red corpuscles have been reduced and the hemoglobin eliminated, it will change in time, producing tints, according to which is present at the time of death; it may appear blue, green, or yellow. These spots do not disappear on pressure. Their shape is generally round or triangular and their edge is always uneven or denticulated. Their size varies usually from that of a pin head to that of a pea or bean, and in some cases they may be as much as several inches in circumference. The smallest spots, not larger than a finger nail, are termed petechiæ; the larger, ecchymoses. The spots are usually level with the skin.

Treatment.—Very rarely the epidermis (cuticle) is raised in the form of a bulla, containing serum and blood=corpuscles. When these spots appear, as stated above, they cannot be removed. The blood having passed into the tissues outside of the walls of the capillaries, and the pigment being of a permanent color, there is nothing that will affect them unless it be injecting directly through the hypodermic needle into the spots. This, no doubt, will modify the discoloration to a certain extent, if it does not remove it altogether. Bleachers placed upon the outside can do no good, as the chemicals will not pass into the coloring=matter which produces the spot. The flesh tints artistically used will cover these extravasations. In the general treatment of the case, the disease causing death will have to be considered.

LEUKEMIA.

This is a disease in which there is a decrease of the red corpuscles in the blood, while the white corpuscles are increased correspondingly in number. In health and in normal blood, the proportion of white to red corpuscles is about 1 to 666, but in this disease the white corpuscles are so increased that the surface becomes almost entirely white. A pale or anemic color will appear in the face, hands, and other exposed parts. Its characteristics are well=marked in most cases. The blood=changes are associated with marked changes in the spleen, bone=marrow, and lymphatic glands. The organs just enumerated, being concerned in the manufacture of blood, it is very reasonable to suppose that leukemia is a disease which primarily affects them, and that an increase in the white corpuscles results from derangement of their normal condition.

The cause of this disease is not known. It is supposed by some authors to be some specific affection, but they have not been able, thus far, to prove the truth of their surmise. Even an exciting cause can be discovered in only a few cases. The disease develops spontaneously in perfectly healthy persons. It is a disease of middle life, say between the ages of thirty=five and forty=five years. Occasionally well=marked cases have been observed even in childhood, but less frequently in old age. Men are much more liable to the disease than women.

There is usually extreme wasting of the body, and sometimes dropsy is present. The heart and veins are distended with large blood=clots. The portal, cerebral, pulmonary, and subcutaneous veins may be remarkably distended. There is usually a clotted condition of the blood, and an enormous increase of the white corpuscles, giving a paste=like appearance to these blood=clots, so that on opening the vessels at the right side of the heart, the clots are very often mistaken for the contents of abscesses.

These coagula have a dark=greenish color, resembling somewhat the fat of a turtle. There is diminished alkalinity of the blood, but the fibrin is increased. The lesions of the bone=marrow are the next in frequency to those of the spleen. In the majority of cases the marrow presents a peculiar yellowish or puriform appearance, resembling the consistent matter which forms the core of an abscess or it may be dark in color. There may be hemorrhagic infractions. The shell of the bone may be extended considerably, and localized swellings, which are tender and yield to firm pressure, are found. The spleen may attain the size of from six to eight pounds, and the length of a foot. Strong adhesions may unite it to the abdominal wall, the diaphragm, or the stomach. The capsule may be thickened and the organ be in a condition of chronic hyperplasia. The swollen spleen pulp may be soft, and even rupture may occur from the intense hyperemia, filling the abdomen with blood. The lymphatic glands are enlarged, sometimes in conjunction with splenic enlargement; or they may be enlarged and the spleen remain normal. The cervical, axillary, mesenteric, and inguinal groups of glands may be very much enlarged, but they are usually soft, isolated, and movable. The tonsils and the lymphatic follicles of the pharynx and mouth may be enlarged, also.

In these cases there is always present asthenia and anemia. The bodies are usually very thin, indeed. On observing the body, it might be supposed that nothing remained but "skin and bones"; it is true there is not much else but the diseased tissues.

Treatment.—If the blood does not pass immediately into the venous side, but remains a little while in the arteries, coagulation will take place, forming occlusions, when it will be impossible to inject fluid into tissues through the arterial system. On this account, cases of this kind should be embalmed as quickly as possible after death. If the arteries are full, open them and allow the blood to escape. Insert the small trocar into the left ventricle of the heart, keeping in mind the heart's exact position; pierce it, and inject a ten per cent. solution of salt water, say one to two ounces. This will produce enough irritation to bring about post=mortem contraction of the involuntary muscular substance of the circulation.

We have found this operation to work admirably in two cases. Of course, that is not a sufficient number of cases to determine positively its practicability, but it is worthy of a trial, as the retension of blood in the left side of the heart and arteries for a period of time, say from two to three hours, will result undoubtedly in the coagulation of the blood, which will positively close up the channels through which the capillaries and all the tissues of the body are filled. If the spleen is enlarged to any considerable extent, it can be detected easily by palpation. If it is enlarged, it is possible that blood is coagulated within, and fluid will not be received by the spleen through the splenic artery. In that case, fluid should be injected into the organ directly through the hollow=needle. Inject fluid into the cavities and fill the arteries thoroughly in the usual manner, using sufficient fluid to fill the body.

PUERPERAL OR CHILDBED FEVER.

Puerperal fever is an acute infectious disease, due to the septic inoculation of wounds, resulting from childbirth. Pathogenic bacteria are always present. The head of the child, in its descent through the soft parts, produces abrasions in the parts, in many cases, especially through the contracted bony outlet. Sometimes, as a result of inertia of the womb, or a slight or incomplete dilatation of the parts, they remain firm and hard, and instruments are used to aid the delivery of the child. Whether in the hands of an expert, or of a mere tyro, the parts may be ruptured on account of pressure. Skill renders these accidents more infrequent, but it cannot always prevent them. The pathogenic bacteria get into the mutilated surfaces from some source, and are there absorbed by the circulation, and deposited in the different tissues of the body, especially in the peritoneum and the serous membranes. When deposited in the peritoneum, inflammation follows, and the morbid changes that take place are precisely the same as those which attend the inflammation of other serous membranes.

The exudation from the surface of the peritoneum, when inflammation is present, may form a false=membrane, from one=fourth to one=half inch in thickness. More or less fluid matter will be found in the cavity of the peritoneum. In many cases there will be more or less suppuration. When the exudation is purulent, it will be either thin and greenish=yellow in color, or opaque=white and creamy. If the material is putrid, it is of a grayish=green color, quite thin, and has a putrefactive odor. Pus or abscesses are found in the lungs and other organs, and in the serous membranes, such as the pleuræ, pericardium, arachnoid, etc. The septic matter may be taken up by the blood and carried to all parts of the body, resulting in septicemia, or blood poisoning, which may cause death. Rigor mortis is never marked, usually coming on and passing off within an hour; or it may be instantaneous. The blood may have a putrefactive odor, and be very thin, with here and there small, very dark or black coagula. Putrefaction follows very rapidly, especially in the lower or under surfaces of the body, and along the large veins.

Treatment.—These cases give more trouble to the embalmer than any other, and must be treated very thoroughly. Nothing must be left undone that will assist in the preservation of the body. The amount of morbid material found within the peritoneal cavity varies from one to many pints. In many cases, a great deal of gas accumulates within the different serous cavities, and should be removed at once. The morbid material should be pumped out, and these cavities filled with fluid. The femoral artery and vein should be raised for the purpose of injecting fluid and withdrawing blood. Raise the vein and insert a drainage=tube, placing the body well on the incline. Raise the arms above the head and allow the blood to escape, aided by the force of gravity. Then begin the injection of fluid through the artery. Fill the arterial system thoroughly, injecting sufficient fluid to fill all the tissues.

These cases require a large amount of fluid. Enough should be injected to swell the surface. If possible, cause the fluid to make the whole circuit of the circulation, continuing the injection until the fluid appears at the opening of the femoral vein. Then remove the tube and close the artery, vein, and incision.

Remove as much of the effusions as possible from the serous cavities. The fluid that is first injected dissolves or dilutes the semisolid or thick matter, and much of this diluted material can be aspirated with the fluid. Then the cavities should be refilled thoroughly, putting in a large amount of the fluid, say several quarts. Fluid should not be saved in these cases; a liberal amount should always be used.

A female assistant should fill the vagina with a tampon of absorbent cotton, which has been filled thoroughly with fluid.

The body should be washed with a strong disinfectant, and fluid should be injected into the external openings.

PERITONITIS.

Acute, general peritonitis is an acute inflammation of the peritoneum. It may be primary or secondary. That is, the peritoneum may be attacked primarily, or it may result secondarily from some other disease, such as inflammation or extensive ulcerations of the stomach or intestines, cancer, suppurative inflammations of the spleen, liver, pancreas, or the pelvic viscera. Perforation of the peritoneum occurs frequently and is followed by inflammation. It may result from external wounds, ulceration of the stomach, intestines, or gall=bladder, abscess of the liver, spleen, or kidneys, appendicitis, or inflammation of the ovaries.

When the abdomen in a recent case of peritonitis is opened, the coils of the intestines are found distended and glued together by lymph, and the peritoneum appears to be congested in patches and sometimes over the whole surface. Sometimes, there will be but little effusion present—only a thick exulation upon the walls. Then again, the intestinal coils will be covered with lymph, and there will be present a large amount of yellowish, sero=fibrinous liquid. If the stomach or intestines be perforated, food and fecal matter may be mixed with the effused fluid.

When purulent, the exudation is either thin and greenish=yellow in color, or opaque=white and creamy; if the material is putrid, the exudate is grayish=green in color, thin, and has a putrid odor. This usually results from perforative or puerperal peritonitis. If blood is present, it results in cases caused by wounds, cancer, or tubercle. The amount of effusion into the peritoneal cavity varies from one to several pints. These different conditions are produced by some of the various species of micro=organisms.

Acute inflammation of the small intestine and colon, obstruction of the bowels, and other diseases, may be mistaken for peritonitis, as their symptoms are similar. Such being the case, the physician's certificate may be misleading.

Treatment.—In cases of peritonitis, the other serous membranes usually are involved. The serous sacs in the thoracic cavity—the pleuræ and pericardium—will be found to have a greater or less amount of effusion within them, which, with the abnormal matter in the peritoneum, produce a condition that will require very thorough treatment. The amount of effusion within these several cavities will vary in quantity. Gas accumulates also very rapidly and should be removed at once with the morbid material. After removing the gas and effusions, the cavities should be filled with fluid.

The blood should then be withdrawn and the arterial system injected with sufficient fluid to fill the body very thoroughly. The femoral artery and vein are preferable for the purpose, as, the femoral vein being more dependent, a greater amount of blood can be withdrawn than from any other point. A vein=tube long enough to reach above the valves beyond Poupart's ligament, and allowing the outer end to reach a vessel for the purpose of receiving the blood, should be inserted. The arterial=tube should be introduced into the artery and fluid injected, which will aid gravity in the removal of the blood. After the arterial injection, the fluid should be withdrawn from the cavities and fresh fluid injected. A large amount of fluid should be injected in these cases, as bacteria are found frequently in the blood, which indicates that the germs are in every tissue after death. After the operation, the body should be placed on the level, with the head slightly elevated.

CHAPTER XXX.

DISEASES OF THE AIR-PASSAGES AND CHEST.

PNEUMONIA—LUNG FEVER.

Acute or Croupous Pneumonia—Pneumonitis.

Pneumonia and pneumonitis are the technical terms, and lung fever the common term, used to indicate the same disease. Pneumonia is an acute infectious disease, produced by the diplococcus pneumoniæ, which prevails in all cold climates and attacks all ages.

To understand its morbid anatomy, the student should study the anatomy of the lung. He should remember that there are two circulations through the lungs, the pulmonary and the nutrient. The pulmonary circulation carries the blood from the right side of the heart, through the pulmonary artery and its many subdivisions, to the air-cells, where it gives off carbonic acid gas and receives oxygen from the air. It is then taken up by the pulmonary veins and carried to the left side of the heart.

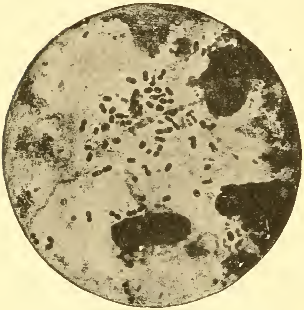


Fig. 56. Microccus Pneumoniæ Crouposæ,
In sputum of a patient with pneumonia, X 1000. From photomicrograph by Frankel and Pfeiffer.

The nutrient (bronchial) arteries are branches of the thoracic aorta, and carry the arterial blood to the lungs, for the purpose of nourishing the lung tissue. The waste is taken up through the general system of capillaries and carried back to the general circulation by the bronchial veins. It is through the bronchial arteries that fluid is carried to the lungs in arterial embalming; no fluid enters the lungs through the pulmonary circulation. The blood=vessels and bronchi, with the connective tissue and lymphatics, form the bulk of the lungs. These tissues are elastic. The walls of the bronchi and air=cells are also elastic, and will admit of much dilatation. The whole are bound together closely by a strong, elastic, fibrous covering.

In pneumonia there is inflammation of the walls, or mucous membrane, lining the bronchial tubes. Mucous of a darkish=red color is thrown off in abundance, forming the prune=juice sputum, which is coughed up by the patient suffering with the disease. This takes place during the stage of engorgement, which occurs early in the disease. In this stage the lungs are engorged; the blood=vessels are filled to a certain extent in both circulations. The lobe or lobes of the lung that are involved will be enlarged, although, if death occurs in this stage, that part of the lung will be found to contain more or less air. Indeed, if a piece be cut from it and thrown into the water, it will float.

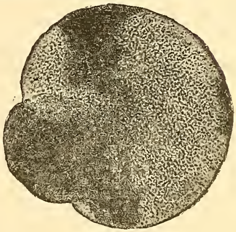


Fig. 57.
Single colony of micrococcus pneumoniæ crouposæ upon agar plate 24 hours old. X 100. (Frankel and Pfeiffer.)

If death occurs later in the disease, say during the second or third week, the condition of the lung will be quite different. This is the stage known as red hepatization. The lung involved will appear like the substance of the liver. It will be perfectly solid, and red in color, showing that the vessels are filled with blood. The parts will be very much enlarged, and will fill the side or cavity or cavity of the chest, pressing upon the outer walls sufficiently to bulge the intercostal muscles. If the diseased portion is taken from the cavity, the outer surface will have indentations of the ribs upon it. No air will be found in the diseased part. If a portion be cut from it and thrown into the water, it will sink like lead. The part of the lung not involved, will be filled with a frothy substance. If a large portion of the lung is involved, there is likely to be purging of a bloody, frothy material, a few hours after death.

Still later, the stage of gray hepatization comes on; the lung is solid and has a gray appearance. If the lung is cut through, the knife turned edgewise, and the surface scaped, there will be purulent matter on the edge. Sometimes the lung will be softened, and only a large pouch or bag of pus will be found.

Treatment.—If death has occurred during the first or engorgement stage, the arteries should be filled thoroughly, the cavities treated as usual, and fluid injected into the lungs through the trachea and bronchial tubes. Usually such treatment will be sufficient to preserve the case.

If, however, death occurs during the second stage, known as red hepatization, it is necessary to embalm the body very thoroughly, filling the tissues through the arteries, the lungs through the trachea, and filling the cavities in the usual manner. This may be all that is necessary, but in some cases, as where a large amount of the lung is involved, and the weather is warm, purging will result in from twenty=four to thirty=six hours after death. When such is the case, the body may be turned over, and as much of the matter pressed out through the respiratory tract as possible, and the lungs filled again through the trachea.

If the case is an obstinate one, the purging will return in a very short period. To inject fluid again through the trachea will not remedy the case. Some have advised to close or tie the trachea, but such operations are impracticable. If the trachea is tied or closed, gas will be formed, and it must have an outlet. If it cannot pass out through the trachea, which is the natural outlet, it will pass through the tissues, get into the cellular tissue beneath the skin, and swell the neck, face, and body. To close the respiratory tract at any point will give this result; therefore, it is necessary to resort to other means.

The diseased portion of the lung should be mutilated by the introduction of a scalpel or sharp=pointed bistoury, through the front wall of the chest, severing the bronchial tubes which lead directly to the trachea. After a thorough mutilation of the diseased part, inject fluid into the lung through the hollow=needle, which should be inserted at the point from which the mutilation was performed. The general embalmment will have taken place some hours before; consequently, if the circulation is ruptured, no harm will result.

Gases are produced within the lung by putrefaction. The putrefactive bacteria get into the diseased portion of the lung, which is so solid that it will be impossible to receive the fluid; therefore, there is nothing to prevent their growth, and to cause a liquefaction of the lung, in spite of all the fluid that can be put into it through the respiratory tract. Indeed, if much of the lung is involved, there will be little fluid received in that manner, and what is received will settle to the posterior part. The bacteria will grow rapidly, and putrefaction of the whole body will follow. As a last resort, mutilate and inject the lung as above directed.

When death takes place during the third stage, or stage of grey hepatization, it is necessary to pump out the softened contents of the lungs, or pus, and fill the cavity within the lung with fluid. Otherwise, treat the body as directed when death has resulted during the first stage.

GANGRENE OF THE LUNGS.

Upon post=mortem examination, in cases of gangrene of the lungs, the morbid changes will consist of a cavity, irregular in outline, with ragged walls, sometimes containing loose fragments of lung tissue, or a dirty=greenish or brownish mass of material, with the regular gangrene odor. The cavity is usually in the middle or lower lobe of the right lung.

Treatment.—In the treatment of a case of this kind, fluid should be injected into the lungs through the respiratory tract, filling the diseased parts thoroughly. An artery should be raised and fluid injected, and the cavities should be filled in the usual manner.

PLEURISY—PLEURITIS.
Inflammation of the Pleura.

Pleurisy is defined as an inflammation of the pleura, of whatever nature or extent. The causes of pleurisy may be local, as wounds or bruises of the chest wall; fracture of the ribs; caries of the spine; escape of irritating matter into the pleural cavity, as from the lungs in tuberculosis, or from the bronchial glands, or through the sides of the abdomen, as in gall=stones, or abscesses which perforate the diaphragm, etc.

The general or systemic causes of pleurisy are very obscure. It may follow a chill; or, it may occur in a rheumatic or gouty habit; or the bacteria, which frequently cause inflammation of the other serous sacs, may find their way into the pleurae. It is frequent as a complication of other diseases; it always accompanies acute pneumonia; it often follows scarlatina and accompanying diseases of the kidneys; it arises sometimes after measles, which is possibly due to the inflammation of the lungs, which so frequently results from measles; it may be caused by rupture of pyemic abscesses; it also accompanies tuberculosis, following each new invasion of the lung tissue involved.

Acute pleurisy, when idiopathic, is more often on the left side than on the right; it is rarely bilateral (both sides). When due to acute rheumatism or nephritis, it is generally bilateral.

Acute pleurisy is common at all ages. It is found sometimes in the first six months of life. In these little ones, it is often overlooked, unless there is an abundance of effusion. Very often it is not noticed even then. At the age of five it is frequent, but at middle life it reaches its maximum of frequency. The younger the child, the more readily the effusion becomes purulent, and, in such cases, the inflammation often extends, before death, to the pericardium. Cases of pleurisy are known to have existed in persons beyond three score years of age, but, as a rule, it is very rare in an aged person. The male is affected more commonly than the female, owing, no doubt, to exposure to the weather.

Traumatic pleurisy results from the breaking of a rib, or a wound, as from a knife or sword thrust, etc.

The morbid changes that follow pleurisy differ but little from those of inflammation of other serous sacs. Effusions of the serofibrinous and the proliferative kind quickly infiltrate the tissues, and the natural gloss of the membrane gives place to opaqueness. In active cases, the effusion is not very voluminous, but is very rich in fibrin, and a false membrane forms on the pleura and is often of considerable thickness. Its attachment is very tenacious. Some of the loose or adherent, gluey effusion degenerates, forming purulent matter. Clots of fibrin will be found floating freely and abundantly in the effused serum, containing a great abundance of imprisoned cells. In the effused fluid itself, cells are very few in most cases, but, when present in large quantities, purulent transformation is more apt to take place during the course of the disease.

In cases of large effusion in the pleural sacs, the lung is found compressed and often bound down by false membranes extending from the walls of the cavity. In adults, the lung is found usually thrust upward, inward, and backward—that is, in the back of the apex of the cavity. It may be compressed from one=fourth to one=eighth of its normal size. It appears flattened, leathery, bloodless, airless, and will sink in water.

If the effusion has been present for some length of time, complete or partial adhesions, or bands of connective tissue, will have bound the lung into the position it assumes on account of the pressure of the effusion. Pleuritic adhesions are found very commonly after death from other diseases, their origin being unknown or forgotten. On the other hand, false membranes and bands may have become the seat of the degenerative process, and pus, tubercule, and the like may be found in them. The compressed lung will be found in the degenerative stage, with ulcerations and septic changes in the lung tissue.

The pathological changes that are found in every part of the contents of the side of the chest that has been diseased are very extensive. A great amount of purulent matter may exist. The position of the heart and other viscera may be changed, and the chambers of the heart and pulmonary veins may be full of clots. Secondary abscesses may exist in other parts of the body, furnishing a good soil for the development of bacteria.

Treatment.—In the treatment of cases of this kind, it is always necessary to pump out the cavity of the chest, removing from it as much of the effusion as possible. Then fluid should be injected in sufficient quantity to sterilize thoroughly everything that remains. Fluid should be injected through the respiratory tract, as the lung itself may be involved, as is seen in the above discription in certain cases. Fluid should be injected also into the arterial system in sufficient quantity to sterilize the tissues in every part of the body. The abdominal cavity should be treated, always keeping in mind that abscesses may exist in all parts of the peritoneal sac or in the mesenteries. Pleurisy being a very common disease, the effusions are overlooked in the young by the physician; the embalmer should be very careful to examine the pleural sacs and endeavor to pump out as much of the effusion as possible before injecting fluid into them. No trouble should result if these cases are properly treated.

PERICARDITIS.

Inflammation of the Pericardium.

The pericardium (heart sac) is a seromembranous sac, with the visceral layer closely enveloping the heart and roots of the great vessels connected with the heart, while the parietal layer is loosely reflected along the organs, having its external surface intimately united with a dense sheath, which passes outward to the roots of the vessels, and continues below with the attachment of the diaphragm. A serous fluid is thrown out in the interior of this sac, for the purpose of preventing friction during the movement of the heart, while it is expelling the blood.

The morbid anatomy of pericarditis is simple enough, according to Balfour:—

"Very early, pericarditis is rarely seen except as associated with Bright's disease, and then, at first, we have merely vascular injection with a few shreds of lymph visible about the roots of the great vessels. In a few days, the whole surface of the heart may be covered with a fine fibrous layer which may, even at this early stage, have connected together the visceral and parietal payers of the pericardium somewhat firmly. More usually there is some serous exudation mingled with the fibrous matter, which is found covering the pericardium. This serous effusion not infrequently amounts to several pints; it is always turbid from the fibrin suspended in it, and is of a yellowish, greenish, brownish, or reddish color. When, along with any considerable layer of lymph upon the pericardiac surfaces, there is much fluid diffused, the surface of the lymph is covered with shaggy processes floating in the fluid. In a very short time, a fine network of capillaries is developed in the fibrinous exudation, and the rupture of these newly developed capillaries now and then gives rise to what is termed hemorrhagic pericarditis, in which the fluid, and even the solid lymph, is deeply stained with the blood coloring matter."

This also happens when pericarditis is associated with purpura or scurvy. Sometimes layers of coagulated blood are found alternating with layers of unstained lymph. Frequently connective tissue is gradually developed in the fibrinous layers, either locally, giving rise to partial adhesions, which at the base of the heart are more dense, but at the apex are drawn out to fibrinous strings; or the two layers of the pericardium may be united so closely, that they can be separated only by the use of considerable force. Occasionally pus, or the cheesy or calcareous remains of such a deposit, is found encysted between the adhering layers of the pericardium; and it happens sometimes that this calcareous layer envelops the whole heart, which makes it appear as though it had been converted into bone.

True purulent pericarditis, though of rare occurrence under any circumstance, is most frequently fatal, and seems to occur more often in connection with general disease, or accompanying a rupture of local abscess of the liver or lungs into the pericardium. In one case, which was used for demonstration before one of our classes, the stomach was found adhered to the under surface of the diaphragm, and a fistulous canal connected the cavity of the stomach with the pericardium, in the latter of which was found, mixed with the pus, undigested particles of both animal and vegetable matter, which had passed through the fistulous opening from the stomach into the pericardium. These cases are rare, but occur occasionally.

When the sac is filled, more or less, with purulent or abnormal matter from the liver, lungs, or stomach, putrefaction often takes place in these effusions, and causes them to become brownish in color and to have a strong odor. Putrefaction may arise from the entrance of air into the pericardium after an operation by a surgeon, conducted without antiseptic precautions; or it may arise in patients greatly enfeebled by exhaustive disease, without any entrance of air into the pericardium. An exudation which has become ichorous may corrode the pericardium, making it a dirty color.

Putrefaction of the effusions causes the development of various gases within the pericardium, which sometimes will be sufficient to press the lungs up into the apex of the thorax, and crowd the diaphragm well down into the abdominal cavity, making pressure upon the large blood=vessels, forcing the blood upward through the superior vena cava and jugular veins, causing a dark discoloration of the face, head, and neck. In rare cases, the effusion will be so great as to fill the thoracic cavity, making the extreme pressure upon the surrounding tissues. A case is reported by Flint in which ten pints of effused matter were removed from the pericardium.

Treatment.—In the treatment of a case of pericarditis, it is always necessary to examine the pericardium and remove the gas and other contents; also fluid should be injected before the removal of the needle. If blood has been forced into the head, face, and neck, the heart should be tapped after placing the body upon an incline, and all the blood that is possible should be removed. The pericardium can be reached from the same point through which the needle is inserted in the operation of withdrawing blood from the right auricle, by turning the needle downward along the right side of the heart; or it may be reached from the epigastrium. If the pleuræ or lungs are involved in the disease, they should be treated specially; otherwise, the body should be treated in the usual manner, by filling the cavities and the arterial system with plenty of fluid.

HYPOSTATIC CONGESTION OF THE LUNGS.

Hypostatic Pneumonia—Splenization.

Hypostatic congestion of the lungs follow the long-continued fevers and the adynamic states generally. The back part or base of the lung becomes dark in color and engorged with blood and serum, causing extreme solidification in many cases. This is due, in part, to the position assumed by the patient during the disease, but chiefly to the weakened heart action. Indeed, if parts of the involved lung are removed and thrown into the water, they will sink, as in the second stage of pneumonia. In cerebral apoplexy the bases of the lungs become engorged, but not to the extent that they do in the long-continued fevers, the lungs containing more air. In all cases of typhoid fever, and the adynamic fevers in general, if the body has remained for a long time in the same position in a recumbent posture, hypostatic congestion will be a complication and should not be forgotten by the operator.

Treatment.—The treatment consists of the ordinary injection through the arterial system, and the filling of the cavities, with the addition of the injection of fluid through the respiratory tract. If, after a few hours, purging of a bloody, frothy material should result, the body should be turned and pressure made upon the chest and diaphragm to force out the contents as much as possible; then the lungs should be filled again. If purging arises again, and appears to be obstinate, the lungs should be mutilated and fluid injected, as in a case of obstinate purging in pneumonia.

ANEMIA OF THE LUNGS.

Anemia of the lungs means a deficiency of blood in the lungs. It can be general or local. Besides hemorrhage and other causes of general bloodlessness, certain local causes produce anemia of the lungs. In pulmonary vesicular emphysema, and in senile atrophy, destruction of the capillaries is associated with anemia. Partial anemia of the lungs results from embolism of the branches of the bronchial artery supplying the part. The main vessel is rarely ever obstructed by an embolus. Compression or obliteration by the invasion of a malignant growth, or aneurism of the main division, more commonly occurs. Aneurism of the pulmonary artery, or of one of its branches within the lung, usually causes anemia by pressure, or the same may result by an aneurism of the bronchial artery. In extreme anemia, as by death from hemorrhage, the lungs and the bronchial mucous membrane are exceedingly pale from the absence of blood. They are unchanged in all respects, except that they are lighter in weight than normal.

In the general disease known as anemia, the lungs, with the other organs, partake of the general deficiency of red blood. The lungs are of normal weight, but paler and more moist than natural, and are sometimes slightly edematous. The results of pulmonary anemia are atrophy of its texture, as in senile emphysema, and in local deficiency of blood in partial obstruction of a large branch of the bronchial artery. Death, and the sloughing of the area of lung supplied by the bronchial artery, results from complete destruction by embolism, or by an embolus. Hemorrhage, in these cases, occurs from sudden arrest of the circulation through a limited portion of the lung, which gives rise to stress in collateral circulation.

There will be leakage when the arteries are full, at least into the substance of the lung itself, if not from the mouth or nose.

In atrophy of the lungs, there is wasting of the lung tissue from defective nutrition. It may occur in only a small portion, or it may involve the whole lung. The cause of simple atrophy of the lungs, is that general failure of nutrition which is natural to advanced life. Hereditary predisposition may determine an earlier failure of nutritive change in the lungs. Any cause that interferes with the circulation in the parts, will cause atrophy of that part; if it extends to the main vessel supplying nutriment to the lung, the whole lung will be atrophied.

The appearance of an atrophied lung may be seen best in a case of natural or senile atrophy. The lung is small, light, and more or less deeply colored; is drier in texture and less firm and resisting than natural; becomes pitted, on pressure, from want of elasticity; and is capable of being squeezed into a very small space. The air=cells are increased in size, and, if a portion of the lung be inflated and dried, large cells may be seen, evidently resulting from the coalescence of two or more infundibula. Filaments, or remnants of small bronchi, or blood=vessels, may extend across such cells. The pulmonary artery and its branches are diminished in size, and the walls of the bronchial tubes are much thinner than is normal.

When atrophy of the lung is associated with, or the result of, other diseases, as emphysema or forcible collapse, the process is essentially the same, but is combined, in the former case, with an over=stretching of the air=cells, and a thickening, more or less, of the tissue derived from the bronchial walls. In this case, the lung is heavier, and there is more marked fatty degeneration of its fibrous tissue. Atrophy of the lung, too, will follow from long=continued pressure of fluid in the pleura. The pleura is always thickened from the original inflammation, and the fibrous processes are directed inward from it between the lobules, so that expansion of the lung is rendered difficult.

Treatment.—In either of the above cases the bronchial, or nutritive circulation of the lung is destroyed to a greater or less extent, so that when fluid is injected into the arterial system it will not reach the lung tissue, and the result will be similar to that of pneumonia in its second stage. Fluid does not reach the lungs through the pulmonary circulation; it only reaches them, when in normal condition, through the bronchial portion of the general circulation. Therefore, in cases of this kind, fluid must positively be injected into the lungs through the bronchial tubes. Even these may be atrophied or destroyed, so that it will be necessary to inject, in a few hours after the arterial injection is made, directly into the lung substance through the hollow=needle. Examine the pleural sacs, and, if they contain effusions, pump out the effused material and inject fluid in large quantities. The pericardium may be involved, and should be treated thoroughly. Otherwise the cavities should be treated as in an ordinary case.

OTHER DISEASES OF AIR-PASSAGES AND CHEST.

Such as Laryngitis, Bronchitis, Etc.

The embalmer should use his judgment in the treatment of these cases; there being no extensive morbid changes, no line of special treatment is necessary to be laid down. Usually, the filling of the arteries and cavities with fluid is all that is necessary.

CHAPTER XXXI.

DISEASES OF THE DIGESTIVE SYSTEM.

APPENDICITIS.

Inflammation of the Appendix Vermiformis.

The position of the appendix vermiformis is extremely variable. Frequently it lies behind the ilium, with its end pointing toward the left side of the abdomen; or it may lie behind the cecum; or upon the psoas muscle, with the end near the margin of the pelvis. It is found in almost every region of the abdomen. It may be in close contact with the bladder; or in the central portion of the abdomen, lying near the liver; or at the left lower side of the abdomen, etc. Notwithstanding the popular idea, foreign bodies are not found frequently in the appendix. We have noticed in dissections but three cases containing foreign bodies; one contained a solid fecal substance; another, apple seeds; another, a hard concretion, supposed to be enteroliths.

The appendix is often the seat of very extensive inflammation, some recent, while others may have been a considerable time in the past. As a result, the appendix may be obliterated partially or totally. Sometimes, the end near the cecum is dilated enormously, even to the size of the finger, or larger; it may be free or adherent. We have noticed one case in which an abscess was capsulated, containing quite an amount of fluid. In cases where perforation of the walls has taken place, the extent of peritonitis is variable. In some cases, the perforation excites a very diffuse and violent peritonitis, while in others, where adhesion has occurred, or, owing to the location, there may result only circumscribed peritonitis, and an intra=peritoneal abscess of very small size may form. Perforation may take place at the back part of the appendix, which is not covered with the peritoneum, and the inflammation may occur over the psoas muscle in the neighborhood of the cecum only. As a result, an abscess may form in the pelvis or close to the sacrum.

Large, circumscribed, fecal abscesses form, sometimes, in the iliac region, or at points midway between the navel and anterior side of the ilium. Abscesses are liable to develop in almost any situation. One case is reported where an enormous abscess developed and pushed the diaphragm up to the second rib, producing the symptoms of pneumothorax. Perforation of the pleura may have occurred, forming a fecal pleural fistula. Abscesses may burrow along the psoas muscle to the hip=bone, or may have passed into the neighborhood of the rectum, or abscesses may form even in the scrotum, or pass down in the back part into the gluteal region, forming large gluteal abscesses; even perforation into the bladder may have occurred, but it is not common; perforation into the bowel may have taken place, and large quantities of the pus may have been carried off in this manner. A case is reported in which the appendix was discharged through the anus. Hemorrhage may have occurred, in which case a great deal of blood is found in the region. Even such arteries as the internal iliac and deep circumflex iliac have been perforated.

Treatment.—In cases of appendicitis, it can be seen, by careful study of the foregoing, that a great amount of tissue may be involved. When we consider the amount of purulent matter that may be formed in the body, as a result of this disease, it is easy to understand why many of these cases are very troublesome to handle. They require very careful treatment to preserve them. On account of the tendency of the pus to burrow, it may be carried to remote points by gravitation. The pus forms an excellent soil for the rapid growth of the bacteria of putrefaction.

The injection of fluid through the arteries will reach the normal tissues only, unless arteries in the neighborhood of the pus are perforated by the disease, forming an exit for the fluid that is injected into the arteries. Fluid must be injected into the cavities and mixed directly with the purulent matter in sufficient quantity to destroy, or prevent the growth of, putrefactive bacteria.

If the body has not been opened by the surgeon for the relief of the sufferer, or cure of the disease, just prior to death, it will be impossible to know how much pus is contained within the several parts of the abdominal cavity, unless an incision is made into the cavity, to which operation embalmers are not in the habit of resorting. It is necessary to inject fluid beneath the posterior wall of the peritoneum and into every part of the abdominal cavity, using a large amount of fluid. When this is resorted to, the location of the aorta and its larger branches must always be kept in mind; if not, the circulation may be destroyed. Then, too, it must be remembered that the external iliac and the circumflex iliac are of large size, and, as stated before, they may be perforated; if that be the case, arterial injection would only result in filling the cavities, as the perforation would destroy the circulation, preventing the filling of the tissues in the upper portions of the body. In a case where perforation has resulted, it will be necessary to tie the artery that has been perforated; or to make pressure by a compress over the region, sufficient to prevent leakage; or to inject through the subcutaneous, cellular tissue, over the upper surfaces of the body. If the body is injected thoroughly, through the arteries, and the cavities are filled, a sufficient amount of fluid being mixed with the purulent matter contained in the cavities, the body will be preserved, and no trouble will result.

OBSTINATE CONSTIPATION.

Obstinate constipation is caused by intussusception, torsion, or knotting of the bowels, or by foreign bodies, or by stricture. Usually, the skin has an icteric or sallow appearance. The color of the contents of the intestinal canal and stomach—half=digested food, as partly=altered milk, meat, or vegetable matter—is brown, black, dark=green, or yellow. Sometimes the colon is distended so as almost to fill the abdomen. Ulceration of the mucous membrane, and perforation of the intestinal walls, with extravasation into the abdominal cavity, often follow. Peritonitis may result. Abscesses may form in the cellular tissues around the rectum.

The accumulation of fecal matter in the sigmoid flexure may be very excessive. Peacock reports a case where fifteen quarts of semisolid, greenish-colored fecal matter were removed at the autopsy. Samazurier reports one of thirteen and a half pounds, and Chelins one of twenty-six pounds. Bristowe reports one where the whole length of the colon, from the anus to the cecum, was filled with semisolid, olive-green-colored feces, and the small intestine was filled throughout with semifluid, olive-green contents. In composition the mass consists of fecal matter with unaltered vegetable fiber; it may be composed partly of the skin of grapes, cherry-stones, biliary calculi, hair, woody fiber, magnesia, or other foreign substances.

Treatment.—After removing the gases, withdraw the blood and fill the tissues through the arteries; then treat the viscera very thoroughly. If the colon is filled with semifluid and semisolid matter, remove it, if possible, by aspiration. This matter should be removed at all hazard, even if an incision has to be made for this purpose; if an incision is necessary, make it in the median line above the pubic arch. After removal of these contents, fill the stomach and intestines, and inject fluid around the organs, filling the abdominal cavity. Then place the body on the level, elevating the head.

DYSENTERY—FLUX.

By dysentery is meant a disease of the large intestine, which may appear sporadically, but appears more frequently in epidemics. It is undoubtedly infectious. The bacterium producing the disease, however, is not yet determined. The disease prevails in the tropical countries, where it is much more violent and wide-spread than in the North. In the northern climate most of the epidemics occur in the latter part of summer and in autumn.

In severe cases, the inflammation is very extensive, involving not only the rectum, but the greater part of the colon. The affected membrane, on examination after death, is found to be reddened, congested, swollen, softened, pulpy, presenting, in different cases, ecchymoses, excoriations (from peeling off of the epithelium), abrasions, and ulcerations in greater or less numbers, the latter being sometimes small and sometimes of considerable size. The ulcers may or may not be seated in the internal glands. The swelling of the membrane is due to submucous infiltration, and the latter is sometimes so great, at certain points, as to give rise to protuberances which resemble warty growths. The protuberances may be more or less numerous, and sometimes coalesce, giving to the surface a lobulated appearance. Patches of exuded fibrin are adherent, frequently, to the inflamed membrane, presenting a greenish or brownish color. The intestine contains more or less morbid material, as pus, fibrinous flakes, and bloody, serous liquid. The intestine may present a dark, almost black appearance, from congestion. Sloughing and ulceration are present. As a rule, the appearances denote progressively a greater amount of disease in passing from the upper part of the large intestine downward to the anus, the greater amount being in the rectum and sigmoid flexure of the colon. Sometimes the mesenteric glands are enlarged considerably, and in some instances contain pus. The disease usually is confined to the rectum and the lower part of the large intestine, but sometimes it extends higher up in the colon, producing ulcerations and involving the mesenteries, which is followed by peritonitis.

Treatment.—If inflammation of the peritoneum has resulted, it should be treated as directed in the treatment for peritonitis. Gases will be present in the large intestine, which must be removed, and fluid injected in sufficient quantity to fill the colon and rectum. The cavities should be treated in the usual manner, and an artery raised and injected, filling all the tissues of the body.

CHOLERA INFANTUM

This disease is peculiar to infantile life. It rarely attacks children above two years of age. Great emaciation commonly results; and usually death occurs during the second or third day. Rigor mortis comes on soon after death and passes off within the hour. The mucous membrane of the large and small intestines is of a dark=reddish color. There is more or less softening and congestion of the cerebral tissues.

Treatment.—As decomposition commences soon after death, prompt treatment should follow. The body should be placed on the board in the usual manner and washed thoroughly, filling the openings with fluid; the carotid or femoral artery may be raised and fluid injected; or the tissues can be filled by one of the needle processes. The thoracic and abdominal cavities should be filled in the usual manner.

HERNIA OR RUPTURE.

The morbid changes in hernia or rupture are confined to the lower part of the abdomen, especially in the inguinal canal. The inflammation that is produced may result in peritonitis.

Treatment.—A case of this kind should be treated as a case of peritonitis; otherwise the treatment should be the same as in an ordinary case.

JAUNDICE.

Jaundice is not strictly a disease of itself, but is really a symptom of a disease. It occurs in nearly all of the hepatic disorders, or diseases of the liver, such as hepatitis (inflammation of the liver), cirrhosis (hobnailed liver), phlebitis (inflammation of a vein), cancer, renal colic (passage of gall-stones), and such troubles as may affect the ducts, causing congestion of the mucous membrane, sufficient to close the duct. It also occurs in many of the constitutional diseases, such as septicemia, puerpural fever, remittent fever, etc. In several of these diseases, the amount of discoloration is very extensive, as in cirrhosis, cancer, hepatitis, etc.; in others, it is present only in a slight degree. It is due, in all cases, to the presence of biliverdin, or bile pigment, in the blood, which is reabsorbed in the liver after its secretion.

Bile is secreted by the liver and is thrown off during digestion, being carried through the ducts to the duodenum, or upper portion of the small intestine. During the interval between the digestion of a meal and the next meal, the bile is deposited in the gall=bladder, which serves as a reservoir for the excretion during the intervening period, as bile seems to be secreted constantly. If, perchance, the ducts are closed, as from diseases of the liver, or from one of the diseases which affects the ducts indirectly, producing congestion or closure, the bile cannot pass off through its natural channel. It is then reabsorbed by the liver, and taken up by the hepatic veins and carried into general circulation. From the right side of the heart, it passes through the lungs and throughout the whole arterial circulation, and is deposited in all the tissues of the body.

The biliverdin, that causes general discoloration of the surface of the body, is deposited in the soft layer of the skin, known as the pigment layer, and in the subcutaneous tissues. If life continues after the ducts are reopened, and the bile passes off in its natural channel, the bile=pigment is taken up or reabsorbed from the tissues by the blood and thrown off through the usual excretory organs. But when death occurs during this jaundiced condition, the bilverdin will remain where it is deposited and cannot be removed; no bleacher will have any effect upon it.

Treatment.—Jaundice does not bring about a condition that is hard to preserve, but the disease which causes it may induce a morbid condition that will require special treatment to preserve the case; for instance, in cirrhosis there may be extensive dropsical effusions. In hepatitis, cancer, etc., dropsical effusions may exist, from a mere extension of the skin, sufficient to cause the person to look as though he were only gaining a little flesh, to distention of the body, sufficient to be designated anasarca. When dropsy is present, it always interferes with the circulation of fluid. Pressure upon the small arteries and capillaries may be sufficient to prevent fluid entering the tissues. If a complete circulation of fluid is not possible, putrefaction will not be arrested.

Again, in cases of dropsical effusion, the presence of such an enormous amount of moisture will increase the tendency to putrefaction, especially in warm weather. A case of this kind should be treated as directed in dropsy, without reference to the jaundiced condition, or discoloration from the presence of biliverdin. The water should be removed as far as possible, and, when the body has been embalmed thoroughly, to produce the best effect, it should be placed in a room with the curtains drawn in such a manner as to darken the room completely.

Biliverdin is a permanent color, and nothing can remove it or bleach it out in a dead body. It is always best to explain to the family that they need not expect a perfect case, that the discoloration cannot be removed, but that it can be modified in some cases. With their permission the room can be so arranged, with the aid of artificial light, properly placed, that the case may be made to look almost perfectly natural in color.

INTESTINAL CATARRH.

In the majority of cases of intestinal catarrh, the conditions are due to an abnormal irritation of the mucous membrane of the intestines by their contents, similar to that of gastric catarrh. The irritants are of a mechanical or chemical nature, in most cases, and depend, principally, upon the quantity and quality of the food, which explains why catarrh of the stomach and of the intestines are found so frequently to accompany each other. If noxious substances are taken into the system, by the ingestion of spoiled food, like spoiled meat, fish, beer, and many other things, they play a part very often in the origin of intestinal catarrh. To the toxic catarrhs, which are produced by taking into the digestive tract poisonous substances, may be added the intestinal catarrhs caused by improper food. The intestinal mucous membrane is found severely inflamed, by the taking into the system of certain poisons by mistake, or with suicidal intent, such as the mineral acids and corrosive alkalis, arsenic, corrosive sublimate, etc. Imprudent use of certain drugs, especially active cathartics, may induce intestinal catarrh.

Then a great many cases of intestinal catarrh are due to infectious influences, such as those that are apparently spontaneous, or attributed to taking cold or getting wet, and those that develop epidemically in hot weather, which are termed cholera morbus, summer complaint, summer diarrhea, etc. Both sexes and all ages are predisposed to intestinal catarrh. There is a pronounced tendency to this disease in children; in fact a greater number of deaths among children is produced, especially during the summer months, by inflammation of the alimentary tract than by any other cause.

The pathological changes are similar to those met with in the inflammation of other mucous membranes. The mucous coat is swollen and red, secretion of mucous is increased, and purulent products on the surface of the membrane, and cellular infiltration of the tissues, are found in severe cases. The glands, both solitary and agminated, are swollen, finally becoming ulcerated. In severe cases, superficial erosions are frequent on the remainder of the mucous membrane. The mucous membrane, in long=continued cases, becomes thickened, which makes the surface uneven and puffy; the connective tissue becomes increased in thickness and results in a studded appearance. There is cystic degeneration of the follicles, due to the retention of the intestinal juices, caused by the occlusion of the mouths of the follicles.

Treatment.—In cases in which this disease is due to the ingestion of spoiled food or of other poisonous substances, as mentioned above, there will be present the bacteria of putrefaction. The amount of secretion varies greatly in different cases; but in all cases there is sufficient to furnish a proper soil for the growth of bacteria, resulting in putrefaction, which, if the case is not properly treated, progresses very rapidly. These cases, as already stated, usually occur during the hot summer months, when heat and moisture are present to a sufficient degree for the rapid growth of bacteria. Therefore, in the treatment of these cases, the cavities should be filled very carefully. The alimentary canal should receive enough fluid to disinfect and sterilize its contents thoroughly. Several quarts should be injected into the abdominal cavity alone. Effusions are found, sometimes, in the pleural sacs, which should receive special attention. All tissues of the body should be filled through the arterial system.

SPORADIC CHOLERA—CHOLERA MORBUS.

Cholera morbus is an affection of the mucous membrane of the stomach and intestines, characterized by violent pain in the abdomen, nausea, violent and incessant vomiting, and by purging of watery fluid. The disease is not contagious, and rarely proves fatal, although a state approaching collapse sometimes occurs, which is followed, usually, by a reaction. Even when the symptoms are the most severe during life, we do not always find morbid changes sufficient to account for the cause of death. Usually there are evidences of gastro=intestinal catarrh; the mucous membrane is congested throughout; the solitary glands and Peyer's patches are swollen and prominent; the blood is dark and thickened; the kidneys are congested and large. The appearance may resemble that of Asiatic cholera.

Treatment.—The gas should be removed from the large and small intestines, and fluid should be injected before the needle is removed. The peritoneum should be treated carefully, the cavities filled in the usual manner; fluid should be injected through the arteries in sufficient quantity to fill all the tissues of the body.

OTHER DISEASES OF THE ALIMENTARY CANAL.

Such as Gastritis, Enteritis, Colitis, and Entercolitis, usually known as Inflammation of the Bowels, etc.

The morbid changes in these diseases are confined to the parts affected, except when perforation, or extensive and deep inflammation, exists, usually involving the peritoneum, causing peritonitis, as in inflammation of the stomach and intestines, both large and small. Cancer may involve the liver, spleen, pancreas, kidneys, and bladder.

Treatment.—In all such cases treat the abdominal cavity very thoroughly, besides the usual general treatment of the vascular system. The stomach and intestines should be filled with fluid.

CHAPTER XXXII.

DISEASES OF THE KIDNEYS AND BLADDER.

BRIGHT'S DISEASE.

Acute Bright's Disease; Waxy Bright's Disease; Cirrhotic Bright's Disease.

There are at least three different diseases of the kidneys which are known as Bright's disease. Each of these maladies involves either one or the other of the structures of the organs, and only secondarily affects the others. For instance, one disease originates in the uriniferous tubules; one in the blood=vessels, particularly in the Malpighian tufts; and the other in the fibrinous stroma. The first is known as inflammatory, and may be either acute or chronic; the second as waxy or amyloid; and the third as cirrhotic or gouty.

Acute Bright's Disease.

The first, or acute Bright's disease, is an acute or chronic affection of the kidneys, caused by exposure to cold, or by scarlatina, or by other blood diseases, consisting of inflammation of the elements, passing through the various stages of transformation, namely, inflammatory enlargement, fatty degeneration, and atrophy. There is usually present, in the earlier stages, diminution of urine, albuminuria, frequent hemorrhage causing blood in the urine, tube=casts, and dropsy; changes in the heart, blood=vessels, and other organs follow, death having been caused by dropsy, uremia, or some other complication.

Waxy Bright's Disease.

The second, or waxy Bright's disease, is a chronic affection of the kidneys, caused by tuberculosis, syphilis, caries, suppuration, and other exhausting diseases, consisting in waxy or amyloid degeneration of the Malpighian bodies, small arteries, and sometimes other parts, with, in many cases, transudation into the tubules. Usually, in this disease, there is albuminous urine, the absence of dropsy, and waxy disease of other organs, such as the liver, spleen, and intestinal canal. Death is caused usually by exhaustion, uremia, or coexisting affections of the kidneys or other organs.

Cirrhotic Bright's Disease.

The third, or cirrhotic Bright's disease, is a chronic affection of the kidneys, caused generally by the abuse of alcohol, sometimes by the poison of gout, occasionally by plumbism or other conditions. This causes increase of the fibrinous stroma, with thickening of the capsule of the kidney, and the ultimate atrophy of the organ. There is present albuminuria, enlargement of the heart, polyuria, edema of the lungs, and uremia. Death usually results from uremia, edema of the lungs, or other inter=current affections.

In the inflammatory form the kidney is enlarged; its capsule strips off readily; its surface appears more or less red, sometimes of a deep=purple color; and occasionally extravasations of blood are present in its substance. On section, the cortical substance is found to be increased in bulk. Its vessels, as well as those of the cones, are congested. Its structure appears somewhat coarser than usual, while its convoluted tubes often present an opaque appearance, and sometimes contain blood. Fatty transformation follows, there being yellowish, opaque, sebaceous=looking material in patches, mingled with more natural structure. In some cases, there may be atrophy of the kidney, the organ being reduced to, or even below, the natural size. Its capsule will strip off with little difficulty and without tearing the surface. The surface is smooth, presenting a pure example, with little or no mottling. The small arteries are thicker and more prominent, all their coats, but especially the middle, being increased in volume. Many of the tubules are atrophied, but the epithelium of such as are not involved is for the most part natural. Cysts are numerous, and are found in connection with the tubules, the Malpighian bodies, and the cells.

These peculiarities of the kidneys are mentioned merely for the purpose of showing to the undertaker the morbid conditions that take place during the disease; not that he will derive much benefit, in the preservation of cases, by the use of embalming fluids, but it is the organs of the body that are affected by complication that give the greatest trouble. Dropsy of the feet and ankles, thickening, sclerosis, and atheroma of the arteries, causes the waxy affection of other organs, especially of the liver, which is enlarged, its margin being usually felt and sharply defined below the ribs. The spleen is increased in size also; the blood is lighter in color, the white corpuscles being increased, and the red rather flabby. There is a peculiar appearance of the eye, from edema of the conjunctiva, a hypertrophied condition of the heart, and the vessels become sclerosed and degenerated.

In some cases, there is a great deal of dropsical effusion, while in others there is none at all. Even in some bodies there will be found pleuritic adhesions (pleurisy being one of the sequela), inflammation of the bronchial tubes, or pneumonia. The chief organic changes are fatty degeneration, cirrhosis, and syphilitic affections of the different organs of the body, especially of the liver. The surface is pale and pasty, and the eyelids are found edematous. This peculiar appearance will be found in many cases. The surface will sometimes be of that light jaundiced color, which cannot be removed, it being permanent. It may be modified by the injection of a good bleaching fluid into the capillaries through the arteries.

Treatment.—As will be observed, the lungs are involved frequently, either by the presence of pneumonia or mediastinal congestion. In either case it will be necessary to treat the lungs carefully, and in many cases there will be complications, so that it is best to treat the lungs specially in all cases. True, there may be hydrothorax, so that it will be necessary to aspirate the pleural cavities and inject fluid. The amyloid condition of the liver, spleen, and other organs of the abdominal cavity, will make it necessary to treat these organs by the direct operation through the hollow=needle, as the circulation within them will be partially or entirely destroyed. Otherwise the body should be injected in the usual manner, filling the arteries and cavities, which will be all that is required for preservation and disinfection.

NEPHRITIS.

Inflammation of the Kidney.

Dropsy is always present in nephritis. It may be slight or excessive. Otherwise the body will be in a condition similar to Bright's disease, and will require the same treatment.

DIABETES.

Sugar in the Urine.

Diabetes is not a disease of the kidneys, as was formerly supposed. The organs merely excrete sugar contained in the blood brought to them by the renal arteries. The sugar in the blood increases the functional activity of the kidneys, acting like a diuretic, and hence the quantity of urine is greatly increased.

This disease has no constant anatomical character, aside from lesions belonging to concomitant or consecutive affections. The kidneys are often enlarged or hypertrophied, atrophied, or contain abscesses. The blood contains sugar. It has been found in the saliva, in the infusions, in the serous cavities, in the humors of the eye, and in the spermatic fluid.

Pulmonary affections, such as pneumonia or tuberculosis, are frequent complications. Desquamation of the cuticle often exists. Boils, and sometimes large abscesses, are found in different parts of the body; also, gangrene, or ulceration without gangrene, of the lower extremities. Edema of the legs often occurs.

Treatment.—The treatment in these cases depends entirely upon the amount of tissues involved by complication. Inject the vascular system and cavities thoroughly in every case. If dropsy is present, which is frequently the case, adopt the usual means of removing water from the tissues. If abscesses or gangrene are present, use hardening compound, as directed under the head of gangrene. These cases should be handled carefully, as, the tissues, being filled more or less with water, there is a liability to "skin=slip." For this reason a little formalin might be added to the fluid, to harden the skin.

DISEASES OF THE BLADDER.

The bladder may be the seat of the following morbid conditions: inflammation with acute or chronic abscess; atrophy or hypertrophy; mechanical distention with chronic engorgement; the retention of urine; tumors or other growths; epithelioma and carcinoma; tubercular disease; ulceration; vesico=vaginal or vesico=intestinal fistula. It may contain blood or purulent material.

Treatment.—The trocar should be introduced immediately above the pubic arch in the median line, directing it inward and downward to reach into the bladder. Withdraw all liquid matter and inject fluid, mixing it thoroughly with the contents, filling the organ as full as possible. Otherwise, the body should be treated in the usual manner.

CHAPTER XXXIII.

DISEASES OF THE NERVES.

PARALYSIS.

Paralysis means the loss of voluntary motion in the muscles of the body which are controlled by the will. The complete loss of the power of active motion is termed paralysis, while the mere weakening of it is termed paresis. In complete paralysis of any part of the body, or of a single muscle, the slightest voluntary motion cannot be produced in it; while in paresis in a diseased part, certain movements are still possible, they are more or less below the normal in strength, extent, and duration.

A study of the pathological conditions, resulting from diseases of the nervous system, will undoubtedly throw light upon these cases. From the manner in which the nervous and vascular systems interlock, all diseases and pathological conditions of the body are inseparably related to one another. The modes of interference with the functions of the vascular system, through the changed nervous action, are few and simple. The heart, under the influence of modified nervous stimulation, may depart from its customary order and rate of contraction; it may be more rapid or slower in its number of beats per minute; it may be stronger or weaker than normal. The small arteries, over a greater or less extent of the body, may be diminished in caliber; or they may become unduly dilated; but, save for such changes as these, and their direct consequences, the work of the vascular system, under the above conditions, is carried on as if such changes had not taken place.

On the other hand, diseases of the nervous system may be induced by an altered quality of the blood, or by changes in the action of the heart or some other part of the vascular system. The entire function of the system may be degraded, owing to the fact of its receiving an inadequate amount of blood from the slowly acting or feeble heart; or the functions of that part of the system may be interfered with by an undue contraction or dilatation of the small arteries, or by an impediment in the outflow of blood, producing mechanical congestion.

Again the complete or partial arrest in the flow of blood in the vessels of some important region, owing to thrombosis or embolism therein, or the rupture of one of the branches of such a vessel with extravasation of blood into the organ, may impair or destroy the functions of that particular part. Both local perversion of function and change in structure in the nervous system, are produced more frequently by an altered quality of blood, or a change in the vessels of the part, than by an actual morbid change in the nervous tissue.

Thus, it can be seen that, at times, the vessels in the paralyzed parts, as say one upper or one lower extremity, or even one=half of the body, will be contracted to a very small caliber; or possibly they will be dilated unduly. In either case, there will be an entire arrest of the flow of blood in the vessels, owing to a blood=clot; or, it is possible there will be rupture of the branch or branches of some vessel, with extravasations of blood in the organ. A large amount of blood may be found in the arteries. The arteries may not have emptied after death, owing to the non=contraction of the arteries and capillaries on one side of the body, producing a congestion of the surface, whereby redness may follow; but this result does not occur in all cases.

Treatment.—In some cases, especially those in which the arteries are dilated, a complete circulation of the fluid will follow, while in others it may be only partial. In still other cases, the circulation of fluid in the diseased part will not take place at all. In a case where it is impossible to inject sufficient fluid into the parts that are paralyzed through the arterial system, fluid should be injected through the cellular tissue on the upper surfaces. The artery should be raised on the side or in an extremity that is not paralyzed, and as much fluid should be injected as is necessary to fill the capillaries. If it is found that none has passed into the paralyzed parts, then the cellular injection should follow. The cavities, the alimentary canal, and the lungs should be treated in the usual manner.

APOPLEXY—CEREBRAL HEMORRHAGE.

The cause of cerebral hemorrhage or apoplexy is found in some cases in the ends of the minute cerebral arteries. In 1886, it was first shown by Charcot and Bonchard that, in almost every case of cerebral hemorrhage, there are miliary aneurisms of the small arteries of the brain substance, allowing the blood to escape. All later investigators have confirmed their discovery, and the importance of these miliary aneurisms.

Osler, in his recent work, states that one of the changes which may lead directly to apoplexy is "the production of miliary aneurisms, rupture of which is the more common cause of cerebral hemorrhage. . . . They occur most frequently on the central arteries, but also on the smaller branches of the cortical vessels. On section of the brain substance, they may be seen as localized, small, dark bodies, about the size of a pin's head. Sometimes they are seen in numbers upon the arteries when carefully withdrawn from the anterior perforated spaces."

These aneurisms may attain the diameter of a millimeter or more. They usually appear like spindle-shaped dilitations of the entire circumference of the vessels, although sometimes the bulging is found to one side. Endoarteritis or periarteritis, occuring in the cerebral vessels, usually leads to apoplexy, by the production of aneurisms either large or small. It is stated that there are certain cases in which the most careful search fails to reveal anything but the diffuse degeneration of the vessels, particularly of the smaller branches, which indicates that spontaneous rupture may occur without the previous formation of aneurisms.

The process of the development of aneurisms, starts with disease of the inner coat. This layer or coat presents diffuse proliferations, and also a fatty degeneration of the endothelium. Later on, the inner and the middle or muscular coats become hard or atrophied. The disease of the vascular wall, which leads to the formation of these aneurisms, is identical with ordinary hardening of the walls, or atheroma. We very often find that cerebral hemorrhage attacks persons who present either general arterial sclerosis, or a more limited atheromatous condition of the cerebral arteries, and most of the factors, which are said to promote cerebral hemorrhage, are the same as favor the development of these hard arterial walls.

Hemorrhage of the meninges (coverings of the brain) may be outside the dura mater, between it and the bone, or inside the dura mater, between it and the arachnoid, or between the arachnoid and the pia mater. Fracture of the skull is one of the chief causes of this form of hemorrhage, which results, usually, from ulceration of the meningeal vessels, or from the torn sinuses (veins). The blood may be found either on the outside of the dura mater, or between it and the arachnoid. Another cause is the rupture of aneurisms in the larger cerebral vessels; then the blood is found, usually, in the subarachnoid spaces.

Meningeal hemorrhage may occur in the constitutional diseases and fevers. Blood will be found in large quantities at the base, but may extend into the cord. The Sylvian fissures are found distended with blood, owing to the frequency of the aneurism in the middle cerebral vessels. Hemorrhage in the cerebellum is not uncommon, and usually comes from the cerebral artery. It has long been recognized that age has a bearing in these cases, although sometimes a young person may be attacked. The majority of sufferers are over fifty years of age. This is at the time of life when the coats of the arteries may be indurated (hard). Cerebral hemorrhage is more frequent in men than in women, which is also true of atheroma. Alcoholism, syphilis, and gout are reckoned among the causes of the above disorders, and the hereditary predisposition is very rarely demonstrable.

The "apoplectic habit" also deserves mention. It is described as a person who is not very tall, corpulent, broad chested, with a short, thick neck, and round face. They are inclined to the pleasures of the table, and sometimes they suffer from emphysema, moderate hypertrophy (enlargement) of the heart, and general induration (hardening) of the coats of the arteries, as the condition of the radial and temporary arteries may disclose even during life. At least the coats of the arteries must be diseased in all cases of cerebral hemorrhage, because, if the arteries were normal, they could not possibly be torn, no matter how great the arterial tension became; but, if aneurisms have already been developed, then the persistent or even temporary elevation of the blood pressure must favor the bursting of the walls. Cerebral hemorrhage, for example, may follow severe muscular exertion, the ingestion of a large amount of food, indulgence in alcohol, taking a cold bath, or violent exertion of any kind. In cases of recent apoplexy, where death follows soon after the attack, usually the surface is found congested, and the capillaries and blood=vessels about the face and neck full of blood, sufficient to cause extensive discoloration.

Treatment.—It becomes necessary in these cases to withdraw blood from the heart, either by the direct operation or through the veins. The blood does not coagulate any sooner than in the ordinary case. Fluid should be injected through the arteries in sufficient quantity to fill the capillaries of the whole body; it is well to inject a large amount; in a body weighing one hundred and sixty pounds, at least one gallon should be injected into the arteries. If that amount or more is injected into the arterial system, the fluid will reach the brain substance through the intact arteries and penetrate the parts wherein the circulation is destroyed. The cavities should be relieved of gases and filled in the usual manner; then the body should be placed on a level, with the head slightly elevated.

CHAPTER XXXIV.

CANCEROUS AND CONSTITUTIONAL DISEASES.

MALIGNANT TUMORS—CANCERS.

Cancers are internal or external, soft or hard. Internally, the liver and stomach are most frequently the seat of cancer, followed by that of the womb, in the female, but they may be found in almost any other organ or structure. Externally, the parts exposed, as the face, neck, and hands, and in the female, the breast, are the most frequent seat of the disease. The surfaces of these cancers are usually denuded of skin, and are soft and ulcerated.

Treatment.—Internal cancers should be treated directly with the hollow=needle, in addition to the general treatment of the body. In cancer of the womb, a pledget of cotton, filled with fluid, should be introduced into the vagina.

External cancers should be cleansed thoroughly with hot water and sprinkled with a thick layer of hardening compound; the whole then covered with bleached muslin or some other white fabric. It has been recommended that if the face is involved, the parts may be built up with plaster of Paris and treated with pigments. This practice may be well enough in the hands of an artist, but, with an ordinary operator, it will result, most likely, in failure. The friends cannot expect the features to look natural; if the parts are cleansed and thoroughly deodorized, and dried by the use of hardening compound, and are covered with a white cloth, the results will be satisfactory.

CANCER OF THE STOMACH.

Cancer of the stomach is a malignant disease, death resulting sooner or later. The stomach is the seat of cancer more frequently than is any other organ of the body. Cancer of the stomach is almost always primary; consequently, secondary malignant affections of the stomach are exceedingly rare. The tendency to the disease increases with age. Men seem to be about twice as liable to gastric cancer as women. In a large number of cases there seems to be a hereditary predisposition to the disease, as it is often seen that more than one member of a family is affected. Neither anxiety, poverty, nor intemperance seems to influence the development of the disease. All varieties of cancer are met with in the stomach. The scirrhous or hard cancer is the most frequent form. According to Brinton, about seventy=two per cent. of all cases are scirrhous. Other forms may exist alone or in combination with scirrhous.

Cancer usually begins in the submucous tissue and spreads from this to the other coats. The muscular structure varies in appearance in different cases. In some, the normal tissue is partially destroyed, and, what appears to the naked eye as a muscle, under the microscope, proves to be a mass of cancer=cells and fibers. In other cases, even at some distance from the disease, the muscular fibers are found very much increased in thickness, and the contractile fiber=cells are greatly enlarged. The presence of the new growth stops nutrition, so that the muscular fibers in the walls of the stomach seem to be reduced to a mere mass of fibrous threads. This takes place at the same time in the mucous membrane lining the wall of the stomach. The glandular tissue over the tumor usually is destroyed, leaving nothing but cells and fibers to represent the original textures. The glandular structure is always disorganized at a distance from the original disease. This is most marked in hard cancer. In most cases, the cancer attacks the orifices of the stomach; this occurs most frequently at the pyloric or small end. According to Brinton, about sixty per cent. of all cases are located at the pylorus, about thirteen per cent. affect the cardiac orifice, while the fundus is scarcely ever primarily affected. Cancer always has the tendency to spread in a transverse direction through the organ, so that stricture is a common result. It scarcely ever implicates the duodenum, and seldom appears at the cardiac orifice without spreading to the lower end of the esophagus.

As is seen above, cancer affects the structure of the stomach, changing it entirely; it also changes the circulation, destroying the capillaries and vessels, not only in the stomach, but, as the disease spreads, in the liver and the surrounding organs. Much tissue may be involved, requiring special attention by the embalmer.

Treatment.—A peculiar appearance of the surface or skin is always met with in cases of cancer, which is called a cancerous cachexia. This becomes more or less marked during the course of the disease, and exists in the tissues after death. It consists of a paleness of the lips and a greenish, or slightly jaundiced, hue of the skin. This will remain, with some modification, after the injection of fluid. Bleachers applied to the surface will not affect it in the least, although the injection of fluid into the capillaries of the skin and subcutaneous tissues will modify it to a degree. Fluid does not enter the cancerous structure, because of the destruction of the circulation, by ordinary injection, therefore, it is necessary to inject fluid into the diseased parts through the hollow=needle. The diseased organs should be punctured in every part, mutilating them as much as possible, and fluid should be injected into and over the surface in large quantities. Cancerous structure, on account of the destruction of the circulation in the diseased organs, should be treated in this manner in every part of the body.

CANCER OF THE LIVER.

Cancer of the liver is seldom primary, but generally is met with as a secondary disease. By secondary, we mean that the liver becomes cancerous after other organs have been affected with cancer. It follows most frequently when the primary growth is found in the portal system, intestines, rectum, esophagus, or pancreas. Sometimes the projection of the primary growth in the lumen of a branch of the portal vein has been demonstrated, thus furnishing the obvious source for cancer in the liver.

These cancers are found both within the organ and upon its surface; if upon the surface, they form flattened protuberances, which are dippled in the middle. The liver may be greatly enlarged—so much so, if the new growth is very extensive, as to occupy a great portion of the abdominal cavity. If the case is one of primary cancer, which is very unusual, it may be found either in the form of large nodules, or some diffused cancerous infiltration, pervading the greater part of the organ, without complication of either of the above mentioned organs of digestion.

Hepatic cancer is most frequent in advanced life, say from forty to sixty years. Special causes of cancer are not known. It seems possible, sometimes, to trace a hereditary predisposition; but, in many cases, gall=stones seem to start the development. Frequently, in these cases, there will be peritoneal dropsy and enlargement of the spleen from the pressure on the portal vein, and jaundice from pressure on the bile=ducts.

Treatment.—In the treatment of a case of cancer of the liver, if ascites is present, the peritoneum should be tapped and the water removed. The arterial system should be injected thoroughly; then ordinary injection of the cavities, without reference to the treatment of the liver or the cancer itself, should follow. After the usual treatment in this manner, the body should be allowed to remain upon the board for twelve hours or more. At the end of that time the tissues will have absorbed the fluid that has been injected through the arteries, and the viscera of the cavities (except the liver) will have absorbed a sufficient quantity to preserve the several organs. Then it will be necessary to puncture the liver in many places, or even to break it up; at least, it should be broken up as much as possible, and fluid injected into all parts of the organ, as the circulation in the liver is more or less destroyed. The vessels and capillaries have been destroyed, as a result of the abnormal growth of the liver, therefore, the liquid injected through the arteries will not be sufficient to reach all parts of the organ; hence, the necessity for breaking up the abnormal growth and injecting fluid throughout, as directed.

BENIGN TUMORS.

By a benign (not malignant) tumor is meant a more or less circumscribed mass, growing in some tissue or organ of the body, and dependent on a morbid excess of, or deviation from, the normal nutrition of the part. Tumors are of many varieties, and may be found in every portion of the body. Cystic tumors of the ovary, which sometimes attain an enormous magnitude, are the kind that most requires attention. They vary in size from those of very small dimension to tumors weighing many pounds. As they grow, their walls sometimes become very thick and firm, and often of great toughness. The contents may be thin and slightly colored, or thick and of a dark color; sometimes of a yellowish hue. The quantity of these contents will vary from pints to gallons. Encysted tumors, containing hair and fatty matter, will be met occasionally. The fatty matter may be in a somewhat fluid condition.

Treatment.—To treat an ovarian or any other tumor whose contents are liquid, the hollow=needle should be introduced into the growth and the liquid matter withdrawn. In a single=cyst ovarian tumor, the water can be withdrawn as easily as from the serous sacs when effusions are present; but, if it be composed of many cysts, the cyst=walls will have to be mutilated thoroughly before the contents can be withdrawn. If the matter within the tumor is semisolid, fluid should be injected for the purpose of diluting the material, which then should be withdrawn and fresh fluid injected.

In ovarian tumors, after the water is withdrawn, fluid should be injected in sufficient quantity to disinfect the growth. If the tumor does not contain liquid or semisolid matter, fluid should be injected in the mass at a number of different points. Circulation in these tumors is abnormal, which will prevent the fluid from entering in sufficient quantity by arterial injection. As a rule, there is no necessity for removing tumors from the cavity of the abdomen, or, in fact, from any other part of the body, if treated as directed above. the general treatment of the body should be the same as in an ordinary case.

DROPSY.

Dropsy is not a disease *per se,* but only a symptom of a disease. It often occurs as a result of disease of the heart, liver, or kidneys.

A dropsy receives its name from its location. If it is seated in the serous cavities, it is designated by the prefix "hydro" to the name of the serous membrane; as in dropsy of the peritoneum, it is called hydroperitoneum, or in dropsy of the pericardium or pleural sacs, it is called hydrothorax, etc. Dropsy of the cellular tissue at any point is called edema, as edema of the glottis, edema of the legs, arms, face, etc. Effusion in the air=cells is called edema of the lungs. If dropsy is confined to the abdomen, it is called ascites, or abdominal dropsy. When edema exists all over the surface of the body, as when the cellular tissue in all parts underneath the skin is filled, it is called anasarca, or general dropsy. When there is edema of the glottis, edema of the lungs, or hydrothorax, death is caused frequently by asphyxia.

When death is caused by asphyxia, the peripheral or superficial veins and capillaries will be congested, and extensive discoloration of the face and neck will result. This should be removed by tapping the heart direct or raising one of the veins. In general dropsy, the cavities and subcutaneous tissues in every part of the body are filled more or less with the dropsical fluid. The cavities of the body, especially of the thorax and abdomen, will be filled some times to great distention. As much as fifty pints have been taken from the abdominal cavity after death. The lungs may be collapsed, and the heart pushed out of position, by effused dropsical fluid in the pleural sacs. The upper and lower extremities —especially the hands, forearms, feet, and legs—and other parts of the body, may be distended to an enormous size.

In many cases, on account of the presence of water so near the surface, the cuticle will have a tendency to siip, resulting in "skin-slip."

Treatment.—Dropsical cases are not hard to preserve, if treated properly; to handle such a case, however, requires a good deal of time and work. First, cover the embalming board with a rubber sheet, with the sides rolled up to prevent the water from escaping to the floor, and soiling the carpet, etc. The lower corners should be brought together so as to form a spout, under which a vessel may be placed to receive the dropsical fluid. One of the rubber sheets especially manufactured for the purpose may be used, if desired, but a plain rubber sheet will answer all requirements. Next, place the body upon the embalming board thus prepared, and elevate the head and shoulders.

The cavities should then be relieved of water by the insertion of the trocar or hollow=needle into the serous sacs that are involved. They usually can be reached from the point over the stomach in the hypogastric region, where the needle is inserted, ordinarily, for cavity injection. When so introduced, the water in the abdominal cavity will have to be pumped out. If there is great distension of the abdominal cavity, the trocar may be inserted immediately above the pelvic bone, on the median line, and manipulated in such a manner that the water will gravitate out through the instrument; or, if necessary, the pump may be attached and the contents aspirated. If the thoracic cavity is filled, the needle should be introduced through the diaphragm (as directed in the chapter on "Cavity Embalming"), the pump attached, and the water pumped out; or the needle can be inserted between the ribs, and the contents aspirated.

After the water has been removed from the cavities, proceed to remove it from the extremities. This can be done best by the use of a rubber bandage. A bandage three inches in width by twelve feet in length, is sufficient for the purpose. The skin should be punctured, or an incision made through the skin on the under surface of the arm, from the elbow to the shoulder; then from the elbow to the wrist=joint. Many punctures should be made to give exit to the water. Begin the application of the bandage at the shoulder, wrapping it tightly and regularly downward without reversing until the elbow=joint is reached; then carry it from that point straight down to the tips of the fingers and apply the bandage in the same manner upward toward the elbow, until that joint is reached. If the bandage is applied tightly and slowly, the water will be forced out of the punctures or incision ahead of each turn of the bandage. If enough punctures have not been made, more should be made while the bandage is being applied. These punctures will not show after the water is removed and the extremities are placed in position.

To remove water from the lower extremities, the bandage should be applied, beginning at the hip=joint. It should be wrapped slowly and tightly to the ankle, then carried to the toes and the application should proceed toward the ankle in the same manner. Prior to the application of the bandage, the skin should be punctured at many places, or a single incision should be made through the skin on the under surface from the hip to the ankle.

After the dropsical fluid has been removed in the manner above described, a common roller=bandage should be applied to the extremities. Then the heart should be tapped and the blood withdrawn while fluid is being injected into the arteries. Enough fluid should be injected to fill the capillaries in all parts of the body. The addition of a little formalin, say from one to two ounces in each quart of any of the ordinary fluids, will harden the tissues admirably in a case of this kind. The cavities should be filled in the usual manner.

If death has been caused by asphyxia, the congestion of the surface of the neck and face can be removed, usually, without trouble, by the withdrawal of blood, as it is thin and does not coagulate readily in these cases. Usually the watery portion of the blood is increased greatly, which retards coagulation very materially.

If cases are treated in this manner, the result will be very satisfactory.

RHEUMATISM.

The great majority of cases of acute rheumatism ultimately end in recovery; the proportion of deaths, as the immediate result of an attack, being only a small per cent. On the other hand, a large number of persons suffer from remote effects of the disease, many of which are not only distressing, but likely to lead to death. Of the immediately fatal cases, the large proportion are associated with, if not actually due to, acute diseases of the respiratory organs. The fatal cases which present cardiac diseases, especially acute pericarditis, are scarcely less numerous. Altogether, it may be said that from one=half to three=fourths of all cases of death during acute rheumatism are referable to acute cardiac and pulmonary diseases, either separately or combined.

It is doubtful whether acute rheumatism ever proves fatal —that is, whether any patient dies from the excessive pain, sweating, and consequent exhaustion caused by rheumatism. Hyperpyrexia, next to pulmonary and cardiac complications, is the most common cause of death. In a small number of cases, acute alcoholism and other complications, mentioned elsewhere, lead to fatal termination. A most common effect is valvular disease of the heart, which, in a majority of cases, is referable to acute endocarditis, occurring as a complication of rheumatism.

It is impossible to estimate the number of diseases of the lungs, vessels, brain, kidneys, and other organs, which, in their turn, are caused by such heart diseases. The vessels suffer directly from the effects of rheumatism, and when, in addition, the remote effects of pneumonia and pleurisy, and the other less=common complications of rheumatism, are considered, the ultimate changes are very extensive.

Some of the complications in rheumatism are inflammation of the heart and pericardium, hyperemia, and inflammation of the lungs, trachea, and larynx, inflammation of the various serous membranes, various nervous affections, such as meningitis and mental derangement, erythema nodosum, and scarlatina, albuminuria, hyperpyrexia, hemorrhage, and lastly venous or intercurrent conditions. Cardiac complications are by far the most frequent, being present in no fewer than fifty per cent. of all cases. Inflammation of the heart and pericardium are fully described under their appropriate headings.

Treatment.—The treatment of these cases is indicated by the complicating disease from which the patient dies. It is necessary to know the disease to understand the complications. If the case is one of cardiac disease, or disease of the respiratory organs, the treatment should be the same as that given under the proper heads.

CHAPTER XXXV.

DEATH FROM ACCIDENTAL CAUSES.

POST-MORTEM CASES.

Post=mortem (after death) examinations are held usually by physicians or experts, with a view to examining the viscera of the large cavities of the body. The different viscera have to be removed and the parts subjected to examination. To accomplish this, the different cavities must necessarily be opened. To open the thoracic and abdominal cavities, an incision is made usually from the top of the breast=bone, extending to the center of the pubic arch. The tissues are dissected from the breast=bone and the cartilages of the ribs; then an incision is made through the outer ends of the cartilages, near their junction with the ribs; the breast=bone is turned up over the face and held in that position, while the contents of the thoracic and abdominal cavities are removed.

In the removal of the viscera, the large vessels within these cavities are severed, entirely destroying the circulation. Not only are the large vessels severed, but also many of the smaller ones, which are connected with these by anastomoses, making the ligation of all the vessels very tedious, and, in some cases, impossible. If the organs of the pelvis are removed, the anastomoses of the internal iliac and pubic arteries will be destroyed, which makes it necessary to ligate the external iliac near Poupart's ligament, to prevent leakage while injecting the femoral arteries.

Treatment.—To inject the upper extremities, head, face, and neck, it will be necessary to ligate the innominate, left common carotid, and left subclavian arteries. The tube should be inserted into either the innominate or left common carotid—it matters not which—and the artery tied around it. If fluid is then injected, it will reach the above-named parts. If the fluid is injected through the innominate, it will pass into the right subclavian and ascend through the right common carotid and vertebral arteries to the outside and inside of the cranial cavity, through the circle of Willis at the base of the brain, then downward through the left internal carotid and left vertebral artery to the subclavian artery, thence to the left extremity. If the left common carotid is used, the fluid will take the opposite direction, reaching all the parts in a similar manner.

If the cranial cavity has been opened, by removing the skull-cap, and the brain and the meninges removed, injection through the carotids will amount to nothing; only the upper extremities can be reached, after tying the subclavian on either side and closing the foramen magnum to prevent the escape of fluid from the vertebral arteries. To reach the lower extremities, ligate the largest of the anastomotic arteries and the external iliacs (near Poupart's ligament), which supply these parts. The operation of ligating the arteries above mentioned will take not only a considerable length of time, but also will require an anatomical knowledge of the parts, at least sufficient to locate the arteries which are to be ligated.

If the tube is not tied in one of the several ends of the arteries, the arteries in the different extremities should then be raised at the points where the operator is directed to raise them in an ordinary case. The point of the nozzle can be turned toward the distal end of the extremity, or towards the heart, just as the operator chooses. As the anastomoses are not destroyed in the extremities, the fluid will reach all parts of them, just as in cases where the whole circulation is intact.

The walls of the cavities should be cleansed with a cloth or sponge and hot water, removing as much moisture as is possible; sprinkle the walls thoroughly with a dessicating or hardening compound; then cleanse and wipe dry each of the visceral organs, dusting hardening compound over them, and replace them in the cavities to which they belong. After the viscera have been replaced, the hardening compound should be dusted freely over them. A layer of cotton batting or absorbent cotton may be introduced over the viscera and the edges of the incision drawn together and stitched in the ordinary manner.

If the contents of the cranial cavity have been removed, and the trunk has not been opened, the common carotids should be tied, and a plug may be placed in the foramen magnum to prevent leakage through the vertebral arteries. Fluid can then be injected as in an ordinary case.

If, at the same time, the thoracic cavity has been opened, a ligature may be drawn tightly around the neck, just above the breast=bone, which will strangulate the vessels that have been opened within the thorax; then place the body well on the incline and fill the remainder of the cranial cavity full of fluid, allowing it to gravitate into the tissues of the neck and face. This will follow rapidly. If the brain is to be returned to the cavity, it should be covered with hardening compound or some dessicating powder; then the inside of the skull-cap and the raw surfaces of the scalp that have been removed should be dusted liberally with the drying powder, the skull=cap returned to its place, and the edges of the scalp stitched together, and fluid injected into the cellular tissues beneath the skin in quantities sufficient to fill all the tissues.

Another method, the result of which will be equally satisfactory, is to inject fluid through the cellular tissue over the surface of the extremities, at every point, instead of ligating and injecting the arteries. If enough fluid is injected through the cellular tissue over the upper surface, it will settle downward and thoroughly sterilize and preserve all of the tissues.

Whether the arteries are ligated in all cases or not, the injection through the cellular tissue underneath the skin over the trunk is necessary, as the arteries carrying blood to the soft tissues on the outside of the skeleton in the trunk cannot be reached by the arterial injection. The hardening compound, which is used within the thoracic and abdominal cavities around and over the visceral contents, will only dry and preserve the viscera, and will not penetrate or dessicate all of the soft tissues forming the walls of the cavities.

Frequently, where the circulation through the neck and cranial cavity is intact, if a cord is tied tightly around the neck, to close the arterial and venous channels in that part, one of the needle processes can be used and fluid injected into every part of the face, head, and neck, as well as into the viscera of the cranial cavity, preserving the features in a perfectly natural condition. We have accomplished this successfully in a number of cases.

The operator will be obliged to depend largely upon his own judgment in the treatment of these cases, as what will apply to one will not always apply to another.

DROWNED CASES.

When a body has met death in any manner, and is placed in the water after life is extinct, its preservation will scarcely be affected in the least. Even after remaining in the water for many hours, there is no water found in the lungs, or in any other part of the body, except that which it normally contains.

But when a body is drowned, the conditions are different. Death is caused by asphyxia. At the last effort at respiration, water instead of air is taken into the lungs. Respiration is largely involuntary—that is, respiration is carried on by muscles not under the control of the will to a very great extent. Therefore, the drowning man holds his breath as long as possible, but finally the involuntary muscles compel the effort to breathe, when water is taken into the lungs.

Treatment.—Water taken into the lungs and stomach hastens putrefaction in these organs, and, unless fluid is injected directly into the lungs through the respiratory tract, a bloody purging will follow, usually, within a few hours. After drowning, the body sinks, and, ordinarily, remains at the bottom of the water for some time, or until gases begin to generate in the cavities and tissues, which raise it to the surface. If it is taken from the water, immediately after coming to the surface, it should be covered at once, so as entirely to exclude the light and air, as they will form a kind of corroding of the skin, which cannot be removed. If the body is embalmed at once, the natural features and color may be retained.

A "FLOATER."

If the body is what is termed a "floater" (one that has been floating on the surface of the water), there will be a very disagreeable odor, and the tissues and cavities will be filled with gases. If it has been exposed for some time, the subcutaneous cellular tissue and the cavities will be filled with the gases, so that the skin will be distended to its greatest extent. It will be of a darkish=green color. The middle layer will be softened, and the cuticle will be found loose and shredded. The eyes will be bulging out of their sockets, the lips puffed, etc.

Treatment.—Cases of this kind are hard and unpleasant to handle, and it cannot be expected to make them fully presentable. Indeed, some say that nothing can be done with them, and that they should be buried at once. If these cases were always found near their homes, such treatment might be all that is necessary. But, unfortunately, the human family is migratory, and accidents and suicides occur away from home, making it necessary to ship such bodies. Even if near their homes, their families often insist upon giving them Christian burial, according to the rites of the church.

If purging is going on when the body is received, turn it upon the side, and make pressure upon the ribs with the hands, and at the same time press the diaphragm upward with the knee, to relieve the lungs and stomach of their contents. After removing all matter and water from the lungs and stomach, these organs should be filled with fluid through the trachea.

A case of this kind should be treated as follows: Place the body upon the board; if the cuticle is loose and stredded, wash it off entirely; cleanse the body of other matter; then raise an artery at some point and inject all the fluid the arteries will receive; next fill the cavities; then remove the gases from the cellular tissue and fill with fluid. This can be done by introducing the trocar or hollow=needle underneath the skin along the center of the body, over the breast=bone, the linea alba (white line of the abdomen), the upper surface of the upper and lower extremities, and under the lips, eyelids, and the wings of the nose. The gases should be allowed to escape, and fluid should be injected in large quantities. The amount of fluid necessary to use in adult cases will range from three to five gallons.

If the tissues and cavities are filled in the above manner, the putrefactive bacteria will be destroyed, and the body will harden and can be shipped to any point without giving the least trouble.

LIGHTNING AND ELECTRICITY.

Death resulting from these causes may show, in a post=mortem examination, an entirely different condition in different bodies. Some may exhibit no lesion whatever, the manner of death in these instances being shock to the brain and general nervous system. On the other hand, the electricity, in its passage through the body, may produce a number of mechanical effects. Wounds, like those inflicted by a blunt stabbing=instrument, may mark the point of entry and departure; bones may be broken, the internal viscera torn, and arteries and veins ruptured. Rigor mortis is not apparent as a rule, and the blood remains in a fluid condition.

Treatment. — Usually, decomposition commences very soon after death, so the blood should be removed at once. The femoral vein should be raised, as more blood can be withdrawn from that point than from any other. After raising the femoral artery and vein, a drainage=tube should be inserted into the vein to a point above Poupart's ligament, and tied. The artery should then be opeined and the arterial=tube inserted. The aspirator should be attached to the arterial=tube and fluid injected. However, before the injection begins, the body should be elevated, and the blood be allowed to drain out by gravitation, while fluid is being injected into the artery. After a large amount of fluid has been injected, the cavities should be filled in the usual manner.

If the case is one in which the vascular system has been destroyed, treat the cavities as usual, and fill the soft tissues on the outside of the skeleton by the injection of fluid through the cellular tissue. If the circulation is not destroyed in the head and neck, a cord should be tied tightly around the neck, and fluid injected by one of the needle processes. This will fill the capillaries and tissues of the head, face, and neck; whereas, fluid injected underneath the skin, over the parts that are exposed, will destroy the features, causing mottling or spots.

CASES OF MUTILATION.

As in Railroad and Other Accidents.

In death from railroad and other similar accidents great mutilation of the body often results. The extremities may be torn from the body; the trunk itself served in twain; the head be mashed, and the brains ooze from the wounds; vessels may be trrn, rendering the circulation of fluid through the arteries impossible.

Treatment.—The operator should use his judgment in the treatment of these cases, as they differ very much from the ordinary. If possible, the vessels should be tied and injected, but, where the mutilation is extensive and it is not possible to tie the arteries, fluid should be injected in large quantities into the subcutaneous, cellular tissue.

If an extremity be severed, a cord tied tightly around the stump will be sufficient to strangulate the vessels, so that there will be no leakage when the arteries are filled. The distal end can be injected through the subcutaneous, cellular tissue, and the surfaces be covered with hardening compound and sewed to the proximal end, or stump, covering the seam also with hardening compound.

If several of the extremities are severed, they can be treated in the same manner. When the walls of the cavities are intact, fluid can be injected freely into them and into their visceral contents.

If the trunk is severed in twain, the liquid contents should be removed as far as possible, and hardening compound used freely over the organs; then the body should be sewed together and hardening compound placed over the wound on the outside, using absorbent cotton when necessary. In mutilation which severs the trunk, the circulation will be destroyed. Before sewing the parts together, the arteries should be tied and injected; also fluid should be injected into the subcutaneous, cellular tissue, especially over the trunk and near the mutilation. All gashes and cuts should be sewed neatly and covered with hardening compound. Bruises and discolorations can be covered with pigment.

If the nose, lips, and other parts of the face that are exposed should be torn away, the raw surfaces should be sprinkled with hardening compound and covered with some white fabric. The features may be built out with plaster of Paris by an artist, and tinted, as recommended by some, but the ordinary operator will not, as a rule, find this method satisfactory.

If a body is cut to pieces in such a manner that coaptation of the parts is impossible, the following treatment may be used: Take fifteen pounds of hardening compound and twenty=five pounds of sawdust; mix thoroughly; cover the bottom of an ordinary rough box to a depth of about two inches with the mixture; place the parts therein and cover with the remainder, allowing them to remain for twenty=four to forty=eight hours, after which time they will be dessicated thoroughly, and can be handled without the presence of odor or moisture.

GUNSHOT WOUNDS.

In cases of death resulting from gunshot wounds, the circulation frequently is destroyed in the parts, the immediate cause of death being hemorrhage.

Treatment.—In the treatment of these cases, it will be necessary to cut down to and tie the artery, if it is wounded or severed. Death may result from hemorrhage, caused by the wounding of a large vein within the trunk, or within one of the cavities. If a vein only is wounded, the vessel will not have to be tied.

If the wound be through the aorta, or one or more of its large branches, the injection of fluid through the arterial system would not be successful in filling the capillaries of the soft tissues on the outside of the body. The fluid would pass through to the wound and there escape into the cavities of the trunk, resulting in cavity injection alone; hence, the necessity for tying the artery on both sides of the wound. If the artery or arteries cannot be tied, fluid should be injected into the subcutaneous, cellular tissue over the upper surfaces of the body, and the cavities should be filled in the usual manner.

If the wound is through the skull, the ball having made the hole of entrance and exit through the skull=bones, the holes can be closed with putty, plaster of Paris, or pledgets of absorbent cotton, and the injection can proceed as if the circulation were not destroyed within the cavity.

If the skullcap has been torn away, the body should be placed very high on the incline, an artery raised, and fluid injected very slowly until fluid appears in the wound, when it should be allowed to gravitate and settle into the tissues. After a time, the injection can be repeated, and, in this way, a sufficient amount of fluid be injected to fill the capillaries in the parts below the skull. After the injection through the arteries, fluid should be introduced directly into the remaining brain substance, and the whole covered with hardening compound. The inside of the skullcap should be dusted with powder and the parts that remain should be placed in position. Fluid should then be injected into the subcutaneous, cellular tissue in all parts of the scalp that are not filled with fluid by the injection of the arteries. The wound should then be covered with absorbent cotton, and held in position with a roller bandage.

Again, the arteries may be strangulated in the neck by the application of a fine cord, which should be drawn tightly to prevent leakage through the skull, while the extremities and the trunk are being injected with fluid. The face and upper portions should be treated by the subcutaneous injection of fluid, and the brain or remaining contents of the skull should receive special treatment, as directed above. After a time the cord around the neck can be removed. The judgment of the operator should govern in the treatment of each case.

ASPHYXIA.

Asphyxia is understood to mean the condition that results from the interruption or cessation of the function of respiration. The causes of asphyxia are: disease of, or injury to, the medula oblongata, producing paralysis of the respiratory nerve=centers; paralysis of the nerves or muscles of respiration; collapse or disease of the lungs; closing of the air=passages by tumors or spasms of the glottis; by foreign bodies; suffocation; strangulation; hanging; drowning; etc.

The blood is of a dark color, owing to complete reduction of the hemoglobin and the proportion of the carbonic acid gas being greatly increased. The blood coagulates slowly or imperfectly, remaining fluid for a long time, or forming only a few soft coagula. The right side of the heart, large venous trunks, and the pulmonary artery, are distended with dark blood. Sometimes the left side and large arteries are full, but more frequently they are empty, or contain only a small amount of dark blood. The capillaries of the face and neck may be more or less congested. The lungs may be full of blood, but more frequently are pale and anemic. Usually the abdominal viscera are engorged.

Treatment.—In asphyxia, the smaller vessels and capillaries of the surface are filled with blood, causing a dark-bluish discoloration, especially in the face and neck. To remove this congestion, the body should be placed high on the incline, and the blood withdrawn by tapping the heart direct or through the basilic or femoral vein. It is better to raise the femoral vein, as it is most dependent, and gravity will aid the operation. Fluid should be injected through the femoral artery—that is, provided the femoral vein is used—which will aid in forcing the blood from the vein by pressure upon the peripheral vessels. Fluid should be injected very slowly and carefully. If the radial or brachial artery is used, then the direct operation upon the heart, or the basilic vein-tube, will answer for the withdrawal of blood. This should take place alternately with the injection of fluid through the artery—pumping out as much blood as possible, then injecting a pint or two of fluid, and pumping alternately until the blood has been withdrawn. If the rim of the ear still remains dark, it should be turned upward and pressed upon to remove the blood in the vessels and capillaries. The needle processes are not necssary, as the blood can be withdrawn as directed.

DEATH BY FREEZING.

Bodies that are frozen will be rigid, due to the freezing of the liquids in the tissues near the surface, very much resembling the condition known as rigor mortis. There is this difference, however: when the rigidity of freezing is broken up there will be heard a crackling sound, similar to that of breaking a frozen cloth, due to the fracture of the frozen liquids.

The surface may be frozen and still death may not be present. If there is a doubt, the body should be taken into a room, not too warm, and cold water first applied to the surface, making successive applications, increasing the temperature of the water each time. Then place in blankets, rub and chafe the surface of the body until signs of life return; do not place it too near the fire or a strong heat too soon, as such practice will not result satisfactorily. If death is really present, the blood will be found thin, after the body has been thawed out, as freezing does not coagulate the blood; in fact, it retards coagulation.

Treatment.—As soon as the body is thawed out, the blood should be withdrawn, and the body filled with fluid as in any other case.

CHAPTER XXXVI.

DEATH FROM POISON.

Fluid should not be injected into a case dying from natural causes, if it is known that a post=mortem examination is to be held, or scientific investigation is to be made. If fluid is injected, it will change and harden the structure so that a microscopic examination cannot be made; nor will the tissues have the same appearance after the injection. Neither should fluid be injected into a case dying under such circumstances as to permit a doubt as to whether death resulted from natural causes or from criminal practices. If fluid is injected, the real cause of death may be entirely covered, as when metallic or other poisons are used for the purpose of producing death.

In all such cases, the coroner should be called at once, and the operator should be governed entirely by the official decision in the case. If the coroner permits the embalming of the body, the responsibility rests on him alone; but, if embalming should be practiced without his permission, the mistake will rest with the operator.

When murder is committed, everything should be done to aid the law to place the crime where it belongs. The sources of evidence, in cases of suspected poisoning, are the symtoms, the post=mortem appearances, and chemical analysis of articles of food and drink, and of the body and excretions. The poisons most commonly administered are opium, prussic acid, arsenic in various forms, phosphorus, oil of vitrol, the mercurial salts, and oxalic acid. Sometimes persons are found dead, as the result of poison, concerning the manner of whose death nothing whatever can be learned; a suspicion of poisoning arises from the circumstances under which the corpse is found. In such a case, chemical analysis ought invariably to be invoked.

The effects, in the case of many poisons, may be manifested either suddenly or slowly; hence, we have acute and chronic poisons. Cases of chronic poisoning are usually the result of the repeated administration of small doses of lead, copper, mercury, phosphorus, or arsenic. The general conditions which excite a suspicion of poisoning are the sudden onset of serious and increasingly alarming symptoms in a person previously in good health, especially if a prominent symptom be pain in the epigastric region; or where there is complete prostration of the vital powers, a cadaverous expression of the countenance, an abundant perspiration, and speedy death. In all such cases the aid of a chemist is required, either to confirm well=founded, or to rebut ill=founded, suspicions.

Poisons may be divided into three classes: first, corrosives; second, irritants; third, neurotics.

Corrosive Poisons.—The most commonly administered corrosives are the mineral acids—sulphuric, nitric, hydrochloric, and oxalic; the alkalis—potash, soda, and ammonia; bisulphate and carbonate of potash; and zinc, tin, antimony chlorides, and silver nitrate.

The mineral acids and the alkalis have scarcely any remote effects upon the system, their action being almost purely local. The symptoms of corrosive poisoning are marked and unmistakable, except when the patient is an infant. Immediately after swallowing the corrosive substance, there is an acid, caustic, or metallic, burning sensation felt in the mouth, fauces, gullet, and stomach, which speedily extends over the whole abdominal region. Vomiting usually follows; the contents of the stomach at first are altered, more or less, by the action of the poison; no relief is afforded by the evacuation of the stomach; and, later, the vomits may be mingled, more or less, with altered blood, which may be dark or even black;

shreddy mucus, casts of the gullet or stomach, formed by the shedding of the mucous membrane, and sometimes even the muscular wall of the esophagus, are ejected. The abdominal pain is aggravated greatly by pressure. The whole abdomen is distended by the gases evolved, owing to the action of the poison. The diaphragm is pressed upon, and extreme difficulty of breathing results, owing to pressure upon the lungs. In some cases the secretions are suppressed, while in others they are increased. The mouth, tongue, and fauces exhibit the local effects of the corrosive that has been taken; a yellow coating may be observed in the case of nitric acid; white, at first, and as if covered with paint, from sulphuric acid; and whitish or brown and less thickly coated, from hydrochloric acid. Yellow or brown stains may be observed on the skin, extending downward from the angles of the mouth, caused by trickling of the acid or other corrosive fluids from the mouth. The surface of the body may become of a purplish hue, due to the difficult respiration. Death usually occurs within a period of twelve to twenty-four hours.

When nitric acid or ammonia is taken, death may be caused by the vapors gaining access to the air=passages and lungs.

Oxalic acid in concentrated solution is undoubtedly a corrosive and irritant poison, but it usually produces death by its depressive action upon the heart, before corrosion of the mucous membrane of the alimentary canal takes place.

IRRITANT Poisons are of two classes, usually, metallic irritants, and vegetable and animal irritants, the latter two being grouped together.

An irritant is a poison which causes inflammation of the parts to which it is applied, usually the alimentary canal. The most important of the metallic irritant poisons is arsenic; others are the salts of antimony, zinc, and other metals. Elaterium, essential oils, and gamboge may be cited as examples of vegetable irritants; and cantharides, of animal irritants.

The symptoms differ from those of corrosive poisons by being much slower in development and effects upon the system. The post=mortem appearances, in cases of irritant and corrosive poisons, are corrosions in the mouth, fauces, gullet, and stomach, the mucous membrane being shriveled, altered in consistence and color, and more or less detached; irritation and inflammation of the stomach and upper portions of the small intestine; ulceration; and erosion. In corrosive poisoning the stomach may be perforated, the edges of the aperture may be shreddel, and, in the case of sulphuric acid, the viscera may be blackened from the action of the acid upon the blood=pigment. The small intestine is implicated to a varying extent, or may altogether escape. The large intestine may be attacked, but this is more especially the case in poisoning by mercury. Arsenic experts a specific effect upon the mucous membrane of the stomach.

Neurotic Poisons are those which produce death through the nervous system. This class embraces pure narcotics, such as morphia, chloral hydrate, prussic acid, aconite, belladonna, carbolic acid, stychnia, hyoscyamus, etc. The symptoms are necessarily of the most varied character.

Chloral hydrate causes death after a stage of unconsciousness; the nature of the poisoning is determined usually by the surroundings, there being a bottle or some other retainer which will show evidence of the presence of chloral.

Prussic acid produces its effect in the course of a few minutes, or it may be seconds only. Usually the pupils will be dilated and the surface of the body cyanosed (purplish in color).

Aconite produces death quickly without any apparent anatomical changes.

In cases of belladonna, the pupils will be widely dilated.

Carbolic acid, or phenol, whitens and shrivels the membranes with which it comes in contact, and not only acts as a corrosive, but produces speedy narcosis. The peculiar odor of phenol is always perceptible, though not infrequently overlooked.

In strychnia, the anatomical appearances are very ill=marked, and, at most, consist of some congestion of the spinal cord, and even this may be wanting.

Hyoscyamus, and others above mentioned, have no anatomical lesions that are noticeable.

Treatment.—The treatment in the above cases should be the same as in ordinary cases.

OPIUM OR MORPHIN POISONING.

In consequence of the extent to which opium and its preparations, including morphin, are used for the relief of pain, and the readiness with which the drug is procurable, poisoning by opium is very common, and there is no doubt that a great number of persons perish every year in this country through its improper use, as we have many preparations known as "quack remedies" that contain a large amount of opium. So far as toxicology is concerned, the effects of opium are due to the morphin it contains, since the effects of other active constituents of the drug are overshadowed by those of this, its chief alkaloid.

The post=mortem appearances after opium poisoning are not prominent, or may be said to be almost nil. As a rule the brain is congested, and the lungs and right side of the heart are more or less engorged, as if death were the result of asphyxia; but this is not so in all cases.

Treatment.—The greatest trouble that the embalmer experiences, is in the discolorations that follow after twenty=four to forty=eight hours. The preservation of these cases is as easy as those dying from any ordinary disease. In consultation with undertakers throughout this country, we find that their experience has been, almost universally, that thorough injection of the arterial system, and the introduction of fluid throughout the cavities, will preserve these bodies; but, after twenty=four to forty=eight hours, a discoloration of the surface, either wholly or at certain points, especially over the head, neck, and face, of a chocolate or brownish=yellow color, will follow. The question has been asked many times, "What is the cause of this? Is it due to the introduction of certain chemicals, or is it due to the putrefaction of certain parts of the skin or other tissues of the body?" In fact, it has been a matter that has not been understood heretofore, either by the teachers of embalming, or by those who have had occasion to embalm bodies dying from the effects of opium.

After a thorough examination of such cases and numerous experiments, we have come to the conclusion that this discoloration is due to the pathological changes of certain constituents of the blood. It seems that the corpuscles are disintegrated more or less after the full effects of the opium are present. By placing a portion of the blood under the microscope, we have been able to find an abundance of hematoidin, due to the disintegration of the red corpuscles, the coloring matter of which is dissolved more or less in the liquid portion of the blood. This pigment exudes into all the tissues of the body, including the middle layer of the skin, producing a chocolate color or brownish=yellow tinge.

As will be seen, this tinge is from the imbibition of the aforesaid blood=pigment, that has reached the middle layer in a state of solution. This may occur over the surface of the body and the face at different points. Many cases present general discoloration, while others may be discolored only in certain parts, as a portion of the face on either side, or as spots upon the forehead, etc.

This discoloration is permanent; no bleacher that may be applied externally or internally can possibly remove it. Therefore, to preserve such a case thoroughly is all that can be expected. However, if the embalmer is an artist as well, he may tint the face with pigment to make it appear more natural. The body should be placed on an incline, the blood withdrawn, and the arteries filled with fluid; the gases should be removed and fluid injected into the cavities in the usual manner.

POISONING BY ARSENIC.

Arsenic is classed as a metallic irritant poison, though its action is not limited, by any means, to that of an irritant. It acts specifically on the mucous membrane of the stomach and intestines, whatever be the channel by which the poison gains access to the stomach. The most usual source of acute arsenical poisoning is the administration of white arsenic (arsenious acid), but sometimes the sulphides, various arsenides, and poisonous commercial articles, such as dyes, wall paper, and pigments, may be taken into the system by inhalation or absorption.

Poisoning by arsenic may be either acute or chronic. By acute, we mean that which follows the taking of large doses, especially that of the white arsenic or arsenious acid, which produces death quickly; while by chronic, we mean that form of death which follows the gradual administration of arsenic, or by the inhalation of its fumes in the manufacture of wall=paper, pigments, etc.

The effects of aresnic upon the system are similar, whether large or small doses have been taken, or by whatever channel the poison has gained access to the stomach. As a rule, there is marked inflammation of the stomach and duodenum, and usually of the small and large intestines, also; but not uncommonly the inflammation is limited to the stomach, duodenum, and rectum, the intervening alimentary tract having escaped. If the poison has been administered in a solid form, white patches of the arsenical compound may be found imbedded in thick, bloody mucous and inflammatory exudations. Portions of the white arsenic, also, are converted sometimes, by the sulphureted hydrogen evolved during decomposition, into yellow sulphids. Ulceration of the stomach is rare, and perforation almost unknown. It is true, the above condition in part—that is inflammation of the stomach, duodenum, and small intestine—is present, to a greater or less extent, in poisoning, by all of the irritant poisons, such as corrosive sublimate, hydrochloric and oxalic acids, potash, soda, ammonia, etc.

Arsenic exerts a specific effect upon the mucous membrane of the stomach. On account of the great penetrating character of arsenic, if it is taken in large doses, it will penetrate the tissues and reach almost every part of the body, thereby having a tendency to preserve the tissues, it being antiseptic in its action, and having the power of retarding the growth of the bacteria of putrefaction.

Treatment.—Cases of this kind should not be hard to preserve. As stated above, preservation will follow its presence. The effect upon the circulation and upon the capillaries produced by the straining, caused by retching and vomiting, and the direct effect of the arsenic upon the blood=pigments, may produce peculiar discolorations, which may be hard to remove, although, if the usual means of removing discolorations are applied, a natural appearance may be produced.

The body should be placed high upon the incline, and the blood withdrawn by the direct operation upon the heart, or through one of the veins. If there still remains a dark or bluish discoloration, an application of ice and salt may be made with good effect. Then the body should be injected carefully, through the arterial system, filling the tissues thoroughly. The cavities should be freed from gases and filled with fluid in the usual manner.

POISONING BY MERCURY.

Mercurial poisoning may be either acute or chronic: the former resulting from the administration of one or several large doses at short intervals; the latter form arising from the repeated administration of small doses of the less active preparations of the metal.

Acute Mercurial Poisoning.

The effects produced by a considerable dose of one of the more soluble compounds of mercury, such as the bichlorid or the nitrate, are those of a corrosive, irritant poison. The effects are immediate; even in the act of swallowing the patient experiences an intense burning sensation in the mouth and throat, which is followed by excruciating pain in the stomach and throughout the abdomen. The local effects are frequently seen, as the whitening of the tongue and fauces. When a concentrated solution of bichlorid of mercury is applied to the unbroken skin, most of the effects of mercurial poisoning may result.

The anatomical changes that are induced by mercurial poisoning are those of inflammation and even erosion of the mucous membrane of the stomach and extravasation of blood beneath this membrane. The whole intestinal tract exhibits signs of extensive inflammation, which is noticed especially in the large intestine. The mucous surface of the rectum is covered with shreds of bloody mucus and usually exhibits signs of intense inflammation. The appearance of a peculiar slaty color of the mucous membrane of the stomach and intestines, where inflammation has not been intense, has been thought to be characteristic of poisoning by corrosive sublimate. There is a great resemblance in the symptoms produced by arsenic and those produced by corrosive sublimate and other corrosive preparations of mercury, but the diagnosis is generally not very difficult. The greater frequency of bloody stools and metallic taste in the mouth, following almost immediately on the administration of a large dose of corrosive sublimate, serve to differentiate between the poisons. If doubt exists, an analysis of the secretions may be made. Mercury is most readily detected in the saliva, and arsenic in the urine. Where salivation, and the peculiar fetor of the breath exists, they will also be valuable aids in determining which of the poisons has been taken.

Treatment.—Embalming should not follow, in cases of mercurial poisoning, until permitted by the coroner or some other agent of the law. The treatment should be varied according to the condition. Generally the filling of the tissues and cavities in the usual manner will be all that is required.

Chronic Mercurial Poisoning—Mercurialism.

The repeated ingestion of small doses of the more soluble and active salts of mercury, such as the bicyanid and bichlorid, sometimes gives rise to chronic symptoms, but more frequently those symptoms result when one or more doses of the more insoluble preparations of the metal are administered, such as calomel or the oxids. Chronic symptoms, which follow the administration of one dose of mercury, may not be altogether due to the peculiar idiosyncrasy of the patient, but may be attributable, to a certain degree, to the slowness with which the mercury is eliminated from the system. There appears, also, to be a remarkable difference between mercuric and mercurous salts in respect to their toxic properties, which is not altogether dependent upon their differences in solubility. Mercuric compounds are more solvent than mercurous salts. Salivation is the most common result of the continued administration of mercuric compounds. In these cases, there is a previous discharge from the salivary glands, swelling and tenderness of the gums, and a peculiar fetor of the breath. Occasionally there is gangrene of the cheeks, a fatal result sometimes ensuing.

Workers in mercury, the looking=glass, barometer, and thermometer makers, are apt to suffer from a peculiar form of shaking palsy, known as the "trembles," which may result from the handling of the oxids of the metal, but more frequently results from the mercurial fumes. The upper extremities are first affected, the whole muscular system following by degrees. The condition is intensified on attempting to exert the muscles, as in passing a glass of water to the lips, or in an attempt at locomotion; when the patient tries to walk, he will break into a dancing trot. In advanced cases, the muscles of mastication and deglutition are affected, and finally delirium, mania, and idiocy, may follow the continued inhalation of mercurial fumes, death resulting sooner or later in many cases.

Treatment.—In the treatment of the cases, the ordinary methods will usually suffice. There is generally a metallic tinge in the skin, which it is impossible to remove. Powdering or artistic application of tints will, in many cases, have a pleasing effect.

POISONING BY CARBONIC ACID.

To inhale carbonic acid (carbon dioxid) will produce fatal results sooner or later, owing to the degree of concentration. It accumulates in a very concentrated degree in pits, cellars, mines, old wells, lime=kilns, fermenting=vats, etc. When it is undiluted it is very rapidly fatal, as is seen when persons incautiously descend into an old well, or where miners enter an old mine, or certain parts of a mine after an explosion. Death in these cases results very quickly.

Poisoning by carbonic acid produces the condition known as asphyxia. There is a general engorgement of the whole venous system. The veins of the brain are especially full. The blood is of a dark color and very fluid. It remains fluid for a long time, coagulation being retarded very materially. The hemoglobin is reduced completely, so that it readily transudes into the tissues. The normal heat of the body is retained for a long time after death. Rigor mortis is well marked, coming on slowly and remaining many hours. The appearance of the lungs is not constant. They are not always congested, but are frequently pale and anemic. The posterior and dependent parts of the lungs are congested hypostatically. The surface of the body will appear very dark, on account of the presence of an excess of the carbonic acid gas, due not only to that which is inhaled, but to a large amount being re tained in the system on account of insufficient aeration.

Treatment.—The body should be placed high on the incline and blood withdrawn. If a large amount of blood is withdrawn, the blueness of the surface will disappear, but the red discoloration will remain, owing to the reduction of hemoglobin, and its having transuded into the tissues outside of the vessels, especially those near the surface. An artery should then be raised and the body filled with fluid. The cavities should be treated in the usual manner. On account of the hypostatic congestion of the lungs, fluid should be injected through the respiratory tract. If this is neglected, purging from the lungs is very liable to follow.

POISONING BY CARBONIC OXID.

Carbonic oxid is a far more dangerous agent than carbonic acid, and to it are due many of the effects sometimes ascribed to the latter. It is an extremely active poison. The deaths caused by charcoal fumes are due to the presence of carbonic oxid. It also exists in coal gas and constitutes its main danger. Suicide is committed frequently by the inhalation of charcoal fumes but deaths usually occur by accident from sleeping in close rooms in which the fumes escape from the stove or pipe, death resulting very quickly.

The special morbid characteristics are the bright, cherry=red color of the blood and of the structures and surfaces of the internal organs. If the peripheral vessels are engorged, or the head and face congested, they will be of a very bright=red color. The post=mortem discoloration is of a similar red tint; even where no congestion exists, in certain parts of the body, as of the face, a ruddy hue is attained. The red tint of the blood is due to the compound which carbonic oxid forms with hemoglobin, which is very stable and not readily broken up; and hence the oxygen=carrying power of the corpuscles is paralyzed. The hemoglobin, in these cases, resists reduction in the usual manner, differing, therefore, from the normal blood=coloring matter. The heat of the body is retained for a long time; coagulation is retarded; rigor mortis comes on slowly, is well marked, and lasts for a long time.

Treatment.—After placing the body upon the incline, the blood should be withdrawn, by tapping the heart direct, or through one of the veins. If the body remains on the incline until the blood settles out of the peripheral vessels, the redness of the surface will disappear, as the redness is due to the changed color of the blood only, and not to the reduction of the hemoglobin. Therefore, it does not pass out into the tissues. An artery should be raised and the capillaries filled very thoroughly, followed by the filling of the cavities by the usual operations.

POISONING BY COAL GAS.

Coal gas employed for illuminating and heating purposes contains, in addition to the olefiant gas and analogous hydrocarbons, on which the illuminating power is dependent, certain other gases, called diluents, such as hydrogen, marsh gas, carbonic oxid, together with certain impurities, as carbonic acid, sulphureted hydrogen, and bisulphid of carbon. The characteristic odor of coal gas is mainly dependent upon these impurities. This odor is perceptible when mixed with atmospheric air to the extent of 1:10,000, making it a valuable safe=guard against accidents which occur from escaping gas. In addition to the danger from inhalation, fatal accidents often result from explosions which occur if a match is lighted in an atmosphere containing 10 per cent. of gas. A less proportion than 10 per cent. is non=explosive, but will prove fatal if inhaled for a long period of time.

Poisoning by coal gas is frequently the result of an accident by inhalation, which may ensue among workmen from exposure to a sudden rush of undiluted gas, from gas meters and mains, filling the apartments in which they are confined. Persons who are not in the habit of burning gas for illuminating purposes, may leave the gas=taps open, on account of not knowing how to turn them off properly. Occasionally, coal gas is used for suicidal purposes by turning it on in a close room. More frequently, slowly fatal cases may result from a gas=tap being left open through carelessness, or from the accidental extinction of the light, or from leaking of gas pipes in the house or from the main. In the latter case, the gas enters the room through cellars, walls, or by means of drainage or sewer pipes.

On handling or opening the body, the smell of gas is often very marked. The blood is of a dark color and it coagulates very readily. There is a bright color of the pulmonary tissues, froth in the air=passages, and congestion of the mucous membrane, especially at the base of the tongue. There is also engorgement of the cerebral and spinal veins and rose=colored patches on the thighs. As in all cases of asphyxia, the surface becomes congested and of a dark=bluish color; this is marked in the head, face, and neck. Frequently, a bloody, frothy purge escapes from the mouth and nose.

Treatment.—The blood should be withdrawn as soon as possible after death, on account of its becoming coagulated so quickly, to relieve the congestion and to remove the discoloration, especially in the parts that are exposed to view. If the blood has coagulated already in the large vessels, it can be removed from the surface by application of the ice and salt mixture. If the blood is coagulated firmly in the small vessels and capillaries, nothing will remove the discoloration. Fluid should be injected into the lungs through the respiratory tract; otherwise, the treatment should be as in an ordinary case.

CHAPTER XXXVII.

MSICELLANEOUS DISEASES.

CHRONIC ALCOHOLISM.

In giving the morbid changes that take place in the body from chronic alcoholism, we can do no better than quote from Curnow:

"The amount of fat in the blood is increased, or it becomes more visible. Chronic congestion or catarrh of the stomach, leading to atrophy of the gland=cells, and an increase of sub=mucous connective tissue, is very constant, but chronic ulcer is not frequent. The liver is first enlarged from congestion, and may continue so from a subsequent infiltration with fat; but more frequently it shrinks, owing to cirrhosis. Lobular emphysema, chronic bronchitis, and hypostatic pneumonia are common. The heart is flabby, dilated, and presents fatty infiltration or even degeneration of its muscular tissue; but it may be hypertrophied, probably as a result of coexistent disease of the kidneys. The arteries and endocardium are studded with atheromatous deposits; the capillaries are congested; and the veins varicosed. The kidneys exhibit the fatty, or more commonly, the granular form of Bright's disease. The muscles are pale and flabby, and even in the bones formation of fat takes place at the expense of the bony texture. The nervous centers are atrophied and tough; the convolutions are shrunken; the nerve=cells and nerve=fibers are wasted; and an increased amount of serous fluid exists in the ventricles and subarachnoid spaces. The abnormal adhesion of the dura mater to the cranium, the large Pacchionian bodies, the opaque arachnoid, and the thickened pia mater, will testify to an exaggerated development of fibrous tissue. Occasionally hemorrhage into, or softening of the brain, consequent on the diseased states of the blood=vessels, is met with. The increase of connective tissue is especially marked in spirit drinkers, and explains the emaciated appearance, prematurely aged look, sunken cheecks, and wrinkled countenance, which they generally present. The beer and wine drinkers on the contrary, are loaded with fat, not only in the viscera, but in the subcutaneous tissue and the omenta; and hence, these subjects are corpulent, with oily skins and prominent abdomens. even when the face and extremities are wasted. Gouty deposits are also frequent."

In these cases dropsy is usually present. Congestion of the pharynx, red and inflamed conjunctiva, turgid capillaries, and the face filled with little pimples, known as acne rosacea, mark the confirmed toper.

Treatment.—The above described morbid condition will lead you to determine that a great change has taken place in the confirmed drinker, and it is no wonder that in many cases the small amount of fluid that is used is followed by trouble. It is true that alcohol is antiseptic, but the amount of alcohol in the system is not sufficient to prevent the growth of the bacteria of putrefaction.

Owing to the destruction of the capillaries, and the interference with the circulation in general, fluid does not penetrate every part of the body. Therefore, those parts that are not impregnated with fluid will constitute a soil for the growth of the bacteria of putrefaction. Hence, the trouble we have in these adcohol cases. Indeed, there are cases dying from alchoholism, where putrefaction seems to begin immediately after death. Rigor mortis comes on and passes off within a few minutes. When putrefaction begins in such case, where rigor mortis is absent, the body must be filled. The fluid should be injected, not only through the arteries, but into the cellular tissues beneath the skin through the hollow=needle as well. Also the cavities and all the openings of the body should be well filled with fluid.

ACUTE ALCOHOLISM.

In cases of acute alcoholism we are liable to have only local troubles, such as discolorations. A large amount of undigested food in the stomach and gases in the small and large intestines, and sometimes ruptured blood=vessels, and cerebral hemorrhage, may be present.

Treatment.—Special treatment will be required in each individual case, but there is no reason why a body dying from acute alcoholism cannot be kept in the hottest weather, if sufficient fluid is used. The arteries and capillaries of the circulation are not destroyed, as they are in chronic alcoholism. The tissues are in a more natural condition, not being hard or indurated; neither is the connective tissue filled with an unusual amount of albumen at any point. The chemicals will penetrate the tissues without any trouble, and will reach every part of the body. The arteries and cavities should be filled with fluid; enough should be injected to bloat or swell the body.

DELIRIUM TREMENS.

Delirium tremens (mania a potu) is really only an incident to chronic alcoholism, and results from the long=continued action of the poison on the brain. The condition was first accurately described early in the nineteenth century. The essential nature of the affliction is associated with the loss of the cerebral power in the control of thoughts, emotions, and muscular action, consequent to an over=excitement of alcoholic stimuli; sometimes it is immediately dependent upon the diminution of the degree of excitement to which the brain has been accustomed. Death may result in from three to seven days. The greatest mortality in delirium tremens is between the ages of twenty-five and fifty. The pathological conditions and changes are the same as in chronic alcoholism.

Treatment.—These cases require very thorough treatment. The condition of the arteries is very often such as to prevent a successful injection of the vascular system, and, as all the organs contained in the cavities of the abdomen and chest, as well as the brain, are involved, a most thorough treatment of them is necessary. Use one of the needle processes for the introduction of fluid into the brain tissue. As much fluid as the arteries will receive should be introduced into them. The blood should be withdrawn by one of the processes given. The lungs should be filled by the injection through the trachea. Sometimes there is an effusion in the pleural cavities; aspirate to determine that fact; then fill the cavities with fluid. The stomach should be injected through the esophagus with a stomach=tube, or through the hollow=needle inserted in the epigastric region. The cavity of the abdomen should be injected to distention, allowing the body to remain perfectly level as long as possible, that the fluid may be kept in contact with the liver, spleen, pancreas, and kidneys. A second injection of the abdominal cavity in six to eight hours would be advisable, after aspirating the fluid first injected.

JAUNDICE OF THE NEW BORN.

The normal red color of the skin in children frequently changes on the second, third, or fourth day after birth to a yellow or jaundiced hue. The yellow tinge is deeper on the face and trunk than on the extremities. There is usually no special digestive or constitutional disturbances, although weaklings more often present this discoloration than do the vigorous. In a large majority of cases, the hue is almost certain to vanish within a week or two, leaving no trouble behind. Occasionally, though, there are complications which produce death, leaving this jaundiced condition of the surface.

The cause of this trouble is still a disputed matter. Numerous theories have been advanced, but no one of these has gained universal acceptance to this day. Formerly there was a considerable tendency to regard the jaundice as a peculiar change taking place in the blood. This was supposed to be due to the transformation of the pigment of broken down corpuscles. This view was supported, to a certain extent, by the light color of the urine. and the yellow color of the stools—the yellow color of the stools showing that the bile was passing through the ducts, and the light color of the urine indicating that it did not contain bile-pigment. But more recent and accurate examinations have shown that the urine does contain biliary-pigment, as does also the kidneys of such children as happen to die during the existence of the jaundice; biliary acids will be found also in the effusion of serum in the serous sacs. Therefore, it may be considered certain that this discoloration is due to hepatic changes. But just how the retention of the bile, and the consequent absorption by the circulation, are caused, we are not able to state. It is possible that the bile is not ejected properly, on account of weakness, or the ducts may be too narrow, or they may be temporarily obstructed by some foreign substance.

It has been noted that after death there is a tendency to considerable passive congestion of the liver, with edema of Glisson's capsule, and pressure upon the small bile-ducts. The tendency, for the first few days of life, to a comparatively large amount of bile secretion, due to the destruction of considerable numbers of the red globules, should be considered carefully. In rare instances, there is complete closure, or even absence, of the large biliary ducts, due to malformation. Then of course, marked jaundice comes on at once after birth, and is persistent, death resulting after a few weeks.

Treatment.—This discoloration cannot be removed; it is, no doubt, due to the bile-pigment, and is a permanent discoloration, which is located in the middle or soft layer of the skin and deeper tissues. These cases may be preserved by the injection of fluid into the cavities, with the addition of the application of fluid over the entire surface of the body. The method of applying the fluid should be through the medium of cloths, lintine, or absorbent cotton, which should be soaked in the fluid and placed over the entire surface of the body, the whole being covered with some fabric, such as rubber cloth or oiled silk, which will prevent the air coming in contact with the fluid. The tissues, being very soft, may, in due time, absorb a sufficient quantity of fluid to sterilize the tissnes on the outside of the body.

DEATH OF MOTHER AND FETUS IN UTERO.

While the mother is alive, a dead fetus in the womb, thus protected from the air, duoes not putrify, but undergoes the process of masceration; the whole body becomes soft and flaccid, its tissues being infiltrated with fluid; but it has no odor. The skin presents points filled with reddish=brown serum, and the epidermis is readily detached with slight friction. The color of the surface is of a bluish cast, which, after exposure to the air, becomes more or less bright=red; it is not greenish, as is seen in putrefaction. The cellular tissue is infiltrated with bloody serum. The viscera of the different cavities have lost their peculiar tints and have become a reddish=brown color. The cranial bones are unnaturally mobile, overlapping one another to a greater extent than in life; and the periosteum may be absent from them.

When the death of the mother also takes place, the conditions of the fetus are quite different. The body of the child is immersed in the liquor amnii (water of the womb). This water will become filled very quickly with putrefactive bacteria, causing putrefaction to take place almost immediately in the fetus. If the liquor amnii were not present, there would be no cause for the immediate putrefaction of the fetus.

Treatment.—In the treatment of a case of this kind it is essential to insert the hollow=needle and remove the water entirely, or as much of it as possible; then inject fluid sufficient to fill the entire cavity of the womb. This takes the place of the former fluid, thoroughly immersing the child, making it impossible for putrefaction to take place.

The proper point to insert the needle, to reach the cavity of the womb, is the median line, between the umbilicus and pubic arch. It should be pushed through the wall of the abdomen, and through the wall of the womb. The womb will be found to be a hard substance, and you will readily observe when the point has reached the cavity. The child may be lying immediately in front of the point, and the instrument may enter the body of the child, which would prevent the withdrawal of water. Therefore, it is necessary to be careful, and manipulate the instrument in such a manner as to reach the water.

Fluid injected into the arteries of the mother is said to reach the child through the arteries and circulation connected with the mother, in the same manner that the nourishment reaches the child while life is present in both child and mother. Even if that were the case, the amount reaching the fetus, in this manner, would not be sufficient to destroy the possibility of putrefaction, as the medium through which putrefaction takes place has not been removed. The injection of fluid into the fetus is not necessary; as, by filling the womb with the fluid, the child will be practically in pickle.

In these cases, the mother should be treated in the usual manner, always considering the disease producing death. These cases have been troublesome to the embalmer, and very frequently questions are asked concerning them, and experiences related in regard to them; but the method given above, if followed carefully, will result in every instance in a thoroughly preserved case.

SENILITY OR OLD AGE.

Senility (old age) is the condition of the body which usually supervenes naturally after the seventieth year, but sometimes occurs earlier. We do not know why the body should gradually decline after it reaches a state of maturity and vigor, but such is the case, to a greater or less extent. The most characteristic change of the structure is progressive atrophy of almost all of the tissues and organs of the body. The degree of waste varies, but the weight and height is diminished generally, except in those persons who carry with them through this age an increase of fat or adipose tissue.

Among the organs which exhibit simple atrophy in the highest degree are the brain and spinal cord, organs of generation in both sexes, the mucous membrane and glands of the digestive tract, the mucous membrane of the bronchi and bladder, the spleen, the lymphatic glands, and the kidneys. The muscles waste, the teeth fall out, and the bones become thin and deficient in animal matter—some much altered, as, for instance, the lower jaw.

Among the most important changes, and one that exercises a very direct influence on tissue nutrition, is the excessive shrinking and even obliteration of the capillaries in almost all textures. The skin becomes much diminished in thickness, especially in the inner layer. When this occurs, it is easily seen why in old age there will follow, after the injection of fluid into the arterial system, greenish, brownish, and soft spots, in the different parts of the body, especially noticeable in the face, neck, and hands. The products of degeneration may accumulate in the tissues and cause them to be thicker than they are in health, as is seen in the vessels, the walls of which are much thicker than normal. The blood contains fewer corpuscles and solid constituents, is more watery, and coagulates more readily; also the total quantity is less. The pericardium, the endocardium, and the capsules of the liver and spleen, are opaque and toughened. Degeneration of the cardiac substance may lead to a state of asthenia, which gradually produces death. Dilatation of the orifices of the heart may be the more prominent lesion, or they may be contracted by atheroma, or by thickening of the valves or rings. Indeed, all kinds of cardiac lesions are met with in old age. The lungs are changed more or less, increasing the bronchial secretions, which during life have been attended by severe paroxysms of coughing.

Treatment.—In many cases death has resulted from pneumonia, requiring the lungs to be treated specially. The embalmer meets with something that he terms peculiar in these cases. As is stated, there is generally an asthenic condition in most bodies, and apparently only a small amount of fluid would be needed to prevent putrefaction. But, as is seen in the above description of the anatomical changes that take place, all the organs are more or less affected.

But it seems that the structural changes that cause the embalmer the most trouble occur in the capillaries, they being frequently extensively shrunken or obliterated entirely in all parts of the body. When this condition exists, it is utterly impossible to fill the tissues with fluid, which is necessary to destroy the bacteria of putrefaction, so that it must be expected, that, in many cases, soft, brown, and green spots will follow the usual methods of embalming. When these spots do occur, fluid should be injected into the tissues direct, especially in the affected parts.

GANGRENE—MORTIFICATION.

Senile Gangrene.

Gangrene is liable to occur in any part of the body. It is due to the destruction of the circulation in that part. It may be either moist or dry, acute or chronic. The failure of the circulation in the part may be due to the presence of a blood=clot, or to destruction of the vessels carrying nutrition to the part, as in case of an accident.

In senile gangrene, the walls of the arteries become ossified, losing their elasticity; they thus fail to aid in forcing the blood into the part, and a clot forms within the vessel. This usually occurs in the lower extremities, following some injurious stimulation of the tissues, as a slight abrasion of the foot, injury to a corn, or a severe cold, which sets up inflammation in the already weakened part. These, by still further obstructions of the circulation therein, impairing their vitality, cause death.

In an extremity, for example, decomposition proceeds as follows: Gases are generated in the part, principally sulphureted hydrogen, ammonia, and carbonic acid, the tissues at the time undergo the process of softening or liquefaction, the part becoming exceedingly offensive, and, owing to alterations in the transuded coloring matter of the blood, changes from a reddish to a brownish or greenish=black color. This is known as moist gangrene. It occurs only in external parts and those internal organs to which the air is freely accessible, as the lungs and mucous membrane of the respiratory tract. The gases arising from the parts affected in this manner have a very strong, unpleasant odor, which will penetrate every part of the room, and is tenacious and will remain for some length of time, unless destroyed by the use of some deodorant.

In dry gangrene, the odor is not usually so strong; the parts do not assume the same changes that are noticed in the moist form of gangrene. They appear to the observer more like mummified tissue or like a piece of charcoal.

Treatment.—In the treatment of gangrene, especially of the moist variety, the parts should be washed with hot water, to which a small amount of carbolic acid, say four per cent. is added. After immersing the parts, desiccating or hardening compound should be sprinkled freely over them; then the extremities should be wrapped in a cloth, covering every part, followed by a roller bandage, a number of layers of which should be applied. Inject the body in the usual manner, filling the arteries and capillaries as in an ordinary case.

SUNSTROKE.

Sunstroke is a condition resulting from excessive exposure to heat. This disease does not follow direct exposure to the rays of the sun only, as its name indicates, but exposure to excessive heat with physical exertion in boiler rooms of ships and other extremely hot places, will produce the disease termed sunstroke; the attack may even come on at night. The condition is usually that of prostration, collapse, restlessness, and, in severe cases, delirium, which follow each other in the order named. The surface of the body is cool, the pulse small and rapid, and the temperature may be as low as 95° to 96° F.

Rigor mortis comes on early. Putrefactive changes begin with great rapidity. Venous engorgement in the brain and its membranes is extreme. The venous trunks and right side of the heart are full of blood, and the pulmonary vessels may be greatly engorged. The blood itself is very dark and more fluid than normal; the left ventricle of the heart, usually, is contracted, while the right is dilated. There is great congestion of the lungs. Changes occur in the parenchyma of the liver and kidneys. The face becomes dark and swollen; the brain retains a high temperature for some time after death; gases follow quickly; purging and general putrefaction soon begin.

Treatment.—A case of death from sunstroke, should receive heroic treatment; as is noted above, putrefactive changes take place very early. The blood should be removed quickly; the femoral artery and vein should be raised for the purpose of injecting fluid and withdrawing blood; the body should be placed on a high incline; the drainage=tube inserted in the vein so as to reach above Poupart's ligament, and tied; the artery raised and the arterial tube introduced as usual, and fluid injected, while the blood gravitates from the vein; the blood being thin will run freely. If the femoral vein is used for the withdrawal of blood, the greater part of the blood in the body may be forced out by this method.

A large quantity of fluid should be injected. From one to one and a half gallons should be injected into the arteries of a body weighing 150 lbs., and a proportionate amount into those weighing more or less. After filling the arteries, the cavities should be treated in the usual manner. The lungs should be treated through the trachea, using enough fluid to fill the whole respiratory tract. One of the needle processes might be used with benefit, as the congestion is so great in the cranial viscera that it might impede the flow of fluid through the small cranial arteries.

PART FOURTH

BACTERIOLOGY, SANITATION, AND DISINFECTION

INTRODUCTION TO PART FOURTH.

It is only within the last few decades that much progress has been made in the science of sanitation. Previous to the middle of the present (nineteenth) century, general sanitation was not practiced as it is to-day. The protection of a community from disease and epidemics in general was scarcely considered.

When the cholera, the plague, or the yellow fever entered our borders, it ran like wildfire over the land, destroying the lives of many of the inhabitants in the courses over which it traveled.

It is true, ships were cleansed in the ordinary way, but disinfection did not necessarily follow; at least it was not carried out properly. The harbors, streets, outhouses, alleys, etc., were filled with all kinds of filth, wherein infectious matter lay in wait for its victims. It was not thought necessary to destroy any such matter, as it was not known that disease lurked within.

It was not until science proved that many diseases, and especially those that prevail as epidemics, were caused by micro-organisms, which inhabited the filth in our streets, alleys, drainage systems, etc., that sanitary measures were adopted.

The governments of most of the States and nations have taken up the matter, and have enforced sanitary measures to such an extent that epidemics of all kinds are now almost completely under control. When contagious diseases make their appearance, such safeguards are thrown around the patient that it is almost impossible for dissemination to take place.

All embalmers should become sanitarians. They should take up the subject for their own protection against disease. They should prepare to defend themselves against the apparent arbitrary ruling of health boards, by fitting themselves to become intelligent members of such boards, for the purpose of taking care of their own interests as well as to protect the public health.

Each undertaker should be able to give advice as well as to disinfect all materials connected with the death chamber, as during the time of mourning, it is very important that sanitary measures be enforced, which can be done best by the funeral director or embalmer.

In the following chapters we have aimed to give a brief history of bacteriology, infection, disinfection, and sanitation; the best methods that are practiced at present in sanitation; rules for shipping bodies, etc.

CHAPTER XXXVIII.

BACTERIOLOGY.

HISTORY OF BACTERIOLOGY.

During the seventeenth century, Athanasius Kircher mistook blood and pus corpuscles for small worms, and built up on his mistake a new theory of disease and putrefaction. Christian Lange, a professor of Pathological Anatomy, in Leipsic, expressed his opinion that the purpura of lying-in women, measles, and other fevers, were the result of putrefaction caused by worms or animalcula. From time to time since then, a "Pathologia Animata" has been put forward to explain the causation of disease. Imperfect as were the observations, and crude as was the theory on which it was based, it is marvelous that Kircher, with the simple lenses he had at his disposal, was able to make out as much as he did. These lenses magnified only about thirty-two diameters, or one thousand times. His observations were not generally credited, which was natural enough. They were received with chilling incredulity by his contemporaries.

Remarkable as were Kircher's observations, still more wonderful were those of Anthony von Leeuwenhoek. Leeuwenhoek was born at Delft, Holland, in 1632. He was not considered liberally educated, as he had been apprenticed in his early years to a linen draper. During his apprenticeship he learned the art of lens grinding, which enabled him ultimately to produce the first really good microscope that had been constructed. By this instrument he could see much smaller objects than had hitherto been seen by microscopes in use at that time.

It was in the year 1675 that he gave birth to the study of bacteria by the observations he then made with his microscope. He was still following in the trade of the linen draper in Amsterdam at the time he made his discoveries. He published the fact that he could detect living motile animalcules of the very smallest dimensions—smaller than anything that had heretofore been seen—by means of his perfected lens. He continued his work to the examination of various materials for the presence of animal life, as he considered it, in its most minute form. In sea water, in well water, in his own diarrheal stools, and in the intestinal canals of frogs and birds, he found micro=organisms, whose morphology differed, and which also differed in the peculiarity of their movements.

Later, he examined the tartar scraped from between the teeth, and discovered a form of micro=organism upon which he laid great stress. He contributed a paper on this discovery, which, on September 14, 1683, was presented to the royal Society of London. This paper was important because of the careful description given of the objective nature of the bodies seen by him and for the illustrations which accompanied it. Leeuwenhoek, with his lens, had undoubtedly seen the bodies which we now recognize as bacteria.

He was greatly astonished when he saw distributed everywhere through the material which he was examining, animalcules of the most microscopic dimensions, which moved themselves about in a remarkably energetic way. Describing them, he says: "I saw with very great astonishment, especially in the material mentioned, that there were many extremely small animals which moved about in the most amusing fashion; the largest of these (represented by him in an admirable figure) showed the liveliest and most active motion, moving through rain=water or saliva like a fish of prey darts through the water; this form, though few in actual numbers, was met with everywhere; a second form moved round, often in a circle, or in a kind of curve; these were present in greater numbers. The form of a third kind I could not distinguish clearly; sometimes it appeared oblong, sometimes quite round. They were very tiny, in addition to which they moved forward so rapidly that they tore through one another. I had the impression that I saw several thousands in a single drop of water or saliva which was mixed with a small part of the above=named material not larger than a grain of sand, even when nine parts of water or saliva were added to one part of the material taken from the incisor or molar teeth. Further examination of the material showed that out of a large number which were very different in length, all were of the same thickness. Some were curved, some straight, lying irregularly and interlaced."

Plenciz, a Vienna physician, a believer in the work of Leeuwenhoek, in 1762, made observations confirming the discoveries of the latter. He claimed a casual relation between the micro=organisms discovered and described by Leeuwenhoek and all infectious diseases. He also claimed that infection could be nothing else than a living substance, and endeavored to explain the variations in the incubation period of the different infectious diseases on these grounds. He believed that the micro=organisms were capable of multiplying in the living body, and spoke of the possibilities of the transmission of infection through the air. He taught that each disease had its special germ, on the principle that only one kind of grain can grow from a given cereal.

He found innumerable minute animalcula in all decomposing matter, and was so thoroughly convinced of their etiological relation to the process, that he formulated the law that decomposition can only take place when the decomposable material becomes coated with a layer of the organisms, and can proceed only when they increase and multiply.

The arguments of Plenciz were looked upon by some as the imaginations of an unbalanced mind, and by others as entirely absurd.

Oxanam, in 1820, expressed himself on the subject as follows: "Many authors have written concerning the animal nature of the contagion of infectious diseases; many have indeed assumed it to be developed from animal substances and that it is itself animal and possesses the property of life. I shall not waste time in efforts to refute these absurd hypotheses."

Many other medical men expressed similar opinions during this time, doubting the possibility of animal life existing in these micro=organisms.

The true relation of the lower organisms to infectious diseases was established scientifically, just before the middle of the present century, by the coincidence of a number of important discoveries. The cause of putrefaction in beer and the souring of wine, by Pasteur; the finding of rod=shaped organisms in the blood of all the animals that die of splenic fever (anthrax) by Pollender and Davaine; and the knowledge of the parasitic nature of certain diseases of plants, aroused attention to the old question of animal contagion. Henle was the first to logically teach this doctrine of infection. The principal point that had occupied the attention of scientific men from time to time, up to the middle of this century, was the origin of these micro=organisms. One side claimed that they descended from creatures that existed previously, of the same kind. Needham, in 1749, held firmly to the doctrine of spontaneous generation, as a result of vegetation changes in the substances in which they were found. He experimented with a grain of barley placed in a watch crystal of water, carefully covered, allowed it to germinate, and claimed that the bacteria that were present were the result of changes in the barley grain itself, incidental to its germination.

Spallanzani, in 1769, drew attention to the laxity of Needham's methods, and demonstrated that, if infusions of decomposable vegetable matter were placed in flasks, hermetically sealed, then allowed to remain in boiling water for some time, no living organisms nor decomposition would appear in the infusion so treated. Objection was raised to this method, on the ground that the high temperature to which the infusion had been raised had so altered them, and the air around them, that the favorable conditions no longer existed to spontaneous generation. To meet this objection he took one of the flasks that had been boiled and tapped it gently against some hard object until he produced a very minute crack; organisms and decomposition appeared, as in infusions that were not so treated.

Very little advance was made from this time until 1836, when Schulze called attention to the subject by his investigations. He allowed air, deprived of its organisms by passing through a strong acid or alkalin solution, to gain access to boiled infusions, and no living organisms or decomposition appeared in the infusions.

Schwann, in 1873, robbed air of its organisms by passing it through highly heated tubes into his infusions.

Schroder and VonDusch interposed cotton wool between the infusion and the air, robbing the air of its micro=organisms as it passed into the infusions by infiltration.

Hoffman, in 1860, and Pasteur, in 1861, demonstrated that all that was necessary was to draw out the neck of the flask into a fine tube, bend it down along the side of the flask, and then bend it up again a few inches from its extremity, and leave the mouth open, to prevent the access of bacteria to the infusion in the flask, as when boiled the drop of water of condensation in the lower angle will avert the organisms and none can enter the flask. Doubters still existed and some still held out for "spontaneous generation," wanting further proof, when, in 1876-77, Prof. Tyndall made his investigations upon the floating matter in the air, and demonstrated that these organisms, being present in decomposing fluids, were always to be explained, either by the pre=existence of similar living forms in the infusion, or upon the walls of the vessel containing it, or, by the infusion having been exposed to the air which had not been deprived of its organisms.

Though it is during the past thirty years that the research in this line has received its greatest impulse, yet it was developing for at least two centuries.

Indeed, modern hygiene owes much of its value to a more intimate acquaintance with the biological activities of the micro=organisms. Also, our knowledge in regard to infectious diseases has been developed to the present position. Though the contributions of the last few years have done more to place bacteriology on the footing of a science, yet during the earlier years of its development, many were the observations made, which formed the ground=work for a great deal of that which has followed.

BACTERIA—THEIR FORMS AND GROWTH.

The organisms known as bacteria are members of the lowest group of the plant kingdom. The entire body consists of a single cell, which is a minute mass of a substance called protoplasma, semisolid, gelatinous substance, which, viewed with the ordinary microscope, is apparently homogeneous, but which, according to Altmann, consists of small granules of an albuminous nature, embedded in a similar, structureless, albuminous matrix. These elementary granules or granulæ are often arranged in threads, sometimes in such a way as to form a sponge=like network. It is the simplest and lowest form of a living thing now known, a true elementary organism or seat of life. Growth and reproduction are always met with in the cell. Each cell contains a definite, rounded body, called the nucleus; also, many cells, especially plant cells, are surrounded by a dense wall or cell membrane. In bacteria, the spore corresponds to the seed in flowering plants, but contains no embryo. Usually it is a single=celled body.

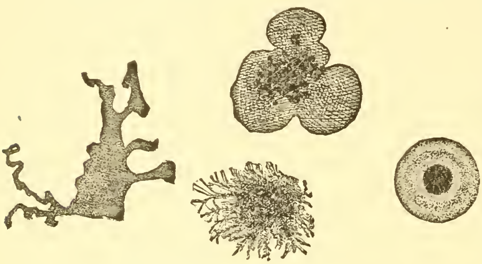


Fig. 58. Colonies of Bacteria.

Many bacteria possess the faculty of self=movement, carrying themselves in all manner of ways across the field of the microscope, some very quickly and others leisurely. Some bacteria vibrate in themselves, appearing to move, but do not change their place. Little threads or lashes (flagella) are found attached to many of the motile bacteria, either at the poles or along the sides, sometimes only one, and on some several, forming a tuft. These flagella are in constant motion and can be considered as organs of locomotion.

Bacteria multiply either through simple division, or through fructification by means of small rounded or oval bodies, called spores, from spora (seed). If by division, the cell elongates, and at one portion, usually the middle, the cell=wall indents itself gradually, forming a septum and dividing the cell into two equal parts. These are called fission bacteria. Each bacterium gives rise to but one spore; it may be at either end or in the middle. Some rods take on a peculiar shape at the site of the spore, making the rod look like a drum=stick.

What the real contents of the spores are is not known. In the mother cell, at the site of the spore, little granules have been found which are different from the rest of the cell, and these are supposed to be the beginnings, or sporogenous bodies. The most important part of the spore is its capsule. To this it owes its resisting power. The capsule consists of two separate layers, a thin membrane around the cell and a firm gelatinous envelope. When the spore is brought into favorable conditions, it begins to lose its shining appearance. The outer, firm membrane begins to swell, and it now assumes the shape and size of the one from which it sprang, the capsule having burst so as to allow the young bacillus to be set free. A certain amount of heat and oxygen are necessary for the formation of spores. Spores are not easily influenced by external measures because of the very tenacious

Fig. 59.
Pus containing streptococci, X 800 (Flugge).

envelope. It is said to be the most resisting object of the whole organic world.

Chemical and physical agents that easily destroy other life have very little effect upon spores. Many spores subjected to a dry heat at a temperature of 284° F. require several hours to destroy them. The spores of the various potato bacilli can withstand the application of steam at 212° F. for four hours.

In the earlier studies of bacterial forms, certain kinds with marked characteristics were found in connection with various specific diseases and specific decompositions. These could be distinguished from one another with such ease that particular stress was laid upon the description of such typical regulation forms. It came to be recognized later, however, that these different cells are linked together by all possible intermediate stages. In order to permit of a rapid orientation it has become, therefore, a general practice to enumerate only three chief form groups.

1.—Coccus forms (cocci or microcci), comprising spherical or ellipsoid cells.

2.—Rod=shaped forms (bacilli), plainly elongated in one direction. These may be distinguished, according to their lengths, as long and short rods. Many rods have an approximately uniform diameter throughout, and the ends may be either rectangular in outline or more or less rounded. In some rods the diameter of the cell varies in different portions, so as to produce a spindle=shaped or club=shaped cell, or one fashioned like a pestle, or a whetstone or drum=stick. Rods may be rigid or flexible, and, in the latter case, often appear curved.

3.—Cork=screw forms (spirilla) comprise all spirally=twisted bacteria. The smallest forms often resemble rods bent with a comma=like flexure. The screws may be rigid or flexible, of equal diameter throughout, or varying in diameter at different points.

Bacteria develop from pre=existing bacteria, or the spores of the same. They are not produced spontaneously. They are found almost everywhere upon the surface of the earth.

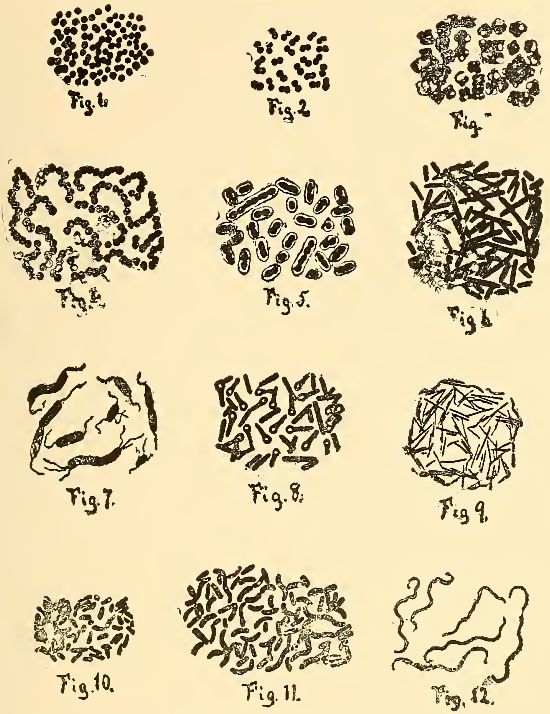


Fig. 60. Forms of Bacteria.

1. Spheroidal bacteria (micrococcus pyogenes), one of the most common species of bacteria, causing suppuration.
2. Spheroidal bacteria arranged in pairs (diplococcus).
3. Spheroidal bacteria grouped in cuboidal masses (sarcina).
4. Spheroidal bacteria grouped in chains (streptococcus erysipelatos), producing erysipelas.
5. Diplococci, slightly lance-shaped, and surrounded by a capsule (diplococcus pneumoniæ), causing acute pneumonia.
6. Bacteria causing typhoid fever (typhoid bacilli).
7. Bacilli with cilia.
8. Bacilli with spores (bacilli tetanei), producing lockjaw.
9. The bacillus of consumption (bacillus tuberculosis).
10. The bacterium of diphtheria (bacillus diphtheria).
11. The spirillum of Asiatic cholera (spirillum choleræ Asiaticæ).
12. The spirillum of recurrent fever (spirillum Obermeieri).

Their wide and almost universal diffusion is due to the minuteness of the cells and the few requirements for their existence. They are disseminated specially by being carried on the floating particles of the air. There are very few places free from germs. It is said that the air on the high seas and on the mountain tops is free from bacteria, but this is questionable.

It is not supposed that one kind of bacteria will produce another kind; that is, a bacillus does not arise from a coccus, nor vice versa, nor will a typhoid fever bacillus produce a bacillus of tetanus.

Bacteria which live on the dead remains of organic life are known as saprophytic, and those which choose the living bodies of other fellow=creatures are called parasitic. Some, however, develop equally well as saprophytes and parasites. These are called faculative.

A temperature ranging from 50° to 100° F. is necessary to the living growth of most bacteria, but some will develop at a lower and some at a higher. As a rule, the saprophytes take the lower temperature, the parasites taking the normal temperature of the body. Some forms require a nearly constant heat, growing within very small limits, as the bacillus of tuberculosis. A majority of bacteria will be destroyed at a temperature of 140° F., while freezing will prevent the growth of all; in fact, several times freezing and thawing will be fatal.

Certain kinds of bacteria will grow only when air or oxygen is present. These are called aerobic. Others cannot live when oxygen or air is present. These are called anaerobic.

Sunlight is a disinfectant, and is very destructive to bacteria. Anthrax bacteria have been destroyed upon a few hours' exposure to the sun. Tubercular bacilli have been destroyed after two days' exposure to daylight. Electricity arrests the growth of bacteria.

Bacteria feeding upon organic compounds produce chemical changes in them, not only by the withdrawal of certain elements, but also by the excretion of these elements changed by digestion. The processes of oxidation and reduction are carried on by some bacteria. Sometimes chemical products, such as ammonia, hydrogen sulphid, etc., are produced by bacteria. Complex alkaloids are found sometimes which closely resemble those found in ordinary plants, and which are named ptomaines, because obtained from putrefying objects. Fermentation is due to the direct action of vegetable organisms. Many bacteria have the power of ferments. Fermentation, when occurring in organic substances and accompanied by the development of offensive gases, is called putrefaction, and is due entirely to bacteria.

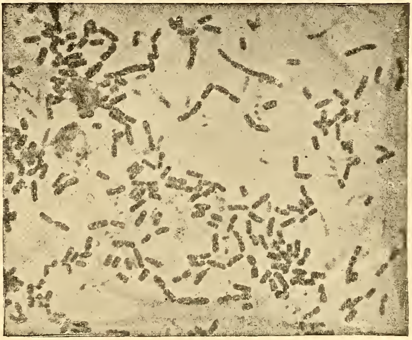


Fig. 61. Bacillus Cadaveris.
Smear preparation from liver of yellow fever cadaver, kept forty-eight hours in an antiseptic wrapping, X 1000. From photomicrograph (Sternberg).

Diseases which are called infectious are pathological processes or changes caused by bacteria, and the germs which produce them are called disease=producing or pathogenic bacteria. Those which do not form any pathological processes are called non=pathogenic bacteria.

Some bacteria are endowed with the property of forming pigments, either in themselves, or by producing a chromogenic body, which, when set free, gives rise to the pigment. In some cases the pigments have been isolated and many of the properties of the anilin dyes discovered in them.

Many bacteria have the power to form light, giving to various objects which they inhabit a characteristic glow or phosphorescence.

Many bacteria, especially anaerobic, produce both noxious and odorless gases. Some germs form odors characteristic of them—some, sweet, aromatic; others, foul, disagreeable smells; and some, sour or racid exhalations.

The life of bacteria usually is of short duration; with age they lose their strength and die.

Bacteria thus carry on all the functions of high organic life. They breathe, eat, digest, and multiply, and are very busy workers.

There are many classes of bacteria, but it is not necessary to enter into their minute classification. It is sufficient to understand those with which we have to deal as embalmers, viz., those that produce putrefaction and those that cause infection.

BACTERIA IN AIR, WATER, AND EARTH.

The means by which bacteria are distributed are air and water. The air in the low valleys and upon the level surfaces of the earth is filled usually with floating particles, consisting of dust, etc., that are loaded with bacteria. In the higher altitudes, there are fewer bacteria floating in the air; in fact in the extremely high altitudes, where there is no moisture, there will be very few, if any, so that neither disease nor putrefaction will occur. Neither are they found in the air on the high seas. The air coming from off the sea along the coast is found to contain but few, while that coming across the land is full of bacteria. Many of them are spore=producing, while others are not.

Fig. 62. Bacillus Tuberculosis,

From a culture on glicerin-agar, X 1000. From a photomicrograph by Frankel and Pfeiffer.

It must be remembered, too, that light and sunlight destroy both living germs and spores, which makes it impossible for them to retain vitality a great while when floating in the air; but some are very resistent to light, being what we term tenacious. These may float in the air any length of time, or be exposed to strong sunlight for a considerable period, without being affected by sunlight. Such as these may be carried in the air to distant parts and still retain their vitality.

Moisture screens the air, to a certain extent, of bacteria, as when passing over the surface of the water, or while a current is passing through a room with moist walls and hanging fabrics. If the surfaces of the walls are examined with the microscope, they will be found to be covered with large quantities of bacteria.

When bacteria are floating in the air, they fill the air we breathe, and at each inspiration, many bacteria are taken into the system. These are deposited upon the mucous surfaces of the respiratory tract, and the chances are that but few reach the lungs. It is found by experiment, when animals are exposed to a current of air containing bacteria of a certain kind, that, after continuous inhalation for some length of time, bacteria will be found in large numbers on the mucous surfaces of the trachea and bronchi. If deposited on the mucous surface of the mouth, they will be taken into the alimentary tract during deglutition (swallowing), but, when taken into the system in this manner, they are likely to be destroyed on reaching the stomach—that is, if there is a normal condition of the digestive organs. If starvation exists, or if the stomach has been overloaded, they will pass directly through into the lower portion of the alimentary canal. The presence of hydrochloric acid in the stomach during normal digestion, or when the digestive organs are in a perfectly healthy state, will destroy bacteria and their spores. For the above reason many persons are supposed to be immune from disease, when the digestion is perfectly normal, that would be affected when the digestion is weakened by disease.

Bacteria are found in all surface water, such as lakes, ponds, pools, open wells, large and small streams, creeks, and rivers. Water of the streams carries bacteria from one point to another. The water of the drainage channels may carry infectious bacteria to a great distance, disseminating disease along its route, where water is used for culinary and drinking purposes. Fecal matter and other infectious material, that have been thrown into sewers, which empty into streams, or have been thrown into the streams themselves, are carried to larger streams, which furnish cities with their water supply. The pathogenic bacteria are there pumped into the water pipes, which carry the water and distribute it to the different parts of the city, where it is used, thus disseminating disease.

Non=pathogenic bacteria are found in the earth near the surface and all places where vegetation exists. The pathogenic bacteria which cause bubonic plague, anthrax, tetanus, etc., are found frequently in the earth in the locality where the disease previously prevailed, especially in the countries of the torrid regions. These bacteria sometimes retain their vitality for a long time, and may be the means of developing the disease when the source is seemingly obscure. For this reason all excreta and the affected material from patients dying of infectious diseases, should be disposed of by being burned, deeply buried, or thoroughly disinfected.

CHAPTER XXXIX.

INFECTION AND CONTAGION.

An infectious disease is one that is caused by the invasion and multiplication within the body of pathogenic organisms derived from various sources, as from the air we breathe, the water we drink, the food we eat, and the clothes we wear.

A contagious disease is an infectious disease that is communicable from one person to another, either directly or indirectly, as by contact, or through the air near by, etc.

For an infectious disease to develop in the living organism, a disposition towards the disease must be present. For instance, if the tubercular bacilli come into contact with the lung tissue of one born of consumptive parents, consumption will develop; while, with those born or parents in whom no consumption=taints exist, the tubercular bacilli will not grow, even when received into the lungs. Usually disease germs can afford opportunity, for the manifestation of this disposition, only when they come in contact with it. That is the broad meaning of the word infection. From this viewpoint, accordingly, the condition of the general surroundings of life, such as air, water, soil, and kind of nourishment, may be of importance, by virtue of being the means by which the disease germ is first introduced into the body, and should be considered carefully.

The various channels through which bacteria enter the body are the mouth, lungs, and skin. The organs affected in an infectious disease are sometimes at the place where the disease germ enters, and sometimes in tissues remote but more disposed toward the disease. From this standpoint, we classify only those diseases as contagious, which can be directly communicated by mere contact with the sick; and those as non-contagious which are not transmitted directly from the sick, but are caused by external agents. Both probabilities of communication exist in the great majority of infectious diseases; one or the other is the more usual merely. If this be the case, such infectious diseases as malaria, typhoid fever, cholera, etc., are not contagious, but smallpox, scarlatina, measles, etc., are always contagious. The word contagion is used in a much narrower sense than that of infection. It should be remembered that all contagious diseases are infectious, but all infectious diseases are not contagious.

The embalmer should be very careful in the preparation of bodies dying from contagion, as disease can be disseminated very easily when persons are allowed to come in contact with a body that is not properly disinfected. All measures that he may be able to apply to prevent such a result should be employed. He should follow strictly the rules adopted by the health boards of his community and the shipping agents of the country. Neither bribery nor influence of any kind should deter the embalmer from his duty, as a failure to prepare a body properly may result in the prevalence of an endemic or epidemic, which would menace the lives of many.

CHANNELS OF INFECTION.

The common mode of infection in tetanus, erysipelas, hospital gangrene, and all other traumatic infectious diseases, is through an open wound or abrasion of the skin. Infectious diseases that are not traumatic may also be transmitted in the same way. The possibility of infection occurring through the broken skin has been proved by a number of bacteriologists. That tuberculosis has been transmitted to man by accidental inoculation of an open wound has been demonstrated satisfactorily. This being the case, other infectious diseases may be transmitted in a similar manner.

There is no doubt that infection may occur also through the mucous membrane of the respiratory organs, which is shown by the experiments of Buchner; this has also been demonstrated by a number of bacteriologists. Buchner mixed dry anthrax spores with lycopodium powder, and caused mice and guinea pigs to respire an atmosphere containing this powder in suspension. In sixty=six experiments of which he noted the results, fifty died of anthrax, nine of pneumonia, and seven survived. It was proved, by comparative experiments, in which animals were fed with double the quantity of spores used in the inhalation, that infection did not occur through the mucous membrane of the alimentary canal. In his experiments on thirty=five animals fed in this way, but a small number contracted anthrax. It was demonstrated by the microscopic examination of sections, and by culture experiments, that the infection occurred through the lungs. These experiments showed that the lungs were extensively invaded, while, in many of the cases, no bacilli were found in the spleen. It seems to be well established that in man infection of anthrax may occur by way of the respiratory organs.

SUSCEPTIBILITY AND IMMUNITY.

In general biology, no questions are more interesting or more important, from a practical viewpoint, than those which relate to the susceptibility of certain species of bacteria, and those that relate to the natural or acquired immunity from such pathogenic action, which is possessed by other animals. That certain infectious diseases, now demonstrated to be caused by micro=organisms, prevail only or principally among animals of single species, has long been known. Typhoid fever, cholera, and relapsing fever are diseases of man; the lower animals do not suffer from them when they are prevailing as an epidemic. Conversely, man has immunity from many diseases which are infectious among lower animals. Exceptional susceptibility and immunity may be due to family or race characteristics; thus, the white race is more susceptible to yellow fever than the colored race. Again, this disease is not so fatal in its results among the Latin races of the tropics, as among the inhabitants of Northern Europe. Among negroes and dark-skinned people, smallpox is exceptionally fatal.

A single attack commonly confers immunity from subsequent attacks in infectious diseases. This is true of eruptive fevers, yellow fever, mumps, whooping cough, and, to some extent at least, of typhoid fever and syphilis, but is not true of epidemic influenza, croupous pneumonia, and Asiatic cholera. In these latter diseases second attacks frequently occur. Diphtheria, erysipelas, and gonorrhea, are localized infectious diseases, and do not prevent subsequent attacks.

There are two classes into which we are able to group infectious diseases. In one there is general infection followed by immunity; in the other, local infection without subsequent immunity. The immunity, following attacks of the eruptive fevers and specific, febrile, infectious diseases generally, is not absolute. Although a large majority of those who suffer an attack of smallpox, scarlet fever, or yellow fever have an immunity for life, second attacks do occur occasionally.

It seems probable that a certain degree of immunity, of limited duration, is acquired in the diseases named in which one attack is not recognized generally as preventing future attacks. The invaded tissues in localized infection, as in gonorrhea and erysipelas, appear after a time to acquire a certain tolerance to the pathogenic action of the invading parasite, and no doubt recovery would occur from these diseases after a time without medical assistance. In some diseases, such as diphtheria, cholera, and epidemic influenza, a certain degree of immunity is afforded, as a second attack does not occur often during the same epidemic. It is reasonable to believe that recent mild, as well as severe, attacks will confer immunity, as is observed in cases of smallpox, scarlet fever, yellow fever, etc. In smallpox, vaccination is a simple method of conferring immunity.

CHAPTER XL.

DISINFECTION AND ITS EFFECTS.

Disinfection means the destruction of infectious material, and this can only be accomplished by the use of disinfectants. disinfectants must not be confounded with antiseptics and deodorants. A disinfectant kills both the disease=producing and the putrefactive organisms, and, therefore, necessarily, answers the purpose of an antiseptic, and also, to a certain extent, of a deodorant. An antiseptic arrests putrefaction or fermentation by the prevention of the growth of micro=organisms while it is present, but does not, of necessity, kill them; for this reason, it can not take the place of a disinfectant. Deodorants are used only for the destruction of bad odors, not having any effect at all upon bacteria. It is true most of the disinfectants are deodorants—that is, they destroy odors as well as the bacteria that produce them.

Strictly speaking, specific disinfection implies dealing with infection. In its popular and wider sense, however, it embraces purification in all its applications. The burning of volatile substances, the libation of liquids, and the sprinkling of powdery compounds on a large scale, are but feeble or futile substitutes for physical or chemical means of destroying infection. In the process of cleansing and purification, all stable and unstable substances, whether they be of organic or inorganic character, are dealt with either by physical or chemical means. Physical means should be applied to all movable material without regard to their preservation. They should be disposed of, either by burial or fire, unless they can be disinfected thoroughly by such means as will be given hereinafter, depending always upon the proximity of dwellings, and other conditions. Under some circumstances they might be deposited upon the surface at a distance from any residence, but this is not advisable. Objects that cannot be removed should be washed and scraped, and the resultant refuse should be removed or destroyed by burning.

There are other methods, in addition to the above, that should be adopted, in preference to the more temporary methods, as by the use of chemicals, usually resorted to for treating organic, decomposing matter. It is the process of chemical treatment of decomposable refuse that popularly and fallaciously passes under the name of disinfection. The usual habit of styling many substances disinfectants, which are not, has fostered this idea.

Putrefaction is due to the presence and growth of bacteria in their beneficent work of resolving organic substances into their innocuous elements. Malodorous gases are given off during putrefaction, and deodorants, whether by breaking up the gases or overpowering the odor, or absorbing it, produce little or no effect. The odors of decomposing substances themselves are the tell=tales of filth, and overcoming them by the use of deodorants is a fallacious remedy. To prevent these odors, preservation against decomposition—thus preventing the odoriferous stage being reached—is effected by the use of antiseptics. The application of antiseptics, however, is limited to substances and places where removal or destruction, either temporary or permanent, cannot be accomplished. Moreover, antiseptics require careful and discriminate employment to be of real value in preventing the growth of micro=organisms in organic substances.

Food is preserved by physical means, such as cold, exclusion or filtration of the air, and by chemical means, as smoking, salting, and the use of other chemical substances. Interest in the preservation of food, in this connection, only lies in the fact that it shows that preservatives, in their effects on organic matter, are closely allied to antiseptics.

The only antiseptics that should be used in the practice of disinfection, are those which, as germicides, not only prevent the growth of, but are directly fatal to, bacteria. In the treatment of organic matter, destruction of the germs, rather than the prevention of their growth, would be much the safer practice. Therefore, disinfectants should always be used instead of antiseptics. It should be remembered, however, that disinfectants, when used in a very diluted or weakened state, become, or only act as, antiseptics.

In a more restricted and accurate sense, disinfection implies the destruction of infection produced by the specific micro=organisms of disease, as distinguished from pollution by the ordinary or non=specific micro=organisms. It must be admitted that our knowledge as yet scarcely enables us to draw a sharp line of demarkation between pathogenic and non=pathogenic organisms, especially in reference to the cause of septic diseases; yet, in the recognized infectious diseases, whether the specific organisms producing them have been discovered or not, disinfection should be applied for the destruction of the specific infection. The only means of knowing positively that the specific infection in matter is destroyed absolutely, is by subjecting some of the infected material to actual experiment by cultivation of known micro=organisms. This can be done properly only by the practical bacteriologist.

Thus restricted to the destruction of the specific infection, the process of disinfection admits of the application of various measures by mechanical means and by physical and chemical agents. Some of the physical means in use are cleansing, exposure to light, burning, moist and dry heat, boiling in water, etc. Moist heat or steam is far more effective than dry heat, as the distribution of the latter is too unequal, and does not penetrate bulky articles. With many substances, boiling in water is most efficacious.

But few of the chemical agents, lauded as disinfectants, possess any real germicidal power. Some are more or less antiseptic, while a large number are merely deodorant, and many are more or less inert.

The effects of a germicide depend upon the quantity in which it is used, and the length of time during which it is allowed to act. Even the best disinfectant may be used in such small quantities, or the material to be disinfected may dilute it to such an extent, that its action may be rendered nil, or at most only that of an antiseptic. This is what occurs very frequently in actual practice.

The extensive and valuable experiments of Koch upon anthrax spores, with a large number of chemical agents in solution, showed that these spores were killed within one day's exposure only by chlorin, bromin (2 per cent.), iodin, chlorid of mercury (1 per cent.), permanganate of potash (5 per cent.), and osmic acid (1 per cent.) Pure oil of turpentine required five days' exposure; hydro=chloric acid (2 per cent.), ten days; chlorid of iron (5 per cent.), six days; chlorid of lime (5 per cent.), five days; formic acid, four days. The latter class is entirely out of the question, as, under ordinary conditions, disinfection must be completed in minutes rather than hours. Osmic acid is not fit for practical use, and the excessive quantity of permanganate of potash that would be required, removes this agent from the list. There remain, therefore, of the first class, only bichlorid of mercury and the halogens, that can be used to advantage in actual practice.

Bichlorid of mercury in solution has been shown to be one of the most convenient and most powerful disinfectants. Koch demonstrated that, used in the proportion of 1 : 1,000,000, the growth of anthrax bacilli was checked; while 1 : 333,=333 arrested the growth, and 1 : 1,000 killed the anthrax spores in ten minutes. The experiments of Klein were in the main confirmatory of those of Koch, but stronger solutions were required to produce the same results. Differences in results, in experiments with disinfectants, due usually to varying conditions, render it difficult to estimate their true value.

The experiments of Koch with carbolic acid have lost that agent its hitherto high reputation as a disinfectant. He found that it required a 1 per cent. solution more than a day to kill anthrax bacilli, and a 5 per cent. solution twenty=four hours to destroy the infection in tuberculous sputum.

Iodin, bromin, and chlorin, known as the halogens, are used in the form of gases, in a similar manner, to nitrous and sulphurous acid gases. But the use of these agents, on account of their destructive effects, have been practically discontinued since the introduction of formaldehyde gas.

Formaldehyde gas is now recognized as the best agent, in the form of gas, for the disinfection of rooms, their contents, clothing, etc. Its use is not limited to the gaseous form, as it combines with water and alcohol in any strength, in which liquid form it may be applied to many uses.

Abbott says:

"In the destruction of bacteria by means of chemical substances, there occurs most probably a definite chemical reaction; that is to say, the character of both the bacteria and the agent employed in their destruction are lost in the production of a third body, the result of their combination. It is impossible to say with absolute certainty, as yet, that this is the case, but the evidence that is rapidly accruing from the more recent studies upon disinfectants and their mode of action, point strongly to the accuracy of this belief. This reaction, in which the typical structure of both bodies concerned is lost, takes place between the agent employed for disinfection and the protoplasma of bacteria. For example, in the reaction that is seen to take place between the salts of mercury and albuminous bodies, there results a third compound, which has neither the characteristics of mercury nor of albumin, but partakes of the peculiarities of both; it is a combination of albumin and mercury known by the indefinite term albuminate of mercury. Some such reaction as this occurs when the soluble salts of mercury are brought in contact with bacteria."

Corrosive sublimate is less effective as a germicide in alkalin fluids, containing much albuminous substance than in watery solutions. In such fluids, precipitates of albuminates of mercury are formed, which are at first soluble, so that a part of the mercuric salt does not exert any action. If these albuminates of mercury are dissolved in an excess of blood or blood=serum, they become very effective. In alkalin solutions, such as blood, blood=serum, pus, tissue=fluids, etc., the soluble compounds of mercury are converted into oxids or hydro=oxids. The soluble compounds can remain in solution only when there are present sufficient quantities of certain bodies which render solution possible. Bodies of this sort are especially the alkalin chlorids, and iodids, and, above all, sodium chlorid, and ammonium chlorid. A very simple way of preventing precipitation of mercury, then, is to add a suitable quantity of chlorid of sodium to the corrosive sublimate. These compounds of mercury, which like the cyanids, are not precipitated with the alkalis, because they at once form double salts, require no addition of salt. These facts were recognized several decades ago, and were made use of in medicine, but had altogether fallen into oblivion, until Liebrich, and later Behring, again brought them to light. The double salts of mercuric chlorid and sodium chlorid are precipitated by the earthy alkalis, and not by the alkalin carbonates, so that the solution should be prepared with distilled or soft water.

The experiments of Abbott, Geppert, and other bacteriologists, have given a new impulse to the study of disinfectants, and have caused the modification of many previously formed ideas concerning the action of disinfectants. The fact has been emphasized especially that we must use a sufficiently strong disinfectant, and enough of it, to destroy the bacteria in the material to be disinfected. It is questionable whether material, such as sputa, excreta, or blood, containing pathogenic organisms, can be disinfected by means of corrosive sublimate, unless used in the presence of chlorid of ammonium or chlorid of sodium. If these are not present, the sublimate may be used up and rendered inactive as a disinfectant by the presence of albumin. We believe, however, that, if a strong enough solution of chlorid of mercury, containing a suitable quantity of chlorid of sodium or chlorid of ammonium, be used in sufficient quantity, in contact with the bacteria, for a long enough time, it will insure their destruction.

DEODORANTS—DEODORIZERS.

A deodorant is a substance or agent that destroys offensive and noxious or unhealthful odors. Odors that are offensive and noxious, which come from decaying matter, very frequently contain sulphur in some state of combination. Deodorants usually produce the effect for which they are used, by causing a chemical change in the bodies to which they are applied, but sometimes their action destroys or counteracts their volatility by absorbing or condensing odorous substances. Charcoal possesses this latter property, but indirectly may produce chemical changes, by bringing the odorous substances into contact with oxygen in a condensed and active condition.

Deodorants may be divided into volatile and non=volatile classes. The action of volatile deodorants is exclusively chemical, being intended to act on bodies which are themselves volatile. They admit of more generally useful application than those which are non=volatile. The most important members of this class are chlorin and its lower oxids; sulphurous acid, nitrous acid, and other oxids of nitrogen, ozone, and peroxid of hydrogen.

Volatile deodorants are of two kinds; those that destroy or remove noxious smells, and those which merely cover one smell with another. In the selection and use, then, of volatile deodorants, it is necessary to distinguish between them. Carbonic acid, for instance, is of little use as a deodorant, while it is very valuable as a disinfectant. It acts as a deodorant by covering a weaker odor with its powerful odor, rendering it less objectionable or imperceptible. On the other hand, chlorid of lime possesses a strong and characteristic smell, and is capable of destroying other noxious odors, and is, therefore, an excellent deodorant.

The chemical action, by which odors are destroyed, is principally one of oxidation, and, therefore, this class of deodorants are generally oxidizing agents. The natural deodorant contained in the atmosphere is ozone or active oxygen, which, no doubt, largely contributes to the destruction of noxious vapors in the air. Volatile oils, which emanate from flowers and other parts of plants, in contact with atmospheric oxygen, produce peroxid of hydrogen, and this, as an oxidizing agent, possesses deodorizing, as well as disinfectant, properties.

Charcoal, earth, lime, oxid of iron, sulphate of iron, chlorid of zinc, nitrate of lead, and permanganate of potash, are non-volatile deodorants. These are very efficient, when brought into contact with noxious gases, which emanate from decaying matter, although they are less generally useful than they would be otherwise on account of their non-volatile character. Charcoal owes much of its efficiency to the surface attraction and power of condensation, which it possesses as a deodorant, by virtue of which it brings noxious gases, such as sulphureted hydrogen, into contact with oxygen in a condensed and active state, so that they are burned up and resolved into innoxious compounds, or compounds less noxious than those from which they are produced.

Earth and oxid of iron, which, like charcoal, are used in the solid or dry, or nearly dry state, absorb and combine with or promote the combination of noxious gases, forming innoxious products. Lime may be used either dry or in a liquid state, as milk of lime. The other substances named above are used in the form of a watery solution.

CHAPTER XLI.

ANTISEPTICS AND DISINFECTANTS.

All material containing the germs of infectious disease is infectious material, and it is disinfected by the application of agents which destroy the living disease=germs or pathogenic bacteria that give it its infecting power. Such agents are called disinfectants. The use of the term disinfectant is extended to germicides in general, that is, to those which kill non=pathogenic, as well as those which destroy pathogenic, bacteria. All disinfectants are also antiseptics, for agents which destroy the vitality of the bacteria of putrefaction, arrest the putrefactive process. Thus these agents, in less amount than is required to completely destroy vitality, arrest growth and act as antiseptics; but not all antiseptics are germicides.

ANTISEPTICS.

The following agents in various strengths act as antiseptics, while in stronger solution they become effective disinfectants and germicides. They are antiseptic in the following proportions:—

Iodid of mercury, 1 : 40000.
Peroxid of hydrogen, 1 : 20000.
Bichlorid of mercury, 1 : 14300.
Osmic acid, 1 : 1666.
Chlorin, 1 : 4000.
Iodin, 1 : 4000.
Hydrocyanic acid, 1 : 2500.
Bromin, 1 : 1666.
Thymol, 1 : 1340.
Sulphate of copper, 1 : 1111.
Salicylic acid, 1 : 1000.
Cyanid of potassium, 1 : 909.
Ammonia, 1 : 714.
Chlorid of zinc, 1 : 526.
Carbolic acid, 1 : 333.
Alum, 1 : 222.
Tannin, 1 : 207.
Arsenious acid, 1 : 166.
Boric acid, 1 :143.
Sulphate of strychnia, 1 : 143.
Arsenite of soda, 1 : 111.
Hydrate of chloral, 1 : 107.
Salicylate of soda, 1 : 100.
Sulphate of iron, 1 : 90.
Chlorid of lime, 1 : 25.
Borate of soda, 1 : 14.
Alcohol, 1 : 10.
Chlorid of ammonium, 1 : 9.
Arsenite of potash, 1 : 8.
Chlorid of sodium (common salt), 1 : 6.
Permanganate of potash, 1 : 285.

DISINFECTANTS.

The following is a list of some of the practical disinfectant agents, giving their germicidal values:—

Carbonate of ammonia, in solution 1 : 77, is a disinfectant sufficiently strong to kill the cholera spirillum in five hours.

Fluosilicate of ammonium, in a 2 per cent. solution, will kill anthrax spores in from fifteen to forty=five minutes.

Chlorid of lime in solution, containing 25 per cent. of available chlorin, is a very powerful germicidal agent and has great value as a practical disinfectant. It is effectual as a germicide when allowed to act for only a minute or two. It is very inexpensive, and can be used in large quantities at a very small cost. It can be procured in any drug=store, and should be used in solution of about six ounces to the gallon of water.

Sulphate of copper, used in solution 1 : 3000, will kill the cholera spirillum in ten minutes. A solution 1 : 20 kills the typhoid bacillus in the same time. It is cheap, and can be used for disinfecting such material as waste, excreta, etc., but is very destructive to colors in fabrics, walls, etc.

Sulphate of iron in solution has been recommended by some authors for the purpose of disinfecting excreta, cess=pools, etc., but its action is too weak for practical purposes.

Protochlorid of manganese is a very valuable agent as an antiseptic and germicide for general disinfecting purposes. It should be used in proportion of 1 : 500 to 1 : 1000.

Cyanid of mercury is one of the strongest disinfectants, is very poisonous, and will kill all bacteria and their spores in a very short time in solution of 1 : 1000 to 1 : 2000.

Iodid of mercury, in a solution of 1 : 40000, has antiseptic value, and, in a stronger solution, will destroy all kinds of bacteria.

Arsenite of potassium is not a disinfectant of much value; but, when used in strong solution for injecting purposes, it will preserve and harden tissue, and has been used from time to time in combination with other chemicals in the manufacture of embalming fluids.

Bichromate of potash is antiseptic in the proportion of 1:909, and, in a stronger solution, is a disinfectant and will kill bacteria and spores of all kinds.

Bromid of potassium, in a 1 per cent. solution, will destroy the bacilli of typhoid fever and the cholera spirilla in five hours.

Chlorid of mercury (mercuric chlorid or corrosive sublimate) is one of the strongest disinfectants and can be used in many ways. In simple solution, it is less effective as a germicide, in all alkalin fluids containing much albuminous substance, than in watery fluids. In such fluids, precipitates of albuminates of mercury are formed, which render the mercuric salt more or less inert; but the precipitated albuminate of mercury in due time will be redissolved, if an excess of albumin is present, when it will have its usual germicidal effect upon the material which is to be disinfected. To make it positively effective in albuminous substance, sodium or potassium chlorid should be added in the proportion of five parts of either of the latter, to one part of the sublimate in solution. The sodium or potassium will prevent the precipitation above mentioned; it will also prevent the action of light from producing alterations in the mercuric chlorid. Chlorid of mercury should be used in solution 1:500 or 1:1000

Calcium hydrate, in the form of milk of lime (freshly slaked lime, 1 part; water, 4 parts), applied by white=washing walls of apartments, out=houses, pavements, walks, etc., is a very valuable disinfectant agent, but its more practical use is its application for the disinfection of excreta, especially that from typhoid and cholera patients. It should be mixed intimately with the discharges, until the mixture gives a strong alkalin reaction, using at least one quart to each stool. In this manner all excreta may be rendered perfectly harmless.

Carbolic acid, when used in a 5 to 10 per cent. solution, is very effective as a germicidal agent, but its use is limited in general practice on account of its somewhat disagreeable odor and its irritating effect, when coming in contact with the skin of those who handle it. Crude carbolic acid, to which has been added an equal volume of concentrated sulphuric acid, is very effective in the disinfection of excreta, etc. It should be kept artificially cold when being mixed.

Nitrate of silver may be placed next to mercuric chlorid as an efficient germicide, and it is claimed by some to be even superior to that salt in albuminous fluids. It cannot be used upon fabrics, or even in embalming fluids, on account of its peculiar staining qualities.

Chlorid of zinc is a disinfectant in strong solutions, but will prevent the growth of bacteria in about 1:200 or 1:300. Its principal use is in the manufacture of embalming fluids, on account of its great hardening qualities.

Sulphate of zinc, in dry powder, is antiseptic, but its principal use is that of drying and hardening soft decomposing animal matter. It is used as the base of all dessicating or hardening compounds.

The Committee on Disinfectants of the American Public Health Association made a very exhaustive investigation with reference to the germicidal value of various agents. Its report embodied some important conclusions, the substance of which is included in the following:—

The most useful agents for the destruction of spore=containing infectious material are a complete destruction by fire; exposure to steam under pressure 221° F.; boiling water for half an hour to an hour the application of chlorid of lime 6 ounces to the gallon; mercuric chlorid solution 1:500.

For the destruction of infectious material which does not contain spores: Complete destruction by burning (fire); boiling in water for ten minutes; exposure to dry heat 230° F.;

for two hours; the application of a 2 per cent. solution of chlorid of lime; a 10 per cent. solution of chlorinated soda; bichlorid of mercury 1:2000; a 5 per cent. solution of carbolic acid; a 5 per cent. solution of sulphate of copper; a 10 per cent. solution of chlorid of zinc; sulphur dioxid (sulphur fumes) exposure for twelve hours in an air=tight compartment, moisture being present.

We would add to the above formaldehyde gas, which can be used in place of moist or dry heat, it being one of the strongest germicides, and having no deleterious effects upon any fabric or surface with which it comes in contact. The best methods for using sulphur dioxid and formaldehyde gas will be given in the following chapter.

The best agents for disinfecting excreta from the body, are: chlorid of lime in a 4 per cent. solution, and the combination of crude carbolic acid and concentrated sulphuric acid, as given above.

The best disinfectant for privy vaults is chlorid of lime in powder or a 4 per cent. solution.

Soiled underclothing, bed linen, and other washable material, if worn out or of little value, should be destroyed by fire; if not worn out, or if of value, they should be boiled for at least a half hour or more. Bed clothing, wearing apparel, such as woolens and silks, and other fabrics, which would be injured by immersion in water, should be exposed with moisture to formaldehyde gas in an air=tight compartment. The mattresses and blankets, soiled by the discharges of the sick, should be destroyed by fire, or after opening up, should be exposed to formaldehyde gas. Rooms with their contents, articles of furniture, etc., may be completely disinfected by subjecting them to the fumes of sulphur or formaldehyde gas in the manner described in the following chapter.

The hands and general surfaces of the body of those coming in contact with the sick or dead, should be washed with a solution of chlorinated soda, 1:10, carbolic acid, 1:50, or mercuric chlorid, 1:1000.

Permanganate of potash is an antiseptic, and, when combined with oxalic acid, and used in warm solution, makes an excellent wash for the hands, as it has no irritating properties. The hands should first be washed with a strong soap, the finger nails cleansed, and then washed with the solution.

To prevent bacteria from passing out from the dead body that has not been sterilized, it should be enveloped in a sheet saturated with chlorid of lime in 4 per cent. solution, or mercuric chlorid 1:500, or carbolic acid in 5 per cent. solution.

Only some of the most important disinfectants have been mentioned, and their strength and application given, which, no doubt, will be changed from time to time, as a result of the numerous investigations that are being made by the students and practitioners of the science of sanitation.

CHAPTER XLII.

DISINFECTION OF ROOMS AND THEIR CONTENTS.

The recent methods practiced for the disinfection of rooms and their contents, on account of the destructive character of the agents usually employed, have been unpopular with the public for a long time, and needed reform before this. These methods have caused the concealment of many cases of infectious diseases. They were an incentive also for the removal of all manner of valuable furniture before being disinfected, where disinfection was ordered, greatly increasing the chances of dissemination of the disease. The persons whose business it was to attend to public disinfection, frequently found rooms almost empty when they were called upon to do their work, the furniture and other valuable articles having been removed to other rooms, or even from the house, to prevent their destruction, in part at least, by the applications of the disinfectants that were used for the purpose of cleansing. This was not due alone to the injurious effect of the chemicals, but to a great extent to the carelessness of the disinfectors themselves.

The mechanical methods employed were not distinguishable by the general public from ordinary cleansing, which was much less harmful. The question of results, however, was much more important. Were the majority of the disease germs actually destroyed by the methods in use? In a partial sense only, could an affirmative answer be given. It is true, articles placed in a steam=oven were purified, but the rooms themselves were not disinfected properly. Cracks and corners and out=of=way places were left unclean, while it was possible to cleanse large surfaces and treat them in such a manner that the disease germs were destroyed. But even then the action of the strongest disinfectants employed, usually did not last long enough to sterilize the surfaces. Even corrosive sublimate 1:1000 solution requires about thirty minutes of undisturbed action to destroy with certainty many of the various germs. Of course, it could not be admitted that they were inefficient, because we had nothing better; it would have caused such attacks upon the utility of disinfection, that it would have resulted in disinfection being dispensed with entirely

We cannot expect, under any method, to destroy all germs within the sick=room. Some will remain in out=of=way corners and in localities outside of the sick=room, or on the clothing or person of those who have come into contact with the patient. We can only expect to destroy the main masses of disease=producing organisms. Flugge says: "When we can destroy over 90 per cent. of disease germs present in a room, the dangers of infection become almost nothing, and we can be satisfied with the disinfection. This cannot, of course, be done with our previous methods, which does not, however, discredit them as partially successful and the best that could be employed. We are ready to give them up as the search for a more suitable method is indubitably successful.

That which constitutes one of the chief means for the prevention of the dreaded disease, is a thorough disinfection of the room and contents which are infected with the disease=producing organisms. The results of the methods which aim to accomplish this, must stand the test of a thorough laboratory trial. A trial or test of this kind may be more severe than those made in actual practice, but yet it constitutes the only safe guide of what a given agent is capable of doing. How much of the disinfectant is to be used, the length of time it is to act, the influence of the presence or absence of moisture, or how the contents of the room are to be arranged in order to secure disinfection, can alone be decided by the laboratory experiment. To pile bedding and clothing in heaps upon the floor, and burn three or more pounds of sulphur, leaving the room closed for several hours, and then assume that everything is done that can be done, is not sufficient. The disinfection of a room is a very delicate experiment and the various conditions which are necessary to success should be well understood before being put into practice. The various organisms are not acted upon by chemical disinfectants in the same manner always, unless their environments and surroundings are exactly the same. Then, too, while under some conditions, the most resistent are destroyed easily, under other conditions they cannot be destroyed at all. Thus, while the anthrax spores in water suspension will be destroyed by corrosive sublimate very readily, if placed in a highly albuminous fluid, such as the blood, they may not be affected at all.

These conditions are equally true for gaseous disinfectants. The very best gaseous disinfectant may fail simply because too much is expected of it. A gaseous disinfectant is not as penetrating as is supposed by some. The most that we can expect from it is the destruction of the bacteria on the surface; even if it is only a surface disinfectant it will accomplish all that is necessary, if properly applied. We can not expect gas to penetrate through several mattresses or large bundles of blankets; and it is not necessary for it to do so, for it is possible to separate the blankets and hang them upon a line, and open up mattresses and allow the gas to come in direct contact with the germs that may be contained therein, so as to destroy them.

Fumigation by the use of sulphur has been practiced for years, but its efficiency has been doubted largely, probably because too much was expected from it. Because sulphur fumes do not kill the anthrax spores and other resisting organisms, there is no good reason for us to conclude, at once, that it will fail to destroy the infection of scarlet fever, measles, or smallpox, for the simple reason that we do not know anything about the germs of the latter diseases. The organisms that produce these diseases possibly may be destroyed as easily as those of cholera, diphtheria, and black plague. If that be the case, then the use of sulphur fumes as a disinfectant in those diseases would be perfectly satisfactory, as far as the destruction of these germs is concerned. There are other reasons why formaldehyde or some other gas would be better, but we do know, that, if fumigation by sulphur is properly carried out, it will prevent the dissemination or spread of certain of the infectious diseases.

Recently formaldehyde gas has attracted much attention as a disinfectant. A number of different forms of apparatus have been devised for its generation and employment. Some of these are worthless, or at least unreliable, while others can be depended upon at all times.

To disinfect a room with gases, it is necessary to make it as nearly air-tight as possible. The walls and windows should be examined carefully and all cracks closed. Cracks in the walls should be closed with plaster of Paris or putty; those between the wash-boards and floors should be caulked with muslin previously moistened with a 1:500 solution of mercuric chlorid; also cracks around the windows and doors (except the one for exit) should be caulked in the same manner. Open grates, air-chambers, registers, and all other openings, should be closed. The throats of chimneys can be closed with bundles of old clothes. The cracks around the door for exit can be closed on the outside.

SULPHUR FUMES (SULPHUR DIOXID).

If the room is to be fumigated by the use of sulphur it will require from three to six pounds to be burned for each 1000 cubic feet of space. To make it effective it will be necessary to moisten the surface of the walls, fabrics, furniture, and other material contained therein. If sulphur is burned and everything allowed to remain dry, its destructiveness will be almost nil, but its efficiency as a disinfectant will be very limited. Moisture renders it very effective in the destruction of the germs, but at the same time it increases its destructive qualities to fabrics, polished metals, and surfaces, to such a degree that it is almost impossible to use it for the purpose of disinfecting rooms. Again, there are certain bacteria, especially their spores, that it will not destroy, whether moisture is present or not.

Sulphur fumes are very destructive to the organisms that produce scarlatina, diphtheria, black plague, etc., and will accomplish as much as any other method of disinfection. The sulphur should be placed in an iron vessel in the center of the room. A little alcohol should be added to aid its combustion. Sulphur is somewhat dangerous on account of fire; sometimes, while burning, some of the material may be thrown out on to the floor in sufficient quantity to set fire to the building. To prevent this a large pan with a little water in the bottom should be first placed on the floor or table and the iron vessel containing the sulphur placed therein.

The door of exit should then be closed, and the cracks and keyhole filled from the outside with strips of muslin soaked in bichlorid solution, or by pasting paper over them. The room should remain closed for at least twelve hours.

Prior to igniting the sulphur, the walls and contents of the room should be moistened by spraying with water; or steam may be produced in the room by an apparatus for that purpose. Spraying with water is more simple and is usually efficient. At the end of twelve hours the windows of the room should be raised and air admitted very freely, when the sulphur fumes will soon disappear.

By the burning of sulphur, sulphurous acid is evolved, which attacks organic matter, on account of its affinity for oxygen, with which forms sulphuric acid, to which fact is really due the greater part of its destructive effect. As stated before, when moisture is present, the burning of sulphur is very effective, but metal surfaces are attacked and fabrics are destroyed thereby, which makes it very objectionable. This destructibility may be obviated to a very great degree, as to metal surfaces, by covering them with fresh lard. As the lard cannot be applied in this manner to fabrics, those with delicate colors should be removed and subjected to dry heat.

FORMALDEHYDE GAS.

Disinfection by the use of formaldehyde gas is much more satisfactory. By its use nothing is destroyed; it has no effect whatever upon metals or fabrics, wall=paper, or anything that may be contained in the room, and its power of destroying bacteria is less limited than that of sulphur. It will destroy all bacteria and their spores, even the most tenacious, if they are in a moist state. If moisture is not used with formaldehyde gas in sufficient quantity to dampen the dust, surfaces of walls, fabrics, and other contents that contain bacteria, it will not be nearly so efficacious as if moisture is present.

As stated above, various methods have been invented for its production. The so=called formaldehyde gas lamps, which evolve the gas from wood=alcohol, are failures, especially on account of the small amount of gas produced by them, but there are other good reasons that we will not enumerate which would be sufficient to relegate them to the store=houses for plunder.

The only efficient methods that as yet have been introduced, that are worthy of consideration, are those known as the Schering method for the regeneration of formaldehyde gas from the heating of paraform pastiles, and the distillation of formaldehyde gas from formalin. Paraform (polymerized formalin) results from the simple evaporation or heating of formalin and appears as a white, indistinctly crystalline powder, which is stable under ordinary conditions, and is made into tablets and sold in that form for disinfection. These tablets are placed in a lamp made for the purpose and volatilized by heat. They are also soluble in hot water or in heated formalin. When dissolved in hot water they possess the characteristics of ordinary formalin, while, if placed in formalin and boiled for a short time, they will increase greatly the quantity of gas that is produced in a given time in formalin distillation.

Formaldehyde gas was discovered in 1867, by Von Hoffman. He produced it by passing the vapor of methyl alcohol mixed with air over platinum powder, heated to redness. It is now produced by the action of silent electric charges on a mixture of hydrogen and carbonic dioxid. Until 1888 the germicidal properties of formaldehyde gas were unknown. They were discovered in that year by Leow. Since that time its great efficiency as a disinfectant has been generally recognized. It is pronounced far superior to any other general disinfectant in use.

Formaldehyde gas has the chemical property of uniting with sulphureted or nitrogenous products of decayed fermentation and decomposition, forming true chemical compounds, which are odorous and sterile. It is from this property of combining chemically with the above substances that formaldehyde derives its germicidal power. Bacteria are not only albuminoid in character, but their food is mainly albuminoid, and when formaldehyde is present, it combines with both, thus destroying the bacteria as well as their food.

Allan says:—

"In this fact lies the surpassing value of formaldehyde over such disinfectants as corrosive sublimate, carbolic acid, lysol, etc., for albuminous matter is at once coagulated by contact with these agents and resulting antisepsis is more or less superficial; while the food solution, being possessed with the chemical affinity for albuminoids, thoroughly impregnates and, consequently, sterilizes all such substances with which it comes in contact. Partly as a natural sequence, to this property is developed the power of hardening and preserving animal tissue, converting soft tissue to a hard, leathery mass, depending upon the strength of the solution and its time of action. This effect is due, as before stated, to its penetrating action, whereby it readily reunites with the albuminoid substance of the protoplasma of the cells and checks all the putrefactive changes permanently, in dead tissue."

It must be remembered, as stated above, that its power of hardening tissues and reducing them to a leathery mass, is dependent upon the strength of the solution and its time of action. When formaldehyde gas is injected into the body by the embalmer, for preserving and sterilizing purposes, if the tissues are dry, or have an amount of watery constituents in the body equal to or less than the normal, the tendency of a strong solution will be to harden the tissues before a sufficient amount can be injected to reach the capillaries in all parts of the body. The tissues, when thus hardened, will prevent the penetration of the gas, which, no doubt, occurs very frequently. The results of the injection of strong solutions of formaldehyde undoubtedly indicate this, as many bodies are not preserved in all their parts, as putrefaction takes place here and there in some bodies, while in others, decomposition follows as readily as if no disinfectant had been injected. For formaldehyde to penetrate, it must be diluted greatly with water when injected into what we commonly call a dry subject. But, if the case be one of dropsy formaldehyde, having a great affinity for water, will penetrate every part of the body readily, if a sufficient quantity of the solution is used. The greatest objection to formaldehyde, when used in an embalming fluid, is its effect upon the tissues, especially its tendency to produce an unnatural bluish or grayish color in the exposed surfaces of the body.

Formaldehyde is non=poisonous in any strength. Even paraform, which contains 100 per cent. of formaldehyde, if accidently swallowed, is perfectly harmless, because of its very slow conversion into the gaseous state at the temperature of the body. It does not act injuriously upon the alimentary canal. The effect upon the operator is not permanently deleterious. It produces a congestion of the mucous membranes of the eyes, mouth, nose, and fauces, when it comes in contact with them, which, however, will soon pass off, leaving no permanent disturbance.

TO DISINFECT WITH SCHERING'S PASTILLES.

The room should be closed and made as nearly air=tight as possible, in the manner directed above. The disinfector, which consists of a container, in which to place the pastilles, and a lamp with a reservoir, is very simple indeed. The disinfector should be placed on an uncovered table, the floor, or other firm support, in the center of the room to be disinfected. In addition to closing and rendering the room air=tight, the doors of cupboards and closets and all drawers should be opened wide, and all bedding and linen should be spread out or hung up. The container of the disinfector is now filled with a greater or less number of pastilles, that is about two or two and one=half pastilles to each cubic meter (35 cubic feet) of space, or 60 to 75 to each 1,000 cubic feet of space. To be absolutely certain, two and one=half pastilles should be used for every 35 cubic feet. The latter is sufficient to kill the most resisting micro=organisms, including the anthrax spores.

The reservoir of the lamp is then filled three=fourths full of alcohol, about twelve fluid ounces; or, if wood=alcohol is used, it should only be about half full. The wick should be even with the level of the tubes, or, at all events, should not project more than about one=twelfth of an inch above them, so that the flames will not be too high and the apparatus not get too hot. For complete disinfection of larger rooms and entire dwellings, two or more disinfectors should be employed. After all the wicks are lighted, the room should be left and the door tightly closed and caulked. If the formalin vapor, which is absolutely innocuous to both men and animals, becomes perceptible in the neighboring rooms, then their windows should be opened. After twelve to twenty=four hours, the windows of the disinfected room should be opened, and allowed to remain so for some time, when the formalin odor will disappear entirely. Sixty grams paraform pastilles per 1,000 cubic feet of space, are sufficient to destroy, within twenty hours, all organisms, regardless of whether they are present as spores or vegetating forms, provided they are moist. The walls and floor of the room, and whatever articles are present, previously spread out as much as possible, should be sprayed with water before exposing to the formalin vapors.

There is but one objection to the above process of disinfecting rooms, and that is the expense. The expense of polymerization, which gives rise to paraform, is unnecessary, as formaldehyde gas can be distilled from formalin without any trouble or extra expense.

FORMALIN DISTILLATION.

Formalin is a saturated aqueous solution of formaldehyde gas, containing 40 per cent. It occurs as a neutral, colorless, volatile liquid of a pungent odor and sharp taste, missible in every proportion with water or alcohol.

Novy says: "The fear of polymerization of formalin on boiling, is not well grounded. Certain it is that formalin can be distilled from its aqueous solution without polymerization, and that the results obtained are every way equal to those obtained with paraform, and are decidedly superior to the so=called formalin lamps."

For the distillation of formaldehyde gas from formalin, an apparatus similar to the one shown and described in the accompanying cut, should be used.

The room should be prepared as directed above; bedsteads and other furniture should be moved away from the walls, and the doors of cupboards and all drawers opened wide; toys, books, etc., should be hung or stood up in such a manner as to give the gas every access to them. A clothes=horse or wash=line should be put in place; blankets, spreads, rugs, and clothes should be hung over it, well separated, and fully unfolded. Mattresses should be hung up by means of cords that have been saturated in sublimate solution 1 : 500. All clothes, coats, shirts (the latter with sticks passed through the arm, coat=collars turned up and pockets turned inside

NOVY'S FORMALDEHYDE GAS GENERATOR

This apparatus consists essentially of two parts, as follows:

First, a copper container, having a capacity of about two liters (two quarts); a funnel tube extends from the top into the exterior of the container to within one-sixteenth of an inch of the bottom; it is eleven inches in length and five-sixteenths of an inch in diameter. An inclined tube, about fifteen inches in length and five-sixteenths of an inch in diameter, screws into the dome alongside the funnel. This is connected by a short piece of rubber tubing to another tube about four inches in length, which readily passes through an ordinary keyhole. The funnel tube serves the double purpose of introducing the formalin solution and to indicate the completion of distillation, as the formalin vapors and steam will issue from the tube, when the liquid in the container has evaporated down to the level of the bottom of the funnel tube.

Second, a large, brass, central-draft, kerosene lamp, placed in a tripod of the same metal, upon which rests the container.

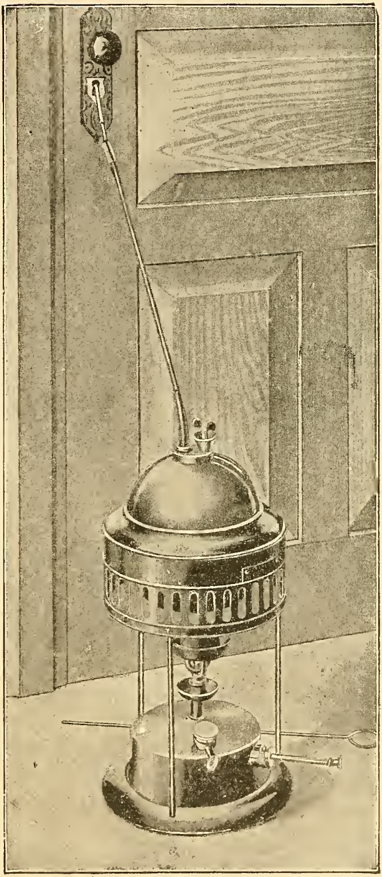


Fig. 63 Novy's Formaldehyde Gas Generator.

out) should be hung on the clothes=line or horse. The walls, floors, carpets, and all other contents of the room, should be sprayed with water, sufficient to dampen them. Then the door of exit should be closed, and the cracks sealed with strips of muslin or putty, and the tube of the distilling apparatus inserted in the keyhole.

To disinfect a room that contains 1000 cu. ft. of space, 150 c. c. (5 oz.) of formalin should be poured into the apparatus. A Bunsen burner, or any other strong flame, should be placed underneath it to boil the contents as rapidly as possible. The ebullition should be sufficient to distill that amount of formalin in from ten to fifteen minutes, as it is necessary to generate the gas as rapidly as possible to secure the very best effect. If the room has more space, there should be a correspondingly increased amount of formalin added to the generator through the funnel. This should be added slowly so as not to cool the boiling contents too rapidly. The room should then be left closed for at least twelve hours. Then the doors and windows should be opened and the apartment ventilated thoroughly. The pungent ordor of formalin is quite tenacious and will remain, ordinarily, for a considerable length of time. Small dishes of ammonium placed in various parts of the room will soon obliterate the remaining evidences of the use of formaldehyde gas.

At the close of a distillation it happens frequently that the formalin vapor present in the container, condenses and polymerizes, producing a solid plug of paraform in the end of the funnel of the tube through which the gas escapes. This being the case, before the apparatus is used again, it should be examined carefully, and, if the tubes are found closed, they should be opened with a wire, or by gently heating, which latter will readily volatilize the paraform. If polymerization should take place, a little borax can be added, which will aid in redissolving the paraform and prevent further polymerization.

As will be seen from the illustration and description, the distilling apparatus is simplicity itself. Any one can use it. Its great advantages are that one apparatus is all that is needed, it matters not how large, or how many rooms are to be disinfected. Also, that it can be used for almost any number of disinfections in the course of a day. The time required for the distillation of sufficient formaldehyde for an ordinary room will not be more than twenty or thirty minutes. Being very light and small, the apparatus is easily transferred from one point to another. It also is under the eye of the operator on the outside of the room during the distillation, so there is no danger of fire or explosion. The fuel and formalin are comparatively inexpensive.

Formaldehyde gas, whether procured from the volitization of paraform pastilles, or distilled from formalin, is undoubtedly the most convenient and most satisfactory disinfectant for rooms and their contents that is known. Its ultimate effects upon the bacteria in many diseases are no more certain than that of sulphur, but in the use of sulphur the destruction of material, with which it comes in contact, is so great that its use cannot be recommended.

CHAPTER XLIII.

TRANSPORTATION OF BODIES.

On the 18th and 19th of August, 1897, the National Conference of the State Boards of Health, was held at Nashville, Tenn. A set of Rules for the Transportation of the Dead was reported by a committee, which had conferred with representatives of the Baggage Agents' and Funeral Directors' Associations at Cleveland, Ohio, in June of the same year. It was taken up and discussed, section by section, and a few slight verbal amendments made. As the subject had been thoroughly studied and discussed by the members who represented the different bodies at Cleveland, the Conference seemed to be satisfied. After being adopted by the Conference of Health Boards, it remained for the General Baggage Agents' Association to take final action, which was done at the meeting of their association in Denver, during the following October. The following resolutions were adopted by the latter association in support of the Shipping Rules:

Resolved, That the rules for the transportation of dead bodies, as recommended by the joint conference of Health Officers, Funeral Directors, and General Baggage Agents, at Cleveland, Ohio, June 9, 1897, and corrected and approved by the National Conference of the State Boards of Health at Nashville, Tenn., August 19, 1897, be approved by this association, and that they be put into effect in every State and province, so soon as the necessary legislation is obtained or State or province supervision and licensing of embalmers and the other essential conditions for their enforcement can be arranged for. That members of the association co-operate with the State and Provincial Boards of Health in the several States and provinces and assist in obtaining the necessary legislation to enable the people to transport their dead in the manner and under the safeguards proposed.

Resolved, That the secretary print 1,000 copies of the rules as approved, with sample of the transit permit suggested, and that copies be sent to the State and Provincial Health Boards and Health Officers of the larger cities and the officials of the principal railway and steamboat lines.

Members of the association were appointed to confer with State and Provincial Health Officers and ascertain what measures were necessary in such States and provinces to give effect to the rules as approved.

THE SHIPPING RULES.

The following are the rules as adopted, with certain modifications, in 1904:

Rule 1.—The transportation of bodies dead of smallpox or bubonic plague from one State, Territory, district, or province to another, is absolutely prohibited.

Rule 2.—The transportation of bodies dead of Asiatic cholera, yellow fever, typhoid fever, diphtheria (membranous croup), scarlet fever (scarlatina, scarlet rash), erysipelas, glanders, puerperal fever, anthrax or leprosy, shall not be accepted for transportation unless prepared for shipment by being thoroughly disinfected by (*a*) arterial and cavity injection with an approved disinfecting fluid; (*b*) disinfection and stopping of all orifices with absorbent cotton, and (*c*) washing the body with the disinfectant, all of which must be done by an embalmer holding a certificate as such, issued by the state or provincial board of health, or other state or provincial authority provided for by law. After being disinfected as above, such body shall be enveloped in a layer of dry cotton, not less than one inch thick, completely wrapped in a sheet, securely fastened, and encased in an air=tight zinc, tin, copper, or lead=lined coffin or iron casket, all joints and seams hermetically sealed, and all enclosed in a strong, tight, wooden box. Or the body being prepared for shipment by disinfecting and wrapping as above, may be placed in a strong coffin or casket, and said coffin or casket encased in an air=

tight zinc, copper, or tin=lined box, all joints and seams hermetically soldered.

Rule 3.—The bodies of those dead from any cause not stated in Rule 2 may be received for transportation when encased in a sound coffin or casket and enclosed in a strong outside wooden box, provided they can reach their destination within thirty hours from the time of death. If the body cannot reach its destination within thirty hours from the time of death, it must be prepared for shipment by arterial and cavity injection with an approved disinfecting fluid, washing the exterior of the body with the same, and enveloping the entire body with a layer of dry cotton not less than one inch thick, and all wrapped in a sheet securely fastened, and encased in an air=tight metallic coffin or casket or an air=tight metal=lined box. But when the body has been prepared for shipment by being thoroughly disinfected by a licensed embalmer, as defined and directed in Rule 2, the air=tight sealing and bandaging with cotton may be dispensed with.

Rule 4.—In the shipment of bodies dead from any disease named in Rule 2, such body must not be accompanied by persons or articles which have been exposed to the infection of the disease, unless certified by the health officer as having been properly disinfected.

Before selling tickets, agents should carefully examine the transit permit and note the name of the passenger in charge, and of any others proposing to accompany the body, and see that all necessary precautions have been taken to prevent the spread of the disease. The transit permit in such cases shall specifically state who is authorized by the health authorities to accompany the remains. In all cases where bodies are forwarded under Rule 2, notice must be sent by telegraph by the shipping embalmer to the health officer, or, when there is no health officer, to other competent authority at destination, advising the date and train on which the body may be expected.

Rule 5.—Every dead body must be accompanied by a person in charge, who must be provided with a passage ticket and also present a full first=class ticket marked "Corpse" for the transportation of the body, and transit permit showing physician's or coroner's certificate, name of deceased, date and hour of death, age, place of death, cause of death, and all other items of the standard certificate of death reccommended by the American Public Health Association and adopted by the United States Census Bureau, as far as obtainable, including health officer's or registrar's permit for removal, whether a communicable or none-communicable disease, the point to which the body is to be shipped, and, when death is caused by any of the diseases specified in Rule 2, the names of those authorized by the health authorities to accompany the body. Also the undertaker's certificate as to how the body has been prepared for shipment. The transit permit must be made in duplicate, and the signature of physician or coroner, health officer, and undertaker must be on both the original and duplicate copies. The undertaker's or registrar's certificate and paster of the original shall be detached from the transit permit and securely fastened on the end of the coffin box. All coffin boxes must be provided with at least four handles. The physician's certificate and transit permit shall be handed to the passenger in charge of the corpse. The whole duplicate copy shall be sent to the official in charge of the baggage department of the initial line, and by him to the secretary of the state or provincial board of health of the state or province from which shipment is made.

Rule 6.—When bodies are shipped by express, a transit permit, as described in Rule 5, must be made out in duplicate. The undertaker's certificate and paster of the original shall be detached from the transit permit and securely fastened on the coffin box. The physician's certificate and transit permit shall be attached to and accompany the express way=bill covering the remains, and be delivered with the body at the point of destination to the person to whom it is consigned. The whole duplicate copy shall be sent by the forwarding express agent to the secretary of the state or provincial board of health of the state or province from which shipment was made.

Rule 7.—Every disinterred body, dead from any disease or cause, shall be treated as infections or dangerous to the public health, and shall not be accepted for transportation unless said removal has been approved by the state or provincial health authority having jurisdiction where such body is disinterred, and the consent of the health authority of the locality to which the corpse is consigned has first been obtained; and all such disinterred remains, or the coffin or casket containing the same must be wrapped in a woolen blanket thoroughly saturated with a 1:1000 solution of corrosive sublimate, and enclosed in an hermetically soldered zinc, tin, or copper-lined box. But bodies deposited in receiving vaults shall not be treated and considered the same as buried bodies, when originally prepared by a licensed embalmer as defined in Rule 2, and directed in Rule 2, provided shipment takes place within thirty days from the time of death. The shipment of bodies prepared in the manner above directed by licensed embalmers from receiving vaults may be made within thirty days from the time of death without having to obtain permission from the health authorities of the locality to which the body is consigned, provided the cause of death was not any of the diseases named in Rule 2. After thirty days the casket or coffin box containing said body must be enclosed in an hermetically soldered box.

Adopted June 22, 1904.

The above have been effective since September 1, 1904.

COMMENTS UPON THE RULES.

Under the first rule the transportation of bodies dead of smallpox or bubonic plague is absolutely forbidden. It seems that the reasons for this are as follows: First, the lack of confidence in the ability of the embalmer with the means at hand, to succeed in sterilizing, or destroying the bacteria of infection within the body; second, the little knowledge attained by the members of these boards, up to the time of the adoption of these rules, in regard to the science of embalming.

If a body can be sterilized that is dead of diphtheria or scarlet fever, undoubtedly those dead from the diseases enumerated under Rule 1, can be sterilized also. The poisonous or infectious matter in a case of scarlatina is certainly just as tenacious as that of smallpox, or bubonic plague. Still, under these rules, the scarlatinal case can be shipped while that of smallpox cannot.

It can be stated with positive truth that a body can be sterilized, it matters not of what infectious or contagious disease it dies, if it is properly treated. The means that are necessary should be at hand, wherever the body is handled, that is dead of any infectious disease. Holding a certificate from the Board of Heath does not afford these means; neither does a little practice upon the body, but by constant study and application only, can the means be obtained.

The injection of fluid into the arteries and cavities does not suffice in all cases. In certain cases the arterial system may be abnormal; arteries may be closed; post=mortem contraction may still exist; arteries may be burst, as is the case frequently in atheroma; the blood may not have passed into the venous side, or clots may intervene at different points. Any one of these conditions will prevent the fluid from passing into the tissues. The tissues of the body must be filled, if entire disinfection results. Any one can see plainly, that if either one of these conditions exist, arterial embalming would be a failure.

There are other means by which the tissues may be filled when the arterial circulation is destroyed. Fluid should be injected directly into the tissues. This can be done in many cases through the subcutaneous cellular tissue; in others, a sufficient quantity cannot be injected in this manner. Therefore in the latter cases, injection should be made also into the deeper tissues through an ordinary hollow=needle.

Enough fluid can be injected in this manner to fill the tissues, in cases where the arterial system is destroyed. The cavities, especially the serous sacs, the alimentary canal, and respiratory tract, should be filled full of fluid. A pint or two is not sufficient, generally, to fill them. As a rule, much more should be used.

If a body is treated in the above manner, with a strong disinfectant fluid, one that will destroy the spores as well as the active bacteria, there will be no doubt of its thorough disinfection.

In addition to the application of the fluid, cotton batting, if properly applied, so as to cover every part of the body without rents, will prevent bacteria from passing out from the body. If a body is sterilized thoroughly and encased in cotton in this manner, it matters not what the disease was that produced death, it can be shipped with perfect safety to any part of the world. There will be no more danger from the body than there would be from a shirt worn by the patient, after being placed in water containing strong disinfectants, and boiled for three or four hours.

As stated above, the shipping authorities have not the confidence in the ability of embalmers in general to prepare bodies in a way to render them perfectly free from the danger of disseminating disease. The reason for that is a great majority of the profession are not students. They learn to raise an artery and inject a little fluid and stop at that point, thinking it is not necessary to know anything more about the business. If all were students and educated in their profession, then the authorities would have more confidence. A certificate from the Health Board does not make the student, nor does it make an embalmer out of the man who injects only a little fluid into the body. Many are in the business, but few are students.

Under Rule 2, bodies of those that have died of diphtheria, (membranous croup), scarlet fever, (scarlatina, scarlet rash), glanders, anthrax, leprosy, etc., will be accepted for transportation provided they are prepared in a certain manner; that is, they shall be disinfected by arterial and cavity injection, with an approved disinfectant fluid. As stated above, it will be seen that frequently the circulation cannot be filled with fluid for reasons there given. If either of these conditions exist, then the tissues can be filled by direct injection of fluid into them through the hollow=needle. The body should then be washed with the disinfectant and the external openings should be injected and then closed with pledgets of absorbent cotton. After the body is disinfected, it should be enveloped in a layer of cotton, not less than one inch thick, completely wrapped in a sheet and bandaged, and encased in an air=tight zinc, tin, copper, or lead=lined coffin or casket, all joints or seams hermetically soldered, and all enclosed in a tight wooden box; or placed in an ordinary coffin after being prepared and then in a zinc=lined box, which should be hermetically soldered, then placed in a strong outside box.

If you observe closely, you will notice that the rules say that the body shall be wrapped in cotton. They do not say what kind of cotton. A certain author, who has written a work on embalming, in giving the rules, has made a misstatement, which is misleading. He states that the body shall be wrapped in absorbent cotton. As a matter of fact, it makes but little difference, if any, what kind of cotton is used, except in expense. Cotton batting, or raw cotton, is very cheap as compared with absorbent cotton. The latter has no advantage whatever over the former; therefore, we would recommend the use of cotton batting.

When the author first recommended the encasing of a body in cotton an inch thick, in a letter* to Mr. Joseph W. Laube,

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* The letter referred to was as follows:

Mr Joseph Laube, Richmond, Virginia.

DEAR SIR:—In response to your request for information as to whether a body can be thoroughly disinfected by embalming so as to be perfectly safe for shipment, we would say—

TO DISINFECT A BODY FOR SHIPMENT.

It should be thoroughly embalmed, using for the purpose the strongest disinfectant chemicals. An antiseptic is not necessarily a disinfectant, indeed, many are not disinfectants at all, but all disinfectants are positively antiseptic.

The chemicals should reach the tissues, organs, viscera, canals, and cavities that contain the infectious bacteria, in such quantities as are necessary to destroy the spores as well as the active bacteria. This can only be done by injecting large quantitles of the solution of chemicals.

of Richmond, Va., during the spring of 1897, he stated that cotton batting (not absorbent cotton) should be used.

The bacteriologist uses cotton batting to screen the air, that passes into the test=tube, of the bacteria that are floating in the air, as bacteria cannot pass through cotton batting. For that reason cotton batting was recommended for the encasement of bodies, to prevent the bacteria from passing out from the body. The cotton should be applied over the whole surface; it should be continuous, no rents or divisions in the encasement.

The best and easiest method for applying it is as follows:—

Each infectious disease is produced by a specific bacterium; that is, one that is always found in the disease, and is present in no other.

These micro-organisms or bacteria are found in large numbers, in certain parts of the body, where the soil is in proper condition for their development—as in the throat, in diphtheria; in the alimentary canal, in typhoid fever; in the lungs, in consumption; in the intestinal canal, in cholera, etc.—but they may be distributed more or less to all parts of the body by the absorbent and blood-vessels.

If anatomy, physiology, and morbid anatomy, and the infectious diseases are studied and understood by the embalmer, he can thoroughly disinfect any body dying from infectious or contagious disease.

As stated above, the strongest disinfectant chemicals should be used (combined with other chemicals to hold them in solution) for the embalming fluid. The fluid should be injected through the arteries into every tissue of the body, filling them thoroughly. Then fill all of the canals and cavities of the body—the respiratory canal, the alimentary canal from the mouth to the anus; the serous cavities, etc.—for the purpose of disinfecting their contents. Then wash the body with the fluid. Fill the ears, nose, and mouth with the same. *Lastly, envelop the whole body in cotton batting, one inch or more thick, keeping the cotton in place with an ordinary bandage. The cotton should be at least an inch thick on every part of the body after the bandage is applied.*

* * * * * * * *

If the above directions are followed in its preparation, any infected corpse can be rendered perfectly safe, when placed in any common wood or cloth-covered coffin or casket, for shipment in any car or conveyance to any part of this country or of the world.

After the embalmment of the body according to the above process it is possible that the fluid has not reached every point, so as to make it perfectly safe, the application of the cotton batting is made in the above manner to cover every portion. Not the least communication with the surrounding air is made with the body except through the cotton, which will positively screen the air, cleansing it thoroughly of the bacteria. It is not possible for the bacteria of any description to pass through the cotton either outward or inward. It is known to every one acquainted with the methods of cultivating bacteria, that if cotton is placed within the test-tube, cultures may be made within the tube. None others floating in the air external to the tube can pass inward through the cotton placed in the outer end of the tube: hence the encasement of the body with cotton batting.

* * * * * * * *

Yours very truly, E. Myers.

Spread upon the floor a sheet sufficiently long to reach at least a foot or a foot and a half above the head and below the feet; then spread layers of cotton, side by side, length=wise over the sheet, covering the whole surface; then cross=wise, side by side, covering the whole surface; then again length=wise as before, spreading the cotton in this manner alternately, until at least six thicknesses of the sheet=cotton or cotton batting is spread upon the sheet; then place the body in the center of the sheet; bring up the cotton from the ends, turning it over the head and feet, throwing the sheet back; then one one side in the same manner, throwing the sheet back, leaving the cotton remain over the body; then bring up the sheet from the other side; it will be seen that in this manner the raw surfaces of the cotton will overlap each other; then the sheet should be brought up from each end, and then from the sides, and stitched or pinned tightly together; then the whole should be wrapped with a roller bandage of about three or four inches in width. To make the application in this manner will require but one assistant, and the bandage can be applied without danger of tearing or slipping the cotton at any point. A sheet should then be moistened in a solution of bichlorid of mercury 1 : 500, and laid across the coffin or casket and the body placed in the coffin and the sheet folded over it. The application of the moist sheet to the outer surface is for the purpose of destroying any bacteria that might be attached to the bandage that has been applied to protect the cotton.

Under Rule 3, bodies dying of typhoid fever, puerperal fever, erysipelas, tuberculosis, measles, or other dangerous communicable diseases, other than those specified in rules 1 and 2, are received for transportation. If these bodies are embalmed as directed above, and wrapped with cotton in the same manner, by one who is authorized by the health board of one of the States, it can be shipped without placing in the hermetically sealed casket or box; but if shipped by persons not holding such certificate, it must be placed in an air=tight box or casket.

There is not much danger of disseminating some of the diseases enumerated, especially that of tuberculosis. There is scarcely a man, woman, or child in this country that is not exposed almost every day to the tubercular infection. There is a possibility of the disease being disseminated through the shipment of the body in the ordinary way, but that possibility is so remote that we can hardly consider it dangerous. There is far greater danger from the living subject than from the dead body. The patient that has consumption is allowed to travel over the country in both sleeping and day cars; to use the floors and cuspidors to deposit the sputum that is brought up from the lungs, which contain millions of the bacteria that produce the disease; when he walks upon the streets he deposits the sputum upon the sidewalks or in the gutters or roadways; or, when riding in the street=car, he possibly deposits it upon the floor; he is allowed the same privileges to which the man without disease is entitled.

To prevent the dissemination of consumption, the necessary methods should not commence with the embalmer; they should begin with the beginning of the disease. It is an easy matter, at the present time, to determine whether or not the patient has consumption. A little of the sputum placed under the microscope by the physician is all that is necessary to make the diagnosis certain. If it is found that the patient has consumption, isolation should be enforced. He should not be allowed to travel our streets, to ride in our public conveyances, or to associate with those who are not affected with the disease. He should be sent by the health boards into a climate that will aid in destroying the bacteria that are growing in his system. If this could be done in the beginning of the disease, there would be but few that would die of consumption. Hospitals should be constructed in proper altitudes and maintained by the government, and all patients sent to them, as soon as tubercular bacilli develop within the system.

It is not necessary to condemn the methods adopted for the shipment of bodies that die of consumption. There can be no fault found with them. The only matter of complaint is that the health boards are not strict where strictness is necessary, in the application of sanitary measures for the prevention of dissemination of tuberculosis.

The adoption and final enforcement of these rules will be a great convenience to those who will have charge of the shipment of bodies in the future. There will be no special rules of the different corporations to conflict, which, heretofore, have made it necessary to ascertain the rules of the different roads before starting with the body. Under the rules, a body can be shipped from, to, and through any of the States and provinces in America without question. Restrictions that are imposed are not hardships, nor do they increase to an appreciable degree, the expenses over previous methods. They have the tendency to do away with the making of false statements in shipping permits, thereby subjecting the public to the dangers of disseminating infectious or contagious disease. They will stimulate the student and compel the ignoramus to enlighten himself. The rules are not perfect, but will be improved from time to time as necessity requires.

Every embalmer should have in his place of business, a dressing=room, in which there is a tight closet, wash=stand, water, soap, and shelves on which to place necessary disinfectants for the purpose of disinfecting himself. He should be provided with a rubber coat, which fits closely around the neck and is long enough to reach within one=half inch or an inch of the floor, a rubber or oiled=silk cap, and an old suit of clothes. These should hang in the closet ready for use in infectious cases, especially those that are communicable. The shelf should contain a bottle each of bichlorid of mercury, 1 : 1000 and 1 : 500, a box of disinfectant salve, a nail brush, and a bar of good soap. When he is called to take care of an infectious case, he should change his usual suit for the old one; then put on the rubber coat and rubber or oiled=silk cap; cover the hands with the disinfectant salve or wear a pair of rubber gloves. Dressed in this manner he is ready to take care of the case. On returning from the case, he should remove the clothing, place them in the closet, and fumigate them. He should also wash his hands, face, and whiskers with soap and the bichlorid of mercury, 1:1000 solution: he should then cleanse and brush the nails very thoroughly; then dip them in the solution of the bichlorid of mercury 1:500.

The instrument-case and instruments used in an infectious case should be fumigated and disinfected just as thoroughly as the clothing that is worn. Great care should be taken to prevent the dissemination of the disease.

PART FIFTH

GENERAL MISCELLANY

INTRODUCTION TO PART FIFTH.

In Part Fifth we have introduced some matter which does not appear to have a proper place in other parts of the work, but which is none the less valuable on that account.

In Chapter XLIV., a number of hints are given to guide the young funeral director in the matter of approaching his clients and preparing the body for the final obsequies; also, on conducting a funeral from the house to the cemetery, including services at the house, church, and grave.

A chapter on Resuscitation is given, as it often happens that the funeral director is the first one called in a case of supposed or apparent death. Therefore, he should be well acquainted with the best means of resuscitation, so as to be able to act promptly in the absence of the physician.

Then follows a consideration of Post-Mortem Wounds, giving the best means of their prevention, and, when received, the proper treatment until a physician can be consulted.

The directions for selection and care of instruments seem necessary to protect the embalmer in his purchases, and to aid him in keeping his outfit in such a condition that it may always appear new, and to reduce to the minimum the danger from handling his instruments.

CHAPTER XLIV.

HINTS ON FUNERAL DIRECTING

The changes have been so great and ideas so advanced along this line in the past few years, that the conducting of a funeral of to=day, compared with the management of one twenty=five years ago, may be likened to the modern electric=lighted train of to=day, traveling at fifty miles an hour, compared with the stage=coach of those days. The change to the present methods of conducting a funeral was a welcome one to the bereaved family, the minister, and laity. And funeral directors are not stopping at what they have attained, for each year brings greater advancement.

When a call comes to him he should receive it with coolness and reserve. He should not rush to the house of mourning as though he were afraid his competitor might get there first. He should approach the family with dignity. The shock to them may be great, and he may not be able to learn all of their wishes at once.

First, get their confidence and learn their desire regarding embalming. If the body is to be embalmed, prepare the body and raise the artery as directed in preceding chapters. Do the work neatly. The trocar should not be used when strangers are present. The prejudice against embalming, no doubt, should be laid largely to indiscriminate use of the trocar. If the subject is that of a female, a lady, a friend of the family if possible, should be invited in to see the operation.

After the body has been embalmed, if a nice couch is in the room, use it. Dress the body completely, for no face application will be needed—there will be nothing to soil the clothing. Spread a drapery over the couch, or a sheet may be used. Stand a screen in front to break the view. If in winter ask for a little heat; never allow the body to freeze. A bunch of flowers may be laid near the body; it has a pleasing effect. Place the body in an easy position, similar to the one occupied in bed. It may be difficult, at times, to place one hand under the head, owing to rigor mortis, but it is a pleasing position to the relatives. Should the subject be a child, use its little bed—if white, a pretty effect would be to trim with smilax and flowers; or a settee can be very prettily draped, arranging over all a drapery of silk illusion.

After having the body cared for, quietly withdraw, returning at a later period the same day, or the next, to learn the wishes of the family as to pall=bearers, singers, minister, number of carriages, flowers to be furnished, casket, etc. Give them the cost of everything. Do not lead them into any unnecessary expense; be reasonable in all charges. Ask regarding door crape; some dislike any insignia, but, where used, a cycas palm leaf or two, tied with black or purple ribbon, is suitable for an aged person, and a wreath or bunch of flowers for a child.

Always place the body in the casket the night before the funeral. It is more comforting to the family and gives them ample opportunity to take their leave prior to the service, which should be insisted upon, be the service at the house or at the church. If at the house, the funeral director should be there at least one hour before the service, and either have an assistant conduct to the casket all who attend, and seat them, or do it himself.

Before the service, when ready for the family,—who should remain in privacy meanwhile,—close the casket, and have the friends come to the room reserved for them. In this manner he will get rid of that horrid custom of tramping past the open casket. Do this with the best trade, and, if he has the full confidence of the people, he will find others will fall into the custom readily. If the service is at a church, it may be impossible to adopt this custom. Some seek and desire ostentation, which should be discouraged, especially among those who do not have the necessary means. If the funeral director stands in the community as he should, he will wield an influence far above any other, and can lead his clients into new ways and customs.

At the house just a nod from the minister should indicate that the services are in the funeral director's hands. Then nod to the pall=bearers, conduct them to the front door, where two assistants, or two of the pall=bearers, should deposit the casket. Have the friends remain seated until the casket is placed in the funeral car. Two assistants should stand at the carriages to seat the friends, as they are sent out, a previous list having been made out, of the manner in which they are to go. Make haste slowly, here of all places: and after all is arranged, get into the buggy and lead the procession.

If it be an Order funeral, place the Order at the head. Although they may have a marshal, the funeral director should be the man in command. He should not forget this, for he belittles himself when he submits to any other authority.

At the grave have chairs for the relatives. Place the Order on the outside in a circle. As the casket is being gently and solemnly lowered into its last resting place, by the bearers, or by one of the modern lowering devices, the ceremony can proceed. A very nice service, and one pleasing to the friends, should there be plenty of flowers, is to give to each one, at the house, a rose or carnation, which, as the last words are said, they should quietly drop on the casket and then retire to their carriages.

There is no need of undue display of sympathy on the part of the funeral director,—it is not what he is called for. His tact and gentleness in handling a funeral will go farther to make friends than anything else.

Charges should be moderate. Do not impoverish the living by lavishing upon the dead an expensive funeral. The tendency is, the more moderate the means, the greater the demands, and it will remain with the funeral director to solve the desire for a hundred=dollar funeral with a twenty=dollar capital back of his customer. Do the work thoroughly and trust to the honesty of the customer for the pay. Encourage briefness of ceremony at the grave. Do what can be done to discourage Sunday funerals; you should appreciate a day of rest and quiet, and be assured the minister will be with you. Ministers have duties enough for that day, and many will not allow anything to interfere with their regular church services.

After all is over there comes a business side to it all. If a custom of allowing a five per cent. discount, if paid in thirty days, were adopted, and the bill sent in, there are, no doubt, many who would avail themselves of this discount. Do not allow bills to accumulate on the pages of the ledger through fear of asking for just dues. You should keep your own bills paid and thereby preserve your credit—good credit may serve you at times better than capital.

The paraphernalia that seems needful is fast growing in magnitude and becoming more burdensome each year. The funeral director should hail the time of more simplicity in funeral trappings. The adoption of many of them is the explanation or solution of so many in the business being impoverished, and, unless the funeral director enjoys a large clientage, he will find himself falling behind. He should have pride enough to have a first=class outfit—one that will command the respect of his patrons,—but he should not entertain the idea that he must possess every new=fangled device presented to him.

The funeral director should keep posted upon matters of his profession; he should enlarge his library, from time to time, by purchasing practical works on embalming and collateral subjects; and he should be a subscriber to and read as many of the trade journals as he can afford; he should join the State Association, and attend its meetings; and lend his help to the uplifting of his profession and thereby help his brother.

CHAPTER XLV.

RESUSCITATION.

The definition of resuscitation (*re,* again; *suscito,* I stir up) is the recovery from suspended animation or apparent death. In these conditions, of course, all signs of circulation and respiration have disappeared, but usually the failure of one function has preceded that of the other.

The methods for producing artificial respiration, and the treatment for the purpose of restoring the vital action of the different organs of the body, are not given in this work for the benefit of the embalmer only, but for all others who are likely to come in contact with the cases herein described. some of the different methods and rules, that have the sanction of the leading physicians and surgeons in the different civilized countries, will be given.

HOWARD'S METHOD OF ARTIFICIAL RESPIRATION.

The first, known and described as Howard's Method of Artificial Respiration, is as follows: Place the patient upon the back with the face upward; a hard roll of clothing beneath the thorax, with the shoulders slightly declining over it. The head and neck should be bent back to the utmost; place the hands on top of the head; strip the clothing from the waist and neck. The operator should then kneel astride of the patient's hips, and place his hands upon the breast so that the ball of each thumb and little finger rests upon the inner margin of the free border of the costal cartilages, the tip of each finger near or upon the ensiform cartilage, the fingers dipping into the corresponding intercostal spaces. His elbow must be fixed firmly, making them one with the hips.

Action of Operator.—He should press upward and inward toward the diaphragm, using his knees as a pivot, throwing his weight forward two or three seconds, until his face almost touches that of the patient, ending with a sharp push which helps to jerk him back to his erect, kneeling position. Rest three seconds, and then repeat the movement as before, continuing it at the rate of seven to ten times a minute; taking the utmost care, on the occurrence of the natural gasp, gently to aid and deepen it into a longer breath, until respiration becomes natural.

This method is said to keep the passage through the larynx free, without the aid of an assistant, or any contrivance for the purpose, and is recommended for that reason. Artificial respiration must precede the use of the stomach pump and be continued until either the pulse or natural respiration returns. Keep up the temperature of the body by hot blankets or hot bottles.

RULES OF THE ROYAL HUMANE SOCIETY.

The Royal Humane Society has recommended the Sylvester method of artificial respiration in the rules that it has published for directions for restoring the apparent dead. The rules are as follows:—

Rule I.—If from Drowning or Other Suffocation, or Narcotic Poisoning.—Send immediately for medical assistance, blankets, and dry clothing, but proceed to treat the patient instantly, securing as much fresh air as possible.

The points to be aimed at are—first and immediately, the restoration of breathing; and, secondly, after breathing is restored, the promotion of warmth and circulation.

The efforts to restore life must be persevered in until the arrival of medical assistance, or until the pulse has ceased for at least an hour.

Treatment to Restore Natural Breathing.

First.—To Maintain a Free Entrance of Air Into the Windpipe.—Cleanse the mouth and nostrils; open the mouth; draw forward the patient's tongue, and keep it forward—an elastic band over the tongue and under the chin will answer this purpose. Remove all tight clothing from about the neck and chest.

Second.—To Adjust the Patient's Position.—Place the patient on his back on a flat surface, inclined a little from the feet upward; raise and support the head and shoulders on a small firm cushion or folded article of dress placed under the shoulder-blades.

Third.—To Imitate the Movements of Breathing.—Grasp the patient's arms just above the elbows, and draw the arms gently and steadily upward, until they meet above the head (this is for the purpose of drawing air into the lungs); and keep the arms in that position for two seconds. Then turn down the patient's arms, and press them gently and firmly for two seconds against the sides of the chest (this is with the object of pressing air out of the lungs; pressure upon the breast-bone will aid this).

Repeat these measures alternately, deliberately, and perseveringly, fifteen times in a minute, until a spontaneous effort to respire is perceived, immediately upon which cease to imitate the movements of breathing, and proceed to induce circulation and warmth.

Should a warm bath be procurable, the body may be placed in it up to the neck, continuing to imitate the movements of breathing. Raise the body in twenty seconds to a sitting position, and dash cold water against the chest and face, and pass ammonia under the nose. The patient should not be kept in the warm bath longer than five or six minutes.

Fourth.—To Excite Inspiration.—During the employment of the above method excite the nostrils with snuff or smelling-salts, or tickle the throat with a feather. Rub the chest and face briskly, and dash cold and hot water alternately on them.

Treatment After Natural Breathing Has Been Restored.

Fifth.—To Induce Circulation and Warmth.—Wrap the patient in dry blankets, and commence rubbing the limbs upward firmly and energetically. Promote the warmth of the body by the application of hot flannels, bottles, or bladders of hot water, hot bricks, etc., to the pit of the stomach, armpits, between the thighs, and to the soles of the feet. Warm clothing may generally be had from the bystanders. When swallowing has returned, a teaspoonful of warm water, small quantities of wine, warm brandy and water, or coffee should be given. Sleep should be encouraged. During the reaction, large mustard poultices to the chest will relieve the distressed breathing.

Rule II.—If from Intense Cold.—Rub the body with snow, ice, or cold water. Restore warmth by slow degrees. It is dangerous to apply heat too early.

Rule III.— If from Intoxication.—Lay the individual upon his side on the bed with his head raised. The patient should be induced to vomit.

Rule IV.—If from Apoplexy or Sunstroke.—Cold should be applied to the head, which should be kept raised. Tight clothing should be removed, and stimulants cautiously used.

Alcoholic stimulants should not be given until natural respiration has been induced, and, in cases of narcotic poisoning, not until consciousness has been restored. If, on the return of consciousness, the patient is in pain or faint, the inhalation of a few drops of ether or smelling ammonia is indicated. In their absense a few teaspoonfuls of brandy may be given. Hot tea and coffee should be the first refreshments swallowed; it should not be pressed upon the patient, as vomiting is more exhausting than waiting a few hours for food.

Syncope and Asphyxia.

For the purpose of treatment you may regard those cases, where the lips and mucous membrane are found pale and bloodless, as syncope; and those where they are dark=colored, as asphyxia.

Syncope may arise (1) from mental emotion, sudden pain, or shock; (2) from drugs and poisons, including anesthetics, especially chloroform; (3) from hemorrhage, or anything which reduces the due supply of blood to the heart; (4) from fatty degeneration or dilatation of the heart.

Treatment.—Place the patient horizontally on his left side, with the pelvis and feet raised; the windows of the room should be opened; the face should be fanned; and a little cold water may be sprinkled on the forehead. Smelling salts should be held to the nostrils. If natural breathing has not returned, begin one of the methods of artificial respiration, as given above, the temperature of the body being kept up by the application of hot blankets or hot bottles. After respiration has been fully established, a little brandy, hot water, wine, or other stimulants, should be given, with care that none of it enters the trachea. If swallowing is impractical, inject warm fluids into the rectum.

Asphyxia from Breathing Noxious Gases.—The body should be carried into the fresh air. All clothing should be loosened around the neck and over the chest. Artificial respiration should be commenced at once, while an assistant should blow into the nostrils three or four times. Hot blankets and hot water bottles should be applied.

Asphyxia from Mechanical Obstruction of the Air=passages.—The cause of obstruction must be removed, if possible, by placing the patient face downward, aiding the dislodgment by the use of the forceps, a button=hook, or the handle of a tablespoon.

Asphyxia from Advancing Coma or from Narcotics and Anesthetics.—In these cases, the breathing is stopped from the failure of the medulla and respiratory nerves to act. Very often there is mechanical obstruction in the larynx, which should be considered. Artificial respiration induced by simply compressing the chest at intervals of five seconds, may suffice. If raising the chin and throwing the head back does not effect a free passage of air, one or the other of the methods of artificial respiration given should be commenced.

Asphyxia from Drowning.--In asphyxia from immersion in water, there are two serious complications, viz., first, the presence of water and mud in the air=passages, and, secondly, the depressing effects of cold. With the view of more effectually removing the water from the air=tubes, Howard gives the following rules:—

1. **Position of Patient.**—Face downward and hard roll of cloth beneath the epigastrium, making that the highest point and the mouth the lowest; the forehead resting on the forearm or wrist to keep the mouth from the ground.

2. **Position and Action of Operator.**—Place the left hand well spread upon the base of the thorax to the left of the spine, the right hand upon the spine a little below the left and over the lower part of the stomach. Throw upon them with a forward motion all the weight and force the age and sex of the patient will justify, ending this pressure of two or three seconds by a sharp push, which helps you back again into the upright position. Repeat this two or three times according to the duration of the immersion; then apply one or the other of the methods of artificial respiration.

3. **Suspended Animation from Lightning Stroke or Electricity.**—In a stroke of lightning or electricity, the shock is not necessarily fatal, in spite of the popular notion to the contrary. The action of the vital organs is suspended, but the organs are rarely destroyed. In these cases, if respiration can be artificially maintained for a sufficient length of time, there is a fair chance that the heart will resume its suspended function and that the victim will finally recover. Consequently, a person struck by lightning, or hav-

ing had a severe shock induced by the electric current, should never be pronounced dead until one of the methods of resuscitation, explained above, has been practiced upon the body for at least two or three hours. Dr. D'Arsonval in France has practiced the Howard method with success and strenuously urges its adoption. Experience in this country also justifies the continued efforts for a long period of time to induce reanimation by one of the methods given above. This is a matter of great importance, for, although comparatively few people are killed by lightning, it seems quite probable that the number could be still further reduced by practicing artificial respiration, continuing it for hours instead of minutes.

Recent reports show that cases of asphyxia, especially those from drowning and suffocation, caused by closure of the respiratory tract, without injury to the body, can be reanimated after a period of several hours, by application of the treatment given above. If the patient has been drowned, and has lain in the water even for an hour or two, do not at once pronounce him dead, but apply the rules given above in a thorough, constant, and scientific manner.

CHAPTER XLVI.

POST MORTEM WOUNDS.

In the putrefaction of albuminous substances in bodies, many chemical combinations are formed, some of which, such as poisonous toxalbumins and certain alkaloids, to which the name ptomains, or cadaveric alkaloids, have been given, are extremely poisonous. That toxic elements exist in the products of decomposition, has long been known to the physician and scientist. The character of these substances was first recognized by Selma, who gave them the names of alkaloids or ptomains. General, fatal poisoning frequently results from the handling of cadavers, or other dead animal matter, by inoculation through the slightest wounds received by the operator.

The poisoning from a corpse usually from inoculation through a small wound or puncture, or where the skin has been abraded, the wound being sometimes so slight as not to be noticed.

Embalmers are subjected more frequently to the dangers of blood=poisoning than any other class of men. Therefore they should be made aware of the consequences that frequently result from the careless manner in which bodies and instruments are handled. The slightest cut or scratch inflicted with one of the sharp=edged instruments, that are used in the operations upon the dead body, may not only cause the loss of a finger, a hand, or even a whole extremity, but may cause intense suffering for many days, finally resulting in death.

Such wounds are called post=mortem wounds. The virus may be received also into the system by inoculation through abrasions or open wounds, previously existing upon the surface of the hands or fingers of the operator. The poison is most virulent in fresh bodies, diminishing in intensity as decomposition advances. It is most marked when inoculation occurs in handling cases of septic peritonitis or pleurisy, pyemia, septicemia, puerperal fever, diffuse cellulitis, erysipelas, spreading gangrene, etc. The poison only acts by direct inoculation, usually occurring through a scratch or wound made accidentally while operating on the body; although any partly healed raw surface, or the cracks in chapped hands, or the little fissures at the margins of the nails, serve equally well as points of inoculation.

Before operating upon the dead body the hands should be very carefully examined. If the cuticle be denuded at any point on the hands or fingers, use rubber gloves or finger=cots, or hand=protector, carbolated vaseline, or some similar preparation. The latter should be rubbed over the hands, under and around the nails very carefully, to prevent the absorption of the poison. It is a good practice to take this precaution even if the cuticle is supposed to be intact, as abrasions may be so slight as to escape notice.

The embalmer, while operating, should be very careful not to wound himself with any of the instruments used in the operations. All punctured wounds are extremely dangerous. If such an accident should occur, wash quickly and suck the wound thoroughly, or cause it to bleed freely; then cauterize it, or wash out with fluid containing bichlorid of mercury 1:1000, or carbolic acid, 3 to 5 per cent., or embalming fluid, and cover with hand=protector, collodion, or plaster. If the wound is on the finger or hand, wear a finger=cot or rubber glove to protect further the wounded part.

If a wound is received and inoculation results, the point of the inoculation, in from twelve to twenty=four hours, will become more or less red and irritated. It may remain in this state for another day, when a brawny swelling of a dusky=red will form around it, and extend rapidly in all directions, but principally along the line of the lymphatics. There is intense burning pain and severe constitutional disturbances, high temperature, and total loss of appetite, which may be followed by spreading gangrene; or, the lymphatic glands may become swollen and painful, and abscesses may form at the elbow and axilla. Septicemia or pysmia may follow.

If any of the above symptoms result, send for the family physician at once and be placed under proper treatment.

When gas from a dead body is inhaled it does not cause blood=poisoning, but may cause a kind of septic fever. For this reason its inhalation should be avoided.

CHAPTER XLVII.

INSTRUMENTS: THEIR SELECTION AND CARE.

With the growth and process of embalming, especially within recent years, a diversified and extensive line of instruments and other paraphernalia has been brought into existence. Some are necessary and useful to the embalmer in his work of caring for the dead, while others are practically useless, having scarcely anything to commend them except their novelty. This admits of great latitude in the selection of an outfit, which should be carefully and judiciously made. The instruments should be of the best quality and, as far as possible, aseptic in their construction. All knives, hooks, etc., should be solid in their entirety, without joints or rivets; or, if they have joints, they should be made so as to be separated in order that they may be easily cleansed and sterilized after each operation.

It usually follows that the lowest in price is the dearest in the long run; but this is not always true, for sometimes a very high price is paid for an inferior article. The success of an embalmer may be judged, as a rule, by the selection, quality, condition, and appearance of his instruments. It is necessary to keep all instruments clean. The importance of this cannot be overestimated, for, if not so kept, they may be the means of inoculating those who handle them with septic matter, causing septicemia or blood poison. Even if death does not follow septicemic inoculation or a long siege of sickness may supervene, entailing a great loss of time, money, and neglect of business. Many cases are on record where serious consequences have resulted from the careless handling of filthy and unsterilized instruments.

Instruments should be cleansed carefully and sterilized thoroughly after each operation. Non=aseptic instruments should not be selected, as the aseptic can always be had from any reliable supply house. Aseptic may be defined as "being free from the living germs of disease, and fermentation or putrefaction." Only those instruments are aseptic which are made without visible joints, or which can be taken apart and every portion cleansed. The embalmer should use every means that is possible to lessen the danger to the living, including his assistants and himself.

The surgeon, physician, and dentist always have the finest and best instruments, for use in their work, that they are able to procure. They keep them in perfect order, never allowing them to remain soiled for a moment longer than can possibly be helped, thereby preventing the liability to rust or destruction by corrosion. The embalmer should be equally careful with his instruments. He should never throw his tools together into his satchel, to be cleansed by some one else, but should at once attend to that duty himself. It is ever a true saying, and one that should be cherished, "that a workman is known by his tools." The progressive undertaker usually spends hundreds or thousands of dollars for his equipment of funeral cars, hearses, carriages, and horses, his show=room, its contents, etc. Oftentimes one thing needful is neglected; the old worn=out cabinet, with its rusty set of tools, usually filthy and septic, is brought forth to do service, when, in fact, this part of the paraphernalia should be one in which he should take pride and make it his duty to have as nearly perfect as possible. This is not only for the sake of appearances but that he may be able to do his work with safety and in a more scientific and professional manner.

Sterilizing Instruments.—To sterilize instruments is to render them free from living germs by heating or otherwise. The following methods for sterilizing are simple and easy of application:—

All steel instruments should be first cleansed, then boiled for half an hour or more in water to which bicarbonate of soda has been added; then wiped perfectly dry with a clean, soft, woolen cloth or chamois. For the usual number of instruments about a quart of water, to which a quarter of a pound of the bicarbonate of soda has been added, is required. A tin or iron vessel may be used. This process will positively free the instruments from all danger of inoculation with septic matter through wounds accidentally made while handling them.

All hard=rubber instruments, such as arterial=tubes, hollow=needles, whether metel=lined or not, pumps, etc., should be sterilized by flushing and washing, and immersion in a 5 per cent. solution of formalin for from a quarter to half an hour; then they should be washed and dried. Do not apply heat in any form.

No heat should be applied to elastic gum and silk catheters, vein and stomach=tubes, rubber tubing, etc. They should be sterilized by flushing and washing with a disinfectant solution, the solution being washed off immediately; then wiped dry with a clean cloth. The most effective solution for sterilizing them is one of formalin of from 3 to 5 per cent. strength.

All arterial=tubes should be examined, and, if found closed, should be opened by passing a small wire through them. Examine all hollow=needles and trocars, and, if found closed, open them with the plunger with which they are accompanied. The above means of cleansing and sterilizing should be used as soon as possible after each operation.

Instruments should not only be kept clean and sterilized, but their edges should be sharp and keen=cutting, that the incisions and other operations can be made as quickly and as neatly as possible to appear workmanlike and professional.

Selecting Instruments.—The quality and number of instruments should be selected with a view to performing all necessary operations and the finest of work. The greater the number and variety, and the better the quality, other things being equal, the better equipped will be the embalmer for his professional duties. All manufacturers and jobbers of instruments have listed satchels and cases of instruments, some fancy, containing everything, at a very high price, some at a medium price, and others at a low price, to meet the size of the purse or ability to pay, of all who wish to purchase, the selection of instruments being made according to the ideas of this, that, or the other embalmer, or simply for show. These satchels contain many instruments that are of little use, while they are lacking in others that are necessary in making the different operations. When selecting a satchel it is important to see that it contains the instruments that are needed in performing all of the usual operations in embalming. The following are recommended as a good selection for a practical outfit:—

One or two scalpels of different sizes; a curved, sharp=pointed bistoury; a grooved=director; forceps; scissors; aneurism=needle; an assortment of arterial tubes of different sizes and lengths; surgeon's needles; thread; absorbent cotton; lintine; adhesive plaster; hand=protector; silk vein=tubes of several sizes, from No. 8 to No. 12; several hollow=needles, from the infant to the adult size, from six to fourteen inches in length, including a cardiac needle for withdrawing blood from the heart; a couple of sizes of inflexible steel nasal=tubes; and a good aspirator and injector: With these, all necessary operations may be performed, although there are other instruments and accessories that will be very handy at times, which can be added as the necessities of the operator demand.

ABSURDITIES TAUGHT IN EMBALMING.

Some of the absurdities taught to=day are not only fallacious, but simply ridiculous; for instance, as "injecting the common carotid downward to prevent flushing the face, when blood remains in some of the larger arteries"; the injection of veins in conjunction with the injection of arteries, to remove discolorations caused by congestion of the capillaries in the exposed parts; the prohibition of poisons, by law, in the manufacture of fluids, for fear of hiding crime; the practice of always injecting from one to three quarts of fluid into the arteries, and a pint or two into the cavities, and calling it embalming; the necessity of injecting the venous system in certain cases, etc.

If fluid is injected through the artery at any point in the upper extremity, it will have precisely the same effect upon all other parts of the body—except the side of the head—on which the common carotid is used; and we will add that the effect will be better in the face and head, because of the more equal distribution of the fluid, as both common carotids are open, and equal distribution occurs, which is prevented by the tying of the arterial tube in the artery, when the common carotid is used. Fluid, to reach that side, must pass upward through the opposite common carotid and vertebral arteries, and through the Circle of Willis, and other anastomotic branches, to reach the side of the head and face on which the common carotid is taken up.

The injection of fluid upward through the distal end of the common carotid is a very dangerous operation, especially when formaldehyde fluids are used. Who has not observed the extreme ashy color on that side, while the other side had an almost normal appearance? It may be admitted that if extreme caution is used, that a slight difference in color may not be noticeable. Further, we might ask, is there any reason whatever why congestion of the head would follow the injection through the artery in the upper extremity rather than by the use of the carotid? As stated before, with the use of the usual instruments, the pressure and direction of the fluid is just the same; and will add that gravity favors the filling of the lower parts first, driving the blood downward in the large vessels, then filling those in the upper part last. Of course, if congestion takes place, the tying of the carotid will no doubt modify the congestion on that side; but how about the other? The congestion will be excessive on one side, while on the other there will be less, but the appearance would certainly be no better.

The injection of veins in conjunction with arteries has been proposed to remove discolorations caused by the congestion of the capillaries in the face. Certainly these capillaries may be reached directly through the arteries, as well as through the veins, and if the blood is not coagulated it is possible to force the fluid on through the capillary vessels, and driving the blood, thus relieving the congestion. If the blood is partially coagulated, the clot may be retained; but if fluid is injected, it may receive enough to even change the color of the clot, thus relieving the dark discoloration at least. If the congested blood is solidly coagulated, the fluid injected through the artery will not drive it out, or will not mix with it to any great extent. In the first place, fluid injected into the vein, if in large quantity, would do harm but no good. In the second place, it would not be necessary to inject the vein; and in the third place, neither harm nor good would follow the injection of the vein.

The prohibition of poisons by law in the manufacture of fluid, for fear of hiding crime, is unnecessary, and prevents the use of some of our very best disinfectants. Society could be just as well protected by the passage of a law preventing the embalmment of a body until after a death certificate has been issued by the proper authorities.

The practice of injecting from one to three quarts of fluid into the arteries, and a pint or two into the cavities, and calling it embalming, is a mistake. No given quantity can be used in all cases, though, as a result of a number of experiments, we would not hesitate to recommend a quantity of less than one pint to each twenty pounds weight of the body for arterial injection, to sterilize all tissues that are reached by the arteries, and in addition a quart or more (owing to the judgment of the operator) to sterilize the contents of the cavities which are not reached by the arterial embalming. From one to three quarts is not enough fluid to fill all bodies. It may fill some, and be all that is necessary when certain conditions are present to preserve, but to disinfect, fill the tissues full of fluid. If putrefaction takes place after embalmment, it usually occurs in the upper portions of the body, thus indicating that the fluid that has been injected has settled, together with the blood and other liquids of the body, to the pendant parts, leaving the upper portions without fluid. Now, in the treatment, had enough fluid been injected, the upper portions would retain the fluid, as well as the pendants, and putrefaction would not have followed in any part of the body. We would advise that the profession be more particular, and break away from routine work, and treat each case separately and from a scientific standpoint.

Fluid should never be injected in the veinous system for any purpose whatever. The entire body, including the contents of the veinous system (the blood), may be thoroughly disinfected by injecting through the arterial system, when the circulation is intact. The fecal matter in the alimentary canal, and contents of the stomach, and the serous sacs may be reached by cavity embalming. Always remember to inject enough fluid in your operations in embalming.

A number of other absurd operations are taught, but calling attention to those referred to above we deem sufficient for our present purpose.

A COMPENDIUM

CONSISTING OF PRACTICAL QUESTIONS AND ANSWERS

INTRODUCTION TO COMPENDIUM.

The questions and answers given in the following pages constitute only a partial review of the more important parts of the body of this work, and will serve as a guide both to the student and teacher. We believe a careful study of them by the student will prove very beneficial and fix important truths in the mind in a way not possible by a simple perusal of the text.

A systematic study of the questions and answers is especially recommended for all those who contemplate taking an examination before one of the State boards. We do not claim that these questions are the same as those asked by the examiners, but we do believe an ability to answer them correctly will qualify one to give appropriate replies to the questions usually propounded by such boards.

We would caution members of examining boards against the use of what are known as "catch questions" in conducting examinations. Such questions do not do justice to those taking the examination. Only such questions should be selected as can be answered after practical training and a reasonable study of the subject. The object aimed at will be best attained by careful and conscientious attention to this matter.

I.—ANATOMY AND PHYSIOLOGY.

BONES, MUSCLES, ETC.

1. What is osteology?

It is the science of the structure and function of bones.

2. Into how many parts is the body divided?

Five: head, neck, trunk, and upper and lower extremities.

3. How many classified bones are there in the body?

There are two hundred

4. In to what classes are they divided?

Long, short, flat, and irregular.

5. Where are the long bones found?

In the upper and lower extremities.

6. Name the long bones.

Humerus, radius, ulna, femur, tibia, fibula, metacarpals, metatarsals, phalanges, and clavicle.

7. Where are the short bones found?

The carpals in the wrist and tarsals in the foot.

8. Where are the flat bones found?

In the cranium and trunk.

9. Name some flat bones.

Occipital, frontal, scapula, innominate, sterum, ribs, etc.

10. Where are irregular bones found?

Principally in the face and spinal column.

11. Name some irregular bones in the head.

Temporal, sphenoid, ethmoid, malar, superior and inferior maxillary, etc.

12. Give the number and names of the bones of the spinal column.

There are 26 in the adult—24 vertebræ, the sacrum, and the coccyx; in youth, the sacrum consists of five and the coccyx of four vertebræ, which finally coalesce into a single bone each.

13. How are the vertebræ divided?

Into the cervical, dorsal, and lumbar.

14. How many of each?

Seven cervical, twelve dorsal, and five lumbar.

15. What are the atlas and axis?

They are the upper two cervical vertebræ, the axis articulating with the occipital bone on either side of the foramen magnum.

16. Of what are the skull-bones composed?

In general, of two compact plates, outer and inner, with a spongy layer, known as the diploe, between; the outer plates are joined by notched edges or sutures.

17. What are sesamoid bones?

Small osseous masses developed in tendons near certain joints.

18. Name the largest sesamoid bone in the body.

The patella or knee=cap.

19. What are ligaments?

They are strong bands of a smooth, compact, fibrous tissue, which bind together the bones at their joints.

20. Locate Poupart's ligament.

It is attached to the upper anterior point of the hip=bone and extends to the center of the pubic arch; it forms the upper boundary of Scarpa's triangle, and the division between the abdomen and thigh.

21. Describe the muscular tissue.

Muscular tissue is the red tissue that is seen on cutting down into the body; it is composed of fibrils, which contract and relax; muscles are of different shapes, and are attached to the parts by tendons.

22. There are how many kinds of muscular tissue?

Two: voluntary and involuntary.

23. What are voluntary muscles?

They are those under the control of the will, as the muscles of locomotion and of prehension and tact.

24. Where are voluntary muscles usually found?

On the outer side of the skeleton.

25. What are involuntary muscles?

Those not under control of the will, as the diaphragm, heart, etc.

26. Where are the involuntary muscles found?

On the inside of the skeleton, as in the organs of the cavities.

27. What is the origin and insertion of a muscle?

The origin is the attachment that is not movable, or least movable; the insertion is the attachment that is movable, or most movable.

28. Give the origin and insertion of the sternocleidomastoid muscle.

It has its origin from the half of the upper end of the sternum and the inner third of the clavicle; and is directed upward and backward along the front and side of the neck, to be inserted into the mastoid process of the temporal bone behind the ear.

29. What is the anatomical guide to the common carotid artery?

The front border of the sternocleidomastoid muscle.

30. What is the anatomical guide for the brachial artery.

The inner border of the biceps muscle.

31. What is the anatomical guide for the femoral artery?

The inner border of the sartorius or tailor's muscle.

32. How many muscles are there in the body?

Over five hundred.

33. What are tendons?

Tendons are white, shiny masses of hard, fibrous tissue, forming the terminations or connections of the fleshy portions of the muscles.

34. Locate and describe Scarpa's triangle.

It is situated in the upper part of the thigh; is of a triangular shape with the base upward, bounded by Poupart's ligament, and the apex downward; the outer border is bounded by the sartorius muscle, and the inner by the adductor longus.

35. Locate and describe the diaphragm.

It is the great muscle of respiration, and is situated transversely across the trunk, between the thoracic and abdominal cavities, which it divides, forming the floor of the former and the roof of the latter.

36. How many openings has it?

Three: the aortic, esophageal, and caval (opening for the inferior vena cava); it is impervious to liquids contained in or injected into either cavity.

37. Locate and describe the axillary space.

The axilla, or axillary space, is the hollow beneath the juncture of the arm and shoulder, known as the armpit.

38. Name the principal soft tissues on the outside of the skeleton.

Skin, cellular (fat) or superficial fascia, deep fascia, muscular, etc.

39. What are the subcutaneous tissues?

Those lying immediately beneath the skin, as the fat or cellular, etc.

40. Describe the skin.

The skin covers the entire surface of the body; is elastic, and protects the tissues beneath; it is an excretory organ, through which part of the waste is excreted.

41. What are its layers?

The skin consists of two distinct layers: The outer—epidermis, cuticle, or scarf=skin; the inner—cutis dermis, or true skin.

42. What is the rete mucosum?

It is the inner layer of the cuticle, which attaches the latter to the true skin and contains the pigment or coloring matter which gives to the different races their complexion.

43. Describe the fat or cellular tissue.

The fat or cellular tissue is composed of white, areolar substance (outer layers of the superficial fascia), which is very loose and is formed into cells; fat is deposited within these cells to a greater or less extent in each individual.

44. How are the fasciæ classified?

Into superficial and deep.

45. Describe the superficial fascia.

It is composed of fibro=areolar tissue; and is beneath and co=extensive with the skin, attaching the latter to the deeper tissues.

46. Describe the deep fascia.

The deep fascia is composed of an inelastic, dense, aponeurotic structure, which binds down the muscles, giving form and symmetry to their bulk, protects the arteries, and forms sheaths for the muscles, vessels, nerves, and tendons.

47. What are the lymphatic vessels?

The lymphatic vessels are distributed to every part of the body, and receive and take up the surplus of the nourishment that has been carried to the tissues by the blood, and conveys it back to the center of the body, where it enters the circulation through the thoracic duct on the left side and the lymphatic duct on the right side.

48. What is the lymph?

It is a transparent, colorless, alkalin fluid, closely resembling blood, with its red corpuscles absent, and diluted with water, which is carried through the lymphatic system.

VISCERAL ANATOMY.

49. How many large cavities are there in the body?

Three: cranial, thoracic, and abdominal.

50. Of what does visceral anatomy treat?

It treats of the organs contained in these cavities, with their appendages and coverings.

51. What are these organs and appendages called?

Viscera, or visceral organs; and those of any cavity are called the viscera of that cavity.

52. Name some visceral organs.

The brain, lungs, heart, liver, spleen, kidneys, etc.

53. Describe the thoracic cavity.

It is a cone=shaped, cavity, situated in the upper part of the trunk, with the apex at the neck and the base downward; its floor is formed by the diaphragm, its side walls by the ribs, front by the breast=bone, and the back by the twelve dorsal vertebræ.

54. How is it divided?

Into a right and left side, and a medium space, the mediastinum.

55. How many ribs are in the thorax?

Twenty=four, twelve on each side, being numbered from above downward; the anterior end of the first rib is located close to and beneath the collar=bone.

56. How are the ribs classified?

On either side into seven true and five false, two of the latter being floating.

57. What are the spaces between the ribs called?

They are called intercostal spaces, and are numbered from above downward, the first being between the first and second ribs, the second between the second and third ribs, etc.

58. Describe the abdominal cavity.

It is the largest cavity in the body and is situated between the thorax above and the pelvis below; it is bounded above by the diaphragm, below by the brim of the pelvis, at the back by the vertebral column and fasciæ, in front and at the sides by the transversalis fascia, lower ribs, and iliac venter.

59. Give the principal contents of the abdominal cavity.

The stomach, large and small intestines, liver, gall=bladder, spleen, pancreas, kidneys, suprarenal capsules, abdominal aorta, inferior vena cava, peritoneum, etc.

60. For convenience of description, how is the abdomen divided?

It is divided into nine regions by two horizontal lines, one between the cartilages of the ninth ribs, another between the crests of the ilia, and two vertical lines from the cartilage of the eighth ribs on each side to the center of Poupart's ligament.

61. Name the regions.

On the right side.	*In the middle.*	*On the left side.*
Right hypochondriac.	Epigastric.	Left hypochondriac.
Right lumbar.	Umbilical.	Left lumbar.
Right iliac or inguinal.	Hypogastric.	Left iliac or inguinal.

62. What are the contents of the right hypochondriac region?

Right lobe of liver, gall=bladder, duodenum, hepatic flexure of colon, upper part of kidney, and right suprarenal capsule.

63. Of the epigastric region?

Right two=thirds of the stomach, left lobe of liver, pancreas, solor plexus, etc.

64. Of the left hypochondriac region?

Splenic or cardiac end of stomach, spleen, upper half of left kidney, and left suprarenal capsule.

65. Of the right lumbar region?

Ascending colon, lower half of right kidney, and part of small intestine.

66. Of the umbilical region?

Transverse colon, transverse duodenum, and part of small intestine.

67. Of the left lumbar region?

Descending colon, lower half of kidney, and part of small intestine.

68. Of the right iliac region?

Right ureter, appendix vermiformis, cecum and spermatic vessels.

69. Of the hypogastric?

Parts of the small intestine, bladder in children and when distended in adults, and uterus during pregnancy.

70. Of the left iliac region?

Sigmoid flexure, left ureter, and spermatic vessels.

NERVOUS SYSTEM.

71. Of what does the nervous system consist?

The brain, spinal cord, and the nerves; it unites the various parts and organs of the body into one complete organic whole, and is the medium through which all impressions upon the mind are received and acted upon.

72. Describe the cranial cavity.

It is an egg=shaped cavity in the head; its walls are formed by the frontal bone in front, occipital behind, parietal and temporal on either side, and ethmoid and sphenoid in the base.

73. What is the cerebrospinal cavity?

It consists of the cranial cavity and spinal canal.

74. What does it contain?

The brain and spinal cord with their coverings or meninges.

75. What are those coverings?

The dura mater, pia mater, and arachnoid; these membranes cover the brain and extend down through the foramen magnum, covering the spinal cord in the same manner.

76. Describe the dura mater.

It is a dense, tough, fibrous membrane, lining the interior of the cranial cavity and spinal canal, being the outer envelope of the brain and spinal cord.

77. Describe the pia mater.

The pia mater is a soft vascular membrane, which closely invests the brain and cord, and extends down between the convolutions; from it the arteries dip down toward the center of the brain and cord, distributing blood to every part.

78. Describe the arachnoid.

It is a double serous membrane, between the dura and pia mater, forming a closed sac, and secretes serum for the purpose of oiling the surfaces to prevent friction.

79. What are nerves?

They are white, glistening cords, made up of bundles of nerve=fibers, and penetrate every part of the body; they are hard to the touch, solid, and can easily be distinguished from arteries or veins.

80. What important organ does the cranial cavity contain?

The brain.

81. Of what is the brain composed?

It is composed of a number of centers, which are connected with one another and with the motory and sensory nerves of the system, and consists of both white and grey matter.

82. Into what parts is the brain divided?

It is divided into three portions: cerebrum, cerebellum, and medulla oblongata.

83. Describe and locate the cerebrum.

It occupies the front and upper back part of the cranial cavity, comprising about seven=eighths of the entire weight of the brain; it is divided into two lateral halves, right and left, which are connected by a transverse commissure, the corpus collosum.

84. How is each hemisphere divided?

By fissures on the under surface into three lobes: anterior, middle, and posterior.

85. Describe the cerebellum.

It is situated beneath the posterior lobes of the cerebrum; is divided into two hemispheres; it is small, weighing only about five ounces, and is a center for the control of voluntary muscles, particularly those of locomotion.

86. Describe the medulla oblongata.

It is the upper and larger portion of the spinal cord, extending from the atlas to the pons varolii; it connects the spinal cord with the cerebellum and cerebrum; it is the part that has entire control over respiration; if it is injured or destroyed, breathing ceases and death results.

87. Describe the spinal cord.

It is the cylindrical, elongated part of the cerebrospinal axis, which is contained in the spinal canal; it is about 16 or 17 inches in length in the adult; begins at the upper border of the axis and ends at the lower border of the first lumbar vertebræ.

88. How many pairs of nerves does it give off?

It gives off 31 pairs: 8 cervical, 12 dorsal, 5 lumbar, 5 sacral, and one coccygeal.

89. How many roots has each nerve?

Two: an anterior (motory) and posterior (sensory); these unite into one sheath, preserving their special functions throughout their many subdivisions.

90. What is the cerebrospinal nervous system?

It includes the brain, spinal cord, and nerves given off from them; it presides over sensation, special senses, voluntary motion, intellect, and all movements which characterize different individuals.

91. What is the sympathetic nervous system?

It consists of nerves and ganglion, of which there are about 30 pairs. It supplies the involuntary muscular tissue, governs all acts of secretion, equalizes the circulation, and controls nutrition.

RESPIRATORY ORGANS.

92. Give the contents of the thoracic cavity.

The right and left lungs and right and left pleuræ on the sides; the heart and pericardium, aorta, part of the ascending vena cava, descending vena cava, the trachea, and esophagus or gullet, in the middle space, or mediastinum.

93. Of what do the organs of respiration consist?

They consist of the respiratory tract, or air=passages, the lungs, and certain muscles which assist in the act of breathing.

94. Of what does the respiratory tract consist.

Of the nose, mouth, pharynx, larynx, trachea, and bronchi.

95. Where do the air-passages begin?

They begin with the mouth and nose; the proper passages for the air to enter in breathing are in the nose, though we can breathe through the mouth.

96. Describe the nasal passages.

They extend from the outer openings of the nose to the pharynx; are lined with a smooth, soft, mucous membrane, the surface of which is greatly increased by the projection into the nasal cavity of peculiarly shaped bones; the lining membrane is constantly kept moist, thus catching particles of dust from the air, which is moistened and slightly warmed in its passage through.

97. Describe and locate the pharynx.

The pharynx, or throat, is a musculo-membraneous sac, conical in form, 4½ inches long, extending from the basilar process of the occipital bone to the lower border of the cricoid cartilage in front and the fifth cervical vertebræ behind; it lies back of the nose, mouth, and larynx.

98. How many openings has it?

Seven: two posterior nares from nose, two eustachian from ears, and one each from larynx, mouth, and esophagus.

99. Describe and locate the larynx.

It is a musculo=cartilaginous, triangular=shaped box, composed of a number of cartilages connected together by ligaments and moved by numerous muscles, situated between the tongue and trachea; the projection in the front of the neck, known as Adam's Apple, is formed by the largest of these cartilages.

100. What are the glottis and epiglottis?

The glottis is the opening from the throat into the larynx; the epiglottis is a leaf=like portion of fibro=cartilage, which closes over the glottis when food or drink is swallowed, preventing the entrance into the windpipe of any foreign matter; during the act of breathing it leaves the glottis unobstructed.

101. Describe and locate the trachea.

The trachea, or windpipe, is a cylindrical, membrano=cartilaginous tube, about 4½ inches in length and 1 inch in diameter, extending from lower border of larynx, opposite fifth cervical vertebra, to third dorsal vertebra, where it divides into two branches.

102. What are the bronchi?

They are the right and left divisions of the trachea, which enter the lungs, dividing and subdividing into many bronchial tubes, ramifying all parts of the lungs.

103. What are the bronchioles?

They are the last and most minute subdivisions of the bronchial tubes.

104. What are the air-cells?

There is an air=cell at the end of each bronchiole, in the walls of which the blood is purified in its passage through the pulmonary circulation.

105. Describe the lungs.

The lungs are two in number, right and left; one placed on the right and the other on the left side of the thoracic cavity; they weigh together about 42 ounces; are conical in shape; the right lung is the larger and has three lobes, while the left lung is smaller and has but two lobes.

106. What is the root of the lung?

The root of the lung is where the bronchial vessels and nerves, bound together by areolar tissue, enter the lung.

107. What is the color of the lungs?

The color of the lungs at birth is pinkish=white, which becomes mottled as age advances by slate=colored patches from deposits of carbonaceous granules in the areolar tissue of the organ.

108. What is the structure of the lungs?

The lungs are invested with a serous coat, and a subserous, areolar tissue, investing the entire organ, extending inward between the lobules and the parenchyma, or true lung tissue, composed of lobules, each consisting of a number of air=cells, arranged around the termination of a bronchiole, and surrounded by plexuses of pulmonary and bronchial arteries and veins, lymphatics, and nerves.

109. How are the lungs nourished?

The lungs are nourished by the bronchial arteries, which are derived from the thoracic aorta; they ramify every part of the lungs to the capillaries, where the blood is taken up by the bronchial veins, which open on the right side into the vena azygos and on the left side into the superior intercostal vein.

110. Describe the pleuræ.

The pleuræ are two delicate, serous, shut sacs, one surrounding each lung and reflected over the pericardium, diaphragm, and inner surface of the thorax.

111. What are the pleural cavities?

They are the spaces between the lungs and thoracic walls on either side within the two layers of the pleural sacs.

112. What is the mediastinum or median space?

It is the space between the two pleuræ in the median line of the thorax, extending from the sternum to the vertebral column, and containing all of the viscera of the chest except the lungs and pleuræ.

ORGANS OF DIGESTION.

113. Of what do the organs of digestion consist?

They consist of the alimentary canal and accessory organs.

114. What is digestion?

It is a process which all food must undergo before it is in condition to afford nourishment to the tissues; it is while passing through the digestive organs that digestion takes place.

115. Describe the ailmentary canal.

It is a musculo=membranous tube, 25 to 30 feet in length, extending from the mouth to the anus.

116. What kind of a membrane lines the alimentary canal?

A mucous membrane, which secretes mucous.

117. Name the divisions of the alimentary canal.

The mouth, pharynx, esophagus, stomach, and large and small intestines.

118. What are the accessory organs of digestion?

The tongue, teeth, salivary glands, liver, pancreas, spleen, etc.

119. Describe the mouth.

It is an oval=shaped cavity, formed by the lips, cheeks, jaws, palate, and tongue; contains the tongue, teeth, hard and soft palates, etc.; and opens posteriorly into the pharynx.

120. Describe the esophagus.

The esophagus, or gullet, is a musculo=membranous canal, about nine inches long, extending along the front of the spine, from the larynx to the cardiac orifice of the stomach, opposite the ninth dorsal vertebra.

121. Describe the stomach.

It is the principal organ of digestion, large at one end and smaller at the other; is about 12 inches in length, and 4 inches in average diameter; lies diagonally across the upper part of the abdomen; and holds ordinarily from three to five pints.

122. Of what are the walls of the stomach composed?

They are composed of three coats, an outer, fibro=elastic connective tissue; a middle, muscular; and an inner, mucous.

123. Describe the small intestine.

It is a convoluted tube, about 20 feet in length, beginning at the pyloric end of the stomach and ending at the ileocecal opening in the right iliac region.

124. Name and describe its divisions.

The upper end is called the duodenum, about 12 finger breadths (10 inches) in length; the jejunum, so named from being usually found empty, includes about two=fifths of the remainder; the ilium, so named from its twisted course, constitutes the balance.

125. Describe the large intestine.

It extends from the termination of the ilium at the ileocecal valve to the anus; is about five feet in length, much larger than the small intestine, more fixed in position, and is sacculated; its chief office is the expulsion from the body of the undigested portion of food, known as feces.

126. Name and describe its divisions.

The cecum, the first part, is the blind pouch below ileocecal opening; the colon constitutes the greater part of the large intestine, extends from cecum to rectum, and is divided into ascending, transverse, and descending portions, and sigmoid flexure; the rectum is about six or eight inches long, ending at the anus.

127. What is the vermiform appendix?

It is a narrow, worm=like tube, about the size of a goose=quill, and from three to six inches in length; it is attached to the cecum or beginning of the large intestine.

128. Describe and locate the liver.

It is the largest glandular organ in the body, weighs 3 or 4 pounds, measures transversely about 12 inches, from front to back about 6 or 7 inches, and in thickness about 3 inches; is located on right side immediately beneath diaphragm in right hypochondrium and extends across epigastrium to left hypochondrium.

129. Into how many lobes is it divided?

Five: right and left lobes, which form the bulk of the liver; lobus quadratus, lobus Spigelii, and lobus caudatus.

130. What is the function of the liver?

It is intended mainly for the secretion of bile, but also effects important changes in certain constituents of the blood in its passage through the gland.

131. What is the bile?

It is a bitter, viscid, yellowish, or greenish liquid secreted by the liver, and discharged into the duodenum, where it mixes with the chyme, aiding in digestion, chiefly acting on the fats.

132. What is biliverdin?

It is the green pigment or coloring matter of the bile.

133. What is the bilerubin?

It is the yellow coloring matter of the bile.

134. What are the biliary ducts?

They are the hepatic and cystic ducts and the ductus communis choledochus, which convey the bile to the intestine.

135. Describe and locate the gall-bladder.

It is a conical, pear=shaped sac, the reservoir of the bile, and lies on the under surface of the liver.

136. Describe the spleen.

The spleen possesses no excretory duct, is oblong and flattened, about the size of a fist, is very brittle, contains much blood of a bluish=red color, and is situated in the left hypocondriac region.

137. What are the suprarenal capsules?

They are two small crescentic=shaped ductless glands, situated one on each kidney.

138. What is the pancreas?

It is a racemose gland, about 7 inches in length, of a grayish=white color, and situated behind the stomach.

139. Describe and locate the kidneys.

They are the largest tubular glands of the body, located in the right and left lumbar regions, behind the peritoneum, anl secrete the urine; they are oblong and flattened, about 4 inches long, 2 inches broad, and an inch thick, and weigh $4\frac{1}{2}$ to 6 ounces.

140. What are the ureters?

They are cylindrical membranous tubes, 16 to 18 inches long, which convey the urine from the kidneys to the bladder.

141. What is the peritoneum?

It is a sero=membranous shut sac, one layer of which covers the abdominal and pelvic viscera, while the other is reflected over and forms the lining of the anterior and lateral abdominal walls.

142. What is the peritoneal cavity?

It is the space between the intestines and abdominal wall within the peritoneal sac.

143. What is the pelvis?

The pelvis is a basin=like cavity, situated at the lower end of the trunk, and is the outlet of the abdominal cavity; it contains the bladder, internal organs of generation, and rectum.

144. Describe the bladder.

It is a musculo=membranous sac located in the adult in the pelvic cavity, and serves as a reservoir for the urine.

THE CIRCULATORY SYSTEM.

145. What do you understand by the circulatory system?

It is a system of organs and vessels by which the blood circulates through and into every part of the body.

146. What are the organs of circulation?

They are the heart and blood=vessels.

147. How are the blood-vessels divided?

They are divided, according to the kind of work done, into three classes: arteries, capillaries, and veins.

148. Describe and locate the heart.

It is a hollow, muscular organ, placed between the lungs and enclosed in the cavity of the pericardium; it rests obliquely across the chest, its base being directed upward and backward to the right and the apex, downward, forward and to the left, corresponding to the interspaces between the cartilages of the fifth and sixth ribs, one inch to the inner side and two inches below the left nipple; it projects about $3\frac{1}{2}$ inches into the left side and $1\frac{1}{2}$ inches into the right side.

149. What are its functions?

It is the central organ of the blood=vascular system, and by its alternate contractions and dilatations propels the blood to all parts of the body.

150. What is the size and weight of the heart?

The adult heart is about 5 inches in length, 3½ in width, and 2½ in thickness, being about the size of the fist; it weighs from 10 to 12 ounces in the male and from 8 to 10 ounces in the female; it increases in size and weight as age advances, the increase being less marked in women than in men.

151. How is the heart divided?

It is divided by a thin, muscular septum, into two lateral halves, which, from their position, are named the right and left; each half is divided into two cavities by a constriction.

152. What are the cavities called?

The upper cavities are called auricles and the lower, ventricles; there are, therefore, a right and left auricle and a right and left ventricle.

153. Describe the right auricle.

It is a little larger than the left, its walls are somewhat thinner, measuring about one line; it consists of a principal cavity and an appendix auriculæ, and has a capacity of about two fluid ounces.

154. Describe the right ventricle.

It is triangular in form, extends from the right auricle to near the apex of the heart; its upper surface is rounded and convex and forms the larger part of the front of the heart, its wall is only about one=half the thickness of the left ventricle.

155. Describe the left auricle.

It is smaller than the right, but its walls are thicker, measuring about one and a half lines; it receives the arterialized blood from the lungs; like the right, it has a principal cavity and an appendix auriculæ.

156. Describe the left ventricle.

It is longer, thicker, and more conical than the right, projecting toward the posterior aspect, forming the apex of the heart; its walls are about two or three times as thick as are those of the right ventricle, being about 6 to 8 lines in thickness.

157. What is the endocardium?

The endocardium is a transparent serous membrane which lines the cavities of the heart.

158. What is the pericardium?

The pericardium is a serous sac which envelops and contains the heart.

159. Which cavities of the heart receive the blood?

The auricles; the right auricle receives the impure blood from all parts of the body, while the left receives the purified blood from the lungs.

160. To what cavities does the blood pass from the auricles?

To the ventricles, which force it out into the arteries.

161. What are the auriculo-ventricular openings?

The openings between the auricles and ventricles, two in number, right and left, the right being guarded by the tricuspid valve, and the left, by the bicuspid or mitral valve.

162. Where is the aortic opening?

The aortic opening is in the left ventricle and is the beginning of the aorta.

163. What is the pulmonary opening?

The pulmonary opening is in the right ventricle and is the beginning of the pulmonary artery.

164. By what valves are these openings guarded?

By the semi=lunar valves.

165. Where are the vena cava openings located?

In the right auricle.

166. Into what cavity do the pulmonary veins open?

Into the left auricle.

167. Are these openings guarded by valves?

They are not.

168. What is the blood?

It is the liquid by means of which the circulation is effected; it permeates every part of the body, carrying nutrition to, and waste from, the tissues of the body.

169. What is the composition of the blood?

It is composed of a thin, colorless liquid, the plasma, and discs or cells; these cells, or corpuscles, are of two different kinds, the red and the white; there are about 666 red to one white corpuscle; the red corpuscles are about 1/3000 of an inch in diameter, and contain the red coloring matter of the blood, called hemoglobin.

170. What is the amount of blood contained in the body?

The amount of blood is equal to about 1/10 of the weight of the body; therefore, in a body weighing 150 pounds, it amounts to about 15 pounds.

171. What elements does the blood contain?

The plasma or liquor sanguinous is rich in mineral matter for the bones, and albumen for the muscles; the red corpuscles contain oxygen, which is so essential to every operation in life; it stimulates to action and tears down all that is worn out.

172. Of what color is impure blood?

It is a dark=blue.

173. What color is pure blood?

It is a bright=red.

174. There are how many principal circulations?

Two: the pulmonary or lesser, and systemic or greater.

175. Of what vessels does the pulmonary circulation consist?

The pulmonary arteries, the capillaries in the walls of the air=cells, and the pulmonary veins.

176. Where does the pulmonary circulation begin, and where end?

It begins in right ventricle of heart and ends in left auricle.

177. Describe the course of, and the changes that take place in, the blood in the pulmonary circulation.

The blood starts from the right ventricle and passes through the pulmonary artery to the capillaries in the walls of the air=cells, where the carbonic acid gas is given off and oxygen is taken on, thereby purifying or oxygenating the blood; from the lungs it is carried through the pulmonary veins into the left auricle; then it passes through the auriculo=ventricular opening into the left ventricle.

178. Of what vessels does the systemic circulation consist?

It consists of the aorta and its branches, the capillaries, and the veins that enter the right side of the heart.

179. Where does it begin, and where does it end?

It begins in the left ventricle, and ends in the right auricle.

180. Describe the course of, and the changes that take place in, the blood in the systemic circulation.

The blood passes from the left ventricle through the aorta and its branches to the capillaries in every part of the body, where nourishment is given to the tissues and waste is taken up; it then passes through the veins into the right auricle; from thence through the auriculo=ventricular opening into the right ventricle.

181. What kind of blood do the arteries of the systemic circulation contain?

They contain bright=red or pure blood.

182. What kind of blood do the veins contain?

They contain dark=blue or impure blood.

183. When is all the blood in the body impure (venous) at death?

In a case where death is caused by asphyxia.

184. What kind of blood does the pulmonary artery contain?

Impure or venous blood.

185. What kind of blood do the pulmonary veins contain?

Pure or arterial blood.

186. Trace the blood from a given point through the entire circuit of the two circulations.

Beginning at the left ventricle, it passes out through the aortic opening into and through the aorta and all of the branches, into and through the capillaries in the tissues; thence, through the veins to the right auricle; then through the auriculo=ventricular opening into the right ventricle; then through the pulmonary opening into and through the pulmonary artery to the capillaries in the walls of the air=cells; thence through the pulmonary veins to left auricle; then, through the left auriculo=ventricular opening to left ventricle, the place of beginning.

187. What is the fetal circulation?

It is the circulation between the mother and unborn child, through the placenta and umbilical cord, by which the fetus receives nourishment.

188. How many coats have arteries and veins?

Each has three: an internal, serous; a middle, muscular; and an external, fibro=connective.

189. What is the collateral circulation?

The collateral circulation is a circulation at the side of the main vessels formed by the anastomoses of the smaller subdivisions of the arterial branches; these anastomoses are extensive throughout the body, so that blood may be carried from one part to another, after the main branch of the artery has been ligated, or destroyed by other means; the anastomoses of the veins are much more extensive than of the arteries.

190. How are arteries and veins usually named?

From the regions through which they pass or the organs to or from which they carry blood.

191. What is the difference between veins and arteries in the extremities?

Veins in the extremities have valves and the blood will not flow backward—that is, towards the fingers and toes—; veins in the trunk, head, and neck have no valves; arteries have no valves throughout their course.

192. What are the smallest arteries and veins called?

The smallest arteries are called arterioles; the smallest veins are called venules.

193. Describe the capillaries.

They are a minute network of vessels formed throughout the tissues of the body between the arterioles and venules; they are from 1/3000 to 1/6000 of an inch in diameter; they lie so closely packed together that to prick the skin with a small needle will wound or injure many of them; they inosculate freely and distribute the blood to the tissues as necessity demands; their walls have a single coat, a continuation of the serous or inner coat of the arteries and veins; it is through these walls that nourishment is given off from the blood and the waste is taken up.

ARTERIES.

194. What is the main artery of the systemic circulation called?

The aorta.

195. Where does it begin and where does it end?

It begins at the aortic opening of the heart, passing upward, thence, backward to the left side and the front of the back=bone, forming an arch, passing downward to the fourth lumbar vertebra, where it divides into the right and left common iliacs.

196. How is it divided?

It is divided into an arch, thence a straight portion which descends to the diaphragm, called the thoracic aorta; then from the diaphragm to its division, called the abdominal aorta.

197. What are the coronary arteries?

The coronary arteries are small branches that are given off from the aorta, just outside of the semilunar valves at the aortic opening, to supply the substance of the heart with nutrient or arterial blood.

198. What branches are given off from the aortic arch?

First, the innominate, which divides behind the junction of the clavicle and sternum into the common carotid and subclavian; second, the left common carotid; third, the left subclavian.

199. What branches are given off from the thoracic aorta?

Pericardiac, bronchial, esophageal, and 20 intercostals.

200. What branches are given off from the abdominal aorta?

Two phrenic, celiac axis, which divides into the gastric, hepatic, and splenic, superior and inferior mesenteric, two suprarenals, two renals, and two common iliacs.

201. Describe the common carotids.

The common carotid on the right side arises from the innominate, while that on the left is longer and deeper and arises from the arch of the aorta; they are separated only by the width of the trachea and they are each contained in a sheath accompanied by the internal jugular vein and pneumogastric nerve; they divide at the angles of the jaws into the external and internal carotids.

202. Describe the external carotid.

The external carotid ascends in front of the ear and divides into a number of branches which supply the tongue, face, pharynx, occipital region, temporal region, and the teeth; the branches of one side anastomose freely with those on the other.

203. Describe the internal carotid.

It ascends in front of the transverse processes of the upper cervical vertebræ, follows the carotid canal in the temporal bone, and, after piercing the dura mater, divides into terminal branches, supplying all parts of the brain and its coverings.

204. What are its principal branches?

They are the anterior cerebral, which is joined to its fellow by the anterior communicating branch, which is about two lines in length; the middle cerebral, which divides into anterior, median, and posterior cerebral arteries; the posterior communicating.

205. Describe the circle of Willis.

It is an anastomosis at the base of the brain between the branches of the internal carotid and vertebral arteries, equalizing the cerebral circulation; the two vertebral arteries join to form the basilar, which ends in the two posterior cerebral; these are connected with the internal carotid by the two posterior communicating; the circle is completed by the connection of the two anterior cerebral branches of the internal carotid through the short anterior communicating artery.

206. Describe the subclavian.

The right subclavian arises from the innominate at the junction of the collar-and breast-bones; the left from the arch of the aorta; they extend to the outer border of the first rib on either side, where they become the axillary arteries.

207. What is the first branch given off from the subclavian?

The first branch is the vertebral, which passes up the neck through the small foramina in the transverse processes of the six cervical vertebræ, and enters the skull through the foramen magnum, where it joins its fellow to form the basilar artery, giving off branches that enter into the formation of the circle of Willis.

208. Describe the internal mammary.

The internal mammary is a branch which descends along the costal cartilages to the sixth interspace.

209. Describe the axillary.

The axillary artery is the continuation of the subclavian; it extends from the outer border of the first rib to the lower margin of the axillary space, where it becomes the brachial.

210. Describe the brachial.

It is the continuation of the axillary from the lower border of the armpit to where it divides into the radial and ulnar, which is usually one=half inch below the bend of the elbow.

211. Describe the radial.

It is a division of the brachial, extending from the bifurcation to the deep palmar arch on the radial side of the forearm.

212. Describe the ulnar.

It is the other division of the brachial and extends along the ulnar side of the forearm of the superficial palmar arch.

213. Describe the superficial palmar arch.

It is that part of the ulnar artery in the palm of the hand which anastomoses with branches from the radial.

214. Describe the deep palmar arch.

It is that portion of the radial artery in the palm which anastomoses with a communicating branch of the ulnar.

215. What arteries supply the fingers?

The digital branches given off from the superficial palmar arch and by the radialis indicis.

216. What arteries supply the lungs with nutrient blood?

The bronchial arteries, which are branches of the thoracic aorta, and which vary in number and origin, being usually one on the right side and two on the left.

217. Describe the intercostal arteries.

They are branches of the thoracic aorta, usually ten in number on each side; they supply the upper intercostal spaces the spinal cord and tissues of the back.

218. Describe the phrenic arteries.

They are branches of the abdominal aorta and supply the under surface of the diaphragm.

219. Describe the celiac axis.

It is about one=half inch in length, arises from the aorta just beneath the diaphragm, and divides into the gastric, hepatic, and splenic arteries.

220. What parts does the gastric artery supply?

The pyloric end of the stomach, duodenum, pancreas, a part of the liver, and gall=bladder.

221. What organ does the hepatic supply?

The liver.

222. What organs does the splenic supply?

The spleen, pancreas, and large or splenic end of the stomach.

223. What does the superior mesenteric supply?

The small intestine, cecum, and ascending and transverse colon.

224. What does the inferior mesenteric supply?

The descending colon, sigmoid flexure, and most of the rectum.

225. What do the suprarenal arteries supply?

The suprarenal capsules.

226. What organs do the renals supply?

The kidneys.

227. What are the common iliacs?

They are the bifurcating branches of the abdominal aorta, are about two inches long, and divide into the internal and external iliacs.

228. What does the internal iliac supply?

The walls and viscera of the pelvis and inner side of the thigh.

229. Describe the external iliac.

It extends to and beneath the center of Poupart's ligament, where it enters the thigh and becomes the femoral artery; its principal branch is the epigastric, which arises a short distance above Poupart's ligament.

230. Describe the femoral

It extends from Poupart's ligament to the opening in the adductor magnus muscle, where it becomes the popliteal; its course corresponds to a line drawn from the center of Poupart's ligament to the inner side of the knee; it lies in a strong, fibrous sheath, with the femoral vein on the inside and the anterior crural nerve on the outside in the upper part of Scarpa's triangle; it lies superficial in the upper third of the thigh; it gives off a number of branches which anastomose freely in all parts of the thigh, forming a perfect collateral circulation.

231. What is its largest branch?

Its largest branch is the profunda.

232. Describe the popliteal.

It is a continuation of the femoral and extends through the popliteal space behind the knee, at the lower border of which it divides into the anterior and posterior tibial, giving off branches to the knee in its course.

233. Describe the anterior tibial.

It extends from the division of the popliteal to the front of the ankle=joint, where it becomes the dorsalis pedis; it is superficial in its lower third, lying on the anterior and outer surface of the tibia.

234. Describe the dorsalis pedis.

It extends from the front of the ankle to the first interosseous space, where it terminates in the dorsalis hallucis and the communicating; it gives off branches to the front part of the foot and toes.

235. Describe the posterior tibial.

It extends from the division of the popliteal along the back of the tibia to the groove behind and below the internal ankle, where it divides into the internal and external plantar, giving off branches to the leg, heel, and sole of the foot.

236. Describe the internal and external plantar.

The internal plantar passes along the inner side of the foot and great toe; the external plantar passes obliquely, outward and forward, and at the base of the metatarsal bones inosculates with the communicating branches of the dorsalis pedis, forming the plantar arch; it gives off branches to supply the muscles on the outer part of the foot and the interosseous tissues, and three or four digital branches of the toes.

VEINS.

237. What are veins?

Veins are vessels that carry the blood from the capillaries to the auricles of the heart.

238. Into how many classes are veins divided?

They are divided into superficial and deep veins.

239. Which are deep veins?

Those beneath the fascia; they usually accompany the arteries.

240. What are superficial veins?

Those lying immediately beneath the skin in the areolar tissue.

241. What are venæ comites?

They are two small veins which accompany secondary arteries in the same sheath.

242. What are the two largest veins called?

The superior or descending vena cava and the inferior or ascending vena cava.

243. What vessels unite to form the superior vena cava?

The right and left innominate veins.

244. What vessels unite to form the inferior vena cava?

The right and left common iliac veins, which unite at the fourth lumbar vertebra.

245. What are sinuses?

They are large veins within the cranium and other parts of the body; in the brain their coats are farmed by duplications of the dura mater.

246. Through what large veins is the blood carried from the cranial sinuses to the innominate veins?

Through the internal jugulars.

247. Through what large veins is the blood returned towards the heart from the external surfaces of the head and face?

Through the internal, external, posterior, and anterior jugular veins.

248. What vein accompanies the common carotid artery?

The internal jugular, which lies on the outer side of the artery within the sheath.

249. Name the principal veins of the upper extremities.

The veins of the forearm are, first, the deep—venæ comites; second, superficial—radial, ulnar, median, median cephalic, and median basilic (at the elbow): in the arm, deep—venæ comites; superficial—cephalic on the outside of the arm, basilic near the brachial artery, axillary accompanying the axillary artery, subclavian accompanying the subclavian artery.

250. What are the principal veins of the lower part of the trunk and lower extremities?

In the leg, deep—venæ comites; superficial—external or short saphenous and internal or long saphenous; in the popliteal space, popliteal vein; in the thigh, deep—femoral vein and profunda branch, superficial—internal or long saphenous, which joins the femoral in Scarpa's triangle; in the lower part of the trunk, external and internal iliacs accompanying the external and internal iliac arteries, and common iliacs, which accompany the common iliac arteries, and join to form the inferior vena cava.

251. What is the portal circulation?

It is an appendage of the venous portion of the systemic circulation.

252. What veins form the portal system?

The inferior and superior mesenteric, splenic, and gastric veins form the portal vein, which carries the blood from the intestines, spleen, and stomach to the liver.

II.—EMBALMING.

253. What is embalming?

Embalming is the filling of a body with a preservative and disinfectant fluid.

254. What are the chief reasons for embalming?

The chief reasons are those of preservation and disinfection.

255. To preserve a body only, what kind of fluid should be injected?

A fluid containing antiseptics is all that is necessary.

256. To disinfect as well as preserve, what kind of fluid should be injected?

A fluid containing strong disinfectants should be used.

257. Why is preservation desired?

Preservation is desired only for the present, to keep the body in a natural condition and prevent the usual bad odors that accompany putrefaction, during the mourning period or until interment.

258. Why is disinfection desired?

In all cases dying of contagious and infectious diseases, disinfection is desired to prevent dissemination of the disease.

259. How soon after death should the body be embalmed?

As soon as possible after the arteries are empty.

260. Why?

If blood is to be removed it should be done before coagulation takes place; the tissues can be filled much more readily when rigor mortis is absent, when they are flaccid.

261. When is it necessary to withdraw blood from the heart or veins?

In all full=blooded bodies, and in all bodies during hot weather, it is a good practice; while in septicemia and pyemia it is necessary because the blood is full of the putrefactive bacteria and for the purpose of enlarging the space for the reception of a greater amount of fluid, in order to destroy the bacteria that are in the tissues of all parts of the body.

262. What are the nutrient fluids of the body?

They are the blood, lymph, and chyle; but the blood is the most important to the embalmer.

263. Why is the blood the most important fluid to the embalmer?

Because it is the chief source of discolorations, and putrefactive changes take place in it very soon after death, especially in hot weather.

264. How would you fill the body with fluid?

As a rule, by raising an artery and filling the capillaries in all parts of the body through the systemic circulation; also filling the cavities, especially the respiratory tract, alimentary canal, and serous sacs, through the hollow=needle.

265. Why is it necessary to fill the cavities?

To sterilize the contents.

266. Is there a possibility of the circulation being destroyed in certain cases?

Yes; in old people, on account of the presence of atheroma; in cases of post=mortem examination; in railroad or other severe accidents; and in some cases by the arteries not being emptied after death.

267. If the circulation is destroyed, how would you fill the tissues?

By tying the arteries or by injecting fluid through the hollow=needle into the cellular and deeper tissues throughout the upper surfaces of the body.

268. What is death?

Death is the cessation of physical life.

269. What are the modes of death?

Cessation of the functions of the heart, cessation of the functions of the lungs, cessation of the functions of the brain; the latter is an indirect mode as it ultimately affects either the heart or the lungs.

270. What conditions simulate death?

Syncope, asphyxia, and trance.

271. Is there a single, early, positive sign of death?

No; a number of signs should be taken together.

272. Give tests to determine when the heart has ceased to act.

First, place the ear or stethoscope over the heart to gather sounds; second, apply a ligature around a finger or toe to see if the distal end will become swollen or discolored; third, open a dependent artery to see if it contains blood. If no sounds are gathered, and no swelling or discolorations appear, and the artery is found empty, all are signs that the heart has ceased to act.

273. Give tests to determine when respiration has ceased.

The application of a cold mirror over the mouth will condense the moisture in the air when respiration is going on; a flock of cotton applied to the mouth or nose will move to and fro if respiration continues; the placing of a cup of water upon the chest will determine whether the chest is heaving or not.

274. Name other signs of death.

If the skin is stretched it will not readily resume its normal position; if burned with a match or hot iron, it will not blister; opaqueness of the cornea; great pallor of the surface of the body; if, in cutting or puncturing the tissues, the wound remains open; reduction of occular tension; the flattening of the surface when pressure is removed; coldness of the surface; the presence of post=mortem discolorations and staining, which come on usually in eight or ten hours after death; and rigor mortis, all indicate the presence of death; the last and only certain sign, putrefaction, which shows about the third day in an ordinary case in an average temperature.

275. What change takes place in the blood after death that prevents its removal?

Coagulation.

276. How soon after death does coagulation usually take place?

As a rule, in from 12 to 24 hours; it may occur sooner in some diseases, while it may be retarded to a much longer period in others.

277. Can coagulated blood be removed from the veins or heart?

No; it neither can be dissolved nor withdrawn from the heart or veins.

278. What portion of the entire weight of the body is blood?

About one-tenth.

279. When coursing through the vessels, about how much of the blood is required to fill the arteries and capillaries?

About one-half, the remainder being in the veins.

280. When injecting the arteries, what vessels do we aim to fill?

The arteries and capillaries of the systemic circulation.

281. That being the case, how much fluid should be injected into the arterial system to fill the tissues?

A quantity equal to about one=half of the blood or about 1/20 of the weight of the body, or one pound to each twenty pounds' weight of the body.

282. In what condition are the arteries found after death?

They are usually found empty.

283. What causes them to be empty?

Post=mortem contraction of the heart and arteries, which begins at the heart and ends at the arterioles.

284. When does this contraction take place?

It usually comes on and passes off within an hour or two after death, but, being a tonic contraction, it may last for a much longer period; one case on record shows that it lasted 36 hours.

285. Does this contraction ever interfere with the filling of the arteries?

Sometimes the contraction will last for some hours after death, and, when the artery is raised, it is found so small that the tube will scarcely enter and only a very small amount of fluid can be injected.

286. What should be done when the arteries are contracted?

Wait until their walls relax, when they can be filled easily.

287. Where is the blood usually found after death?

After the arteries are emptied it is found in the deep and dependent veins.

288. How should the body be placed while being injected?

It should be placed on an incline with the lower extremities and lower part of the trunk lower than the head.

289. In what order will the different parts of the body be filled?

When the fluid is injected slowly, the lower extremities and lower part of the trunk will fill first; then the upper portion of the trunk, neck, head, and face last.

290. If too little fluid is injected, what will be the reuslt?

If too little fluid is injected, the lower parts of the body receive it, while the neck, face, and head receive none; therefore, these parts are first discolored and the features changed in many cases.

291. Does the fluid reach the cavities of the heart?

Not unless the valves are diseased or injured.

292. Does the fluid ever reach the right side of the heart?

Not unless the fluid makes the whole circuit of the systemic circulation, in arterial injection, or by one of the needle processes.

293. Why are arteries injected instead of veins?

Arteries are usually empty of blood, while veins are never empty; arteries, if injected when empty, will not cause flushing, while veins, if injected, will cause flushing; arteries have no valves, while veins in the extremities are full of valves which would prevent fluid from entering the extremities.

294. What tissues are cut through in raising an artery?

The skin, fat, and cellular, or superficial fascia and deep fascia.

295. How do you raise an artery?

By making a cut through the skin on the guide line long enough to expose a sufficient length of the artery; scrape away the fat; raise the fascia on the grooved=director and incise it with the curved, sharp=pointed bistoury; raise the sheath upon the handle or shank of the aneurism=needle; open it with the scissors or scalpel, and separate the artery from the vein or veins and nerve; pass a double thread underneath the artery; incise the wall of the artery; and insert and tie in the arterial tube.

296. How would you incise the wall of an artery?

Raise it out of the wound and place it upon the shank or handle of the aneurism=needle; then make a cut in its long axis with the curved bistoury or scissors.

297. Why make the cut in its long axis?

Because it will not weaken the artery, while the transverse or diagonal cut impairs the walls and a little force is liable to tear the vessel in two.

298. In what direction would you insert the arterial-tube?

With the nozzle toward the heart.

299. Could fluid be injected with the nozzle directed from the heart?

Yes; but too much fluid might be injected into the distal end of the extremity in which the artery is raised, causing discoloration and a distorted appearance.

300. If the arteries are full of blood, what would you do?

Wait until post=mortem contraction takes place to empty them; or raise the femoral artery and place the body well on the incline, tie in a drainage=tube and let the blood drain out, which frequently will stimulate the walls of the arteries to contraction; after the blood is drained out, inject the arteries.

301. What effect would it have on the surface of the body to inject the arteries when full of blood?

If soon after death, the surface would be flushed red, as a rule, in all diseases, except asphyxia.

302. Is the blood in the arteries always pure or arterial?

No; in case of asphyxia there is no arterial blood in the body, the blood in both the arteries and veins being impure or venous.

303. In a case of death from asphyxia when the arteries are full, what color would the flushing of the surface be?

If the arteries were injected it would be of a dark=blue or venous color.

304. If you were by mistake to inject a vein for an artery, what effect would it have on the surface of the body?

It would flush it a dark=blue or venous color.

305. Which arteries are usually raised for embalming purposes?

Brachial, femoral, carotid, radial, and posterior tibial.

306. Is one artery better than another?

No; if an artery is large enough to receive the arterial=tube, it is as good as any other artery.

307. If blood is to be withdrawn through the vein, which artery should be raised?

Either the brachial, which has the basilic vein near it; the femoral, which is accompanied by the femoral vein; or the carotid, which is accompanied by the internal jugular.

308. Is the carotid any better for injection than the brachial or femoral?

No; there is no reason why it should be raised in preference to either the brachial or femoral; and there are no good reasons why either of them should be avoided.

309. Where are the brachial artery and basilic vein located?

They are located on the inner side of the arm in the groove between the biceps and triceps muscles, the vein lying to the inner side of the artery and usually nearer the surface.

310. Give the anatomical and linear guides to the brachial artery.

The anatomical guide is the inner border of the biceps muscle; the linear guide is the line drawn from the center of the armpit to the center of the elbow, when the palm of the hand is turned upward and the arm placed at right angles with body.

311. What vessels and nerve accompany the brachial artery within the sheath?

The venæ comites and median nerve, the artery always lying beneath the nerve, in the middle third of the arm.

312. When you raise the brachial artery through what vein would you remove blood?

Through the basilic vein, using a tube that is of sufficient length to reach the right auricle of the heart, and is of a caliber that will readily pass through the vein.

313. Does it make any difference which arm is used when blood is to be withdrawn through the basilic vein?

No; as the tube can be passed through the vein of one arm as well as the other; when the right is used, if the end of the tube is checked in the neck, a little pressure in the hollow above the inner end of the clavicle will start it down through the innominate vein.

314. Why should the carotids be avoided?

Because they lie deep and the mutilation is extensive, especially in fleshy persons, and is readily exposed; blood can be withdrawn directly from the heart or through either the basilic or femoral vein just as easily as through the internal jugular.

315. When is it best to raise the radial or tibial artery?

When the body is already dressed; in this case, blood can be withdrawn, if necessary, from the heart by the direct operation.

316. What do you find in the sheath with the artery?

Always one or two veins and sometimes a nerve.

317. How do you discriminate between an artery, vein, and nerve?

An artery is usually empty, cylindrical in form, of a creamy=white appearance and somewhat firm to the touch, owing to the heavier walls. A vein, if deep, usually contains blood; if so, it has a bluish appearance; it is collapsed and has a soft velvety feel, owing to its thinner walls; if empty, its color is similar to that of an artery. The nerve is white, hard, dense in structure; is never hollow. Arteries are contained in sheaths, always accompanied by one or more veins; when accompanied by two veins the veins are usually of small size; superficial veins are never within a sheath, and lie near the surface.

318. Where are the femoral artery and vein located?

In the thigh.

319. What superficial vein lies to the inner side of the femoral artery?

The internal or long saphenous, which is often mistaken for the artery.

320. Through what triangle does the artery pass in its descent through the thigh?

Scarpa's triangle; it enters the triangle at center of the base, passing through to the apex, in which it lies nearest the surface.

321. Give the anatomical and linear guides to the femoral artery.

The anatomical guide is the inner border of the satorius or tailor's muscle; the linear guide is a line drawn from the center of Poupart's ligament to the inner side of the knee when the foot is turned out.

322. How would you withdraw blood from the femoral vein?

The vein should be raised and opened and a drainage=tube of sufficient length inserted to reach above the bifurcation of the common iliac vein, through which the blood will drain when the body is placed well on the incline.

323. Give the anatomical and linear guides to the common carotid artery.

The anatomical guide is the front border of the sterno-cleidomastoid muscle; the linear guide is the line drawn from the mastoid process downward and forward to the junction of the clavicle and sternum.

324. Give the guide to the radial artery.

The guide is the groove on the radical side of the arm between the first prominent tendon and the outer edge of the radius, where the doctor takes the pulse=rate.

325. Give the guide to the anterior tibial.

The guide to the anterior tibial is the outer side of the front border of the lower end of the tibia.

326. What is the guide to the posterior tibial?

The guide to the posterior tibial is the groove behind and beneath the internal malleolus (ankle).

327. In what position would you place the body after embalming?

Upon a level, with the head but slightly elevated, so as to prevent the fluid from draining out of the upper portions of the body.

328. What methods are used for withdrawing the blood?

Either by the direct operation upon the heart or through one of the larger veins.

329. In the direct method at what point should the needle be introduced?

If blood is to be withdrawn from the right auricle by the direct method, the point of the needle should be inserted in the third intercostal space, close to the margin of the breast=bone on the right side, and directed straight back toward the right of the center of the back=bone, to avoid wounding the great aorta.

330. Does the direct operation destroy the circulation?

To puncture the right auricle does not destroy the circulation for the injection of the fluid; when the circulation is destroyed it is usually the unfortunate wounding of the great aorta by directing the point of needle to left of the center of the back=bone.

331. What effect does heat have on the blood?

It coagulates it.

332. What effect does freezing have on the blood?

It prevents coagulation; the blood will not coagulate as long as it remains frozen.

333. How much blood can be withdrawn from the body?

That depends, as a rule, upon the size of the body and the disease; in some cases only a few ounces can be removed, while in others the quantity is large, being as much as four quarts; ordinarily only one pint to two or three quarts can be withdrawn.

334. Why do we practice cavity embalming?

To sterilize the contents of the different subdivisions of the abdominal and thoracic cavities, especially the contents of the alimentary canal and respiratory tract.

335. What parts of the cavities should be filled in all cases?

The pleural and peritoneal sacs, the alimentary canal, and the respiratory tract.

336. Can a body be preserved and disinfected thoroughly by cavity injection?

No; the fluid will only reach the cavities and sterilize the contents, or settling down through the tissues, will possibly sterilize the tissues of the back of the trunk.

337. Will cavity injection alone preserve the body?

It will aid in preserving some bodies temporarily, as putrefaction will not take place to a great extent, for some days, in the outer soft tissues, especially while rigor mortis is present.

338. Which is the best point to insert the hollow-needle for relieving the cavities of gases and fiilling them with fluid?

If only one point is selected, it should be in the epigastrium as the needle can be directed through the diaphragm close to the ribs and over the lungs into the pleural sacs, and through the peritoneal sac to all parts of the abdominal cavity, always bearing in mind the location of the aorta and heart; these should not be punctured under any circumstances.

339. In what organs are gases usually formed in the abdominal cavity?

When a large quantity of gas is present it is usually formed in the large intestine; in certain diseases, as in peritonitis, it may be formed in the peritoneum; there is always more or less gas in the small intestine.

340. In opening the abdominal cavity, where should the incision be made?

Through the linea alba (white line) in the center of the front wall, where there will be no danger of cutting through an artery.

341. How do you inject fluid through the respiratory tract?

By using an inelastic, steel nasal=tube, long enough, when introduced through the nose or mouth, to pass through the glottis; the end of the tube can be felt through the front wall of the larynx, or Adam's apple; fluid should then be injected through the tube; or a hollow=needle may be inserted at a point immediately above the upper end of breast=bone, through front wall of trachea, through which fluid can be injected.

342. Should fluid be injected into the left ventricle through the hollow-needle?

No; because you will have no assurance that the needle has entered the proper cavity of the heart; it will be like groping in the dark and the results are likely to be disastrous; as a practical method, certainly no embalmer would recommend it.

343. When and by whom was the needle process introduced?

It was introduced in 1884 by the late Dr. Benjamin Ward Richardson, of London, England; he injected through the cranial cavity by introducing the needle through the apex of the eye=socket into the spaces at the base of the brain.

344. Do the needle processes take the place of arterial embalming?

No; as an auxiliary the needle processes are useful, but should not be depended upon alone as a method of injecting ordinary bodies.

345. Which is the best method of introducing the needle into the cranial cavity?

Through the cribriform plate of the ethmoid bone at the root of nose; the needle can be so introduced easily, and there will be no leakage after its removal.

346. Should the right side of the heart be tapped if either of the needle processes is used?

It should not; because there will be leakage into the mediastinal space, on account of the principal part of the fluid passing downward through the veins.

347. What is putrefaction?

Putrefaction is the separating of the constituent elements of the body, due to the presence and growth of bacteria.

348. In what bodies does putrefaction progress most rapidly?

Those dead from drowning, septicemia, child=birth, and dropsical cases.

349. Under what conditions will putrefaction progress most rapidly?

In a warm temperature, from 80° to 100° F., when moisture is present.

350. What will retard putrefaction?

A cold temperature, a high altitude, deep water, and earth.

351. What will prevent putrefaction?

Freezing; a high, dry temperature; the presence of an antiseptic.

352. Name the putrefactive gases of a body.

Sulphureted and carbureted hydrogen, carbonic acid, ammonium, etc.

353. How are gases generated in the body?

Gases are generated during putrefaction and are due to the presence and growth of bacteria.

354. How prevent the generation of gasses?

By destroying the bacteria or preventing their growth.

355. What causes purging from the mouth and nose?

Putrefaction of the contents of the stomach or lungs, or of the lung=substance itself.

356. How would you determine whether purging is from stomach or from lungs?

The matter from the stomach is usually of a brownish, coffee=ground appearance, and has a peculiar smell; that from the lungs is of a bloody, frothy character, and has essentially a putrefactive smell.

357. How would you stop purging from the stomach?

By tapping the stomach with a hollow=needle and relieving it of gases and injecting fluid before removing the trocar; then puncturing the intestines, relieving them of gasses and injecting fluid before removing the instrument.

358. How would you stop purging from the lungs?

In an ordinary case the body may be turned and all of the matter may be pressed out that is possible; then inject fluid through the respiratory tract; if it is an obstinate case, the lungs should be mutilated, and fluid injected into the tissues direct through the hollow=needle; the mutilation may be made with the hollow=needle or the scalpel, by cutting through the intercostal spaces over the front of the chest. If the mutilation is thorough and the lung=substance filled with fluid, it will stop the purging completely.

359. Does the mutilation of the lungs interfere with arterial embalming?

As it occurs some hours after the body is embalmed arterially it will not matter whether the circulation be destroyed or not.

360. Should the respiratory tract be closed to prevent purging from the lungs?

No; never close the throat or tie the trachea in obstinate cases, as putrefaction will continue and gases will be formed which will pass out through the tissues and swell the surface of the body.

361. What is "skin-slip," and what causes it?

Skin=slip is a slipping of the cuticle, due to the softening of the rete muscosum or pigment layer of the skin; this occurs in putrefaction and also in cases in which there is a superabundance of water present in the tissues, as in heart, liver, and kidney diseases.

362. How may skin-slip be prevented?

In a case where putrefaction has progressed to any great degree or in one of dropsy—that is, where there is an increase of the normal quantity of water in the tissues—a strong formaldehyde fluid should be used; as formaldehyde gas has a great affinity for water, and is also a great hardener of tissues, it will reach the parts directly, hardening the tissues and preventing skin=slip.

263. What is post-mortem discoloration?

It is the settling of the blood into the dependent portions of body, as seen along back of trunk eight to ten hours after death.

364. What is post-mortem staining?

In post=mortem staining there has been a reduction of the red corpuscles and the hemoglobin or coloring matter has been eliminated from them, passing out through the walls of the vessels into the tissues, leaving a permanent stain of a bright=pink color.

365. Can post-mortem staining be removed by bleachers?

No; it cannot be removed by the application of bleachers in any manner.

366. Can post-mortem discoloration be removed?

Yes; as the discoloration is due to the presence of blood in the vessels near the surface, by changing the position of the body, the blood will gravitate to other parts.

367. Can discoloration be removed by the application of bleachers to the surface when applied in the usual manner?

No; if bleachers are applied they should be covered with rubber or oiled=silk, so that the air will not absorb the moisture if applied in this manner, good results may be obtained.

368. If the blood is coagulated can the dark discoloration be removed from the face and upper portions of the body?

If it is only coagulated in the larger vessels, and not firmly in the capillaries, it can be removed by the application of ice and salt, or by rubbing and pressure; but, if firmly coagulated in the capillaries, nothing will remove it; bleachers placed on the outside are of no avail under any circumstances.

369. What discolorations appear on the surface as a result of death?

Congestion of the face and capillaries, post=mortem discoloration, post=mortem staining, greenish discoloration or putrefaction, and brownish or grayish spots.

370. What other discolorations may be present at death?

Discolorations resulting from the various diseases—as in cancer, Bright's disease, etc.;—jaundice, ecchymotic spots, as a result of purpura, Addison's and other diseases, bruises, etc.

371. How can small greenish, brownish, or grayish spots be removed?

By the injection hypodermically of the following solution: bichlorid of mercury, 10 grains; pure alcohol, 4 ounces; mix; inject a few drops underneath the skin of the part involved.

372. How should a bleacher be applied externally to make it effective?

It should be applied by moistening a folded cloth, lintine, or absorbent cotton, which should be placed over the part to be bleached, and covered with a piece of rubber or oiled=silk to prevent air from absorbing the moisture.

373. Can the discoloration known as jaundice be removed?

No; it can be modified by filling the tissues through the arterial system with a good fluid.

374. What causes the surface of a body to be dark in a drowned case?

Death is due to asphyxia, and, therefore, the blood is all venous, of a dark=blue color; it is slow to coagulate in cold water, and should be removed at once by the direct operation upon the heart or through a vein.

375. How would you treat a floater?

If the cuticle is shredded, thoroughly wash the surface, rubbing away the cuticle; then raise the femoral or some other artery and inject a large quantity of fluid; then fill the cavities and inject through the hollow=needle over the upper surfaces of the body in the cellular and deep tissues. A large amount of fluid (at least three or four gallons) should be injected into a body of medium weight.

376. In what kind of a room should a jaundiced body be placed and how prepared?

It should be placed in a dark room and artificial light should be reflected upon the parts exposed, as the face, neck, and hands; this will give the body a very natural appearance.

377. What is the color of all of the blood in a body when death is caused by illuminating gas?

It is a very dark=bluish color.

378. What is the color of the blood when death is caused by charcoal gas (carbonic oxid)?

It is of a bright=cherry=red color.

379. What is the first thing necessary to do in a case of asphyxia?

The body should be placed high on the incline, and blood should be withdrawn as quickly as possible to relieve the peripheral veins and capillaries of congestion, which causes discoloration of the surface.

380. What is always necessary in the treatment of a case of consumption?

To fill the lungs through the respiratory tract, and the mediastinal space and pleural cavities; otherwise the body should be treated in the usual manner.

381. How would you inject the pleural cavities in tuberculosis?

If the lungs are not adhered to the front wall of the chest, introduce the hollow=needle from the hypogastrium; if they are adhered, the needle should be introduced between the second and third ribs on either side at a point about four or five inches from the breast=bone; then aspirate as much of the contents as is possible, and fill the lungs with fluid, which will sterilize the remaining contents.

382. In a case of general dropsy, how remove the water?

Remove it from the peritoneum either by introducing the needle in the hypogastrium or at a point in the middle of the body just above the pubic arch and aspirate it; insert the needle in the pleural cavities in the usual manner and aspirate; to remove from the upper and lower extremities incise or puncture the skin underneath in many places, and apply a strong rubber bandage made of rubber webbing, known as Esmarch's bandage.

383. How would you treat a case in which an autopsy has been held?

If the autopsy has included the thoracic and abdominal cavities only, the arteries leading to the extremities, as well as those leading to the head and neck, should be tied and fluid injected into the upper extremities, head, and neck, by raising the brachial artery and tying the tube into it, or tying the tube into one of the severed ends, such as the innominate, left common carotid, or left subclavian. In the lower extremities tie the tube into the iliacs and inject toward the feet; then cleanse the cavities, wiping them dry; sprinkle hardening compound freely over the inside and cover each of the organs as it is replaced, finally, cover freely with the powder and stitch the edges of the incision together; then inject fluid directly into the tissues of the trunk through the hollow=needle.

384. How would you treat a body with the calvarium (skullcap) removed?

Place the body in a sitting posture; raise an artery at some point and inject very slowly until all parts of the body, including the neck and base of the skull, are filled; then replace the contents, covering the same with dessicating or hardening compound; then replace the skullcap and stitch the scalp, and inject fluid into the tissues of the scalp through the hollow=needle.

385. What is the color of the blood in a body dead from sunstroke?

Death is caused by coma, which ultimately stops respiration while the heart is still performing its function, resulting in asphyxia; the blood is all venous, which gives a dark color to the tissues of the body.

386. How would you treat a case of death from sunstroke?

Place the body on a high incline so that all the blood that is possible can be withdrawn; then fill the tissues and cavities thoroughly with fluid, using a larger amount than in an ordinary case, as there is a tendency to rapid putrefaction.

387. What is the color and condition of the blood in a body dying of pneumonia in the early stages?

It is a dark color, due to the interference with respiration which results in only partial oxygenation of the blood; in some cases respiration will entirely cease while the heart continues to beat for a short period, which sends the blood through the lungs without aeration; it coagulates sooner than in an ordinary case.

388. What is the color and condition of the blood in a body dying of pneumonia in the later stages?

It is not necessarily of a dark color, as aeration may be sufficient to relieve the blood of the waste, or carbonic acid gas, and it will be found much thinner and less prone to coagulation than if death had occurred in the early stages.

389. What should be done in a case of consumption or other diseases of the lungs should there be leakage of the fluid from the mouth and nose?

Close the pharynx with a tampon or pledgets of cotton and continue the injection of fluid until all of the tissues are filled; the leakage is caused by rupture of the bronchial arteries in the cavities within the lungs.

390. How would you embalm a body dead of gun-shot wounds?

It depends on the parts involved; if the ball has penetrated the head, the hole or holes in the skull may be firmly closed by the use of plaster of Paris, putty, or some other similar substance, and the injection proceed as in any other case. If the aorta and other large vessels are mutilated, they should be tied and the injection follow; then the blood and other liquid substances should be removed and a good dessicating or hardening compound should be used freely.

391. How would you treat a case with the throat cut?

If both carotids are cut, by tying three of the free ends, and inserting and tying the tube in the fourth free end with the nozzle toward the heart; then attach the pump and inject as in any other case.

392. Will fluid reach the head and neck by injecting in this manner?

Yes; it will reach the head and neck through the vertebral arteries, which, with the carotids, form the circle of Willis, by anastomoses, from which vessels reach every part above the wound.

393. In what diseases is the operator in great danger of blood-poisoning.

Erysipelas, septicemia, syphilis, diphtheria, and bodies recently dead of many other diseases.

394. Is it very dangerous to handle a body in which putrefaction has taken place extensively?

No; it is less dangerous than in a fresh one.

395. How would you treat a wound received while operating on a body?

Make it bleed freely and cauterize with carbolic acid or some other cauterizer.

396. If you have abrasions, hangnails, or cracks on the hands, how would you protect yourself while operating?

By the use of rubber gloves or finger=cots, or covering the hands with "hand protector" or carbolized vaseline.

397. What is an anomaly?

An anomaly is a deviation from the rule, type, or form; irregularity; anything abnormal or contrary to analogy.

398. What is an anomalous condition of an artery?

It is an artery that is irregular in its form, division, or course, as is found often in the brachial artery.

399. What is an abnormal condition?

A deviation from the natural stucture, division, or course; unnatural; irregular, as an abnormal development of an organ.

400. What is a malformation?

It is any congenital irregularity in the formation or development of parts in an organism.

401. How can blood be removed from the cranial cavity?

If the blood is within the vessels and not coagulated, the body should be placed high on the incline in order to gravitate the blood to the trunk.

402. If it is coagulated in the cranial cavity can it be removed?

No; not by any process known unless the skullcap were removed, which is not practical.

403. Is it ever necessary to remove blood from the brain cavity?

It is scarcely necessary unless the operator wishes to remove the pressure upon the vessels.

404. Are either of the needle processes practical for this purpose?

No; if there is hemorrhage in the subarachnoid spaces, an extremely small amount may be withdrawn in this way, but not sufficient to amount to anything.

405. Can blood be removed from a drowned case having been in the water for some length of time?

Yes, if not coagulated; if coagulated, it cannot be removed.

406. What effect does the water have upon the blood in a drowned case?

Unless mixed with the blood, it retards coagulation.

407. What is the mode of death in a case of drowning?

Death through the lungs, or asphyxia.

408. As a rule, what effect has asphyxia upon coagulation?

It retards coagulation.

III.—SANITATION AND DISINFECTION.

409. What are bacteria?

They are the lowest forms of plant or vegetable life.

410. Where are bacteria found?

Everywhere, except in mid=ocean and in the highest altitudes, where no moisture is present.

411. There are how many general forms of bacteria?

Three: micrococci (cocci), spherical=shaped; bacilli, rod=shaped; spirilla, spiral=shaped.

412. What bacteria interest the embalmer most?

Those of putrefaction and those of infection.

413. What kind of bacteria cause disease?

Infectious or pathogenic bacteria.

414. What kind cause decomposition of the body?

Putrefactive or nonpathogenic bacteria.

415. Between what degrees of temperature will bacteria grow?

Between 32° and 120° to 130° F.

416. At what temperature will they grow most rapidly?

About the normal heat of the body.

417. What agents prevent their growth?

Antiseptics.

418. What agents destroy them?

Disinfectants.

419. Define an antiseptic.

An antiseptic is an agent or body that will prevent the growth of bacteria when present, without of necessity killing them; it is only a preservative.

420. Define a disinfectant.

A disinfectant is an agent or body that will kill bacteria; it is also a preservative.

421. Name some disinfectants.

Bichlorid of mercury, 1:1000 or 1:500; carbolic acid, 5 to 10 per cent.; chlorid of lime, six ounces to the gallon; sulphur fumes; formaldehyde gas; fire; moist and dry heat (230° F.); and boiling water.

422. What is a deodorizer?

A deodorizer is an agent or body that destroys odor either by absorption or covering it with a stronger odor.

423. Name same good deodorizers.

Bichlorid of mercury, chlorid of lime, etc.

424. What should a good fluid contain?

Disinfectants sufficiently strong to destroy all bacteria in the body, especially those producing the disease which caused death; the fluid should not destroy the appearance of the body, if used in a case where a private or public funeral is to be held, or which is to be exposed to view in any manner.

425. What is infection?

It is a poisonous matter that contains infectious or pathogenic bacteria.

426. When is a disease said to be infectious only?

When the infection is taken into the body by inoculation, or through the food we eat, or the water we drink, or the air we breathe,—as bacteria, when dry, may be carried in the air.

427. Name some diseases which are infectious only.

Pneumonia, grip, malaria, cholera, etc.

428. What is contagion?

It is poisonous matter containing infectious bacteria, which can be communicated by contact from the sick to the well.

429. When is a disease said to be contagious?

When it is communicable from one person to another, by direct contact or through the surrounding air at no great distance.

430. What kind of diseases are smallpox, scarlatina, whooping-cough, and measles?

They are both contagious and infectious.

431. What is the object in embalming a contagious or infectious disease?

To prevent the dissemination of the disease.

432. Should a public funeral be held in a contagious case?

No.

433. What rules should govern the funeral director in handling a contagious case?

The rules adopted by the State and local health boards under whose jurisdiction he is doing business.

434. Should bodies be embalmed that are dead of contagious or infectious diseases that are to be buried at once?

For preservation merely it is not necessary, but as a sanitary measure all should be embalmed.

435. What is formaldehyde gas?

It is a product of wood=alcohol produced by heating; it is not a commercial product in the form of gas; it is freighted and sold only in the form of a solid, called paraform, which is of 100 per cent. strength, or in liquid form having a strength of 40 per cent., called formalin, formol, or formaldehyde; the gas is produced for use by dissolving the paraform by heat or by the distillation of the gas from formalin.

436. How would you disinfect a room and its contents?

By closing the cracks in the room as tightly as possible, separating hangings upon the walls, hanging up bed=clothing and other material upon lines stretched across the room, opening wide all drawers and doors of closets, hanging up their contents, separating the clothing, and everything as much as possible; then spraying the walls and contents with water sufficient to dampen them; leave the room and fasten the cracks of the door of exit by pasting or caulking with strips of cotton soaked in bichlorid of mercury 1:500; then distill five ounces of formalin for each thousand cubic feet of space, directing the formaldehyde gas through the key=hole and keeping the room closed for from ten to twelve hours.

437. In the absence of formaldehyde gas what would you use to disinfect a room?

Sulphur fumes; burning at least three pounds of sulphur for each 1,000 cubic feet of space; all surfaces and contents should be moistened with water sprayed, or steam, preparing the room as when formaldehyde gas is used and leaving it closed for at least twelve hours.

438. For what reason is formaldehyde gas preferred to sulphur?

There is no danger of fire, as distillation takes place outside the room; neither will it destroy colors of the wall paper or fabrics, nor tarnish polished metallic surfaces, while, when sulphur is used, there is danger of fire, of the destruction of certain colors in wall paper and other fabrics, and of the tarnishing of all polished metallic surfaces.

439. What is meant by bichlorid of mercury 1:1000?

It means one grain of bichlorid of mercury to 1,000 grains of water, or seven grains to one pint of water (an avoirdupois pint weighing 7,000 grains).

440. What does 1:500 mean?

Two grains to 1,000, or fourteen grains to one pint.

441. How would you disinfect soiled, washable material, such as wearing apparel and bed-clothing?

If not worn much, by boiling in water from one to two hours; if nearly or entirely worn out, by burning them.

442. How would you treat soiled, unwashable material, much as silks, woolens, bedding, and mattresses?

Moisten them by spraying, and expose them to formaldehyde gas, in a tight compartment, for from ten to twelve hours.

443. How would you dress and prepare yourself when called to take charge of a case of contagious disease?

Dress in a suit of old clothes, covering the whole with a rubber coat buttoned closely about the neck and around the body, and reaching to the shoes; cover the hair with an oiled-silk or rubber cap.

444. How would you care for yourself after the work is done?

After the body is taken care of and the room disinfected, the coat, hat, and old suit of clothes should be fumigated, and the hands, face, beard, and hair should be washed with soap and water and a solution of bichlorid of mercury 1 : 1000.

445. How would you prepare a case of diphtheria for burial?

Place the body upon the board, then wash it with a strong bichlorid solution; inject a strong disinfectant fluid into the mouth and nose; raise an artery at some point and fill the arteries and capillaries thoroughly; then fill the cavities; inject more fluid into the mouth and nose and other openings of the body; then, if sufficient time intervenes before the funeral, disinfect the room, including the body, with formaldehyde gas; if sufficient time does intervene, the body can then be carried to the coffin, which should be placed in an outer room; previously to removing the body, it should be wrapped in a sheet wrung out of a strong disinfectant; after removing from the room, it can be dressed and placed in the coffin or casket; if the body has been disinfected in the room, the coffin can be carried into the apartment and the body dressed and placed therein; if disinfection of the room amounts to anything at all, it will have destroyed the bacteria in the room.

446. If the body is to be shipped, how should it be prepared further?

The openings of the body should be filled with pledgets of absorbent cotton soaked in fluid, the body wrapped in cotton batting at least one inch thick, and still further prepared according to the rules adopted by the General Baggage Agents' Association for transportation.

447. How is typhoid fever usually communicated?

By drinking water or eating cold food in which there are typhoid bacilli.

448. Have the germs of all contagious and infectious diseases been determined?

No; the bacteria that produce scarlet fever, smallpox, measles, etc., are not known.

449. What kind of a disease is diphtheria?

It is an acute, infectious and contagious disease, produced by the diphtheretic bacilli.

450. In what parts of the body are bacilli developed in diphtheria?

In the false membranes of the throat, nares, and sometimes in the larynx.

451. Does the blood contain the diphtheretic bacilli in diphtheria?

It does not; the blood, however, is very poisonous; it is, therefore, very dangerous to cut or wound yourself while handling a case of diphtheria.

452. In preparing a body for shipment, is absorbent cotton better than cotton batting for the purpose of encasing the body?

No; it has no advantage over cotton batting; cotton batting answers every purpose, and has an advantage over absorbent cotton by not being so expensive; twenty or thirty cents will buy enough cotton batting to encase a body, while absorbent cotton will cost much more.

453. What is the best and easiest method of applying the cotton?

Spread a bed sheet upon the floor, cover the surface of the sheet lengthwise with a layer of cotton, then crosswise with a layer, and so on alternately until it is covered by at least six layers; then the body should be laid in the center of the sheet; bring the cotton up over the feet and head first; then from one side and then from the other, pinning or stitching the sheet over the whole; then for further protection, apply a roller bandage.

454. What persons are susceptible to contagious diseases?

All those who have never had a previous attack, and in smallpox those who have not been vaccinated.

455. What persons are immune?

With few exceptions all persons who have had a previous attack, and in smallpox those who have been vaccinated.

456. What is an immune?

One who is protected from an infectious or contagious disease by a previous attack, vaccinating, or by reason of race or acclimatization.

457. Name some of the chemicals used in embalming fluids.

Arsenic; mercuric chlorid; chlorid of zinc, ammonium, sodium, and potassium; arsenite of potassium and sodium; sulphate of zinc and potassium; etc.

458. What gases are used in combination with chemicals in the manufacture of embalming fluids?

Sulphurous acid gas and formaldehyde gas.

459. Does it make any difference in which arm the injection is made?

No.

460. How would you inject the common carotid artery?

Always inject downward until the body is filled. The fluid will reach the tissues above the point of injection, provided enough fluid is used, through the opposite carotid artery and vertebral arteries—that is, if the circulation is intact; otherwise, fluid may be injected upward.

461. Should veins ever be opened while injecting arteries?

When blood is to be withdrawn it is a good practice, as the pressure of the fluid will aid in forcing the blood out.

462. Is it ever necessary to draw blood from the arteries?

When the arteries contain blood that is in the way, it should be drained out of some pendant artery before beginning the injection.

463. How soon after death should a body be embalmed?

As soon as you have ascertained that death is actually present, and the arteries are empty, it may be embalmed.

464. In what cases is it necessary to do cavity embalming?

The pleural cavities should be filled in all cases of lung diseases, and the abdominal whenever gases are present, which shall be your guide in the operation.

465. How should the injection be completed when fluid appears at the mouth, caused by leakage probably from the respiratory tract?

I would wait from a quarter to half an hour, then inject a small amount, continuing, at intervals, the injection slowly and in small amounts until all of the tissues are filled. Or the throat may be closed by tampons of cotton.

466. In a case where both common arteries are cut, how must the embalmer proceed?

He should pick up and tie both upper and one lower end, then tie the arterial tube into the other lower end. Fluid will reach all parts above the severed arteries through the vertebral and collateral circulation. If the ends cannot be found, raise the arteries somewhere else and tie severed ends when leakage points them out.

467. Is it necessary to inject the distal part when an artery is raised in an extremity?

We have never found it necessary. Although by leaving the distal end of the artery open at the beginning of the injection the operator will soon have positive evidence. The fluid usually appears sooner or later. If it does not appear at all, then inject the distal end.

468. If the chin drops after embalmment, how would you remedy the matter?

Such a contingency is positive evidence that no fluid has reached the masseter and other muscles of the face and jaw. We would direct the use of more fluid and the chin=rest—the latter for a few hours only.

469. Where is the blood usually found after death?

In the veins and capillaries of the deeper and pendant parts of the body.

470. What is meant by the vascular system?

It usually means a system of vessels in the body that carries the blood from one part to another. It consists of arteries, veins and capillaries.

471. When a body dies of consumption, what is the condition of the lungs?

The conditions are very various. We may have hepatization of some parts, and cavities in others, with much broken down lung tissue; while in still other parts the tissue may be practically normal. In all cases of consumption fluid should be injected through the respiratory tract in addition to arterial injection. Usually the lungs are diseased in all parts before death takes place.

472. How would you proceed to eliminate the disagreeable odors from a decomposing body?

First, we would remove and deodorize the gases from the cavities, using freely a strong deodorant over the surface of the body and throughout the room or container; then fill the body with fluid.

473. How yould you prevent mould from forming on the face and hands when placing in a vault?

By covering the face and other exposed parts with several layers of cloth. The mould will then form on the outside of the cloth.

474. How does fluid reach the visceral organs?

Through the arteries that supply them with blood in life.

475. How does fluid reach the lungs?

Through the bronchial arteries.

476. How does fluid reach the diaphragm?

Through the phrenic arteries.

476. How does fluid reach the stomach?

Through the gastric artery.

478. How does fluid reach the liver?

Through the hepatic artery.

479. How does fluid reach the spleen?

Through the spleenic artery.

480. How does fluid reach the kidneys and suprarenal capsules?

Through the renal and suprarenal arteries.

481. How does fluid reach the walls of the intestines and messentaries?

Through the superior and inferior messenteric arteries.

482. Why do we do cavity embalming?

To disinfect the contents of the intestines, stomach and plural cavities when necessary.

483. What indicates the necessity for cavity embalming?

The presence of gases and the disease which caused death.

484. When should the pleural cavities be injected?

When death was caused by consumption or other diseases causing pleural effusions.

485. What is the guide for the effectual embalmment of the alimentary canal?

The gases that may be present. After the gases have escaped through the needle, pump in fluid before its removal. By this means fluid will reach the contents.

486. Is it ever necessary to inject fluid into the peritonial cavity?

Not unless effusions are present.

487. If all of the visceral organs are reached by arteries, is it ever necessary to inject fluid into them to preserve them?

No, not if the circulation is intact. Yes, only when the arterial circulation is destroyed.

488. Does the old method of cavity embalming amount to anything?

Not much, unless by accident fluid is injected into the alimentary canal.

489. Why is the old method a failure?

Because, by relieving the intestines and stomach of gases, the walls collapse, making it impossible to mix fluid with their contents.

490. When should the abdominal cavity be treated?

Whenever gases form causing distention.

491. Where are abdominal gases usually formed?

In the stomach and intestines.

492. Why do gases sometimes form in the stomach and intestines after arterial embalming?

Because the fluid only reaches the walls of these organs, and not their contents.

493. How much fluid should be injected in arterial embalming?

That depends entirely on the size, purpose and general conditions. To disinfect, not less than one pint of fluid to each 20 pounds weight of the body, or not less than one gallon of fluid to a body weighing 150 to 160 pounds. A less quantity may preserve when weather conditions are good.

494. When should blood be removed?

When it is in the way, from all full=blooded and congested bodies.

495. When the artery is full of blood, should the injection proceed?

No. Wait until they are emptied by post=mortem contraction; or raise a pendant artery and let the blood drain out before proceeding to inject.

496. How fill the tissues with fluid when the circulation is destroyed?

By direct injection into the tissues through the hollow=needle.

497. Is it ever necessary to inject a vein?

Certainly not. No rational operator would ever think of injecting fluid into a vein for any purpose whatever.

498. Are there any bodies that cannot be preserved by our present methods of embalming?

No. All bodies may be preserved, if treated properly.

499. To what may the usual failures be ascribed in embalming?

To the operator, usually, and not to the fluid.

500. Why is the operator usually at fault when a failure occurs?

Because he does not use his fluid properly; he fails to fill all of the tissues; or he does not understand the case.

501. What essentials are necessary for a man to become a first-class embalmer?

A fair knowledge of anatomy, physiology, morbid anatomy, a good student, and good judgment are some of the essentials.

502. Describe Hunter's Canal.

It is formed by the vastus internus muscle on one side, and the adductor longus and adductor magnus on the other, together with a strong fibrous band passing over from the vastus to the tendons of the adductors. The femoral artery runs through this canal to become the popliteal. It is situated in the lower part of the thigh.

A PRACTICAL DICTIONARY

OF SCIENTIFIC AND MEDICAL TERMS

INTRODUCTION.

Readers and students of this work will find in the Practical Dictionary brief and concise definitions of the medical, scientific, and technical words and terms used in the Text-Book, which were thought to need defining. With these are included some words of the same character frequently met with in the literature of the profession.

The Standard Dictionary and Gould's Medical Dictionary have been consulted jointly as authorities on definitions. For spelling, compounding, and forming of words, division of syllables, and accentuation, the former authority has generally been followed.

In spelling, some deviation from the style observed in our former editions has been found necessary to conform to the latest and most approved methods. Among such changes may be noted the substitution of "e" for the diphthongs "æ" and "œ," as "fetus" instead of "fœtus," and the dropping of the final "e" in such chemical terms as "bromin," "chlorid," "morphin," etc.

The German double hyphen is used to join compound words and phrases, not only in the dictionary, but in the body of the work, to avoid confusion which would arise were a simple hyphen used.

PRACTICAL DICTIONARY.

A

ab-do′men. The large cavity in the trunk between the thorax and pelvis; the belly.

ab-dom′i-nal. Pertaining to the abdomen.—**a. aorta.** Aorta below the diaphragm.—**a. cavity.** The cavity within the walls of abdomen.—**a. regions.** The clinical regions of the abdomen.—**a. viscera.** Organs of the abdomen. [of body.

ab-duct′. To draw away from median line.

ab-duc′tion. Movement from median line.

ab-duct′or. A muscle that draws the extremity from the median line.

ab-er-ra′tion. Deviation from the normal.

ab-nor′mal. Contrary to customary order.

ab-o-li′tion. Complete suspension, as of a function. [velopment of disease.

a-bort′. To miscarry; to prevent the de-

a-bra′sion. An excoriation of the skin.

ab′scess. A circumscribed cavity containing pus. [wormwood and aromatics.

ab′sinthe. A cordial containing oil of

ab-sorb′. To take up; to imbibe.

ab-sorb′ent. Taking up by suction; imbibing.—**a. cotton.** Cotton freed from impu-

ac-ces′so-ry. Auxiliary; assisting. [rities.

ac-cli-ma′tion. Becoming inured to a cli-

ac-crete′. Grown together. [mate.

ac-cre′tion. Accumulation; adherence of

a-ceph′a-lus. Headless. [parts.

a-ce-tab′u-lum. A cup-shaped cavity that receives head of femur.

a-cet′ic acid. The acid of vinegar.

A-chil′les, tendon of. Large tendon of heel.

a-cic′u-la. A slender needle-like process.

ac′ne. Inflammation of sebaceous glands. —**a. ro-sa′ce-a.** Chronic congestion of skin

ac′rid. An irritant poison. [of face.

ac-ro′mi-on. Process at summit of scapula.

ac′tion. Performance of a function or process.—**reflex a.** An involuntary action of one part of the body, due to an impression on some afferent nerve end-organ; involuntary action of one part of body.

act′ive. Energetic; the reverse of passive.

a-cute′. Rapid, severe; sharp.

Ad′am's apple. A prominence in front of neck made by thyroid cartilage of larynx.

Ad′di-son's disease. A disease involving the suprarenal capsules. [line.

ad-duc′tion. Movement toward median

ad-duc′tor. A muscle that draws an organ or part towards the axis.

a′den. A gland; a bubo.

a-de′ni-a. Hodgkin's disease.

ad-en-i′tis. Inflammation of a gland.

ad′en-oid. Form resembling a gland; glandular.—**a. gland.** Prostate gland.

ad-en-o′ma. A glandular tumor.

ad-he′sion. Union of two surfaces or parts.

ad′i-po-cere. Grave-wax; a waxy substance of decomposition in moist soils.

ad′i-pose. Relating to fat; fatty.—**a. tissue.** Fat cells united by connection tissue. [tion.

ad-i-po′sis. Corpulency; fatty degenera-

ad-o-les′cence. The period between puberty and maturity. [sels.

ad-ven-ti′ti-a. External coat of blood-ves-

ad-ven-ti′tious. Accidental, foreign, or acquired. [power.

ad-y-na′mi-a. Deficiency or loss of vital

ad-y-nam′ic. Asthenic; physically weak; pertaining to adynamia.—**a. fevers.** Accompanied by great asthenia. [air.

a-er-a′tion. Mixture or impregnation with

a-e′ri-al. Pertaining to air; atmospheric.

a-e-ro′bi-a. Bacteria requiring free oxygen.

a-e-ro′bic. Unable to live without oxygen. —**a. bacteria.** Bacteria that are unable to live without air or oxygen.

af-fec′tion. A synonym of disease, as an affection of the lungs. [center.

af′fer-ent. Conducting inward, toward the

af′flux. Flow of blood or liquid to a part.

af-fu′sion. A pouring upon, as water upon the body.

aft′er-birth. The placenta and fetal membranes expelled after a birth.

a′gar-a-gar (or **a-gar.**) A gelatinous substance from algæ, used by bacteriologists as a nutrient solution.

ag-glom'er-ate. Massed together; aggregated. [of wounded edges.
ag-glu-ti-na'tion. A joining together, as
ag'mi-nate. Arranged in clusters; grouped. —**a. glands.** Pyer's patches. [fering.
ag'o-ny. The death struggle; intense suf-
a'gue. Malarial or intermittent fever.
air. The atmosphere.—**a. cells.** An air vesicle.—**a.-passages.** The nares, mouth, larynx, trachea, and bronchial tubes. —**a-pump.** An instrument for producing a
al-bu'men. The white of an egg. [vacuum.
al-bu'min. A proteid substance, the chief constituent of white of an egg. [bumen.
al-bu'min-ate. A basic compound of al-
al-bu-mi-nu'ri-a. The presence of albumin in the urine. [of hydrogen.
al'de-hyde. Alcohol deprived of two atoms
a-leu-ce' (or ke) mi-a. A deficiency of white corpuscles in the blood.
al'i-ment. Nourishment; food.
al'ka-li. An electropositive substance, combining with an acid to form a neutral salt. —**fixed a.** Potassium and sodium hydrate.
al'ka-line. Having the properties of an
al'ka-loid. Resembling alkali. [alkali.
al-lan'to-ic. Relating to the allantois.—**a. circulation.** The fetal circulation through the cord and unbilical vessels. [fetus.
al-lan'to-is. Membrane enveloping the
a-lu'mi-num. A whitish metal, with a low specific gravity.
a-mal-ga-ma'tion. The art or process of forming an amalgam.
am-mo'ni-a. Same as ammonium.—**a. water.** A watery solution of ammonium.
am-mo'ni-um. Hypothetic base of am-
am-ne'si-a. Loss of memory. [monia.
am'ni-on. Inner embryonic membrane.
am-ni-ot'ic fluid. The liquor amnii. [crystal.
a-mor'phous. Formless; structureless; non-
am-phi-ar-thro'sis. Articulation by fibrous tissue or strong ligaments, permitting slight motion. [pertaining to starch.
am-y-la'ce-ous (or am'y-loid). Starch-like;
am'y-loid. Starch-like. [sugar.
am-y-lo-lyt'ic. Converting starch into
am'y-lum. Starch.
an-a-e-rob'ic. Living without air.—**a. bacteria (or an-a-e-ro'bi-a).** Bacteria which flourish without air.
a'nal. Pertaining to the anus.
a-nal'o-gous. Conforming or answering to; bearing analogy or resemblance.
an-a-sar'ca. General dropsy.
a-nas-to-mo'sis. Union or interlacing of arteries, veins, or other vessels; inosculation.
a-nas-to-mot'ic. Pertaining to anastomosis.
an-a-tom'ic. Pertaining to anatomy.
an-a-tom'i-cal. Pertaining to anatomy. —**a. guide.** A muscular or tendinous guide to a vessel.
a-nat'o-my. The science of organic structure.—**human a.** Anatomy of the human body.—**morbid a.** Study of diseased structure.—**visceral a.** Study of the viscera.—**regional a.** Study of the correlated regions of the body. [corpuscles.
an-e'mi-a. Deficiency of blood and red
a-nem'ic. Pertaining to anemia; bloodless.
an-es-the'si-a. A state of insensibility.
an-es-thet'ic. A substance producing anes-
an-eu'ri-a. Lack of nervous power. [thesia.
an'eu-rism. Dilatation of an artery.
an-hy'drous. Destitute of water. [notic.
an'i-lin. A powerful antiseptic and hyp-
an-i-mal'cule. A microscopic organism.
an-i-mal'cu-lum (pl.-la). Some as animal-
an'kle. Joint between foot and leg. [cule.
an-ky-lo'sis. Knitting together of two bones or parts of bones; stiffness of a
an-ky'roid. Hoop-shaped. [joint.
an'nu-lar. Formed like a ring; ring-like.
a-nom'a-lous. Deviating from the ordinary.
a-nom'a-ly. That which is anomalous.
an-o-rex'i-a. Absence or loss of appetite.
an-ox-e'mi-a. Lack of oxygen in blood.
an-te-flex'ion. A bending forward.
an-te-ver'sion. A turning forward.
an'thrax. A carbuncle; the disease produced by the anthrax bacilli.—**a. spores.** Spores of the anthrax bacilli.
an-ti'cus. Anterior; in front of.
an'ti-dote. An agent that counteracts action of a poison. [lic element.
an'ti-mony. A silver-white, hard, metal-
an-ti-sep'sis. The prevention of sepsis.
an-ti-sep'tic. An agent that prevents the growth of bacteria.
an-ti-tox'ic. Opposed to poisoning.
an-ti-tox'in. A substance formed in the body that counteracts poison.
an-ti-zy-mot'ic. Preventive of fermentation or contagion.
a-nu'ri-a. Absence or deficiency of urine.
a'nus. External opening of the rectum.
a-or'ta. The main arterial trunk.
a-or'tic. Pertaining to the aorta.
ap'er-ture. An opening or orifice.
a'pex. Summit or extremity of anything.

ap-ne′a. Breathlessness; difficult, respiration. [a tendon.
ap-o-neu-ro′sis. A fibrinous expansion of
ap-o-neu-rot′ic. Pertaining to aponeurosis. —**a. fascia.** A deep fascia.
ap′o-plex-y. Paralysis from rupture of a cerebral vessel. [organ as a part of it.
ap-pen′dage. That which is attached to an
ap-pen-di-ci′tis. Inflammation of the appendix vermiformis.
ap-pen′dix. An appendage; a prolongation.—**a. vermiformis.** The worm-like attachment to the cecum.
ap-po-si′tion. The act of fitting together.
ap-prox′i-mate. To cause to approach.
a′qua. Water. [duct.
aq′ue-duct. A canal.—**a. of Sylvius.** Tear-
a′que-ous. Pertaining to water; watery. —**a. humor.** A watery substance in the anterior of the eye.
a-rach′noid. Resembling a web; arachnoid membrane.—**a. membrane.** Middle membrane of the brain and spinal cord.
ar′bor-vi′tæ (tree of life). Tree-like figure in a section of cerebellum.
arch. Term applied to various curved portions of body.—**a. of aorta.** Curved part extending from heart to third dorsal ver-
ar′cus. A bow, arch, or ring. [tebra.
a′re-a. Any space with boundaries. [sue.
a-re′o-læ. The interstices in connective tis-
a-re′o-lar. Full of interstices.—**a. tissue.** Connective or cellular tissue.
ar-e-om′e-ter. An instrument for measuring specific gravity of fluids. [cine.
ar-gen′tum. Silver, a metal used in medi-
arm. Upper limb from shoulder to elbow.
arm′pit. Cavity under arm; axillary space.
ar′se-nic. A chemical element of grayish-white color.—**a. acid.** A colorless white crystalline compound.
ar-se′ni-ous ac′id. White arsenic.
ar-te′ri-al. Pertaining to an artery.—**a. blood.** Blood after aeration in lungs.
ar-te-ri-al-i-za′tion. Oxygenation of blood.
ar-te′ri-al-ize. To oxygenate the blood.
ar-te′ri-ole. A small artery.
ar-te-ri′tis. Inflammation of an artery.
ar′ter-y. Vessel carrying blood from heart.
ar-thro′di-a. Joint with gliding movement.
ar-thro′sis. An articulation; a suture.
ar-tic′u-lar. Pertaining to a joint.—**a. la-mel′la.** Articulation of thin scales or plates of bone.
ar-tic-u-la′tion. A joint or an arthrosis.
ar-y-te′noid. Cup or ladle-shaped.—**a. cartilage.** Certain cartilage of the larynx.
as-ci′tes. Dropsy of the abdomen.
a-sep′sis. An absence of septic matter or blood-poisoning. [ease germs.
a-sep′tic. Free from septic matter or dis-
as-phyx′i-a. A condition caused by non-oxygenation of the blood.
as-phyx′i-ate. To bring into asphyxia.
as′pi-rate. To pump out, as blood or effusions from the body. [pumping out.
as-pi-ra′tion. The act of aspirating or
as′pi-ra-tor. An instrument for extracting fluid from the cavities of the body.
as-sim-i-la′tion. The act of absorbing nutriment. [debility; weakness.
as-the′ni-a. A loss of strength; general
as-then′ic. Feeble; without strength.
asth′ma. Paroxysmal dyspnea with oppres-
asth-mat′ic. Affected with asthma. [sion.
as-trag′a-lus. The ankle-bone.
as-trin′gent. An agent producing contracting of organic tissues.
a-tax′i-a. Irregularity in functions of organs; incoördination of muscular action.
ath-e-ro′ma. (1) A soft encysted tumor. (2) Degeneration of arterial walls.
ath-e-ro′ma-tous. Affected with atheroma.
at′las. The uppermost vertebra.
at-mos-pher′ic. Pertaining to the atmosphere.—**a. pressure.** The pressure of 15 lbs. per sq. in. exerted at sea-level in all directions by the atmosphere.
at′om. The ultimate unit of an element.
at′ro-phy. A wasting of a part from lack of nutrition. [tened; a band or tie.
at-tach′ment. That which is held or fas-
at-ten′u-a-ted. Wasted; thinned. [together.
at-trac′tion. Tendency of particles to draw
au′di-to-ry. Pertaining to the organs of hearing.—**a. canal.** Canal of the ear. —**a. nerves.** Nerves of the ear.
au′ral. Pertaining to the ear.
au′ri-cle. (1) The external ear. (2) An upper chamber of the heart.
au-ric′u-lar. Pertaining to the ear.—**a. appendix.** The anterior prolongation of the auricle of the heart.
au-ric-u-lo-ven-tric′u-lar. Pertaining to both the auricle and ventricle.—**a. opening.** Opening between auricle and ventricle.—**a. valve.** Valve guarding the auriculoventricular opening.
au′ris. The external ear.
aus-cult′. To examine by auscultation.

aus-cul-ta′tion. A method of determining the conditions of an organ by listening to the sounds produced by it, as the lungs or heart. [by volition; spontaneous.

au-to-mat′ic. Not affected or controlled

au-ton′o-mous. Independent; self-govern-

au′top-sy. Post-mortem examination. [ing.

aux-il′i-a-ry. Giving aid or support; subsidiary; accessory.

av-oir-du-pois′. Common English system of weight in which 16 oz., equals a pound.

ax-il′la. The armpit.

ax′il-la-ry. Pertaining to the axilla.—**a. glands.** Lymphatic glands of the axilla. —**a. plexus.** The plexus of nerves in the axilla.—**a. space.** The armpit.

ax′is. (1) The second vertebra. (2) An imaginary line through center of body.

az′y-gos. Without a fellow, as a muscle or vein. [and veins.

az′y-gous. Not paired, as certain muscles.

B

bac′il-lar. Resembling little rods or bacilli.

ba-cil′lus (pl.-li). A rod-shaped bacterium; one of the three general forms of bacteria. —**comma b.** (of Koch). A comma-shaped bacterium; the cholera bacillus.

bac-te-ri-ol-o′gist. One versed in bacteriology. [organisms.

bac-te′ri-ol′o-gy. The science of micro-

bac-te′ri-um (pl.-ri-a). Lowest known form of plant life; micro-organism; microbe.

band′age. A narrow strip of muslin or other material for binding wounds, fractures, etc.—**rubber b.** A narrow strip of rubber made into a roll for pressing the liquids out of the subcutaneous tissues or vessels of a part.—**roller b.** Same as bandage.—**Emarck's b.** A rubber webbing used for same purpose as the rubber.

ba-rom′e-ter. An instrument for measuring pressure of the atmosphere.

base. (1) The lower part. (2) Chief substance of a mixture.

base′ment mem′brane. Delicate membrane beneath the epithelium.

ba′sic. (1) Of a nature of a base. (2) Having properties opposed to acid.

bas′i-lar. Pertaining to base, especially of skull.—**b. artery.** Artery at base of brain.

ba-sil′ic. Any important structure or drug. —**b. vein.** The largest vein on the inner side of the arm. [jars or galvanic cells.

bat′ter-y. A series of connected Leyden

bel′ly. Colloquial term for abdomen.

be-nign′. Not malignant; mild.—**b. tumor.** One that does not recur after removal.

be-nig′nant. Same as benign.

ber′i-ber-i. An East Indian infectious disease. [especially the flexor muscle of arm.

bi′ceps. Muscle with two heads or origins;

bi-chlo′rid. A chlorid with twice as much chlorin as a protochlorid.—**b. of mercury.** Mercuric chlorid; corrosive sublimate.

bi-con′cave. Hollow on both surfaces.

bi-con′vex. Rounded on both surfaces.

bi-cus′pid. Having two cusps or points. **b. teeth.** Teeth having two cusps.—**b. valve.** Valve guarding the auriculoventricular opening on left side of heart.

bi-fur′cate. Divided into two branches.

bi-fur-ca′tion. A dividing into two parts.

bi-gas′ter. Having two bellies. [sides.

bi-lat′er-al. Two-sided; pertaining to two

bile. The yellow bitter liquid secreted by the liver.—**b.-cyst.** The gall-bladder. —**b. duct.** See biliary duct. —**b.-pigment.** Coloring-matter of the bile. —**b.-stone.** A calcareous concretion in the gall-bladder and its ducts.

bil′i-a-ry. Pertaining to the bile.—**b. duct.** A duct communicating with the liver.—**b. calculus.** A bile or gall-stone.

bil-i-ru′bin. The orange pigment of bile.

bil-i-ver′din. The green pigment of bile.

bi-lo′bate. Having two lobes.

bi′na-ry. Compounded of two elements.

bi-ol′o-gist. One versed in biology. [things.

bi-ol′o-gy. The science of life and living

bi′ped. Having two feet.

bi-pen′ni-form. Having a resemblance to a quill pen, as a muscle. [urine.

blad′der. The membranous receptacle of

bleach′er. A mixture supposed to restore the normal color, when applied to the surface of a dead body. [chlorinated lime.

bleach′ing pow′der. Disinfectant mixture;

bleb. See Bulla.

blood. The nutrient fluid which circulates in arteries and veins.—**b.-cell.** A blood-corpuscle.—**b.-clot.** A coagulum.—**b.-corpuscle.** Cellular elements of blood; blood-cells.—**b.-crystals.** Crystals of hematoidin.—**b.-disk.** A red blood-corpuscle.—**b.-fibrin.** The nitrogenous proteids which coagulate in exposed blood.—**b. plasma.** Fluid portion of blood.—**b.-poisoning.** The absorption of toxins into the blood. —**b.-serum.** Fluid constituent of blood. **b.-vessels.** Vessels which carry blood.

blow′pipe. A short tube used to direct a pencil of flame. [work of the body.
bone. The hard tissue forming the frame-
bo′rax. Sodium diborate; used as an anti-
bow′el. The intestine. [septic.
brach′i-al. Pertaining to the arm.—**b. artery.** A continuation of the axillary artery.—**b. glands.** Lymphatics of the arm.—**b. veins.** Those that accompany the brachial artery within its sheath. [bow.
brach′i-um. The arm from shoulder to el-
brain. Contents of cranium, especially the cerebrum.—**b. fever.** Inflammation of the brain or its membranes; meningitis.
breast. The upper anterior part of the trunk.—**b.-bone.** The sternum.
brim. An edge or margin.—**b. of pelvis.** Boundary of superior strait of pelvis.
Bright's disease. Disease of the kidneys first described by Dr. Bright, of London.
bro′mate. A salt of bromic acid.
bro′mid. A basic salt of bromin.
bro′min. A reddish-brown liquid, very poisonous escharotic, giving off a suffocating vapor.
bron′chi-a. The bronchial tubes that divide and subdivide in the lungs.
bron′chi-al. Pertaining to the bronchi.—**b. tube.** A bronchus. [tubes.
bron′chi-ole. The most minute bronchial
bron-chi′tis. Inflammation of the bronchial tubes.
bron′cho-cele. Morbid enlargement of the thyroid gland; goiter. [of trachea.
bron′chus (pl.-chi). One of main branches
bu′bo. An inflammatory swelling of a lymphatic gland, due to infection.
bu-bon′ic. Pertaining to bubo.—**b. plague.** A contagious, epidemic disease with fever, delirium, and buboes. [mouth.
buc′ca. The hollow part of the cheek; the
buc′cal cavity. Cavity of the mouth.
buc′cin-a-tor. A thin, flat muscle of the cheek. [oblongata and pons.
bulb. An expansion of a canal or vessel; the
bul′la. A large bleb or blister; inflated portion of bony external meatus of ear.
burn. To cauterize; to decompose by fire; to become inflamed. [force a way through.
bur′row. To make a hole or furrow; to
bur′sa. A pouch or sac; a small sac interposed between movable parts.—**b. mu-co′sa.** A membranous sac secreting synovial
bur′sal. Pertaining to a bursa. [fluid.
but′tocks. The nates; rumps.

C

ca-chec′tic. Characterized by cachexia.
ca-chex′i-a. A depraved condition of nutrition; malnutrition.
ca-da′ver. The dead body; corpse.—**c. rigidity.** Rigidity after death; rigor mortis.
ca-dav′er-ous. Resembling a dead body.
cal-ca′re-a. Lime.
cal-ca′re-ous. Having the nature of lime.—**c. degeneration.** A deposit of lime-salts
cal-cif′ic. Forming lime. [in a part.
cal-ci-fi-ca′tion. The deposition of lime-salts in the tissues.
cal′ci-um. A metal, the basis of lime.—**c. phosphate.** The phosphate of lime.
cal′cu-lus. A stone-like concretion formed in the body.—**arthritic c.** A gouty concretion.—**biliary c.** A gall-stone.—**nephritic c.** A stone formed in the kidney.—**urinary c.** A stone-like concretion in urine.
cal′i-ber. The internal diameter of a tube.
cal-lo′sum. The corpus callosum.
cal′lous. Hard; indurate.
cal′o-mel. A mercuric chlorid or mild chlorid of mercury; a purgative.
ca-lor′ic. Pertaining to heat or its principle.
cal-va′ri-um. The skullcap.
calx. (1) The heel. (2) Lime or chalk.
camp fever. A synonym of typhus fever.
cam′phor-a-ted. (1) To impregnate with camphor. (2) A salt of camphoric acid.
ca-nal′. A tube for carrying fluids of the body.—**alimentary c.** The whole digestive tube from the mouth to the anus.—**Ha-ver′sian c.** One of the numerous channels for capillary blood-vessels in bone substance.—**Hunter's c.** The sheath of the femoral vessels behind Poupart's ligament.—**nasal c.** A canal in the nasal bone for the transmission of the nasal nerves.—**spinal c.** A canal formed by the vertebræ for the transmission of the spinal cord. [in a bone.
can-a-lic′u-lus. A small canal or tube, as
can-cel′li. The divisions of the interior of bone. [duction of epithelial cells.
can′cer. A malignant tumor, with the pro-
can′cer-ous. Of the nature of a cancer.
can′ker. Any ulcerous sore with a tendency to gangrene.
can′tha-ris (pl.-i-des). Spanish fly; dried and powdered beetle (Cantharis vesicatoria)
cap′il-la-ry. A minute blood-vessel, like a hair.—**c. attraction.** The force that

causes fluids to rise in fine tubes or interstices.—**c. circulation.** Circulation of blood through the capillaries.—**c. repulsion.** Repelling the blood from the capil-

cap′su-lar. Pertaining to a capsule. [laries.

cap′su-late. To enclose in a capsule.

cap′sule. A membranous sac enclosing a part. **Mal-pi′ghi-an c.** A membrane enclosing the Malpighian bodies.—**supra-renal c.** A small, flat body on the upper

cap′ut. The head. [side of the kidney.

car-bo-hy′drate. A compound of carbon with hydrogen and oxygen.

car′bo-la-ted. Carbolized.

car-bol′ic ac′id. Phenol from coal-tar.

car′bon. A non-metallic substance, occurring in the forms of diamond graphite and charcoal.—**c. dioxid.** Carbonic acid gas.

car-bo-na′ceous. Pertaining to or yielding carbon. [and a base.

car′bon-ate. A compound of carbonic acid

car-bon′ic. Pertaining to or obtained from carbon.—**c. acid.** Carbon dioxid, or the gaseous impurity in venous blood.—**c. oxid.** A poisonous gas formed by the combustion of charcoal. [closed in a box.

car′boy. A large globular glass bottle en-

car-ci-no′ma. A cancer, which see.

car′di-ac. Pertaining to the heart.

car-di′tis. Inflammation of the heart.

ca′ri-es. Ulceration and decay of a bone. —**c. of the spine.** Inflammation of the spinal column.

ca-rot′id. Principal artery of neck.

car′pal. Pertaining to the carpus or wrist.

car′pus. The wrist; the wrist-joint.

car′ti-lage. Gristle; a non-vascular, elastic tissue, softer than bone.—**articular c.** That lining the articular surface of bones.

car-ti-lag′i-nous. Of the nature of cartilage. [for mummies.

car′ton-nage. The material used as casing

car-touche′. An oblong figure, with rounded ends, containing the name of a king, queen, or deity.

ca′se-in. The clotted proteid of milk.

cast. A mass of plastic matter having form of the cavity in which it has been molded.

cat′a-lep-sy. Nervous condition associated with loss of will and muscular rigidity.

ca-tarrh′. Inflammation of a mucous membrane.—**epidemic c.** Influenza.

ca-thar′tic. A purgative medicine.

cath′e-ter. A slender tube for introduction into canals or passages.

cau′da. A tail, or tail-like appendage.—**c. equina.** The fibrous termination of the spinal cord. [like process of the liver.

cau′date. Having a tail.—**c. lobe.** The tail-

cau′dex cer′e-bri. The crura cerebri. [iron.

caus′tic. An escharotic. [drug or heated

cau′ter-ize. To burn or sear with a caustic

ca′va. One of the large veins of the body.

ca′val. Hollow; pertaining to a cave.—**c. opening.** The opening in the diaphragm for the inferior vena cava.

cav′ern-ous. Having hollow places.

cav′i-ty. A hollow space within a body or thing.

ce′cal. Pertainng to the cecum. [testine.

ce′cum. Blind pouch at head of large in-

ce′li-ac. Pertaining to the abdomen.—**c. artery.** An artery of the belly.—**c. axis.** A branch of the abdominal aorta.

ce-li′tis. Inflammation of abdominal or-

cell. A small protoplasmic mass. [gans.

cel′lu-lar. Composed of cells.—**c. tissue.** Areolar or connective tissue. [sue.

cel-lu-li′tis. Inflammation of cellular tis-

cel′lu-lose. The predominating element of plant-tissue. [root and neck of a tooth.

ce-ment′. The bony substance covering the

cen′ti-grade. Having 100 degrees.—**c. ther-mom′e-ter.** A thermometer with 100 degrees as the boiling-point of water and zero as the freezing-point.

cen′ti-gram. Hundredth part of a gram.

cen′ti-li-ter. Hundredth part of a liter.

cen′ti-meter. Hundredth part of a meter.

cen-trif′u-gal. Receding from center.

cen-trip′e-tal. Tending toward center.

cen′trum. Center or middle part.—**c. tendinosum.** With the tendon in the center

ce′ra. Wax. [or the middle part.

ce-ra′ceous. Of the nature of wax; waxy.

cer-e-bel′lar. Pertaining to the cerebellum.

cer-e-bel′lum. The principal organ of the central nervous system; the inferior and posterior part of the brain.

cer′e-bral. Relating to the cerebrum or brain.—**c. softening.** Sometimes of brain.

cer-e-bro-spi′nal. Relating to the brain and spinal cord.—**c. axis.** The brain and cord. **c. fever,—c. meningitis.** Inflammation of the membranes of brain and cord; spotted fever.—**c. system.** The nervous system, including brain and spinal cord, and nerve-branches given out from them.

cer′e-brum The upper and anterior part of the brain, constituting its chief portion; the seat of thought and will.

cere′cloth. A cloth coated or saturated with wax or cerate, used as a wrapping or winding-sheet for the dead.

ce-ru′men. The ear-wax.

cer′vi-cal. Pertaining to the neck.

cer′vix. The neck, especially the back part.

chalk. Carbonate of lime.

cham′ber. A hollow or cavity. [ulcer.

chan′cre. The primary or hard syphilitic

chan′nel. A furrow or groove.

chem′is-try. The science of molecular and atomic structures of bodies.

chem′ic-al. Pertaining to chemistry.—**c. elements.** That form of matter which cannot be decomposed by any means known to science.—**c. analysis.** The resolution of a compound into its parts or elements, including quantitative as well as qualita-

chem′ist. One versed in chemistry. [tive.

chest. The thorax; upper portion of trunk.

chi′asm. A crossing; the optic commissure.

chlo′ral. A colorless crystalline solid.—**c. hydrate.** A hydrochlorate. [radical.

chlo′rid. A compound of chlorin and a

chlo′rin. A non-metallic gaseous element.

chlo′ro-form. A heavy, colorless, volatile liquid compound, used as an anesthetic.

chol′e-doch. Carrying bile.—**c. duct.** The bile duct that opens into the duodenum.

chol′er-a. An infectious disease caused by the presence of the Spirillum choleræ Asiaticæ.—**Asiatic c.** A malignant form of cholera; epidemic cholera.—**c. infantum.** Summer complaint.—**c. morbus.** Sporadic cholera.

cho′ri-on. The outer envelop of the fetus.

cho′roid. The second or vascular tunic of the eye.—**c. coat or membrane.** The choroid.—**c. plex′us.** Fold of membrane near lateral ventricles of brain. [acute.

chron′ic. Long continued; the reverse of

chyle. The nutritive, milky fluid of intestinal digestion.

chy-lif′er-ous. Transmitting chyle. [food.

chy-li-fi-ca′tion. Chyle-formation from

chy-lo-poi-et′ic. Chyle-producing.—**c. organs.** Chyle-producing organs.

chyme. Food that has undergone gastric but not intestinal digestion. [cicatrix.

cic-a-tri′cial. Resembling or forming a

cic′a-trix (pl.-**tri-ces**). A scar or mark of a

cic-a-tri-za′tion. Process of healing. [wound

cic′a-trize. To heal, to promote healing, as of a wound or ulcer.

cil′i-a (pl. of **cil′i-um**). The eyelashes; hairlike processes of certain cells.

cil′i-a-ry. Pertaining to the cilia.—**c. body.** The ciliary muscles and processes.—**c. ganglion.** The ganglion of the apex of the orbit.—**c. muscle.** The muscle of accommodation of the eye.—**c. process.** Circularly arranged folds of the choroid, continuous with the iris in front.

cir′cle of Wil′lis. An arterial anastomosis at base of brain, between terminal branches of carotid and basilar arteries.

cir-cu-la′tion. Passage of blood through the body.—**collateral c.** Passage of blood through secondary channels after closing of the principal route.—**fetal c.** That of the fetus.—**portal c.** Passage of blood from the digestive organs into and through the liver and its exit by the hepatic veins.—**placental c.** Same as fetal C.—**pulmonary c.** Passage of blood through the lungs for purification.—**systemic c.** Passage of blood through all the tissues of the body for their nourishment.—**vi-tel′line c.** That of carrying oxygen and nutriment to the embryo.

cir′cu-la-to-ry. Pertaining to the circulation.—**c. system.** The system of vessels through which the blood circulates.

cir-cum-duc′tion. Continuous circular movement of an extremity.

cir′cum-flex. Surrounding, as a vessel or nerve; winding. [ing, or winding.

cir-cum-flex′ion. The act of bending, curv-

cir-cum-scribed′. Clearly defined, as an abscess. [tissue of an organ.

cir-rho′sis. Thickening of the connective

clav′i-cle. The collar-bone.

cla-vic′u-lar. Pertaining to the clavicle.

clei-do-cos′tal. Pertaining to the ribs and clavicle. [and mastoid process.

clei-do-mas′toid. Pertaining to the clavicle

clo′sure. A closing or shutting up.

clot. See Coagulum.

co-ag-u-la-bil′i-ty. Producing coagulation.

co-ag′u-late. To change a liquid, as blood or milk, into a clot or jelly. [ting.

co-ag-u-la′tion. A clotting; the act of clot-

co-ag′u-lum. A clot or mass of thickened

co-a-lesce′. Grow or come together. [blood.

co-a-les′cence. Union of two or more parts.

co-ap-ta′tion. Adjustment of the edges of fractures or of parts.

coc′cus. (pl.-**ci**). A spherical bacterium; synonym of micrococcus.

coc-cyg′e-al. Pertaining to the coccyx.

coc'cyx (pl.-**cy-ges**). Last bone of the spinal column. [ternal ear.

coch'le-a. One of the passages of the in-

co-he'sion. Act or condition of cohering;

co-li'tis. Inflammation of colon. [union.

col-lapse'. Failure of the vital powers.

col'lar-bone. The clavicle.

col-lat'er-al. Accompanying; aiding.—**c. circulation.** See Circulation, Collateral.

col-lo'di-on. A dressing for wounds, made by dissolving guncotton in ether.

co'lon. Principal part of the large intestine.

col'or. A pigment.—**c. matter.** That which

col'umn. A rod or pillar. [imparts color.

co'ma. An abnormally deep sleep; stupor.

co'ma-tose. In a condition of coma. [tion.

com-bus'tion. Process of burning or oxida-

com'ma ba-cil'lus. A bacillus shaped like a comma, found in cholera patients.

com'mis-sure. A bridge-like structure uniting two contiguous similar parts.

com-plex'ion. Color or hue and appearance of skin. [ditions.

com-pli-ca'tion. Interaction of morbid con-

com-po-si'tion. Constituents of a mixture.

com'press. Folded cloths for local pressure.

con'cave. Presenting a hollow incurvation.

con'cha. The outer ear; the turbinated bone.

con-cre'tion. A calculus; an osseous deposit; abnormal union of adjacent parts.

con'dyle. An enlarged and prominent end of a bone, as the femur.

con-fine'ment. The period of parturition.

con'flu-ent. Running together, as smallpox pustules.

con-gen'i-tal. Existing from birth; innate.

con-gest'ed. Hyperemia; morbidly engorged with blood.

con-ges'tion. Hyperemia of a part.

con-glom'er-ate. Massed together, as glands.

con'i-cal. Cone-shaped.

con-junc-ti'va. Mucous membrane of eye.

co'noid. Conic; of form of a cone.

con-stit'u-ent. Forming a necessary part. **c. element.** One of the elements of which the body is composed.

con-sti-tu'tion-al disease. Inherited diseases; those that pervade the whole system.

con-strict'. To draw together in one part.

con-ta'gion. Communication of disease from person to person by direct or indirect contact. [(2) Transmitting disease.

con-ta'gious. (1) Transmissible by contact.

con-ta'gi-um. Septic matter by which contagious disease is communicated.

con-tort'ed. Twisted. [contagion.

con-tract'. To draw together; to acquire by

con-tract'ile. Having the power to contract.

con-trac'tion. Act of contracting or state of being contracted.

con-tuse'. To bruise. [blunt body.

con-tu'sion. A bruise from a blow by a

con-va-les'cence. Period of recovery after disease. [gether toward a common focus.

con-ver'gence. An approaching near to-

con-ver'gent. Tending to a point, as lines.

con'vo-lu-ted. Folded together; intricate.

con-vo-lu'tion. A folding upon itself of any organ. [traction; a spasm or fit.

con-vul'sion. A violent involuntary con-

co-or'di-nate. Harmonious action, as of

cop'per. A reddish brown metal. [muscles.

cop'per-as. Sulphate of iron; green vitriol.

cor'a-coid. Shaped like a crow's beak.—**c. process.** A process of the scapula.

cor'date. Heart-shaped.

cord, um-bil'i-cal. The navel cord. [ma.

co'ri-um. Deep layer of the cutis; the der-

cor'ne-a. Transparent front part of eyeball.

cor-nic'u-la lar-yn'gis. Small cartilaginous nodules of the larynx.

cor'nu. A horn-shaped process.

cor'o-na-ry. Encircling, as a vessel or nerve. —**c. arteries.** Those supplying the heart substance.—**c. sinus.** A passage for blood into right auricle—**c. valve.** Valve guarding opening of coronary sinus.

cor'o-noid. Beak-like.

cor'por-a. Plural of Corpus.

corpse. A cadaver; a dead body.

cor'pu-len-cy. Obesity.

cor'pus. A body; the human body; main or chief portion of an organ—**c. cal-lo'-sum.** A hard body uniting the cerebral hemispheres.—**c. fim-bri-a'tum.** The lateral thin edge of the tænia hippocampi.

cor'pus-cle. A minute body; a cell.

cor-re-la'tion. Reciprocal relation.

cor-rode'. To eat away gradually. [degrees.

cor-ro'sion. Eating away of a part by slow

cor-ro'sive. Having the power of corroding.—**c. alkali.** Alkaline chemicals that eat away a part—**c. poison.** One that eats away the mucous membrane when taken internally.—**c. sublimate.** Bichlorid of mercury.

cor-ro'sives. Agents that corrode.

cor'tex. Outer layer of an organ, as cortex

cos'tal. Pertaining to the ribs. [of brain.

Cor'ti-an fibers. Those discovered by Corti.

cor'ti-cal. Pertaining to a cortex.—**c. substance.** Outer or investing layer of organ.
cor-y'za. Catarrhal inflammation of the [nose.
cos'ta. Rib or rib-like structure
cos'tal. Pertaining to the ribs.—**c. spaces.** Spaces between the ribs. [and vertebræ.
cos-to-ver'te-bral. Pertaining to the ribs
cot'y-loid. Cup-shaped.
cra'ni-al. Pertaining to the cranium.
cra'ni-um. The skull.
cras-sa-men'tum. A clot, as of blood. [cle.
cre-a'tin. Nitrogenous constituent of mus-
cre-ma'tion. Burning of the dead body.
cre'o-sote. An oily liquid obtained from the distillation of wood-tar.
cres-cen'tic. Moon-shaped.
crest. Upper part of an organ.—**c. of the ilium.** Expanded upper border of ilium.
crib'ri-form. Shaped like a sieve.—**c. plate.** Perforated plate of ethmoid bone.
cri'coid. Ring-like.—**c. cartilage.** Ring-like cartilage of larynx.
croup. Inflammation of the trachea, with membranous deposits. [bar pneumonia.
croup'ous pneu-mo ni-a. Same as acute lo-
cru'ra. Plural of crus. [Poupart's ligament.
cru'ral. Pertaining to the crura.—**c. arch.**
crus. The leg; a leg-like structure.—**c. cerebelli.** Peduncles of cerebellum.—**c. cerebri.** Peduncles of cerebrum.
crypt. A small sac or follicle in skin or mucous membrane.—**c. of Lie'ber-kuhn.** Those in small intestine.
crys-tal-line. Like a crystal; transparent. —**c. lens or humor.** Transparent lens of eye.
cul-de-suc'. A sac-like cavity or passage without an outlet.—**Douglas's c.** A prolongation of peritoneum into pelvis.
cul'ture. Propagation of germs in suitable fluids or other media.—**c. media.** Substance for cultivating bacteria.
cu'ne-i-form. Wedge-shaped.
cu-ta'ne-ous. Pertaining to the skin.
cu'ti-cle. The epidermis or scarf-pin.
cu'tis. The derma or true skin.—**c. vera.** The corium.
cusp. Pointed crown of a tooth.
cy'a-nosed Affected with cyanosis.
cy-a-no'sis. Blue discoloration of the skin.
cy-lin'dric-al. Pertaining to or in form of
cyr-to'sis. Curvature of spine. [a cylinder.
cyst. Any membranous sac or vesicle; any abnormal sac containing fluid.
cyst'ic (1) Pertaining to a cyst; encysted. (2) Relating to urinary bladder or gall-bladder.—**c. duct.** Duct of gall-bladder.

D

dac'tyl. A digit of the hand or foot.
death. Cessation of life.—**molecular d.** Death of individual cells.—**d.-rate.** The annual mortality per 1,000.—**d.-rattle.** The gurgling sound in the throat of dying persons.—**somatic d.** Death of the whole
dec'a-gram. Ten grams. [organism.
dec'a-li-ter. Ten liters, equals 10,567 quarts.
dec'a-me-ter. Ten meters.
de-cay'. Putrefactive change.
de-ceased'. Dead. [the fetus in utero.
de-cid'u-a. The membraneous envelop of
de-cid'u-ous. Shedding; falling off.
dec'i-gram. One-tenth of a gram; 1.54 Troy grains.
dec'i-li-ter. One-tenth of a liter; 3.38 fluid
dec'i-met-er. One-tenth of a meter. [ounces.
de-cline'. Gradual decrease or wasting a-
de-col-or-a'tion. Removing of color. [way.
de-com-pose'. To separate into constituent parts or elements.
de-com-po-si'tion. The act of separating the constituent elements of a body.
def-e-ca'tion. Evacuation of the bowels.
de-fect'. An imperfection; absence of a part
de-fi'bri-nate. To free from fibrin. [or organ.
de-fi-bri-na'tion. The removal of fibrin from the blood or lymph. [course.
de-flect'. To turn or bend from a straight
de-gen'er-ate To decline in character; become worse or inferior.
de-gen-er-a'tion. Deterioration in structure of a tissue or organ.—**amyloid d.** Starchy infiltration of tissues.—**carcareous d.** Deposit of lime in a part.—**colloid d.** Jelly-like disorganization.—**fatty d.** Conversion of a tissue or organ into fat.
deg-lu-ti'tion. Act or power of swallowing.
de-hy-dra'tion. The removal of constitutional water from a salt. [ments.
de-jec'ta. Discharges from bowels; excre-
de-jec'tion. (1) Despondency. (2) A discharge of fecal matter; excrement.
del-i-ga'tion. Application of a ligature.
de-lir'i-um. Mental aberration due to disease.—**d. tremens.** Mental aberration due to alcohol poisoning.
de-liv'e-ry. Parturition; child-birth.
del'toid. Delta-shaped; the deltoid muscle.
de-men'ti-a. Profound mental incapacity.
den'tate. Toothed; notched. [teeth.
den-tic'u-late. Furnished with minute
den'tin. Bony structure of teeth.
den'toid. Shaped like a tooth.

de-nude′. To lay bare. [offensive odors.
de-o′dor-ant. An agent that will destroy
de-o′dor-ize. To free from odor.
de-ox′y-gen-ate. To deprive of oxygen.
de-pend′ent. Hanging down; pendent.
de-ple′tion. Diminishing the fluid of body.
de-pos′it. A sediment. [process.
dep-u-ra′tion. Purification; a cleansing
der′ma (or **derm**). The true skin.
der′ma-toid. Like the skin.
der′mis. Same as Derma.
des′ic-cant. Drying; a drying agent.
des-ic-ca′tion. The process of drying.
des-qua-ma′tion. Scaling of cuticle. [sever.
de-tach′. To separate from another; to
de-tri′tion. Wearing or wasting of a part.
de-vel′opment. Progression toward maturity. [normal.
de-vi-a′tion. A turning aside from the
dex′ter. Right; on the right side.
dex′trin. A soluble gummy substance obtained from starch.
dex′trose. A sugar of the glucose group.
di-a-be-tes. A disease characterized by an excessive flow or urine.
di-ag-nose′. To make a diagnosis.
di-ag-no′sis. Recognition or determination of a disease from its symptoms. [an object.
di′a-gram. A figure giving the outlines of
di-al′y-sis. The separation of parts.
di-am′e-ter. A straight line passing through the center of a body or figure.
di′a-phragm. Muscular wall between thorax and abdomen. [of bowels.
di-ar-rhe′a. Morbidly frequent evacuation
di-ar-rhe′al. Of the nature of diarrhea.
di-ar-thro′sis. A freely movable articulation. [dilatation of the heart.
di-as′to-le. Period of regular expansion or
di-ath′e-sis. Constitutional predisposition
di-e-tet′ic. Pertaining to diet. [to disease.
dif-fer-en-ti-a′tion. A specialization of tissues, organs, or functions.
dif-fuse′. Scattered or spread about.—**d.** inflammation. Inflammation throughout all tissues of an organ.
di-gas′tric. Having two bellies. [or chyle.
di-ges′tion. Conversion of food into chyme
di-gest-ive. Pertaining to or aiding digestion.—**d. organs.** Organs in which digestion is accomplished.
dig′it. A finger or toe.
dig′i-tal. Pertaining to the fingers or toes.
di-la-ta′tion. Expansion of a vessel or organ.
dil′u-ent. An agent increasing fluidity.
di-lute′. To weaken.
di-lu′tion. A weakening with water or some other fluid.
dim-in′ish. To lessen, to reduce.
dim-i-nu′tion. Act of diminishing.
diph-the′ri-a. An acute infectious disease caused by the diphtheretic bacillus.
dip-lo-coc′cus. A micrococcus whose spherules are joined two and two. [nial tables.
dip′lo-e. Cellular bony tissue between cra-
di-plo′ic. Pertaining to the diploe.
dip-so-ma′ni-a. An uncontrollable desire for spiritous liquors. [a knife or trocar.
di-rect′or. A grooved instrument to direct
dis-charge′. A morbid secretion.
dis′coid. Shaped like a disc.
dis-col-or-a′tion. A strain; a discolored spot or part.—**post-mortem d.** A dark or bluish color of the back after death.
dis-ease′. A morbid condition of the body. —**acute d.** Marked by rapid onset and course.—**constitutional d.** One that affects a system of organs or the whole body. —**chronic d.** One that is slow in its course. —**contagious d.** One that is communicated by contact.—**idiopathic d.** Spontaneous; one that is not dependent on another. —**infectious d.** One that is produced by pathogenic germs.—**organic d.** One due to structural changes in the organ affected. —**septic d.** One due to pyrogenic or putrefactive germs within the body.—**specific d.** One due to a specific virus or poison within the body.—**wool-sorters' d.** Anthrax.—**zymotic d.** A term for the whole class of germ diseases.
dis-in-fect′. To free from infection.
dis-in-fect′ant. An agent that will destroy germs. [matter.
dis-in-fec′tion. Purification from infectious
dis-in-fec′tor. An apparatus for disinfecting; one who disinfects. [ponent parts.
dis-in-te-gra′tion. Act of reducing to com-
dis-in-ter′. Exhume; disintomb.
dis-lo-ca′tion. A displacement of organs or articular surfaces. [ganic structure.
dis-or-gan-i-za′tion. A destruction of or-
dis-sect′. To separate the parts.
dis-sec′tion. A separating by cutting of parts of the body.—**d. wound.** A wound received by instruments while dissecting.
dis-sem′i-nate. To scatter. [ease germ.
dis-sem-i-na′tion. A scattering, as of dis-
dis-so-lu′tion. Death; process of dissolving.
dis-solv′ent. A solvent; resolvent.
dis′tal. Peripheral; from the center.—**d. end.** Farthest from center.

dis-tend′ To expand; lengthen.

dis-til-la′tion. Vaporization of liquid with subsequent condensation.

di-vi′sion. To divide; divided into parts.

dor′mant. Torpid; resembling sleep.

dor′sal. Pertaining to the back.

dor′sum. The back; posterior part.—**d. of the tongue.** Back part of tongue.

Doug-las's cul-de-sac′. See Cul-de-sac.

drachm (or **dram**). A weight of sixty grains.

drain′age. Gradual removal of liquid from a cavity by gravitation through a tube.

drop′si-cal. Pertaining to dropsy.

drop′sy. Effusion of fluid into the tissues or cavities of body.

drown′ing. Suffocation in water or other liquids.

drum (of the ear). The tympanum.

duct. A tube to convey a liquid.—**bile d.** See Bile Duct.—**cystic d.** Excretory duct of gall-bladder.—**hepatic d.** One receiving bile from liver.—**lachrymal d.** Conveys tears to lachrymal sac.—**lymphatic d.** Conveys lymph to right subclavian vein.—**nasal d.** Conveys tears from lachrymal sac.—**salivary d.** Conveys saliva from salivary glands.—**Stenson's d.** Conveys saliva secretion of parotid gland to mouth.—**thoracic d.** Conveys chyle to left subclavian vein.

ducts of Ri-vi′ni-us. Salivary ducts from sublingual gland.

duc′tus. A canal or duct.—**d. arteriosis.** Continuation of pulmonary artery in fetus.—**d. communis choledochus.** See Choleduch Duct.—**d. venosus.** A fetal blood-vessel that joins umbilical vein to the ascending vena cava.

du-o-de′nal. Pertaining to duodenum.

du-o-de′num. First part of small intestine.

du′pli-ca-ture. A doubling.

du′ral. Relating to the dura.

du′ra ma′ter. The dense hard covering of the brain.

dy-nam′ic. Pertaining to motion as the result of force.

dys′en-ter-y. Inflammation of rectum and colon with bloody discharges.

dys-pep′si-a. Impaired digestion.

dys-pne′a. Difficult or labored breathing.

E

ear. Organ of hearing—**e.-drum.** See Tympanum.—**e.-wax.** See Cerumen.

eb-ul-li′tion. Boiling.

ec-chy-mo′ma. A skin tumor caused by extravasated blood.

ec-chy-mo′sis. Extravasation of blood into areolar tissue.

ec-chy-mot′ic. Pertaining to ecchymosis.

ec′to-blast. Outside membrane of a cell.

ec-to-zo′a. External parasites.

ec-trot′ic. Preventing development of disease.

ec-ze′ma. Inflammation of skin with exhalation of lymph.

e-de′ma. Accumulation of serum in cellular tissue.

e-dem′a-tous. Relating to edema.

ef-fete′. Worn out; sterile; barren.

ef′fer-ent. Conveying from the center, as a nerve.

ef-flo-res′cence. Redness of skin; rash.

ef-fu′sion. Extravasation of blood into tissues or cavities.

e-ges′ta. Excreta; discharges from the bowels.

e-las′tic. Having elasticity.—**e. tissue.** That which stretches.

e-las-tic′i-ty. Property of stretching and retracting.

el-bow. Articulation of arm and forearm.

el′e-ments. The ultimate constituents.

el-e-men′ta-ry. Pertaining to element.

el′e-va-tor. A muscle lifting a part.

e-lim′i-nate. To remove; cast out.

e-lim-i-na′tion. Act of casting out; excretion.

e-ma-ci-a′tion. A loss of flesh; leanness.

em′a-nate. That which proceeds from a body; to give out, diffuse, shed.

em-balm′er. One who embalms the dead.

em-balm′ing. Filling of a body with a preservative and disinfectant fluid.—**arterial e.** Filling of all the tissues in which there are capillaries with fluid—**cavity e.** Filling of cavities with fluid—**cranial e.** Filling of tissues by injecting into the cranial cavity.—**e. fluid.** Fluid composed of antiseptics and disinfectants.—**e. needle.** A hollow-needle used to penetrate the walls of cavities for cavity embalming.

em-balm′ment. The act of embalming.

em′bo-le (or **em′bo-lus**). A blood-clot obstructing a vessel.

em′bo-lism. Obstruction of a blood-vessel by an embolus.—**miliary e.** A state in which many small blood-vessels are the seats of embolism.

em′bry-o. A fecundated germ up to fourth month.

em′i-nence. A protuberance or process.

e-mis′sion. A sending forth.

em-py-e′ma. Pus in the pleural cavity.

e-mul-si-fi-ca′tion. The process of forming an emulsion; last stage of fatty degeneration.

e-mul′sion. A milky fluid obtained by suspending oil in water.

en-am el. Hard substance enveloping crown of tooth.

en-ceph′a-lon. The brain tissue.

en-cyst′ed. Enclosed in a sac or cyst.

en-do-ar-te-ri'tis. Inflammation of intima of an artery.

en-dem'ic. Peculiar to or prevailing in or among some countries or people; circumscribed.—**e. disease.** Not epidemic. [heart.

en-do-car-di'tis. Inflammation of lining of

en-do-car'di-um. The endothelial lining membrane of the heart.

en-do-cra'ni-um. The dura mater.

en'do-derm. Inner germ-layer of embryo.

en-dos'te-um. The lining membrane of the medullary cavities of the bones.

en-do-the'li-al. Pertaining to endothelium.

en-do-the'li-um. Lining membrane of vascular and serous cavities.

en'er-gy. Power or force of organism.

en-gorge.' To fill with blood.

en-gorge'ment. Vascular congestion.

en-sheathed'. Within a sheath. [phoid fever.

en-ter'ic fever. Inflammation of bowels; ty-

en-ter-i'tis. Inflammation of intestines.

en-ter-o-co-li'tis. Inflammation of small and large intestines.

en'ter-o-lith. A stone in intestines.

en'trails. The intestines.

en-vel'op. To enclose. [envelops.

en-vel'op-ment. A covering; that which

ep-idem'ic. A prevailing disease not confined locally.

ep-i-der'mis. Outer layer of skin; cuticle.

ep-i-gastric. Pertaining to epigastrium. —**e. region.** The epigastrium.

ep-i-gas'trium. Region over stomach

ep-i-glot'tis. A thin cartilaginous plate over the larynx.

ep'i-lep-sy. A nervous disease with loss of consciousness and tonic and clonic con-

ep-i-lep'tic. Relating to epilepsy. [vulsions.

ep-i-the'li-al. Pertaining to the epithelium. **e. cells.** Cells in the epithelium. —**e. tissue.** Same as epithelium.

ep-i-the'li-um. External layer of skin and minute layer lining alimentary canal.

e-ro'sion. An eating away by corrosive agents or ulceration. [ease.

e-rup'tion. A breaking out, as in skin dis-

e-rup'tive fevers. Fevers characterized by an eruption. [by infection.

er-y-sip'e-las. A disease of skin produced

e-ry-the'ma. A superficial flush or redness of the skin.—**e. no-do'sum.** An inflammatory form marked by elevated nodules.

es'char. A dry slough or crust of dead

es-cha-rot'ic. Producing an eschar. [tissue.

e-soph-ag'e-al. Pertaining to esophagus.

e-soph'a-gus. Tube leading from pharynx to stomach, through which food is taken.

es-sen'tial oil. Volatile or distilled oil from odoriferous vegetable substances.

e'ther. Subtle fluid filling all space.

eth'moid. Like a sieve; sieve-bone.

e-ti-o-log'i-cal. Pertaining to etiology.

et-i-ol'o-gy. Science of causes of disease.

Eu-sta'chi-an. Pertaining to Eustachian tube or valve.—**E. canal.** A passage in temporal bone for Eustachian tube.—**E. tube.** Passage from middle ear to pharynx. —**E. valve.** A fold of membrane in the right auricle of heart in fetus. [bowels.

e-vac-u-a'tion. Defecation; emptying the

e-ver'sion. A turning backward or inside

e-vis'cer-ate. The act of evisceration. [out.

e-vis-cer-a'tion. Removal of the viscera.

ev-o-lu'tion. Process of developing from a simple to a complex, specialized, perfect form. [ing away of a part.

e-vul'sion. A plucking out; forcible tear-

ex-ac-er-ba'tions. Increased severity of symptoms.

ex-co-ri-a'tion. Abrasion of epidermis.

ex'cre-ment. The feces.

ex-cre-men-ti'tious. Pertaining to or producing excrement or feces. [body.

ex-cres'cence. An abnormal outgrowth of

ex-cre'ta. Natural discharges of body.

excrete'. To throw off effete material.

ex-cre'tion. (1) A discharge of waste products of body. (2) Matter so discharged.

ex'cre-to-ry. Pertaining to excretion.—**e. organs.** Organs by which excretion is carried on, as skin, lungs, and kidneys.

ex-ha-la'tion. Vapor given off the body.

ex-haus'tion. Tending to exhaust.

ex-hu-ma'tion. Disinterment of the body.

ex-hume'. To disinter.

ex-pec'to-rant. An agent promoting a secretion of bronchial mucus.

ex-pec'to-rate. To spit forth. [from chest.

ex-pec-to-ra'tion. Expulsion of secretions

ex-pel'. To force out. [lungs; death.

ex-pi-ra'tion. Act of expelling air from

ex-pul'sion. The act of expelling.

ex-san'guine. Without blood. [in blood.

ex-san'gui-nat-ed. Deprived of or deficient

ex-tension. Act or process of extending; a reaching or stretching out; enlargement; increase of dimensions.

ex-tir-pa'tion. Total removal of an organ or growth by surgical means.

ex-trav'a-sate. Act of extravasation.

ex-trav-a-sa'tion. Effusion of fluid into tissues. [tion.

ex-trem'i-ty. A limb; an end or a termina-

ex-u'date. Product of exudation.

ex-u-da'tion. A morbid oozing out of fluids.

ex-u'ded fi'brin. Fibrin that has passed out from the blood.

eye. Organ of vision.—**e.-ball.** Globe of the eye.—**e.-brow.** Hair, skin, and tissue of the eye.—**e.lash.** Hair of the eyes.—**e.-lid.** Protective covering of the eye.—**e.-needle.** A small hollow-needle used for cranial embalming.—**e.-process.** Inserting of a needle through eye-socket into cranial cavity.—**e.-sight.** Power or sense of sight.—**e.-teeth.** Canine teeth of upper jaw.

F

fac'et. A small, plain articulating surface.

fa'cial. Pertaining to the face.—**f. nerves.** Nerves that supply face. [acquired power.

fac'ul-ta-tive. Pertaining to functional or

Fah'ren-heit's thermometer. One in which the interval between freezing and boiling is divided into 180 equal parts or degrees. Zero being 32° below the freezing of water.

Fal-lo'-pi-an. Pertaining to following.—**F. canal.** Same as Fallopian tubes.—**F. ligament.** The round ligament of uterus.—**F. tubes.** Two passages leading from ovaries to the womb. [sternum by cartilages.

false ribs. Ribs that do not connect to the

falx. Sickle-shaped.—**f. cerebelli.** A sickle-like process between the cerebellar lobes. **f. cerebri.** That between cerebral lobes.

far-i-na'ceous. Having the nature of farina; containing or yielding starch.

fas'ci-a. Fibrous membrane covering muscles, arteries, and other tissues.—**deep f.** Strong fibrous layer which lies beneath the superficial fascia.—**f. lata.** The dense fibrous aponeurosis surrounding thigh. —**superficial f.** The layer beneath the skin extending over the whole body.—**trans-versalis f.** The layer beneath the transversalis muscle and peritoneum.

fas'ci-cle. Small bundles of fibers. [fibers.

fas-cic'u-lus. A bundle, especially of nerve-

fat. Yellowish oily substance of adipose tissue.—**f. cells.** Cells containing oil in connective tissues.

fat'ty. The nature of fat.—**f. degeneration.** See Degeneration.—**f. tissue.** Tissue that

fau'cal. Pertaining to fauces. [contains fat.

fau'ces. Throat from mouth to pharynx.

feb'rile. Pertaining to fever.

fe'cal. Pertaining to feces.

fe'ces. Excrement; dung. [lific.

fec'un-date. To impregnate; render pro-

fem'o-ral. Pertaining to femur.—**f. artery.** The artery in femoral region.—**f. canal.** See Hunter's Canal.—**f. ring.** Abdominal end of femoral canal.—**f. vein.** The vein accompanying femoral artery.

fe'mur. The thigh-bone.

fer'ment. A body exciting chemical changes in other matters when brought in contact.

fer-men-ta'tion. Such changes as are effected exclusively by the vital action of

fer'rum. Iron. [ferments.

fer'tile. Prolific. [Peculiar to the fetus.

fe'tal. Pertaining to fetus.—**f. circulation.**

fet'id. Having an offensive smell, as putrid

fe'tor. Stench. [matter.

fe'tus. Products of conception after fourth month of gestation. [sociated symptoms.

fe'ver. A rise of body temperature with as-

fi'ber. Filamentary organ or structure.

fi'bril. A small fiber or filament.

fi'brin. A nitrogenous proteid coagulating in exposed blood.

fi'brin-o-gen. The precursor of fibrin.

fi-bro-a-re'o-lar. Composed of fibrous and areolar tissue. [cartilaginous tissue.

fi-bro-car'ti-lage. A mixture of fibrous and

fi'broid. Having a fibrous structure.—**f. infiltration.** Filling in or transforming tissue into fiber-like material. [fibers.

fi'brous. Consisting of or pertaining to

fil'a-ment. A thread-like structure.

fil'i-form. Like filament, thread-like.

fil'let. A loop-shaped bandage.

film. A thin membrane or skin.

fil-tra'tion. Process of straining or filtering.

fis'sion. Reproduction by splitting into two or more equal parts.

fis'sure. A groove or cleft.—**f. of Sylvius.** The cleft between anterior and middle lobes on under surface of brain.

fis'tu-la (or **fis'tule**). An abnormal tube-like passage in the body giving vent to pus or other secretions.

flac'cid. Soft; flabby. [a large cilium.

fla-gel'lum (pl.-la). A lach-like appendage;

flake. A small flat fragment.

flesh tints. Colors to tint the skin; to cover spots or discoloration.

Flex. To bend.

flexed. Bent or curved.

flex-i-bil'i-ty. Being flexible.

flex'ion. Process of bending.

flex'or. Muscle that bends or flexes a part.
flex'ure. The act of bending; a bent part. —**sigmoid f.** The bend in lower end of colon.
float'er. A dead body which floats on the surface of water.
float-ing. Free to move about.—**f. ribs.** The free ribs; the two lower pairs.—**f. kidney.** A movable or misplaced kidney. [lation.
fluc-tu-a'tion. A wave-like motion; oscil-
flu'id. A substance whose molecules move freely upon one another.—**amniotic f.** See Liquor Amnii.—**cerebrospinal f.** Fluid between the arachnoid membrane and pia mater.—**f. dram.** Equals 56.96 grains of distilled water; eighth part of a fluid ounce.—**embalming f.** See Embalming fluid.—**f. ounce.** Eight fluid drams.
flu-id'i-ty. State of being fluid.
flu'o-rid. A binary compound of fluorin.
flu'o-rin. A gaseous element resembling chlorin in chemical properties.
flush'ing. Act of coloring the surface.—**f. of the face.** Causing surface of face to be colored red or blue while injecting arteries.
fo'cus. Principal seat of a disease; meeting point of reflected rays.
fol'li-cle. A small secretory sac or tube.
fol'i-cles of Lie'ber-kuhn. Mucous follicles in small intestine.
fol-lic u-lar. Containing follicles.
fo'mes (pl. **fom'i-tes**). Any porous sub-
food. Aliment. [stance absorbing contagion.
foot. The organ at the extremity of the leg.
fo-ra'men (pl.-**mi-na**). A passage or an opening.—**f. ovale.** Opening between right and left auricles in fetus—**f. magnum.** Large opening in base of skull.
fore'arm. Arm between wrist and elbow.
for'eign body. An irritant substance in a wound or cavity.
for'mal. An anesthetic and hypnotic.
for-mal'de-hyde. See Formic Aldehyde.
for'ma-lin. A 40% aqueous solution of formic aldehyde. [ful disinfectant properties.
for'mic al'de-hyde. A gas possessing power-
fos'sa. A depression, furrow, or sinus.
Fow'ler's solution. A solution of arsenic.
frac'ture. Breaking of a bone.
fre'num. A fold of membrane acting as a check.—**f. of the tongue.** Fold of membrane underneath tongue.
fri'a-ble. Easily broken down.
fric'tion. The act of rubbing; attrition.
fron'tal. Bone of forehead. [liver turns.
ful'crum. Point or pivot about which the
fu'mi-gate. Act of exposing to disinfectant vapors. [vapors.
fu-mi-ga'tion. Exposure to disinfectant
fu'mi-ga-tor. One who or an apparatus that
fu'ming. Emitting fumes. [fumigates.
func'tion. Normal or special action of a
fun'da-ment. The base; the anus. [part.
fun'dus Rounded end or base of an organ.
fu'si-ble. That which can be easily fused
fu'si-form. Spindle-shaped. [or melted.
fu'sion. Liquefying a solid by heat.

G

gall. The bile.—**g-bladder.** A pear-shaped sac in right lobe of liver, reservoir for the bile.—**g.-cyst.** The gall-bladder.—**g.-ducts.** The ducts conveying bile.—**g.-stones.** Calcareous concretions in gall-bladder and its ducts. [quarts.
gal'lon. A standard liquid measure; four
gam-boge.' Gum-resin obtained from Garcinia hamburii. [center.
gan'gli-on. A semi-independent nervous
gan'grene. Mortification or death of soft tissue.—**senile g.** Gangrene of the extremities in the aged.
gas. An aeriform substance.
gaseous. Of the nature of gas.
gas'tric. Pertaining to stomach.—**g. catarrh.** A flow producted by irritation of gastric mucous membrane.—**g. juice.** Normal secretion of stomach.
gas-tri'tis. Inflammation of stomach.
gas-tro-en-ter'ic. Pertaining to both stomach and intestines. [ach and bowels.
gas-tro-en-ter-i'tis. Inflammation of stom-
gas-tro-ep-i-plo'ic. Pertaining to both stomach and omentum.
gas-tro-in-tes'ti-nal Pertaining to stomach and omenta.—**g. catarrh.** Inflammation of mucous membrane of stomach
gath'er-ing. An abscess. [and intestines.
gel'a-tin. A nitrogenous principle obtained by boiling certain animal tissues.—**g. culture.** Micro-organisms grown in gelatin solution. [like.
gel-at'i-nous. Resembling gelatin; jelly-
gen'er-ate. To beget; to produce.
gen-er-a'tion. The begetting of offspring.
gen'i-tal. Pertaining to organs of generation. [a spore.
germ. A microbe or bacterium; an ovum;
germ'i-cide. Agent which destroys germs.
ger'mi-nal. Pertaining to a germ. [or germ.
ger-mi-na'tion. The development of a seed.

gland. A secretory organ; a lymphatic ganglion.—**agminate g.** In the small intestine; Peyer's patches.—**axillary g.** Lymphatics in the armpit.—**blood g.** See Ductless.—**ductless g.** Without ducts. —**parotid g.** A large salivary gland in front and below the ear.—**racemose g.** Arranged in clusters like grapes.—**sebaceous g.** In the skin.—**solitary g.** An isolated gland of the intestines.—**sublingual g.** Salivary glands in floor of mouth. —**submaxillary g.** Salivary glands in floor of mouth.—**thymus g.** Situated at root of neck in front; disappears before maturity.—**thyroid g.** A blood-gland situated in neck over upper end of trachea.

glan'du-lar. Pertaining to glands.

gle'noid. A hollow, shallow pit.—**g. cavity.** In the scapula for articulation with

glob'u-lar. Shaped like a globe. [humerus.

glob'ule, or **glo'bus.** A small spherical body.

glob'u-lin. Albuminous constituent of

glos'sa. The tongue. [blood-corpuscles.

glos'sal. Pertaining to tongue.

glos-so-ep-i-glot'tic. Pertaining to tongue and epiglottis. [and pharynx.

glos-so-pha-ryn'ge-al. Pertaining to tongue

glu'cose. Grape-sugar.

glu-te'al. Pertaining to buttocks.—**g. region.** Region of or around buttocks.

glu'ten. Nitrogenous element of wheat.

glu'ti-nous. Viscid; glue-like. [and fats.

glyc'er-in. The sweetish principle of oils

gly'co-gen. Animal starch; found in blood and liver.

goi'ter. An enlargement of thyroid gland.

gon-or-rhe'a. A contagious inflammation with a purulent discharge from genitals.

gon-or-rhe'al. Pertaining to gonorrhea.

gout. Disease associated with joint inflammation, swelling, uric acid in blood, etc.

gout'y. Pertaining to or of nature of gout. —**g. habit.** The peculiar state of body predisposing gout.

grac'i-lis. Rectus internus femoris muscle.

gram. Unit of measure of metric system; 15.43 Troy grains.

gran'u-lar. Composed of grains or granulations.—**g. tissue.** Form of epithelial tissue.

gran'ule. A spore.—**g. layer.** One of the retinal layers; subcortical layer of cerebellum. [granule.

gran'u-lose. A soluble portion of starch-

grav-i-ta'tion. Force with which bodies are drawn to earth's center.

grav'i-ty. Property of possessing weight.

gray mat'ter. Cortical substance of brain.

grip. See Influenza.

gristle. Cartilage.

gris'tly. Cartilage-like. [trunk.

groin. A depression between thigh and

gul'let. The esophagus. [syphilis.

gum'ma. A soft gummy tumor due to

gum'ma-tous. Resembling a gumma.

gut'tur-al. Pertaining to the throat.

H

hair. Hirsute appendage of the skin.—**h.-bulb.** Expanded portion at lower end of hair-root.—**h. follicle.** A recess lodging the root of a hair.

hair'y. Characterized by hair.

hal'lux. The great toe.

hal'o-gens. The electronegative elements, chlorin, bromin, iodin and fluorin.

hal'oid. Any salts of the halogens.

ham'strings. Posterior muscles of thigh.

hand. Wrist, palm, and fingers together of upper extremity.—**h. protector.** An antiseptic ointment for applying to the hands when operating. [ing at root of nail.

hang'nail. A fragment of epidermis hang-

hard'en-ing compound. A desiccating mix-

head. Upper part of body. [ture.

heart. Hollow muscular organ, center of circulatory system.—**h. clot.** Coagulation of blood in cardiac cavities.

heat-stroke. Sunstroke.

hec'tic. Pertaining to phthisis.—**h. flush.** Reddening of cheeks in tuberculosis.

hec'to-gram. One hundred grams.

hec'to-li-ter. One hundred liters.

hec'to-me-ter. One hundred meters. [calcis.

heel. Hinder part of foot.—**h.-bone.** The os-

he'mal. Pertaining to blood or the vascular

he-mat'ic. Bloody [system.

hem'a-tin. A brown pigment from hemoglobin. [found in blood.

hem'a-to-blast. A minute colorless disk

hem'a-to-cele. A blood tumor.

hem'a-to-cyst. A blood-cyst.

hem'a-toid. Blood-like.

hem-a-toid'in. Same as Bilirubin.

hem-a-tol'o-gy. The science of the blood.

hem-a-to'ma. Same as Hematocele.

hem-a-to'sis. Blood formation.

hem-a-tu'ri-a. Blood in the urine. [body.

hem-i-ple'gi-a. Paralysis of one side of

hem'is-phere. A half of a sphere.

hem-o-glo'bin. Coloring-matter of red cor-

hem-op'ty-sis. Spitting of blood. [puscles.

hem′or-rhage. A flow of blood from vessels.
hem′or-rhoids. Small blood tumors in the anal orifice; piles. [rhoids.
hem-or-rhoid′al. Pertaining to hemor-
he-pat′ic. Pertaining to liver.—**h. artery.** One that supplies the liver.—**h. cancer.** Cancer of liver.—**h. duct.** See Duct, Hepatic.—**h. lobes.** Anatomical division of liver.—**h. veins.** Three veins running from liver to the inferior vena cava.
hep-a-ti′tis. Inflammation of the liver.
hep-a-ti-za′tion. A conversion into a liver-like substance.
he-red′i-ta-ry. Acquired by inheritance.
he-red′i-ty. The influence of parents upon offsprings. [sealed.
her-met′ic. Impervious to air and fluids;
her′ni-a. Protrusion of a viscus from its normal position; rupture. [nature.
het-er-o-ge′ne-ous. Differing in kind or
hi-a′tus. Gap, opening, or chasm.
hi-ber-na′tion. A sleeping through winter.
hi′lum of the kid′ney. Depression in center
hinge-joint. See Diarthrosis. [of kidney.
hip. Upper part of thigh.—**h.-bone.** The femur.—**h.-joint.** Articulation of femur and innominate bone.
hir-sute′. Covered with hair; hairy.
his-tol′o-gy. Study of intimate structure of tissues. [projections; from atrophy.
hob′nail liver. One marked with nail-like
hol′low-needle. An embalming-needle.
ho-mo-ge′ne-ous. Having the same nature.
hu′me-rus. Large bone of the arm.
hu′mor. Any fluid of the body.
Hun′ter's ca-nal′. See Canal, Hunter's.
hy′a-loid. Transparent; resembling glass. —**h. membrane.** Transparent membrane enclosing vitreous humor.
hy′dra-ted. Combined with water.
hy-dre′mi-a. Excess of water in the blood.
hy-dro-ceph′a-lus. A collection of water in head; dropsy of brain.
hy-dro-chlo′ric. Containing chlorin in combination with hydrogen.—**h. acid.** A colorless corrosive compound, exceedingly soluble in water, being an effective germicide; muriatic acid.
hy′dro-gen. A light gaseous element; a constituent of water.—**h. peroxid.** A colorless oily fluid used as a disinfectant.—**carbureted h.** A compound of hydrogen with carbon, etc.
hy-dro-tho′rax. Dropsy of chest.
hy′gi-ene. The science of health.
hy-gi-en′ic. Pertaining to health.
hy′oid. Having the form of the Greek letter Upsilon.—**h. bone.** A U-shaped bone at the base of the tongue.
hy-os-cy′a-mus. Henbane. [blood in a part.
hy-per-e′mi-a. Abnormal accumulation of
hy-per-pla′si-a. A hypertrophy of tissue.
hy-per-py-rex′i-a. Excessive high temperature. [of a part or organ.
hy-per′tro-phy. Abnormal increase in size
hyp′no-tism. State of artificial somnambu-
hy-po-car′di-um. Below the heart. [lence.
hyp-o-chon′dri-um. Beneath the cartilage; regions of the abdomen at each side of the epigastrium.
hyp-o-der′mic. Subcutaneous.—**h. injection.** Injecting beneath the skin.
hyp-o-gas′tric. Pertaining to the hypogastrium.—**h. space.** Center space in lower part of abdomen. [inal region.
hyp-o-gas′trium. Lower anterior abdom-
hy-pos′ta-sis. Blood settled into dependent parts; sediment.
hy-po-stat′ic. Pertaining to hypostasis.—**h. congestion.** Settling of blood into a part.

I

ic-ter′ic. Pertaining to jaundice.
ic′ter-us. Jaundice.
ic′tus. A stroke.—**i. so′lis.** Sunstroke.
il′e-us. Pertaining to ileum.
il-e-o-ce′cal. Pertaining to ileum and cecum.—**i. valve.** Valve between ileum and cecum. [and colon.
il-e-o-co-li′tis Inflammation of ileum
il-e-o-co′lic. Pertaining to ileum and
il′eum. Lower 3/5 of small intestine .[colon.
il′i-ac. Pertaining to os ilium or region ilium.—**i. crest.** High broadened edge of ilium.—**i. venter.** Iliac region of belly. **i. region.** Outer and lower part of ab-
il′i-um. Hip-bone. [domen.
im-bi-bi′tion. Absorption of fluids; process
im′bri-ca-ted. Overlapped. [of imbibing.
im-mo-bil′i-ty. State of being fixed.
im-mer′sion. Plunging of body into liquid.
im-mune′. Safe from attack of disease.
im-mu′ni-ty. Freed from risk of infection. **active i.** That conveyed by recovery from infectious disease. —**congenital i.** That with which the individual is born. **moderate i.** Those partially immune. —**passive i.** That conferred by introduction of antitoxins or vaccines.
im-pact′ed. Wedged in. [wedged in.
im-pac′tion. Concussion; state of being

im-pede'. To place obstacles in the way.
im-per'vi-ous. Not permitting a passage.
im'pli-cate. That which is necessarily involved or implied.
im-preg-na'tion. Fecundation.
im-pres'sion. A hollow or depression.
im-pure'. Containing some foreign substance.
im-pu'ri-ty Opposite of purity.
im-pu-tres'ci-ble. Not liable to putrefaction.
in-an'i-mate. Not animate; dead.
in-a-ni'tion. Emptiness; exhaustion from starvation.
in-ar-tic'u-late. Not joined or articulated.
in-can-des'cent. Luminous from heat.
in-cin'er-ate. Act of rendering to ashes.
in-cin-er-a'tion. Cremation; reducing to ashes.
in-cip'i-ent. Beginning.
in-cised'. Cut.—i. wound. A cleanly cut wound.
in-ci'sion. Act of cutting into.
in-ci'sor. One of the four front teeth in each jaw.
in-ci'sure. A slit or notch.
in-com-bus'ti-ble. Incapable of burning.
in-com-pat'i-ble. Not being capable of combining in solution.
in-com'pe-tence. Not capable of performing the natural functions.
in-cor-po-ra'tion. Making into a homogeneous mass.
in'cre-ment. Increase or growth.
in-cu-ba'tion. The period between the inception of a contagion and the appearance of a disease.
in'cus. Middle bone of ear; index; the first finger of the hand.
in-dent'. A shallow depression.
in-den-ta'tion. A notch, dent, or depression.
in'di-ca-tor. The index finger.
in-dig'e-nous. Native to a place.
in-di-ges'tion. See Dyspepsia.
in-dis-po-si'tion. Any slight ailment.
in'dol. Decomposition product of pancreas.
in'du-rate. Hardened.
in-du-ra'tion. Hardening of a tissue or part.
in-ert'. Slow in motion; possession of inertia.
in-er'tia. Sluggishness; inactivity.
in-e-las'tic. Not elastic; incapable of changing shape.
in-farct'. An obstruction or plug.
in-farc'tion. Plugging of vessel by an embolus.
in-fect'. To communicate disease germs.
in-fec'tion. Communication of a disease-germ; matter containing disease germs.
in-fec'tious. Of the nature of infection; contagious.
in-fe-cun'di-ty. Sterility; barrenness.
in-fe'ri-or. Lower.
in-fil'trate. To ooze into interstitial spaces.
in-fil-tra'tion. A fluid effusion into an organ or tissue.—cal-ca're-ous i. Deposit of lime within a tissue.—cellular i. An infiltration of tissues with round cells.—fatty i. A deposit of fat or oil in the tissues.—pigmentary i. Deposit of pigments in tissues. —waxy i. A deposit of a waxy substance.
in'finite. Immeasurable.
in-fin-i-tes'i-mal. Infinitely small.
in-firm'. Weak; feeble.
in-flame'. To undergo inflammation.
in-flam-ma'tion. A morbid condition with hyperemia, pain, heat, swelling, and disordered function.—i. of the bowels. That affecting walls of intestines.—i. of the kidneys. Acute nephritis.
in-fla'tion. Distention with air.
in-flu-en'za. See Grip.
in-frac'tion. Incomplete fracture of a bone.
in-fra-or'bit-al. Below the orbit.
in-fun-dib'u-lum. Funnel-shaped.—i. of the brain A mass of gray matter attached to pituitary gland.—i. of the kidney. One primary divisions of pelvis of a kidney. —i. of the lung. Any of the ultimate expansions of a bronchiole.
in-fu'sion. Slow injection of fluid into a vein; that which is infused.
in-fu-so-ri-a. A class of protozoa.
in-ges'ta. Substances introduced into body as food.
in-ges'tion. Act of introducing food into body, as by eating.
in-gre'di-ent. Any part of compound.
in'guen. The groin.
in'gui-nal. Pertaining to groin.—i. canal. A passage from internal to external abdominal rings.
in-ha-la'tion. Inbreathing of air or other vapors.
in-hale'. To inspire or draw air into lungs.
in-hib'it. To check or restrain.
in-hi-bi'tion. Restraint of organic activity from nerve-actions.
in-hume'. To place in the ground, as a body.
in-im'i-cal. Adverse; incompatible.
in-ject'. Act of injecting.
in-jec'tion. Forcing of a liquid into a vessel or cavity of body.
in-ject'or. An instrument for injection of fluid.
in'let of pelvis. Upper orifice of true pelvis.
in-ner-va'tion. A discharge of nervous force; function of the nervous system.
in'no-cent. Benign; not harmful.
in-noc'u-ous. See Innoxious.
in-nom'i-nate. Nameless.—i. artery. Largest branch of aorta at arch.—i. vein. The

branches formed by junction of internal jugulars and subclavian veins.
in-nom-i-na'tum. The hip-bone.
in-nox'ious. Not harmful; innocent.
in-oc-u-la'tion. Introduction of specific virus into system.
in-o'dorous. Without odor.
in-or-gan'ic. Devoid of organized structure.
in-os'cu-lat-ing. Directly joining. [tomosis.
in-os-cu-la'tion. Union of two vessels. Anas-
in'quest. A judicial inquiry. [insects.
in-sec'ti-cide. Preparation for destroying
in-sen'si-ble. Without sense of feeling.
in-ser'tion. Attachment, as of a muscle. —**i. of a muscle.** The more movable attach-
in-sid'i-ous. Not manifest; hidden. [ment.
in-si'tu. In a given or natural position.
in-sol'u-ble. Incapable of solution.
in-som'ni-a. Inability to sleep.
in-spi-ra'tion. Inhalation of air into the lungs.—**respiratory i.** Pertaining to res-
in'step. Arch of the foot. [piration.
in'stru-ment. A mechanical tool.—**embalming i.** A mechanical tool used in em-
in'su-lar. Isolated in condition. [balming.
in'su-late. To isolate. [of susceptibility.
in-sus-cep-ti-bil'i-ty. Immunity; a want
in-tact'. Left complete or unimpaired.
in-teg'u-ment. The skin. [tivity.
in-ten'si-ty. High degree of power or ac-
in-ter'. To place in a grave or tomb.
in-ter-ar-tic'u-lar. Situated between joints. —**i. cartilage.** Cartilage between joints.
in-ter-cel'lu-lar. Between cells.
in-ter-cos'tal. Between the ribs.—**i. spaces.** Space between ribs. [or intervening within.
in-ter-cur'rent. Occurring between; added
in-ter-me'di-ate. Being in a middle position.
in-ter-mit'tent. Occuring at intervals.—**i. fever.** A fever with period of apyrexia.
in-ter-mus'cu-lar. Between muscles. [rinth.
in-ter'nal. On the inside.—**i. ear.** The laby-
in-ter-os'se-ous. Between the bones.—**i. tissue.** Tissues between the bones.
in-ter-scap'u-lar. Between the shoulder-
in-ter-space'. Spaces between. [blades.
in'ter-sti-ces. Spaces; intervals. [tance.
in'ter-val. Space or lapse of time or dis-
in-tes'ti-nal. Pertaining to intestine.—**i. canal.** Tube leading from mouth to anus.
in-tes'tine. Digestive tube from stomach to
in'ti-ma. Innermost coat of a vessel [anus.
in-tra-ab-dom'i-nal. Within the abdomen.
in-tra-ar-te'ri-al. Within the artery.
in-tra-va-sa'tion. Passage of morbid matter into the vessels. [intestine into another.
in-tus-sus-cep'tion. Slipping of one part of
in-va'sion. Onset of a disease.
in-ver'sion. Turning inside out.
in-vest'. To surround or enclose.
in-volve'. Implicate.
in-vol'un-ta-ry. Independent of will.—**i. muscle.** One not under control of will.
i'o-did. A compound of iodin. [element.
i'o-din. One of the halogens; a non-metallic
i-od'o-form. A yellow antiseptic compound with a strong peculiar odor, formed by the action of iodin on alcohol in an alkaline solution. [iodin and ozone.
i-od'o-zone. An antiseptic compound of
i'ris. Colored membrane of anterior part of
i-ri'tis. Inflammation of the iris. [the eyes.
ir'ri-ta-ble. Easily inflammed or irritated.
ir-ri-ta-bil'i-ty. Susceptible to excitement.
ir'ri-tant. An agent producing irritation. —**i. poison.** A poison that causes irritation of the mucous membrane.
ir-ri-ta'tion. Excitement; stimulation.
is'chi-ac, is'chi-al. Pertaining to ischium.
is'chi-um. Seat-bone; inferior part of hip-bone. [bladders of the sturgeon.
i'sin-glass. A gelatin made from the air-
i-so-ther'mal. Of equal temperature.
i-tis. A suffix meaning inflammation.

J

jaun'dice. A yellow color of skin, due to obstructed excretion of bile.
jaw. Either of two maxillary bones.
je-ju'num. Upper 2-5 of portion of small intestine that succeeds the duodenum.
joint. An articulation.
ju'gu-lar. Pertaining to throat.—**j. veins.** Certain veins of neck.
juice. Any of secretions of the body.—**gastric j.** That of the stomach.—**intestinal j** That of intestinal walls.—**pancreatic j** That of the pancreas.
junc'tion. Joining together.
jux-ta-po-si'tion. In close relationship.

K

ker'a-tin. A nitrogenous compound forming essential ingredients of bony tissue.
kid'ney. Organ secreting urine.
kid'neys, Bright's disease of. Certain diseases described by Dr. Bright.
kil'o-gram. One thousand grams.
kil'o-li-ter. One thousand liters.
kil'o-me-ter. One thousand meters.

knee. Joint between thigh and leg.—**k-cap.** The patella.—**k-pan.** See Knee-cap.
knuck'les. The joints of the phalanges.

L

la'bial. Pertaining to lips.
la'bi-um (pl.-**bi-a**). The lip. [work.
lab'o-ra-to-ry. A place for experimental
lab'y-rinth. The internal ear.
lac'er-ate. To tear.
lac-er-a'tion. Mechanical rupture.
lach'ry-mal. Pertaining to tears.—**l. duct** or **canal.** Passage that carries tears from eyes to nose.—**l. gland.** Organ that secretes the tears.—**l. sac.** Upper rounded extremity of the lachrymal duct.
lach'ry-mose. Shedding tears. [milk.
lac-to-al-bu'min. Albumin as found in
lac-to-glob'u-lin. Globulin as found in milk.
lac'tose. Sugar of milk. [tarrhal fever.
la grippe (**grip**). Contagious, epidemic ca-
la-mel'la. A thin plate or scale.—**l. of bone.** Rings around the Haversian canals.
lam'el-lar. Disposed in lamellas.
lam'i-na. A thin layer or scale.
lar-yn-ge'al. Pertaining to larynx.
lar-yn-gi'tis. Inflammation of larynx.
lar'ynx. Upper part of windpipe.
la'tent. Concealed; not manifest.—**l. period.** Time required for incubation of
lat'er-al. Pertaining to the side. [disease.
lay'er. A mass of nearly uniform thickness spread over an area.
lead. A bluish-white metal.
leak'age. Act or process of leaking.
lec'i-thin. A phosphorized substance found widely in the body.
leg. From knee to ankle-joint.
lens. A transparent disc refracting light. —**crystalline l.** See Crystalline.
lep'ro-sy. An endemic chronic malignant disease. [jury or disease.
le'sion. Structural tissue change from in-
leu'co-cyte. A white blood-corpuscle.
leu-co-cy-the'mi-a. An abnormal increase of the white blood corpuscles. [cocytes.
leu-co-cy-to'ma. A tumor containing leu-
leu-co'sis. Any disease of lymphatics; abnormal pallor of skin.
leu-ke' (or **ce**) **mi-a.** Fatal blood disease with a great increase of white blood-corpuscles.
le-va'tor. A muscle that elevates a part.
lev'u-lose. Natural sugar of fruits.
Lie'ber-kühn's crypts. See Glands.
life. Power by which an organism exists and exercises its function.
lig'a-ment. A band of fibrous tissue binding parts together. [hip-joint.
lig-a-men'tum te'res. Round ligament in
li-ga'tion. Operation of tying, as of an ar-
lig'a-ture. Material used for tying. [tery.
lime. Calcium oxid.
lim'pid. Crystal; clear; transparent.
line. Unit of length; twelfth of an inch.
lin'e-a. A line or band.—**l. alba.** White line in middle of abdomen.
lin'e-ar. Pertaining to linea or a line.
lin'gual. Shaped like the tongue.
lin'gu-la. A small lobe of the brain.
lint'in. Trade-name for compressed absorbent cotton.
lip. One of the two fleshy folds surrounding orifice of the mouth; border of a wound.
lip-o'ma. A fatty tumor.
liq-ue-fac-tion. To render into liquid.
liq'uid. A substance that flows.
liq'uor. A liquid solution.—**l. am'ni-i.** Fluid surrounding the fetus.—**l. san'guin-is.** Blood-plasm. [equal to 1.056 U. S. quarts.
li'ter. Unit of capacity in metric system,
liv'er. Largest glandular organ of body, secreting bile.—**fatty l.** One marked with fatty degeneration and infiltration.—**floating l.** Movable liver.—**hobnail l.** See Hobnail liver. [ashey hue.
livid. Discolored from congestion. of an
lo'bate. Having lobes.
lobe. A rounded division of an organ.
lob'u-lar. Like a lobe.
lob'u-la-ted. Composed of lobes.
lob'ule. A small lobe.
lo'bus. Lobe.—**l. cau-da'tus**—**l. quad-ra'tus,**—**l. Spi-ge'li-i.** Small lobes of the liver.
lo'cal-ized. Confined to a certain area.
lock'jaw. Spasm of muscles of mastication.
lo-co-mo'tor. Relating to locomotion.—**l. a-tax'i-a.** An incoördination of muscles of locomotion.
lu'bri-cate. To cause to slip or glide easy.
lu'bri-ca-tor. Making smooth or slippery.
lum-ba'go. Rheumatic pain in loins.
lum'bar. Pertaining to loins. [gan.
lu'men (pl.-**mi-na**). Cavity of a tubular or-
lung. One of two organs of respiration. —**l. fever.** Croupous pneumonia.—**l. tissue.** Tissue of the lungs.
lu'nu-la. Semilunar area at root of nails.
lymph. A colorless alkaline fluid of lymphatics.—**l.-cell.** A lymph leucocyte.
lym-phat'ic. Pertaining to lymph or **lym-**

phatics.—l. circulation. That of the lymphatics.—l. duct See Duct.—l. gland. See Gland.—l. system. System of lacteals and vessels which carry lymph.—l. vessel. A tube for collecting lymph.

lym-phat'ics. Capillary tubes pervading the body and carrying lymph.

lym'phoid. Having character of lymph.

ly'sol. A disinfectant from cresol, a product of coal-tar.

M

mac'er-ate. To reduce to a soft mass by soaking or digestion. [organism.

mac-ro-coc'cus. A large unicellular micro-

mac-ro-scop'ic. Invisible to the naked eye.

mac'u-la. A spot or small patch.

mac'u-lar. Pertaining to macula.

mac'u-la-ted. Spotted. [ism.

mag-net'ic. Possessing power of magnet-

mag'net-ism. Power of magnet to attract or repel other masses.

mal'a-dy. An illness or disease.

ma'lar. Pertaining to cheek-bone.

ma-la'ri-al. Pertaining to malaria.—**m. fever.** Periodic fever of malaria.

ma-lig'nant. Virulent; fatal.—**m. cholera.** Asiatic cholera.—**m. edema.** Edematous anthrax.—**m. pustule.** A small circumscribed, inflamed elevation of cuticle; pustular anthrax.—**m. vesicle.** See Anthrax.

mal-le'o-lar. Pertaining to malleolus.

mal-le'o-lus. A hammer-head-shaped process of bone one on either side of the ankle-joint. [tion.

mal-nu-tri'tion. Poor or abnormal nutri-

mal-o'dor-ous. Having a disagreeable smell; obnoxious. [stase in barley.

malt'ose. Sugar derived from action of dia-

mam'ma. The breast.

mam'mal. An animal, the female of which has mammas.

mam-ma'li-a. Animals that nourish their young by milk-secreting glands.

mam'ma-ry. Pertaining to mammas.—**m. gland.** The milk-secreting gland.

mam-mil'la. A nipple.

mam'mil-la-ted. Furnished with round-like protuberances or wart-like projections.

man'di-ble. The lower jaw.

man-dib'u-la. Pertaining to lower jaw.

ma'ni-a. Delirium or madness.—**m. a po'tu.** See Delirium Tremens. [part.

man'i-kin. A model of a human being or a

ma-nu'bri-um. First bone of sternum.

ma'nus. The hand.

ma-ras'mus. A wasting or emaciation.

mar'gin-al. Pertaining to or at border of.

mar'row. Fatty substance in cavity of long bones. [mastication.

mas-se'ter. A strong facial muscle aiding

mas-ti-ca'tion. Process of chewing.

mas'toid. Shaped like a nipple.—**m. process.** At lower part of mastoid portion of temporal bone.

ma-te'ri-al. See Matter. [temporal bone.

ma-te'ri-es mor'bi. Specific causes of dis-

ma-ter'nal. Pertaining to a mother. [eases.

mat'ter. Physical substance; pus.

ma-ture'. Ripe; fully developed.

max-il'la. Bone of either jaw.

max'il-la-ry Pertaining to jaws.

max'i-mum. The largest quantity.

may'ol. A preservative compound.

mea'sles. A contagious disease of children; rubeola. [tory or urethral meatus.

me-a'tus. A passage; an opening, as audi-

me-chan'ic-al. Pertaining to mechanics.

me'di-an, me'di-al. Middle or mesial.—**m. line.** Middle line of body.—**m. nerve.** A branch of brachial plexus. [num.

me-di-as-ti'nal. Pertaining to mediasti-

me-di-as-ti'num. Septum of thoracic cav-

me'di-ate. Indirect. [ity.

me'di-um. That in which anything lives; surrounding conditions.

me-dul'la. Fatty substance or marrow in various cavities.—**m. oblongata.** Enlarged portion of spinal cord in cranium.

med'ul-la-ry. Pertaining to the medulla. —**m. canal.** Hollow interior of long bones. —**m. membrane.** The endostium. [eyelids.

Mei-bo'mi-an glands. Glands in margins of

mel-a-no'sis. An abnormal deposit of black matter in various parts of the body.

mel-a-not'ic. About melanosis. [urine.

mel-a-nu'ri-a. Presence of dark pigment in

mel-as'ma. Any discoloration of skin.—**m. suprarenalis.** Ecchymosis of Addison's

mem'ber. Any limb of the body. [disease.

mem-bra'na. A membrane.—**m. tym'pa-na.** The ear-drum.

mem'brane. A thin enveloping or lining substance.—**choroid m.** Middle coat of eye.—**arachnoid m.** Middle covering of brain and cord.—**false m.** An unnatural membrane.—**medullary m.** That which lines cavities of long bones; endostium. —**mucous m.** That which lines the canals that have external openings.—**sclerotic m.** Outer coat of eye.—**serous m.** That which lines vessels and serous sacs.

mem'bra-nous. Like a membrane.—**m. croup.** Diphtheria.

me-nin'ges. Covering of brain and cord.

men-in-gi'tis. Inflammation of meninges.

men'stru-um. A solvent.

men'tal. Pertaining to mind.

men'tum. The chin; under-jaw.

mer-cu'ric. Pertaining to or containing mercury as a bivalent.—**m. chlorid.** Bichlorid of mercury; corrosive sublimate.

mer'cu-ry. Hydrargyrum; a white, heavy liquid metal.

mes-en-ter'ic. Pertaining to mesenteries.

mes-en-te-ri'tis. Inflammation of mesenteries. [small intestine.

mes'en-ter-y. Peritoneal attachment of

mes'o-blast. The mesoderm, which see.

mes-o-ce'cum. Process of peritoneum attached to cecum.

mes-o-co'lon. Mesentery of the colon.

mes'o-derm. Middle germ-layer of the embryo. [tached to rectum.

mes-o-rec'tum. Process of peritoneum at-

met-ab'o-lism. Change in the intimate condition of cells, constructive or destructive.

met-a-car'pal. Pertaining to metacarpus.

met-a-car'pus Bones of palm of hand.

met-al'lic ir'ri-tants. Metals that produce irritation.—**m. poisons.** Metals that produce poisonous effects.

met-a-mor'pho-sis. A passing from one form or shape to another.

met-a-tar'sal. Pertaining to metatarsus.

met-a-tar'sus. Bones of arch of foot.

me'ter. Unit of measure of metric system, 39.37 inches.

meth'yl al'co-hol. Carbonal or wood spirit; colorless liquid distilled from wood.

met'ric sys'tem. A system of weights and measures having the meter as its base.

mi-as'ma. A noxious, morbific exhalation from putrescent matter; malaria.

mi-as-mat'ic. Pertaining to miasma.

mi'crobe. A microscopic organism; especially a bacteria; a micro-organism.

mi-cro'bic. Pertaining to microbe.

mi-cro-coc'cus Spherical micro-organism.

mi'cron. One-millionth part of a meter.

mi-cro-or'ganism. A minute living body, as a microbe or bacterium.

mi'cro-scope. An instrument for examining minute objects. [scope.

mi-cro-scop'ic. Pertaining to the micro-

mid-riff. The diaphragm.

mi'gra-to-ry. Moving from one place to another.—**m. cells** Cells that move from place to place.

mil'i-a-ry. Like millet seed.—**m. aneurism.** Very small aneurism in arteries.—**m. disease.** Disease of sweat-glands.—**m. glands.** Sweat-glands.

milk. Secretion of mammary gland.—**m. sugar.** Sweet principle of milk; lactose.—**m. teeth.** Temporary or first teeth.

mil'li-gram. One-thousandth part of a gram.

mil'li-li-ter. One-thousandth part of a liter.

mil'li-me-ter. One-thousandth part of a meter. [pound found in nature.

min'er-al. Any inorganic homogenous com-

mis-car'riage. The expulsion of fetus before natural time of delivery.

mis'cible. Capable of being mixed.

mis'tu-ra. A liquid mixture; a potion.

mi'tral. Miter-like.—**m. valve.** Left auriculo-ventricular valve of heart.

mo'bile. Movable.

mo-bil'i-ty. Property of being easily moved.

mo'dus op-er-an'di. Mode of operating.

mo'lar. Pertaining to a mole or mass.—**m. teeth.** Back grinding teeth. [turn to dust.

mold'er, mould'er. To decay gradually and

mo-lec'u-lar. Pertaining to molecules.—**m. death.** Disintegration of a part.—**m. vibrations.** The smaller vibrations.

mol'e-cule. Smallest quantity of a substance that may exist and preserve the characteristic qualities. [vis.

mons Ven'er-is. Eminence on female pel-

mor'bid. Pertaining to disease.—**m. anatomy.** See Anatomy.

mor-bif'ic. Causing disease.

mor'bus. A disease, as cholera morbus.

morgue. A dead-house.

mor'i-bund. Dying; in a dying state. [um.

mor'phin. Principal narcotic alkaloid of opi-

mor-phol'o-gy. Science of organic forms.

mors. Death.

mor'tal. Liable to death; deadly. [mortal.

mor-tal'i-ty. Death-rate; state of being

mor'tu-a-ry. Relating to the dead; morgue.

mo'tile. Capable of spontaneous motion.

mo'tor. Applied to muscles and nerves moving apart.—**m. fiber.** The fiber of motor nerves.—**m. nerves.** Those that move apart.—**m. oculi.** Third cranial nerve which supplies most of the muscles

mo'tory. Pertaining to motor. [of the eye.

mouth. Cavity at entrance of alimentary canal; an orifice.

move'ments. Motion or action.

mu'cin. An albuminoid constituent of mucus [rimal sac.

mu'co-cele. A mucus tumor; enlarged lac-

mu'coid. Resembling mucus or mucous tissue. [cus and membrane.

mu-co-mem'bra-nous. Composed of mu-

mu-co'sa. A mucous membrane.

mu'cous. Having nature of mucous.—**m-membrane.** See Membrane. [membrane.

mu'cus. Viscid liquid secretion of mucous

mum-mi-fi-ca'tion. Desiccation of a tissue so that it resembles a mummy in color and

mum'mi-fy. To make a mummy of. [texture.

mum'my. The desiccated body; anciently embalmed body.—**m.-cloth.** The linen or cloth in which the mummy is enwrapped.

mumps. An acute infectious disease of the

mu'ral. Pertaining to wall. [parotid gland.

mu-ri-at'ic acid. A mineral acid.

mur'mur, re-spir'a-to-ry. A low sound heard in auscultation of lungs.

mus'cle. Organic contractile tissue, the means of animal motion.—**m.-corpuscles.** Those in plasma.—**m.-plasma.** Liquid expressed from fresh muscle.—**striated m.** Striped; under control of the will.

mus'cu-lar. Pertaining to muscle.—**m. coat.** Middle coat of walls of arteries and veins. —**m fibers.** Fibers comprising muscle.—**m. sense.** Sensation that accompanies muscular action. [cles and skin.

mus-cu-lo-cu-ta'ne-ous. Pertaining to mus-

mus-cu-lo-phren'ic. Pertaining to diaphragm. [muscle and membrane.

mus-cu-lo-mem'bra-nous. Composed of

mus'cu-lus. A muscle.

my-co'sis. Presence of parasitic fungi in body, as well as disease caused by them.

my'el-in. Medullary sheath of a nerve.

my-el-i'tis. Inflammation of spinal cord.

my'el-oid. Marrow-like; medullary.

my-i'tis. Inflammation of a muscle.

my-o-car'di-um. Muscle mass of heart.

my-o-de'mi-a. Fatty degeneration of muscle-tissue. [cle-fibers; sarcolemma.

my-o-lem'ma. Thin membrane around mus-

my'oid. Resembling muscular tissue.

my'on. A hypothetical muscular unit; a

my-on'o-sus. A disease of muscles. [muscle.

my-op'a-thy. Any disease of a muscle.

my-o-si'tis. Inflammation of muscle tissue.

my'o-spasm. Spasmodic contraction of muscles.

N

nail. Horny lamina at end of finger or toe.

nape. Back part of neck.

naph'tha. Crude petroleum.

nar-cot'ic. A hypnotic allaying pain.

na'res. Opening into nose.

na'sal. Pertaining to nose.—**n. duct.** Tear-duct.—**n. fossae.** Nasal passages.—**n. tube.** A tube for injecting the respiratory tract.

na'tal. Relating to the nates. [body.

na'tes. The buttocks; gluteal region of

na'tri-um. Sodium (from which symbol

na'tron. Native sodium carbonate. [Na.)

nau'se-a. Sickness at stomach.

nau'se-ous. Producing nausea; disgusting.

na'vel. Depression or scar on abdomen where umbilical cord was attached; umbilicus.

na-vic'u-lar. Bone on upper row of carpus.

neck. Part of body between head and trunk.

nec-ro-bi-o'sis. Molecular death of a part.

nec'ro-sco-py. Scientific examination of a dead body; autopsy. [tification; gangrene.

nec-ro'sis. Death of part of the body; mor-

nec-rot'ic. Pertaining to necrosis.

nee'dle. Pointed instrument for puncturing.—**cardiac-n.** Needle for pumping out blood from heart.—**embalming-n.** Needle for aspirating and injecting cavities.—**n.-forceps.** Forceps for pulling the needle in sewing.—**hollow-n.** See Embalming-Needle.—**n. process.** An operation for injecting fluid direct into cranial cavity.

neph'ri-a. Bright's disease.

neph-ri'tis. Inflammation of kidneys.

neph'roid. Kidney-like.

nerve. A bundle of nerve-fibers outside the nervous system.—**n.-cell.** An irregular nucleated cell in nerve-matter.—**n.-center.** A group of nerve-cells.—**n.-current.** Current that passes through nerves that make impressions on brain.—**n.-fiber.** One of essential thread-like units composing a nerve.—**n.-fibril.** An extremely fine nerve-fiber.—**n.-impulse.** Impulse propagated along a stimulated nerve.—**motor-n.** One containing chiefly motor-fibers.—**n. plexus.** A group of nerves.—**sympathetic n.** One of system distributed to blood-vessels and viscera.—**vasamotor n.** A nerve controlling caliber of blood-vessels.

nerv'ous. Pertaining to or full of nerves. —**n. system.** Nerves of the body taken to-

neu'ral. Pertaining to nerves. [gether.

neu-ri'tis. Inflammation of a nerve.

neu-ral'gi-a. Pain in nerve.

neu tral. Possessing neither acid nor basic properties. [tive.
neu'tral-ize. To render inactive or nega-
ne'vus. A birth-mark.
ni'dus. A nest; a cluster.
nid'u-lus. Deep origin of a nerve.
nip'ple. Conic elevation in center of mammary gland.
ni'ter. Saltpeter; nitrate of potash.
ni'tric acid. A mineral acid.
ni'trate. A salt of nitric acid.
ni'trite. A salt of nitrous acid.
ni'tro-gen. A colorless, non-metallic, gaseous element; a main constituent of air.
ni-trog'e-nous. Containing nitrogen.
node. A hard swelling on a tendon or bone.
nod'ule. A small knob or excrescence.
non-med'ul-la-ted. Not medullated; unprovided with medullary sheath.
non-stri'a-ted. Not striped. [ease-producing.
non-path-o-gen'ic. Not pathogenic; not dis-
non-vas'cu-lar. Not vascular.—**n. tissue.** Tissue without blood-vessels.
nor'mal. According to rule or type.
nose. The organ of smell.
nos-ol'o-gy. The science of disease.
nos'tril. A naris.
nos-tal'gi-a. Home-sickness.
notch. An indention; a hollow.—**in-ter-ver'te-bral n.** Any one of depressions of vertebral pedicles.
nox'ious. Harmful; poisonous.
noz'zle. Projecting spout for discharging.
nu-cle-ate. Having nuclei.
nu'cle-a-ted cells. Cells with nuclei.
nu'cle-in. Nitrogenous constituent of cell-nuclei. [nucleus.
nu-cle'o-lus. A small granule in interior of
nu'cle-us (pl.-cle-i). Essential part of a typical cell and controlling center of its acti-
nu-tri'tious. Yielding nourishment. [vity.
nu'tri-ent. A nutritious substance.—**n. vessels.** Those that carry nutrition.
nu'tri-ment. Anything that nourishes.
nu-tri'tion. Process of assimilating food.

O

ob-cor'date. Heart-shaped.
ob-duc'tion. A post-mortem examination.
o-bese'. Extremely fat; corpulent.
o-bes'i-ty. Fatness; corpulency.
o-bit'u-a-ry. Pertaining to death.
ob-lique'. Slanting, as a muscle.
ob-lit-er-a'tion. Extinction; blotting **out.**
ob-lon-ga'ta. The medulla oblongata.

neu'tral. Possessing neither acid nor basic
ing pregnancy and child-birth.
ob-struct'. To close up or interfere. [ing.
ob-struc'tion. Blocking of a canal or open-
ob'tu-ra-tor. That which obstructs a cavity.
oc-cip'i-tal. Pertaining to the occiput.
oc'ci-put. Lower back part of the head.
oc-clude'. To block up or close.
oc-clu'sion. Blocking up of an opening or canal, as of a vessel.
oc-cult'. Hidden; secret.
oc'u-lar. Pertaining to the eyes. [ments.
oc-u-lo-mo'tion. Pertaining to eye-move-
oc'u-lus. The eye.
o-don'toid. Resembling a tooth.—**o. process.** Tooth-like process of axis.
o'dor. A scent, smell, or perfume.
o'dor-ant. Odorous.
o-dor-if'erous. Yielding an odor.
o'dor-less. Without odor.
oil. A greasy liquid not miscible with water, composed of glyceryl and fatty acid.—**o. of cedar.** A volatile oil from the leaves of Juniperus Virginiana used as an antiseptic.—**o. of lavender.** Volatile oil from lavender flowers.—**o. of turpentine.** Spirits of turpentine; a volatile oil from the concrete oleorism of pinus palustris and other species.—**o. of vitriol.** Sulphuric acid. [boiled oil.
oiled silk. Silk made water-proof with
oils, es-sen'tial. Volatile oils distilled from different odoriferous vegetable substances.
o-le-ag'i-nous. Having nature of oil. [base.
o'le-ate. A compound of oleic acid and a
o-le-cra'non. Large process forming head of ulna. [illuminating gas.
o-le'fi-ant gas. Ethylene; a constituent of
o'le-in. A colorless, oily compound, the chief constituent of fatty oils.
o'le-um. See Oil.
ol-fac'tion. The sense of smell.
ol-fac'to-ry. Pertaining to olfaction.—**o. bulb.** Bulbous section of olfactory nerve.—**o. center.** Brain-center governing sense of smell.—**o. nerve.** Nerve of smell.
o-li'va. Olivary body of brain.
ol'iv-a-ry body. The oliva, situated behind anterior pyramid of the oblongata.
o-men'tal. Pertaining to the omentum.
o-men-ti'tis. Inflammation of omentum.
o-men'tum. A fold of peritoneum connecting abdominal viscera with stomach.—**great o.** Fold falling from great curvature of stomach over intestines and returning

to be attached to transverse colon.—**lesser o.** Double fold passing from lesser curvature of stomach to transverse fissure of liver.

ooze. To transude.

o-paque′. Not transparent; impervious to light. [tion.

op′er-a-tor. One that performs an opera-

oph-thal′mi-a. Inflammation of conjunc-

oph-thal′mic. Pertaining to the eye. [tiva.

o′pi-ate. Pertaining to opium; an opium preparation.

o′pi-um. Inspissated juice of poppy.

op-o-bal′sam. Balsam of Mecca.

op′tic. Pertaining to vision or its organs.

op′ti-cal. Pertaining to optics.

or-bic′u-lar. Circular; spheric.

or′bit. Bony cavity for eyeball. [function.

or′gan. Any part of body having a special

or-gan′ic. Pertaining to or having organs.

or′gan-ism. A living organized being.

o-ri-en-ta′tion. The location of one's position in a given environment.

or′i-gin. The beginning or source.—**o. of a muscle.** The beginning or source; the fixed attachment of a muscle. [combined.

o-ro-phar′ynx. The mouth and pharynx

os (pl. **o′ra.**). A mouth.

os (pl. **os′sa**). A bone.—**o. calcis.** The heel-bone, calcaneum.—**o. innominatum.** The hip-bone. **o. hyoides.** The ischium.—**o. pubis.** The pubis. [branes.

os′mose. Diffusion of fluids through mem-

os-mot′ic. Pertaining to osmosis.

os′sa. Plural of os.

os′se-ous Bony; resembling bone.

os′si-cles The small bones of the ear.

os-sif′ic. Generating bone.

os-si-fi-ca′tion. The formation of bone.

os′si-fy. To change into bone.

os-tal′gi-a. Pain in bone.

os′te-in. The gelatinous principle of bone.

os-te-i′tis. Inflammation of the bone.

os-te-og′e-ny. Development and formation

os′te-on. Bone. [of bone.

os-te-o-ne-cro′sis. Necrosis of bone.

os-te-ot′o-my. Incision of bone.

os′ti-um. Mouth of a tubular passage.

o′to-liths. Ear-stones.

o-tos′te-on. An ear-stone; otolith.

ounce. Twelfth part of troy and sixteenth of avoirdupois pounds.

o-va′ri-an. Pertaining to ovaries.—**o. dropsy.** Dropsy of ovary.—**o. tumor.** A tumor of ovary. [producing the ova.

o′va-ry. Organ of generation in female

ov′en. An apparatus for sterilization.

o′vi-ducts. Small tube on each side of

o′void. Egg-shaped. [utero.

o′vule. The unimpregnated ovum.

o′vum (pl. **o′va**). Egg. [ous compound.

ox-al′ic acid. A white, crystalline, poison-

ox′id. Any binary combination of oxygen.

ox-i-da′tion. Conversion into an oxygen.

ox′y-gen. One of the gaseous elements.

ox-y-gen-a′tion. Saturation with oxygen.

o′zone. An allatropic form of oxygen used as an antiseptic and oxidizing agent.

P

pab′u-lum. Food; anything nutritious.

pach-e′mi-a. Thickening of the blood.

pal′ate. Roof of the mouth and floor of nose.—**p. bone.** Bone helping form outer wall of nose, roof of mouth, and floor of orbits.—**hard p.** Bony palate adjacent to gums.—**soft p.** Soft posterior part of

pale. Wanting in color; pallid. [palate.

pal′li-ate. To mitigate; to relieve.

pal′lid. Paleness; lacking color.

palm. Inner side of hand.

pal′mar. Pertaining to palm.—**p. arch.** Arterial arch in palm. [stance of fat.

pal′mit-in. The solid, crystallizable sub-

pal′pa-ble. That which may be perceived by palpitation.

pal′pate. To explore with the hand.

pal-pa′tion. Exploration with the hand.

pal-pi-ta′tion. Violent pulsation, as of heart. [sation.

pal′sy. Paralysis; weakening or loss of sen-

pan′cre-as. A racemose gland in abdomen; sweetbread.

pan-cre-at′ic. Pertaining to the pancreas.—**p. juice.** Fluid secreted by pancreas.—**p. duct.** The canal that conveys the pancreatic juice to the intestines. [ple or pustule.

pa-pil′la. A small conic eminence; a pim-

pap′il-la-ry. Pertaining to tongue; having papillas.—**p. layer.** External layer of true

pap′u-la. Small elevation of the skin. [skin.

par′af-fin. A white waxy crystalline substance. [tary motion.

par-al′y-sis. Loss of sensation or volun-

par-a-ple′gi-a. Paralysis of lower half of body. [other organism.

par′a-site. An organism that inhabits an-

par-a-sit′ic. Having nature of a parasite.

par-en′chy-ma. Soft cellular tissue; connective tissue. [but not sensation.

par′e-sis. Partial paralysis affecting motion

par-es-the′si-a. Same as Paresis.
pa-ri′e-tal. Pertaining to a wall. [ity.
pa-ri′e-tes (pl. of **pa′ri-es**). Walls of a cav-
par-ot′id. Near the ear.—**p. gland.** Salivary gland in front of ear. [mumps.
par-o-ti′tis. Inflammation of parotid gland;
par′ox-ysm. Period of increase or crisis of a disease.
par-tu-ri′tion. Act of giving birth to young.
pas′sage. A channel; act of passing from one place to another.
pas′sive. Not active; submissive.
pas′til, pas-tile′. Tablet or lozenge; having a round, oblong, square, or triangular form.
patch. An irregular spot or area.
pa-tel′la. The knee-cap.
path′o-gene. A bacterium or microscopic organism found in infectious disease, which is supposed to cause it.
path-o-gen′ic. Causing disease.—**p. bacteria.** One that causes disease.
path-o-log′i-cal. Pertaining to pathology.
pa-thol′o-gy. The science of disease.
pa′tient. Sick person; one under treatment.
pec-ti-ne′al. Pertaining to pubic bones.
pec′to-ral. Pertaining to the breast.
ped′al. Pertaining to the feet.
ped′i-cle. Stalk or attachment of a tumor.
ped-un′cle. The supporting part.
pel′vic. Pertaining to pelvis.—**p. cavity.** Basin-like cavity at lower end of trunk.
pel′vis. Bony basin of the trunk.
pen′du-lous. Hanging or dropping.
pen′e-trate. To enter beyond the surface.
pen′ni-form. Shaped like a feather.
pep′sin. Digestive principle of gastric juice.
pep′tic. Pertaining to or promotive of digestion.—**p. gland.** Gland that secretes gastric juice.
pep′tone. An albuminoid produced by action of pepsin.
per′co-late. (1) To filter; strain. (2) That which has percolated.
per-co-la′tion. The process of filtration.
per′co-la-tor. A filterer.
per′fo-rans. Penetrating; perforating; deep flex or muscles of the fingers.
per′fo-rate. To pierce with holes.
per′fo-ra-ting. Making an opening or penetration.—**p. arteries.** Those passing through interosseous spaces or muscles.
per-fo-ra′tion. An opening or penetration.
per-i-ar-te-ri′tis. Inflammation of outer sheath of arteries. [nucleus.
per-i-blast. Protoplasm around the cell
per-i-car′di-al (or **ac**). Pertaining to pericardium.—**p. sac.** Sac enclosing heart.
per-i-car-di′tis. Inflammation of pericardium. [ing heart.
per-i-car′di-um. Serous membrane enclos-
per-i-chon′dri-um. Membrane around carti-
per-i-cra′ni-um. Periosteum of skull. [lage.
per-i-mys′i-um. Membranous sheath of muscles. [anus to genitals.
per-i-ne′um. Space between thighs from
pe′ri-od. An interval of time. [um.
per-i-os-ti′tis. Inflammation of perioste-
per-i-os′te-um. Fibrovascular membrane that covers and nourishes bone.
per-i-o′tic. Surrounding the inner ear.
per-iph′er-al. Pertaining to periphery.—**p. circulation.** Circulation in outer surface of body. [line.
per-iph′er-y. Circumference or boundary
per-i-phle-bi′tis. Inflammation of outer coat of a vein.
per′i-plast. Matrix of a part or organ.
per-i-stal′sis. Worm-like motion of bowels.
per-i-stal′tic. Pertaining to peristalsis.—**p. movement.** Same as peristalsis.
per-is-tro′ma. Villous coat of intestines.
per-i-sys′to-le. Internal between systole and diastole.
per-i-to-ne′al. Pertaining to peritoneum. —**p. cavity.** Cavity within peritoneum. —**p. sac.** Serous sac in abdominal cavity.
per-i-to-ne′um. Serous membrane lining the abdomen. [neum.
per-i-to-ni′tis. Inflammation of perito-
per-i-vas′cu-lar. Around the vessels.
per-o-ne′al. Pertaining to fibula.
per-o-ne′um. The fibula. [oxygen.
per-ox′id. An oxid with highest amount of
per-spi-ra′tion. (1) Secretion and excretion of liquid from skin; sweating. (2) The liquid fluid so secreted; sweat.
pe-tech′i-æ. Small spots of ecchymosis beneath the epidermis.
pet′rous. Resembling bone.—**p. bone.** Lower portion of temporal bone.
pha-lan′ges (pl. of **pha′lanx**). Bones of fingers and toes. [the mouth.
phar′ynx. Musculomembranous sac behind
phe′nol. Carbonic acid.
phe-nom′en-on. (1) Uncommon occurrence. (2) A symptom. [a vein.
phleb-i′tis. Inflammation of inner coat of
phlegm. (1) Watery humor. (2) Mucus from bronchi.
phos′phate. A salt of phosphoric acid.

phos'pho-rus. A non-metal, one of the elements in bone and nerve-tissue.

phthi'sis. Pulmonary tuberculosis. [purge.

phys'ic. Science of medicine; medicine; a

phys'ical. Pertaining to physics or the body. [ology.

phys-i-o-log'i-cal. Pertaining to physi-

phys-i-ol'o-gy. The science of the functions of the body.

pi'a ma'ter. Innermost membrane investing the brain and spinal cord.

pic'ro-mel. A bitter substance in the bile.

pig'ment. An organic coloring-matter.

pig'men-ta-ry. Pertaining to pigment.

pi'la-ry. Pertaining to the hair.

pil'lar of the fau'ces. One of the mucous folds on each side of the throat. [randi.

pi-lo-car'pin. Active principal in jabo-

pi'lose (or **pi'lous**). Hairy; covered with

pi'lus. A hair. [soft hairs.

pim'ple. A small pustule or blotch.

pin'e-al. Shaped like a pine-cone.—**p. body or gland.** The small, reddish, vascular body in back part of the third ven-

pi'ni-form. Conical. [tricle.

pint. Eighth part of a gallon; weight, 7,000 grains. [carpus.

pi'si-form bone. A small circular bone of

pit of the stom'ach. The part of the abdomen just below the sternum.

pit'u-i-ta-ry. Secreting mucus; pertaining to phlegm.—**p. body or gland.** A small reddish body in sella turcica.

pla-cen'ta. The flat-round, spongy body forming organ of intuition for fetus; after-

pla-cen'tal. Pertaining to placenta. [birth.

plague. A contagious malignant epidemic

plan'ta. The sole of the foot. [disease.

plan'tar. Pertaining to sole of foot.—**p. arch.** Arterial arch in sole of foot.

plas'ma. Fluid part of blood and lymph.

pledg'et. A small wad of cotton or lymph.

pleth'o-ra. Abnormal fullness of blood-vessels. [the lungs.

pleu'ra. A serous membrane enveloping

pleu'ral. Pertaining to pleura.—**p. sacs.** Pleuræ.—**p. cavities.** Cavities of pleuræ.

pleu'ri-sy, pleu-ri'tis. Inflammation of the

pleu-rit'ic. Pertaining to pleurisy. [pleura.

plex'us. A network of nerves and veins.

pneu-mat'ic. Pertaining to gaseous fluids.

pneu-mo-gas'tric. Pertaining to lungs and stomach.

pneu-mo'ni-a. Inflammation of lungs.

pneu-mo-per-i-car-di'tis. Inflammation of pericardium attended with gas.

pneu-mo-per-i-car'di-um. An effusion of gas into pericardial sac.

pneu-mo-tho'rax. Gas or air in pleural sac.

pock. A small pustule of smallpox.—**p. marked.** Marked with pits or scars of smallpox.

poi'son. A venomous or toxic agent.

pol'lex (pl.-**li-ces**) The thumb or great toe.

pol-lu'tion. Defilement; uncleanness.

pol-y-he'mi-a. Abnormal increase of blood.

po'mum Ad-a'mi. A prominence in front of neck, due to thyroid cartilage; Adam's apple.

pons. A process or bridge of tissue connecting two parts.—**p. va-ro'li-i.** Connecting brain with spinal cord.

pop-li-te'al. Pertaining to the ham.—**p. space.** Space behind knee-joint. [joint.

pop-li-te'us. Ham or hinder-part of knee-

pore. A small opening in skin.

por'ta. A gate; the hilus of an organ.

por'tal. Pertaining to portal vein.—**p. circulation.** See page 188 body of book.—**p. vein.** Vein carrying blood from liver.

pos-te'ri-or. behind.—**p. nares.** Opening of nose into larynx.

post-mor'tem. After death.—**p. contraction.** Contraction of arteries after death.—**p. discoloration.** The color resulting from settling of blood into dependent parts.—**p. examination.** Examination of body after death; autopsy.—**p. rigidity.** Rigor mortis. **p. staining.** Staining due to transuded hemoglobin near surface or in skin.

pot'ash. A white solid deliquescent compound having a strong alkaline reaction and actively caustic. [ment.

po-tas'si-um. A bluish-white metallic ele-

po-to-ma'ni-a. Same as Dipsomania.

pouch. A sac-like part.

pound. A variable unit of weight or mass.

Pou'part's ligament. A thickened band of fascia that extends from upper anterior part of hip-bone over the vessel of thigh to pubis.

pre-cip'i-tant. Any agent, as a reagent, that when added to a solution causes a precipitation of one or more constituents.

pre-cip'i-tate. A substance separated by precipitation.

pre-cor'di-a. Epigastric region, including the thoracic organs in front of the heart.

pre-cor'di-al Pertaining to the precordia.

pre-dis-po-si'tion. A natural **tendency**.

preg'nan-cy. Condition of being with child.
pre-hen'sile. Fitted for grasping.
pre-hen'sion. The act of grasping.
pre-ma-ture'. Occuring before the proper time.—**p. burial.** Burial before life is extinct. [being preserved.
pres-er-va'tion. Act of preserving; state of
pre-serv'a-tive. Tending to keep from decay.—**p. solution.** A solution for preser-
pre-vent'ive. Warding off. [vation.
pri'ma-ry. First in origin.—**p. arteries.** The larger or first in their course.
prin'ceps. A main artery. [anything.
prin'ci-ple. Essence or primary quality of
proc'ess. A prolongation or prominence of a part.—**coracoid p.** A beak-shaped process of the scapula.
pro-cre-a'tion. Reproduction; generation.
pro-fun'da. A deep-seated artery.
prog-no'sis. Prediction of course and end of disease. [part.
pro-lapse', pro-lap'sus. A falling down of a
pro-lif-er-a'tion. Cell-generation; reproduc-
prop-a-ga'tion. Act of multiplying. [tion.
proper soil. A soil that will produce.
pro-phy-lac'tic. Pertaining to prophylaxis.
pro-phy-lax'is. Prevention of disease.
pros'tate gland. A gland at neck of bladder in the male. [an organ.
pro'te-id. An albuminoid constituent of
pro'te-in. A compound obtained from proteids. [proteids.
pro-te-o-lyt'ic. Causing the splitting up of
pro'to-plasm, pro-to-plas'ma. The viscid, contractile, semi-liquid substance, forming principal portion of animal and vegetable cells; germinal matter. [protoplasm.
pro-to-plas'mic. Of or pertaining to or like
pro'to-plast. Embryonic cell; protoplasm.
pro-trude'. To push out or extend forth.
pro-tu'ber-ance. A projecting part; prominence.
prox'i-mate (or **prox'i-mal**). Nearest.—**p. principle.** An ultimate element of a compound substance. [juice.
prune-juice spu'tum. The color of prune
prus'sic acid. Hydrocyanic acid.
pso'as. Loins; a muscle of the loins.
pter'y-goid. Resembling a wing.—**p. process.** Wing-like process on each side of sphenoid bone.
pter-y-go-pal'a-tine. Pertaining to pterygoid process and palate bone.
pto'ma-in. A putrefactive animal alkaloid.
pty'a-lin. An amylolitic ferment of saliva.
pty'a-lism. Excessive secretion of saliva.
pu'ber-ty. Age of capability of reproduction. [bone.
pu'bes. Anterior portion of innominate
pu'bic. Pertaining to pubes.—**p. arch.** Arch formed by junction of pubic bones.
pu'bis. A pubic bone.
pu'dic. Pertaining to the genitals.
pu-er'per-al. Pertaining to child-bearing.—**p. fever.** Child-bed fever.
pul'mo-na-ry. Pertaining to the lungs.—**p. circulation.** Purifying circulation of blood.—**p. tuberculosis.** Consumption of
pul-mon'ic. Pertaining to lungs. [lungs.
pul-mo-ni'tis. Inflammation of lungs. [tion.
pul-sa'tion. A beating or throbbing sensa-
pulse. Expansive impulse of arteries.—**p. beat.** Same as Pulse.—**p. rate.** Number of beats per minute. [strument.
punc'ture. A wound made by a pointed in-
pun'gent. Acrid; penetrating.
pu'pil. Round aperture in the iris.
purge. To purify or cleanse by carrying off through external opening of body.
purg'ing. Act of purifying or cleansing.
pu'ri-form. Having the nature of pus.
pur'pu-ra. Hemorrhages in true skin.
pu'ru-lent. Having the character of pus.
pus. Fluid product of suppuration.
pus'tu-lant. Causing pustules; an irritant that causes pustules.
pus'tule. A small purulent papule.
pu-tre-fac'tion. Act or process of putrefying; decomposition of animal or vegetable matter.
pu-tre-fac'tive. Of or pertaining to putrefaction; liable to decay; production of putrefaction.—**p. bacteria.** The micro-organisms which cause putrefaction.
pu'tre-fy. To cause to decompose or decay with fetid odor, render putrid; to become fetid from decay; rot. [to decay.
pu-tres'cent. Becoming putrid; beginning
pu-tres'ci-ble. Liable to decay.
pu'trid. Showing putrefaction; rotten; being in a state of putrefaction.
pu-trid'i-ty. That which has become putrid; corruption.
py-e'mi-a. Poisonous infection of the blood, due to absorption of vitiated pus or putrid animal secretions into the circulation; blood-poisoning.
py-lor'ic. Pertaining to pylorus.—**p. orifice.** The pylorus.—**p. valve.** Valve closing pyloric opening.

py-lo'rus. Opening between stomach and small intestine; adjoining portion of stomach. [tained in pus.
py-o-cy'a-min. Blue or violet pigment con-
py'oid. Resembling pus.
py-o'sis. Suppuration. [gan.
pyr'a-mid. Any conical eminence of an or-
py-ret'ic. Affected with or relating to fever.
py-rex'i-a. Abnormal condition of high bodily temperature; fever or feverishness; a paroxysm of fever.
pyr'i-form. Pear-shaped.
py-ro'sis. Chronic catarrh of the stomach.
py-u'ri-a. Passing of urine containing pus.

Q

quack. One who practices quackery.
quack'er-y. Medical charlatanism.
quad'rate. Square.—**q. lobule.** A small lobe of liver.
quad-ra'tus. Square or four-sided.
quad'ri-ceps muscle. A large muscle of the
quart. Fourth part of a gallon. [thigh.

R

rab'id. Affected with rabies or hydrophobia.
rac'e-mose. Resembling a bunch of grapes. —**r. glands.** Glands resembling bunches of grapes in structure.
ra'di-al. Pertaining to the radius.
ra'di-a-ting. Diverting from the center.
ra-di-a'tion. Condition of diverging from a
rad'i-cal. Belonging to the root. [center.
rad'i-cle. Primary root or stem; initial fibril of a nerve; beginning of a vein.
ra'di-us. Small bone of arm.
ra'dix. Root or root-like part.
rag sort'ers' disease. Anthrax. [a part.
ram-i-fi-ca'tion. Branching of an organ or
ram'i-fy. Branch-shaped; to divide and subdivide into branches or subdivisions.
ra'mose. Having many branches; branch-
ra'mus. A branch of an organ. [ing.
ran'cid. Fetid or sour, as fat.
rash. An eruption of the skin. [acid.
rats'bane. Common name for arsenious
re-ac'tion. Responsive action; the action of a reagent.
re-a'gent. Anything producing a reaction.
re-cep-tac'u-lum. A receiving vesicle or cavity.—**r. chyli.** Inferior expanded portion of chyle duct. [R. Take.
rec'i-pe. The caption of a prescription.
rec'tal. Pertaining to the rectum.
rec'tum. Lower part of the large intestine.
rec'tus. In a straight line; name of certain muscles.—**r. muscles.** A muscle that elevates or turns a part.
re-cum'bent. Reclining. [to health.
re-cu-per-a'tion. Convalescence; returning
re-cur'rence. A return.
re-cur-rent. Returning at intervals.
re-duce'. To decompose. [tion.
re-duc'tion. Restoration to a normal situa-
re-du'pli-cate. To repeat again and again;
re-fine'. To make fine or pure. [to multiply.
re'flex. Turned or thrown back; pertaining to or produced by reflex action.—**r. action.** An involuntary action from nerve-stimu-
re'flux. Flowing back; returning. [lus.
reins. The kidney or region of kidney.
re'gion. A certain part or division of body.
re'gions of the ab-do'men. See Text.
re'gion-al. Pertaining to a region.—**r. anatomy.** Study of correlated regions of body.
re-gur'gi-tate. To throw or pour back; cause to surge back. [slacken.
re-lax'. To make loose; to become loose;
re-lax-a'tion. Morbid looseness of an organ or part. [disease.
rem'e-dy. An agent used in treatment of
re'nal. Pertaining to the kidneys.
ren'i-form. Shaped like a kidney.
ren'in. A substance found in the kidney.
ren'net. An infusion of the inner coat of a calf's stomach.
ren'nin. A gastric ferment curdling milk.
ren'o-vate. To make as good as new; to make thoroughly clean; purify.
re-ple'tion. Condition of being full.
re-pro-duce'. To bring forth offspring.
res'er-voir. A receptacle for liquids.—**r. of the thymus.** A receptacle in thymus gland.
res-pi-ra'tion. Inspiration and expiration of air by the lungs.
re-spir'a-tory. Pertaining to respiration. —**r. organs.** The lungs and certain muscles.—**r. tract.** The passage from mouth and nose to air-cells.
res'ti-form. Rope-like; twisted.
re-stor'a-tive. A remedy restoring health and strength. [phyxiated person.
re-sus-ci-ta'tion. Bringing to life of an as-
retch. To strain at vomiting. [growth.
re-tar-da'tion. Delay in development or
re'te. A network or decussation.—**r. mucosum.** A thin layer on under side of epidermis containing coloring-matter.
re-tic'u-lar. In the form of network; full of interstices.—**r. tissue.** Adenoid tissue.

re-tic'u-late. Network-like.
re'ti-form. Net-shaped.
ret'i-na. Internal coat of eye; expansion of [optic nerve.
ret-i-nac'u-lum. Band holding back a part.
ret'i-nal. Pertaining to retina.
re-tract'ile. Capable of being drawn back- [ward.
re-trac'tion. Shortening; drawing backward.
re'tro-. A prefix meaning backward or behind.
re-tro-flec'tion. A bending or flexing back- [ward.
ret'ro-grade. Receding or going backward.
rham'nose. A carbohydrate from various glucosids.
rhi'nal. Pertaining to or belonging to nose.
rib. One of the bones enclosing the chest. —**false r.** One of the five lower ribs not attached directly to sternum.—**floating r.** One of last two ribs.—**true r.** One of the seven upper ribs attached to sternum.
rice-wat'er e-vac-u-a'tions. Stool having the appearance of rice-water.
rig'id. Stiff; immobile.
ri-gid'i-ty. Stiffness; immobility.
rig'or. Coldness; stiffness; rigidity.—**r. mortis.** The rigidity after death.
ring. A circular opening.
rod-bac-ter'ri-a. Bacteria shaped like rods.
rods. Rod-like bodies of the retina.
Roent'gen rays. A recently discovered form of radiant energy that is sent out when the cathode rays of a Crooke's tube strike upon the opposite walls of the tube or upon any object in the tube; discovered by Prof. Roentgen, of Wurzburg.
rol'ler band'age. A long muslin or flannel strip for bandaging.
root. Base of an organ or its place of ori- [gin.
ros'trum. A projection or ridge.
rot. Decay; decomposition.
ro'ta-ry. Turning.
ro-ta'tion. Turning on the axis.
ro-ta'tor. A muscle turning a part.
round lig-a-ment. See Ligament.
ru-be'o-la. Measles.
ru-di-men'ta-ry. Undeveloped; not formed.
rump. End of backbone; the buttocks.

S

sab'u-lous. Gritty, like sand, said especially of particles found in pineal body and adjacent regions of the brain; sandy, said of an abnormal sediment in urine.
sa-bur'ra. Foulness of the stomach.
sa-bur'ral. Pertaining to saburra.
sac. A membranous pouch.
sac'cate. Sac-shaped; having a sac, bag, or [pouch.
sac'cha-roid. Resembling sugar.
sac'cha-rose. Cane sugar.
sac'cu-la-ted. Formed into a series of sac-like expansions; dilated and restricted alternately; encysted.
sa'cral. Pertaining to or situated near the [sacrum.
sa'cra me'di-a. Middle sacral artery.
sa'crum. Large triangular bone above the coccyx.
sag'it-tal. Arrow-shaped.—**s. suture.** A [saw-like seam.
sal. Salt.
sal'ic-yl-ate. A salt of salicylic acid.
sa'line. Salty; containing salt.
sa li'va. Secretion of salivary glands.
sal'i-va-ry. Pertaining to saliva.—**s. glands.** Glands that secrete saliva.—**s. ducts.** Canals that convey saliva to mouth.
sal-i-va'tion. An excessive flow of saliva.
salt. (1) Any union of a base with an acid; (2) Chlorid of sodium.
salt-pe'ter. Potassium nitrate; nitre.
salve. An ointment.
san-gui-fi-ca'tion. Formation of blood [from chyle.
san'guine. Bloody; hopeful; cheerful.
san'i-ta-ry. Pertaining to health.—**s. science.** Science of cleansing and making healthy.
san-i-ta'tion. Act of making healthy.
sa-phe'na. A name given to two large veins of the leg.
sa-phe'nous. Pertaining to saphena.
sa-pon-i-fi-ca'tion. A conversion into soap.
sap-ro-gen'ic. Pus-forming.
sap-rog'e-nous. Arising in decaying mat- [ter.
sap'ro-phyte. A plant deriving its substance from dead organic matter.
sap-ro-phyt'ic. Pertaining to a saprophyte.
sar-co-lem'ma. A delicate membrane surrounding muscle fiber.
sar-co'ma. A tumor of modified embryonic [connective tissue.
sar-to'ri-us. The longest muscle in body; tailor's muscle that aids in flexing knee.
sat'el-lite. Vein accompanying an artery.
sat'u-rate. To fill to excess.
sat-u-ra'tion. Condition of holding in solution of a solid capable of being contained.
scab. Crust formed over a wound or ulcer.
sca'bi-es. The itch; a contagious, parasitic skin-disease.
scale. A small lamina of detached cuticle or bone.
sca-le'nus. A muscle of the neck.
scalp. Integument covering cranium.

scaph'oid. Boat-shaped; hollowed out.—**s. bone.** A bone of carpus and tarsus.
scap'u-la. A large flat triangular bone of shoulder. [ease with scarlet eruption.
scar-la-ti'na. An epidemic contagious dis-
scar'let fever. Same as Scarlatina.
Scar'pa's triangle. A triangular space in upper front part of thigh.
sci-at'ic. Pertaining to ischium or hip-bone.
scir'rhus. A hard form of carcinoma.
scle'ra. Outer membrane of eyeball.
scle'ral. Pertaining to the sclera.
scle-ri'tis. Inflammation of the sclera.
scle-ro'sis. Morbid thickening of a tissue.
scle-rot'ic. Hard; indurated.
scrof'u-la. Tubercular disease of lymphatics; chromic edenitis.
scro'tal. Pertaining to scrotum.
scro'tum. Sac containing testes. [weight.
scru'ple. Twenty grains apothecaries
scurf. Exfoliated cuticle of scalp.
scu'ti-form Having form of a shield.
seam. A suture.
se-ba'ceous. Pertaining to or appearing like fat.—**s. glands.** Glands in the corium of the skin secreting sebum. [baceous glands.
se'bum. Fatty matter secreted by the se-
se-cre'ta. Substance secreted by a gland.
se-cre'tion. Functions of glands and follicles; substance secreted.
se-cre'to-ry. Performing secretion.
sec'tion. A division by cutting.
sed'a-tive. Soothing.
sed'en-ta-ry. Occupied in setting.
sed-i-ment. Matter settled from a liquid.
seg'ment. A small piece; section; lobe.
seg'ment-al. Pertaining to segment.
sel'la. A saddle-shaped body.—**s. turcica.** The pituitary fossa.
se'men. Fecundating fluid of male.
sem'i. Half.
sem-i-lu'nar. Crescent-shaped.—**s. valves.** Valves at pulmonary and aortic openings.
sem-i-mem'bra-nous. Partially membranous; a muscle of the thigh.
sem'i-nal. Pertaining to the semen.
se'nile. Aged; pertaining to senility.—**s. gangrene.** A gangrene of extremities in the aged. [becility.
se-nil'i-ty. Weakening of old age or im-
sen-sa'tion. Corporeal feeling.
sen'si-tive. Capable of feeling; easily affected by outside influences.
sense. The perceptive faculty.
sens'or-gran-ules. Sensorium; a common center of sensation.
sen-so'ri-al. Pertaining to the sensorium.
sen-so'ri-um. A common center of sensa-
sen'sor-y. Pertaining to sensation. [tion.
sep'sis. Putrefaction; septicemia.
sep'tic. Relating to putrefaction.
sep-tic-e'mi-a, sept-e'mi-a. A morbid condition from absorption of septic products.
sep-to-py-e'mi-a. Combined septicemia and pyemia.
sep-to-py-e'mic. Pertaining to septopye-
sep'tum. Dividing membrane or wall. [mia.
se'quel, se-que'la. A supervening disease.
ser-al-bu'min. Albumin of the blood.
se'ries. An order or arrangement of one after another according to some law or rule.
se-ro-fi'brin-ous. Composed of serum and fibrin.—**s. membrane.** A membrane composed of serum and fibrin.
se'rous. Having nature of serum.—**blood-s.** Whey; serum of milk.—**s. albumin.** Same as Seralbumin.—**s. globulin.** Same as Fibrinoplastin.—**s. cavities.** Cavities of the serous sacs.—**s. membrane.** That which secretes serous fluids.—**s. sacs.** The serous membranes.
ser'ra-ted. Notched like a saw.
se'rum. Fluid constituent of blood.
ses'a-moid. Resembling a grain.—**s. bones.** Small bones developed in tendons.
sex. The state or condition of being either
sex'u-al. Pertaining to sex. [male or female.
shaft. A long and cylindrical body or part.
shank. Popular name for the tibia or shin.
sheath. Covering; an investing substance.
shin. The anterior edge of the tibia.
shin-bone. The tibia.
ship-fever. Typhus fever.
shock. A sudden or violent sensation; a stroke; prostration of bodily functions.
shoul'der. Part of trunk between neck and free portion of arm.—**s.-blade, s.-bone.** The scapula.
shred. A small, irregular or jagged strip torn or cut off; fragment or particle.
shred'dy. Consisting of or characterized by
sigh. A long, deep inspiration. [shreds.
sight. The faculty of vision.
sig'moid. Shaped like Greek letter S.—**s. flexure.** Lower part of colon.
sil'i-ca. Silicon dioxid.
sil'i-con. Non-metallic element. [substance.
sim'ple. Not compound; consisting of one
sim-u-la'tion. Counterfeiting disease.
sin'ci-put. Anterior and upper part of head.
sin'is-ter. Pertaining to the left; left.

sin'u-ous. Waxy; winding.

si'nus. A hollow, cavity, recess, or pocket; a large channel containing venous blood; a cavity within a bone.—**s. venosus.** A dilatation of the termination of venous channels, forming a separate chamber.

skel'e-ton. The frame-work of the body, composed of bone and cartilage.

skin. The membranous external investment of an animal; the integument.—**true s.** Cutis or derma.—**s.-slip.** Slipping of the cuticle.

skull. Bony frame-work of head; cranium.

skull'cap. The sinciput; calvarium.

slough. To cast off, as dead from living tissue; shed; to separate or fall away; dead tissue separated and thrown off from the living parts; a scab.

small'pox. An acute, specific, infectious disease, resulting from a specific morbid poison. [perceived; the olfactory sense.

smell. Sense by means of which odors are

sneez'ing. An explosive expulsion of air through the nasal passages and mouth.

snor'ing. Breathing through the nose and open mouth with a hoarse rough noise.

sock'et. The concavity of an articulation.

so'da. A white alkaline compound; sodium carbonate; sal soda.

so'di-um. A silver-white alkaline metallic element.—**s. chlorid.** Common salt.

soft. Not bony or cartilaginous.—**s. palate.** Soft posterior portion of the mouth.

sof'ten-ing. Making or becoming soft; morbid degeneration or softening of a part.

so'lar plex'us. A large plexus of nervous system found in front of spine.

sole. Bottom surface of foot. [tending foot.

so-le'us. A muscle of calf that assists in-ex-

sol'i-ta-ry. Not in a cluster; single; separate—**s. glands.** Scattered lymphoid follicles in walls of small intestines.

sol-u-bil'i-ty. State of being soluble.

sol'u-ble. Capable of being dissolved; dissoluble.

so-lu'tion. Diffusion of a solid in a liquid.

sol'vent. Having power of dissolving; a liquid capable of dissolving substances.

so-mat'ic. Pertaining to body; physical; corporeal.—**s. death.** Death of entire body.

so-por-if'ic. Medicine that produces deep sleep.

sore. An ulcer, chafe, or wound; painful.

sound. Sensation produced through organ of hearing; having all organs or faculties intact. [tart.

sour. Opposite of sweet to the taste; acid;

space. Inclosed or partially inclosed part

spas-mod'ic. Pertaining to spasm. [of body.

spe-cif'ic. Distinctly or plainly set forth; specific; having some distinct medicinal or pathological property.—**s. gravity.** The weight of a substance compared with water. [Suspensory cord of testis.

sper-mat'ic. Pertaining to semen.—**s. cord.**

sphe'noid. (1) Cuneiform; wedge-shaped. (2) One of the small cranial bones at an-

sphere. A globe. [terior base of skull.

spher'i-cal. Like a sphere.

sphe'roid. A solid resembling a sphere.

sphinc'ter. A muscle constricting an orifice.—**s. ani.** Muscle constricting the anus.

spic'u-la. A small spike-shaped fragment of bone. [ments of bone.

spic'u-la-ted. Full of spike-shaped frag-

Spi-ge'li-an lobe. A lobe of the liver projecting backward.

spi'nal. Pertaining to spine.—**s. canal.** Hollow within vertebral column.—**s. column.** Back-bone.—**s. marrow.** Spinal cord.—**s. nerves.** Nerves given off from

spine. The vertebral column. [spinal cord.

spi'ral. In the form of a corkscrew.

Spi-ril'lum (pl. **spi-ril'la**). A spiral-formed bacterium.—**s. choleræ Asiaticæ.** Bacterium that causes cholera. [substance.

spir'it. An alcoholic solution of volatile

splanch'non. The viscera; the entrails.

splanch'nic. Pertaining to the viscera.

spleen. Largest ductless gland in body.

splen'ic. Pertaining to the spleen.

splen-i-za'tion. Becoming like the spleen.

splint. A support for ends of a fractured

spon'gi-form. Similar to a sponge. [bone.

spon'gy. Porous; like a sponge.

spore. Reproductive organ of a cryptogam; any germ or reproductive element less organized than a true cell.

spon-ta'ne-ous. Taking place without aid or volition.

spo-rad'ic. Scattered; occurring in isolated cases.—**s. cholera.** Cholera morbus.

spo-ro-gen'ic, spo-rog'e-nous. Producing spores; producing by means of spores.

spot'ted fever. Cerebrospinal meningitis.

sprain. A violent straining of ligaments.

spray. Liquor vaporized by a strong air

spu'tum. Expectorated matter. [current.

squa'ma. A scale or lamina.

squa'mous. Scaly.

sta'bi-le. Not moving; permanent.

stage. A period of disease.

stag'nate. To cease motion.

stag-na'tion. Cessation of motion.
stain. A dye; a discoloration.
stanch. To check or stop a flow.
stand'ard. An established rule or model.
starch. Amylum.
sta'sis. Stagnation of the blood current.
ste-ap'sin. An unorganized ferment contained in pancreatic juice.
ste'ar-in. A compound of stearic acid and glyceryl found in the harder animal fats.
stench. An ill-smell; an offensive odor.
sten-osed'. Narrowed; contracted.
sten-o'sis. A narrowing or constriction.
Sten'son's duct. See Duct.
ster'ile. Barren; not fertile.
ster-il-i-za'tion. Destruction of germs by heat or a disinfectant.
ster'il-ize. To render sterile or unproductive.
ster'il-i-zer. Instrument for sterilization.
ster'nal. Pertaining to the sternum.
steth'o-scope. A tube for conveying sounds in auscultation.
stim'u-lant. An agent increasing functional activity.
stim'u-lus. Anything exciting an organ.
stitch. A sharp laminating pain; to sew.
sto'ma. The mouth.
sto-ma-ti'tis. Inflammation of the mouth.
stom'ach. Chief digestive organ of body.
stool. Evacuation of the bowels.
stran'gu-la-ted. Constricted to such degree as to have its circulation cut off.—**s. hernia.** Irreducible hermia.
stran-gu-la'tion. Act of strangulating; the state of being strangulated.
strat'i-fied. Arranged in layers.
strat'i-form. Formed into layers.
stra'tum. A sheet or layer of tissue characterized by some special form or arrangement of structure.—**s. corneum.** Outer epidermic layer.—**s. granulosum.** Granular layer of the retina.
strep-to-coc'cus. A curved or twisted chain of micrococci.
stri'ate. Marked with furrows.
stric'ture. A contraction of a duct or tube.
stroke. A popular name for apoplexy.
stro'ma. Foundation tissue of an organ.
struc'ture. An organ; composition of an organ.
stru'ma. Scrofula.
strych'ni-a. An alkaloid of nux vomica.
sty'li-form. Resembling stylus.
sub-a-rach'noid. Beneath arachnoid coat of brain.—**s. space.** Space beneath arachnoid coat of brain.
sub-cla'vi-an. Under the collar-bone.
sub-cu-ta'ne-ous Beneath the skin.
sub-di-vi'sion. After the first division.
sub-ja'cent. Next to.
sub'ject. A body for dissection.
sub-jec'tive. Internal; pertaining to one's self.
sub-lin'gual. Beneath the tongue.—**s. gland.** Gland beneath tongue.
sub-max'il-la-ry. Beneath the lower jaw.
sub-mer'sion. State of being submerged.
sub-mu'cous. Beneath mucous membrane.
sub-per-i-to-ne'al. Beneath peritoneum.
sub-serv'i-ent. Acting in interest of another.
su'dor. Sweat; perspiration.
su-dor-if'er-ous. Producing sweat.—**s. glands.** Sweat-glands.
suf-fo-ca'tion. A stoppage of respiration.
sul'ca-ted. Grooved; furrowed.
sul'ci of brain. Depressions between convolutions.
sul'phate. A salt of sulphuric acid.—**s. of aluminum.** Aluminum and sulphuric acid combined.
sulphid. A combination of sulphur with an element.
sul'phur. Brimstone.
sul'phu-ret-ed hy'dro-gen. Sulphur and hydrogen combined; a gas.
sul-phu'ric. Combined with sulphur.—**s. acid.** One of the mineral acids.
su'per-. A prefix denoting upon or above.
su-per-fi'cial. Near or confined to the surface.—**s. fascia.** A fibro-areolar tissue just beneath the skin.
su-pe'ri-or. The upper.
su'pi-na-ted. Turned upon the back.
su-pi-na'tion. A turning of the palm upward; the attitude of lying upon the bed.
su'pi-na-tor. A muscle that supinates.
sup-ple-men'tal air. Air remaining in lungs after a normal expiration.
sup-pres'sion. Concealment; retention.
sun'stroke. A sudden cerebral disturbance due to excessive heat, usually of the sun.
sum'mer complaint. The cholera of infants.
sup-pu-ra'tion. The formation of pus.
su'pra-. A prefix, above, beyond, or upon.
su-pra-or'bit-al. Above orbit of the eye.
su-pra-re'nal. Above the kidney.—**s. body or capsule.** A gland-like organ of unknown function situated upon the kidney.
su'ral. Pertaining to calf of leg.
sur'face. Exterior or face of body.
sus-cep-ti-bil'i-ty. State of being easily influenced.
sus-cep'ti-ble. Sensitive to an influence.
sus-pend'ed an-i-ma'tion. Temporary cessation of vital functions.
su'ture. Junction of cranial bones; seam.
sweat. Secretion of sweat-glands.—**s. ducts.** Canals leading from sweat-glands to pores. **s.-glands.** Sudoriferous glands.

sweet'bread. The pancreas.
swell'ing. Tumefaction; enlarging.
Syl'vi-us, fissure of. Fissure between anterior and middle lobes of cerebrum.
sym-pa-thet'ic system. Series of ganglions and nerves dominating the viscera and involuntary muscles.
sym'phy-sis. A junction of bones.—**s. pubis.** A junction of pubic bones.
syn-ar-thro'sis. Immovable articulation.
syn-chon-dro'sis. Union by intervening [cartilage.
syn'co-pe. Swooning or fainting.
syn-o'vi-a. Lubricating fluid of a synovial membrane.
syn-o'vi-al. Pertaining to synovia.—**s. membrane.** Sac containing synovia within a joint.
syn'the-sis. A formation of a compound by [uniting elements.
syn-thet'ic. Pertaining to synthesis.
syph'i-lis. A specific infectious venereal dis- [ease.
syr'inge. Instrument for injecting fluids.
sys'tem. Methodic arrangement of parts; [animal economy.
sys-te-mat'ic. Methodic.
sys-tem'ic. Pertaining to a system.—**s. circulation.** Entire circulation of body.
sys'to-le. Contraction of heart and arteries.

T

ta'ble. A layer or plate of bone.—**t. of the skull.** Internal and external plates of the [bone.
tache. A spot or coloration.
tac'tile. Pertaining to sense of touch.
tail. The caudal extremity.
tam'pon. A plug of lint or cotton.
tap'ping. Removing water or other fluid [from cavities.
tar'sal. Pertaining to tarsus.
tar'sus. The instep.
tear-duct. See Duct.—**t.-gland.** See Lach- [rymal gland.
tears. The secretion of the lachrymal gland.
teeth. Organs of mastication.
teg'u-ment. Relating to the skin.
tem'per-a-ture. Degree of intensity of heat. —**normal t.** Temperature of a body in a state of health.
tem-po-ro-max'il-la-ry. Pertaining to temporal and inferior maxillary bones.
ten'di-nous. Pertaining to a tendon.
ten'do, ten'don. A white, fibrous tissue, the attachment of muscles.—**t. of A-chil'les.** Large tendon of heel.
ten'sion. Act of stretching.
ten'sor. A muscle making a part tense.
tep'id. Warm; about blood heat.
te'res. A round muscle.—**t. lig'a-ment.** Round ligament of hip-joint.
es'tes. Glandular bodies in scrotum.

tet'a-nus. A disease produced by bacillus tetani; lockjaw.—**t. ne-o-na-to'ri-um.** A spasmodic disease of infants.
tet-ra-coc'cus. A micrococcus occurring in clusters forming groups of four.
ther-mom'e-ter. An instrument for measuring intensity of heat.—**cen'ti-grade t.** See Centigrade.—**Fah'ren-heit t.** One in which the interval between freezing and boiling points is divided into 180 degrees, the zero point being 32 degrees below freezing of water.
thigh. Upper part of lower extremity.—**t. bone.** Bone of the thigh; femur.
tho-rac'ic. Pertaining to thorax.—**t. aorta.** Descending aorta within chest.—**t. viscera.** Viscera within thorax.
throat. Anterior part of neck.
throm-bo'sis. Formation of a thrombus.
throm'bus. A blood-clot in a vessel at point of obstruction.
thumb. The inner digit of hand or foot.
thy'mus. Glandular organ at base of tongue.
thy'roid. Scutiform or shield-shaped.—**t. body.** A ductless glandular body at upper part of trachea.—**t. cartilage.** Largest laryngeal cartilage.
tib'i-a. Inner and larger bone of the leg.
tinc'ture. Alcoholic solution of medicinal substance.
tis'sue. An aggregation of similar cells and fibers forming a distinct structure.—**a. re'o-lar t.** A form of connective tissue made up of cells and delicate elastic fibers interlacing.—**ad'i-pose t.** Connective tissue with flat cells lodged in the meshes.—**car-ti-lag'i-nous t.** Cartilage.—**connective t.** General name for all tissues of body that support essential elements or parenchyma.—**ep-i-the'li-al t.** Epithelium.—**fi-bro-a-re'o-lar t.** Tissue made up of fibrous and areolar tissue.—**mus'cu-lar t.** Muscle. —**ner-vous t.** See Nerve.—**os'se-ous t.** [See Bone.
toe. A digit of the foot.
tongue. Organ of taste and speech.
ton'ic. Relating to tone.—**t. contraction.** A continuous contraction. [fauces.
ton'sil. A glandular organ on each side of
tor'cu-lar He-roph'i-li. A cavity before internal occipital protuberance for venous sinuses. [inactive.
tor'pid. Affected with torpor; benumbed;
tor'sion. A twisting.
tor'tu-ous. Crooked.
touch. The tactile sense; palpation.

tox-e'mi-a. A poisoned state of blood.
tox'ic. Poisonous.
tox-i-co-gen'ic. Producing poison.
tox-if'er-ous. Carrying poison.
tox'in. Any toxic ptomain.
tra'che-a. The windpipe.
tract. A distinct more or less defined region usually much longer than broad; a course. —**alimentary t.** Alimentary canal extending from mouth to anus.—**digestive t.** See Alimentary Tract.
trac'tion. A drawing or pulling. [syncope.
trance. A form of catalepsy; protracted
trans-fu'sion. A transfer of blood into the
tran'sient. Temporary. [veins.
trans-lu'cent. Partly transparent.
trans-mi-gra'tion. Passage of cells through a membranous septum.
trans-mis'sion. Transfer of a disease.
tran-spi-ra'tion. Act of passing fluid, vapor, or gas, through a membrane.
tran-su-da'tion. An oozing of fluid through skin and other tissues.
tran-sude'. To ooze through.
trans-ver-sa'lis. A structure that lies across another.—**t. fascia.** Fascia that passes across abdomen beneath the muscles. **t. col'li.** Muscle of back part of neck.
trans-verse'. Lying across. [row.
tra-pe'zi-um. First bone of second carpal
trau'ma. A wound; an injury.
trau-mat'ic. Pertaining to a wound.
trau'ma-tism. Condition of one suffering from injury. [sides and with three angles.
tri'an-gle. Space bounded by three lines or
tri'ceps. Three-headed muscle of the arm.
tri-chi'na. A genus of nematode worms.
tri-cus'pid. Three pointed.—**t. valve.** Valve between right auricle and ventricle.
troch'le-a. A pulley-like process. [ities.
trunk. Body except head, neck, and extrem-
tryp'sin. A proteolytic ferment contained in pancreatic juice.
tryp-sin'o-gen. A granular substance contained in cells of pancreas.
tube. A pipe-like structure or instrument. —**air t.** The bronchial tube.
tu'ber-cle. A small eminence; a small nodule of granular cells constituting the condition called tuberculosis.
tu-ber'cu-lar. Pertaining to or containing tubercule.—**t. bacilli.** The bacilli that cause tuberculosis.—**t. men-in-gi'tis.** Meningitis caused by tubercular bacilli.
tu-ber-cu-lo'sis. Infectious disease due to presence of tubercular bacilli; consump-
tu'bule. A minute tube. [tion.
tu-me-fac'tion. A swelling of a part.
tu'mor. A swelling; abnormal enlargement. —**benign t.** One that is not malignant. —**cystic t.** One made up of cysts.—**encysted t.** Having cysts.—**fibroid t.** A fibroma.—**malignant t.** One that eventually destroys life.—**ovarian t.** A tumor connected with the ovary.
tu'ni-ca. An enveloping or lining membrane.—**t. ad-ven-ti'ti-a.** Outer coat of an artery.—**t. in'ti-ma.** Inner coat of an artery.—**t. me'di-a.** Middle coat of an artery.
tur'bi-nal. Turbinated bones.
tur'bi-na-ted. Top-shaped. [of an organ.
tur-ges'cence. A swelling or enlargement
tur'gid. Unnaturally distended, as by con-
tym-pan'ic. Drum-like. [tained air or liquid.
tym'pa-num. The middle-ear cavity. [form.
type. A representative or characteristic
ty'phoid. Resembling typhus; an infectious fever marked by great prostration.
ty'phus fever. An epidemic contagious
typ'i-cal. Characteristic. [fever.

U

ul'cer. Suppuration upon a free surface; an open sore.
ul-cer-a'tion. Process of ulcer-formation.
ul'na. Large bone of forearm.
ul'nar. Relating to the ulna.
ul'ti-mate. Farthest or most remote.
um-bil'ic-al. Pertaining to umbilicus.—**u. arteries.** Arteries of umbilical cord.—**u. cord.** See Cord, Umbilical.—**u. region.** Region around umbilicus.—**u. vein.** Vein of umbilical cord.
um-bi-li'cus. The naval. [sensibility.
un-con'scious-ness. State of being without
unc'tion. Act of anointing; anointment.
unc'tu-ous. Greasy.
un'guent. An ointment.
u-ni-cel'lu-lar. Having but one cell.
u-ni-lat'er-al. Affecting but one side.
un-stri'a-ted. Not striped.—**u. muscular fiber.** Involuntary muscular fiber.
up'per ex-trem'i-ties. Organs of tact and prehension; arms. [umbilicus.
u'ra-chus. A fibrous cord from bladder to
u're-a. Chief solid constituent of urine.
ur-e'mi-a. Toxic condition of blood from accumulation of urea.
ur-e'mic. Due to or marked by uremia.

u-re'ter. Tube carrying urine from kidney to bladder.
u-re'thra. Excretory canal of bladder.
u'ric. Pertaining to urine.—**u. acid.** White, tasteless, almost insoluble compound found in urine and elsewhere.
u'ri-na-ry. Pertaining to urine.—**u. canal.** Canal including ureter, bladder, and urethra.
u'rine. Excretion of the kidneys.
u-ri-nif'e-rous. Carrying urine.—**u. tu'bules.** Minute canals in renal substance.
u'ter-ine. Pertaining to the uterus.
u'te-rus. The womb.
u'vu-la. Pendent fleshy portion of the soft palate.

V

vac-ci-na'tion. Inoculation with vaccine virus to protect against smallpox.
vac'cine. Lymph from a cowpox vesicle.
vac-cin'i-a. Cowpox.
vac'u-um. A space exhausted of air.
va-gi'na. Canal from vulva to uterus.
vag'i-nal. Pertaining to vagina.
valve. A fold across a canal or opening obstructing passage in one direction.
val'vu-læ con-ni-vent'es. Folds of mucous membrane in the small intestine.
valv'u-lar. Pertaining to a valve.
va'por. Gaseous form of a substance.
var'i-cose. Swollen; knotted.—**v. veins.** Knotted veins usually in lower extremities.
va-ri'o-la. Smallpox.
va'ri-o-loid. Slight form of smallpox modified by vaccination.
vas (pl. **va'sa**). A vessel or duct.
va'sa brev'i-a. Short vessels.—**v. va-so'rum.** Vessels of a vessel; minute blood-vessels that supply coats of other vessels.
vas'cu-lar. Pertaining to vessels or ducts. —**v. system.** Entire arrangement of vessels for the circulation of fluids of body.
vas-cu-lar'i-ty. Quality of being vascular.
vas-o-mo'tor. Producing movement in the walls of vessels.
veg-e-ta'tion. Morbid; having fungous growth.
vein. A vessel returning blood to heart.
ve'lum. A veil or veil-like structure.
ve'na. A vein.—**v. portæ.** Portal vein.—**v. cava.** One of the largest veins (superior and inferior) that enter the right auricle.
ve'næ com'i-tes. Two veins accompanying an artery.
ve'nous. Pertaining to a vein.—**v. congestion.** An excessive amount of venous blood in small vessels of surface.—**v. valves.** Valves in veins of extremities that prevent blood from flowing backward.
ven'ter. The abdomen or belly.—**v. of the ilium.** The iliac region. [Region of belly.
ven'tral. Pertaining to belly.—**v. region.**
ven'tri-cle. (1) A small belly-like cavity. (2) Upper right and left cavities of heart.
ven'ules. Little veins.
ver'mi-form. Worm-like.—**v. appendix.** A worm-shaped tube opening into cecum.
ver'te-bra (pl. **-bræ**). A bony segment of spinal column.
ver-te-bral. Pertaining to a vertebra.—**v. column.** Spinal column; back-bone.
ver'tex. Crown or top of head.
ver'ti-cal. In a perpendicular line.
ve-si'ca. The bladder.
ves'i-cal. Pertaining to or supplying bladder.
ves-i-ca'tion. Production of a blister.
ve-sic'u-lar. Pertaining to vesicals.
ves'sel. A tube conveying fluids of body.
vi'a-ble. Capable of maintaining life.
vi-bra'tion. A swinging back and forth.
vi-ca'ri-ous. Taking place of another; assumption of function of an organ by another.
vil'lus (pl.-li). One of numerous minute vascular projections from mucous membrane of intestines.
vir'u-lence. Noxiousness; malignity.
vir'u-lent. Having nature of a poison.
vi'rus. A morbid product; a pathogenic microbe.
vis'ce-ra. Contents of cavities of body.
vis'cer-al. Pertaining to viscera.—**v. anatomy.** Anatomy of the viscera.
vis-cid. A gummy substance produced in viscous fermentation.
vis'cus (pl. **vis'ce-ra**). Any organ enclosed within one of the great cavities of body.
vi'sion. Sight.
vis'u-al. Pertaining to vision.
vi'ta. Life.
vi'tal. Pertaining to life.—**v. functions.** Those upon which life depends.—**v. organs.** Throat, lungs, brain, and all other essential organs to life.
vi-tal'i-ty. Vital principle of life.
vi'tals. Organs essential to life.
vi-tel'lus. Protoplasmic contents of ovum that feed developing embryo.
vit're-ous. Glass-like. **v. humor.** A transparent jelley-like tissue filling ball of eye.
vo'cal. Pertaining to voice.—**v. cords.** Small cords at glottis.
voice. Sound produced by vibration of the vocal cords.
vol'a-tile. Readily evaporating.

vo-li'tion. The power of willing.
vol'untary. Under control of the will.—**v. muscle.** A muscle under control of will.
vol'vu-lus. A twisting of an intestine.
vo'mer. Thin plate of bone between nostrils.
vom'it. To eject from stomach through mouth.
vul'va. External opening of female genital organs.

W

waist. Narrow portion of trunk above hips.
walls. Sides of any cavity or vesicle.
waste material. Excretions of the body.
white of the eye. The conjunctiva.
Wil'lis, circle of. Circle formed by arteries at base of brain to equalize pressure.
wind'pipe. Tube leading from pharynx to the air-cells; trachea.
womb. See Uterus.
Wor'mi-an bones. Small bones in cranial sutures.
wound. Break in continuity of soft parts.
wrist. The carpus.—**w.-joint.** Joint of the carpus and forearm.

X

xan-thic. Yellow.
xan'thin. A white crystalline compound contained in blood, urine, and other secretions.
xan-tho-der'ma. A morbid yellowness of the skin.
xiph'oid. Sword-like.—**x. appendix.** Third and last piece of sternum.
X-rays. Popular name for Roentgen rays.

Y

yawn-ing. Deep inspiration; gaping.
yel-low fe'ver. An epidemic disease of hot moist regions.
y-lig'a-ment. Ileofemoral ligament.

Z

zyg-o-mat'ic. Pertaining to cheek-bone.
zy-mot'ic. Relating to fermentation.—**z. diseases.** Any epidemic, endemic, or contagious disease, produced by some morbific principle acting on system like a ferment.
zy'mo-gen. A substance that develops by internal changes, without apparent decomposition, into a chemical ferment or enzyme.

ADDENDA.

al-bu'mose. A first product of the splitting of proteids by enzymes.
a-me'ba. A genus of rhizopods.
am-e'boid. Having movements of an ameba.
am'id. A compound derived from ammonia by substitution of an acid radicle for hydrogen.
am-pho-ter'ic. Having power of altering both red and blue test-paper.
am'yl-um. Starch; a valuable nutrient.
ben'zene, ben'zol. A liquid hydrocarbon from coal-tar.
car-bam'id. Urea.
cho-les'ter-in. A monatomic alcohol, found in blood, nerve-tissue, and bile.
del-i-ques'cent. Liquefying from absorption of atmospheric moisture.
di'as-tase. A nitrogenous ferment of malt.
e-las'tin. Main constituent of yellow elastic tissue.
en'zym. An unorganized, hydrolytic ferment.
eth'yl-ene. Bicarbureted hydrogen.
fi-bro'ma. A tumor of fibrous tissue.
fi-brin-o-plas'tin. See Paraglobulin.
glu'co-side. A body containing glucose with some organic principle.
hy-dra'tion. Impregnating a substance with water.
hy-dro-lyt'ic. Producing decomposition of water.
ke'tone. A compound of carbonic oxid with two univalent hydrocarbons.
malt'ose. A sugar derived from action of diastase on barley.
nu-cle-o-al-bu'min. A nuclein from cell-protoplasm.
nu-cle-o-pro'te-id. A nuclein having a relatively large amount of albumin.
par-a-glob'u-lin. A native proteid from blood-serum.

GENERAL INDEX

C

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E

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G

T

U

V

W