LIFE WITH HEALTH

HURTY

R. K. ROW & CO.

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A TEXT-BOOK

ON

PHYSIOLOGY, HYGIENE, AND SANITATION

BY

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"I am come that they might have life, and that they might have it more abundantly."—BIBLE.

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PREFACE.

When one looks into a primary schoolroom and sees ninety per cent of the children appearing well nourished, plump, rosy-cheeked, strong, bright-eyed, and joyous, and then passes to a group of children from twelve to fourteen years of age to find thirty or forty per cent looking ill-nourished, anemic, pale, dull-eyed, listless, or fretful, he cannot avoid asking why such changes have come over so many. If he pursues his enquiry carefully, he must conclude that many of the latter group of children have not been living right. He must admit that, in some important respects, these older children have not only not improved, but have actually degenerated. Home life and school life have not ministered to an all round, wholesome growth and development. The process of education, in the broad meaning of that term, has failed in some important particulars.

That all children should learn to observe the essential principles of physiology and hygiene is now a generally accepted item of educational theory. It is equally clear that home instruction and training can only partially and inadequately meet this need, and, hence, that a share of such instruction and training must be assumed by the schools.

The early attempts to meet these demands have naturally been crude and very unsatisfactory. The textbooks prepared for children have been either the texts of medical colleges in anatomy and physiology more or less *written down* for children, or unscientific discussions of matters of little vital interest or importance to the great majority of boys and girls. An appreciation of the real situation, and of the problems involved, is developing among thoughtful parents and educators. The problems do not lie primarily in anatomy and technical physiology, but in how children live in the home and the school. It is true they have to do with the organs of respiration, circulation, digestion, and with the nervous system, but they have more directly to do with the air the children breathe, the food they eat, with cleanliness, clothing, rest and recreation; in short, with all those things which make up the life experiences of the children.

There is no real separation between home and school. The child's life is unified, hence these problems must be stated and discussed in such a way that the reference is to the whole life, and the school instruction should carry over to home interests and home experiences.

This book is written from this point of view, and with the hope that those who study it may be helped in forming rational habits of right living.

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CHAPTER I

INTRODUCTION

HYGIENE

According to mythology, Hygeia was the daughter of Aesculapius, the god of medicine. The story tells us that Aesculapius, being touched by the suffering of mankind, entered upon the life work of curing disease. His daughter Hygeia observed that most of the sickness which plagued the world was brought on by bad living, such as gorging with food, eating unwholesome food, drinking wines, drinking impure water, breathing impure air, and paying insufficient attention to cleanliness. She concluded, therefore, that it was better to prevent disease than to get it and then try to cure it. In this she was far wiser than her father. Ill health, she plainly saw, was largely the result of ignorance and carelessness. That is the keynote of this book.

Education in right living, then, is the way to health, and to the enjoyment of abundant life. And this is *Hygiene.* A knowledge of the subject requires, to some degree, the study of the structure of the body, and, to a considerable degree, the study of *physiology,* which treats of the organs of the body and the work they perform. Hygiene has two divisions—*moral* and *physical.*

Moral Hygiene is of first importance. A healthy mind must lead a healthy body. Without moral health man is, indeed, a failure. Clean thoughts are necessary for clean living. We should reject bad thoughts from our minds as we exclude poison from the stomach. Let the mind contemplate good and beautiful and true things, and the expression of the face and the actions will be those of a a real human being. The secret of genuine success and happiness is to do good to others, for the sake of doing good. There should be constant effort to learn and improve the mind, not in order to achieve triumphs over others, but that we may be better able to help others. The patriarch of old understood the situation when he wrote: "If thou wilt diligently hearken to the voice of the Lord thy God, and wilt do that which is right in his sight, and wilt give ear to his commandments, and keep all his statutes, I will put none of those diseases upon thee, which I have brought upon the Egyptians; for I am the Lord that healeth thee."

Youth is the time to learn and to commence the practice of moral hygiene. The fields, the waving grain and flowers, and the great trees, live pure lives, speak only clean and kind words. Observe them, for they are free from envy, hate, impatience, and moral unhealthfulness.

Cheerfulness is taught by moral hygiene. It is impossible to be a truly good man and not be cheerful, nor can a cheerful countenance naturally accompany evil thoughts and deeds. The commandment to "Honor thy father and thy mother" is followed by a promise of long life, and this implies that there is health and long life in moral actions. It is moral hygiene to practice temperance and moderation in thought and deed. Happiness can only come from doing good things. Slothfulness, idleness, ignorance, unkindness, impatience, untruthfulness, and dishonesty, bring unhappiness, and unhappiness breaks down the health.

> "Know then this truth (enough for man to know)
> Virtue alone is happiness below."

Physical Hygiene.—Perfect and complete living should be the desire of every one. It is a duty to keep oneself healthy. The great educator, Horace Mann, was once asked as to his health. He replied: "I am ashamed to say I do not feel well to-day." He had probably eaten too much the day before, or had been intemperate in his work. To know what to do to preserve and improve the health of the body, is to have a knowledge of physical hygiene. The first step is to know and to understand as much as possible about our bodies. We must learn how we are made, and of what we are made. The organs of the body, and the work they do, must be familiar to us. The conditions under which they are intended to perform their functions must be known, and lastly, we must be wise and train ourselves to observe the conditions.

In the study of hygiene we must consider the body as a mechanism, for, indeed, it is a mechanism that is endowed with that marvelous force called life. The body is of curious origin and history, and of remarkable complexity. It is the most wonderful of machines, receiving its energy in the form of air and food, and being very sensitive to its surroundings.

A living body is in many ways like a watch. If the watch is in good order, running well, and keeping correct time, we say it is a good and normal timepiece. So, also, if the body is in good order, working well, producing good thoughts and good deeds, it is a normal and healthy body. If it is not in good working order, if the functions of the various organs are not properly performed, if there is weakness, if there is pain and discomfort, or if the mind is not right, we say there is illness or disease. Health is a normal condition; disease is an abnormal condition.

The living body, like the watch, may be well or poorly constructed; of good or of mean material; it may be sound and without flaws, or more or less defective. The living body has the power of self-repair, and what we call cure is complying with the conditions under which nature will make repairs. If we learn these conditions, which are taught by hygiene, and are heedful of them, our bodies will be continually renewed, and good health will be the normal condition at all times. It is the decree of nature that all things shall change. The watch, although excellent in material and workmanship, and although well cared for, will wear out. It is the same with the living mechanism. There is all the more reason, then, why we should take good care of our bodies and secure from them fullness of life and proper performance of duty.

Death is as natural as birth. We should have no fear of death, but, rather, should fear wrong living, fear the possible failure of not performing our duties to God and to man; and then, when we come to die, we shall be—

"Like one that wraps the drapery of his couch
About him, and lies down to pleasant dreams."

PHYSIOLOGY

Physiology treats of the organs of the body and the work they perform. It carefully and accurately studies the details of the construction of the body. It follows, from beginning to end, the minutest nerve, muscle, and artery. Experiments are made; the behavior of organs, as the heart, lungs, and liver, is observed in health and disease, and thus a knowledge of them is gained. By this means we learn how the heart pumps the blood to all parts of the body. We learn, also, the conditions under which an organ does its best work. We learn, moreover, the kind of work done by the lungs, and discover what surroundings and what materials they must have with which to work. As fast as knowledge and understanding of the mechanism is gained, we should make it practical by applying it. In the following chapters, it is the aim to present enough regarding the structure of the various organs of the body, and of the work done by each to give a view of the field, and to make plain the reasons for the suggestions and directions on *how to live.* This knowledge will enable us to make our lives more efficient and enjoyable—lives of loving labor and "glad sweet song."

CHAPTER II

BREATHING AND AIR

Breathing is the most important action in all life. Even the trees and plants breathe. We must fill our lungs with air and empty them about twenty times a minute in order to live. If we stop breathing for one minute, we feel oppressed and dizzy; if for two minutes, we become unconscious; and, if for four or five minutes, we should certainly die unless vigorous means were taken to start our breathing again. We are, therefore, deeply interested in this process of breathing.

WHY WE BREATHE

The object of breathing is to purify the blood. When fresh air enters the lungs, some of the *oxygen,* or life-sustaining gas it contains, is taken up by little tubes, called *capillaries,* which contain blood. At the same time, from the blood in these capillaries, there passes into the air in the lungs a gas called *carbon dioxide,* together with a very small amount of waste matter, which is the worn-out material of the body. All of this happens almost instantly, and then follows expiration, which is breathing out to empty the lungs. Inspiration is breathing in, or filling the lungs. So necessary for life is the immediate removal of the waste matters of the body brought to the lungs by the blood, that we grow sick if the breathing stops even for a minute. This is because the waste matter, which is gathered by the blood in its course through the body, is poison. The air that we breathe out contains this poison, which, if not removed, would soon kill us, and therefore air which has been even once breathed is itself poisonous. This explains why we have headaches, and become dull, when the air in a room has been breathed, and fresh air is not supplied by ventilation.

HOW WE BREATHE

In order to understand how we breathe, it is necessary to understand the machinery of breathing, and the structure of the lungs and breathing tubes. The cavity back of the nose, together with the mouth cavity, called the *oral cavity,* is connected with two tubes. One of these tubes, the *esophagus,* is a pipe to convey food and drink from the mouth to the stomach; the other pipe, the windpipe, or *trachea,* is the one we shall consider now, for it is through this pipe that the air passes from the nostrils to the lungs.

Trachea.—The windpipe is a tube about four and one-half inches long, and from three-quarters of an inch to an inch in diameter. It is constructed of rings of tough *cartilage,* or gristle, piled one on top of the other, and held together by a strong tissue, or membrane. A man's trachea, like his hands and feet, is always larger than that of a woman.

Bronchial Tubes.—At the lower end of the trachea are two smaller tubes leading one to the right and the other to the left. These are called the *bronchi,* or *bronchial tubes,* and they connect the trachea with that wonderful arrangement of millions of cells called the lungs. The bronchial tubes divide and subdivide, growing smaller and smaller until some of them are so small that one would be completely filled by a very fine thread. Each subdivision ends in one of the tiny cells, sacs, or air vesicles, of the lungs.

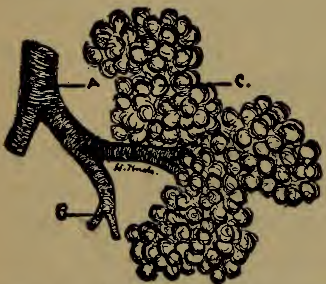


FIG. 1.—MAGNIFIED PORTION OF THE LUNG.
A, small bronchial tube; B, terminal of tube; C, air sacs.

Lungs.—The walls of these air cells are as thin as tissue paper, but, unlike tissue paper, are very tough and elastic. It is through these thin cell walls that the oxygen in the air passes into the blood, and through them, also, the waste gases, which the blood has gathered from all parts of the body, pass into the air in the lungs and thence into the outer air.

The lungs are covered with a smooth, moist membrane called the *pleura,* which protects them. When the pleura becomes inflamed, we are said to have pleurisy. Pleurisy may also be the result of breathing foul air.

Diaphragm.—The lungs may be looked upon as two bags hanging in the cavity of the chest, or *thorax,* sometimes called the *thoracic cavity.* The right lung has three divisions, or lobes, and the left has two; both rest on the *diaphragm*, which is a broad band of tough muscle forming a partition between the thoracic cavity and the abdominal, or stomach cavity. The diaphragm bows upward, but flattens out at each inspiration.

When we inspire, or breathe in, the lungs swell until they meet the walls formed by the ribs, which, obedient to the action of the muscles used in breathing, expand to make room. These muscles then contract, as do also the elastic walls of the lung cells; this contraction expels the air and is called expiration. In this process the arch of the diaphragm is first bent downward by the expanding lungs in inspiration; when expiration begins, the arch returns to its former position. It is the combined action of the muscles of the chest, the muscles of the diaphragm, and the elastic walls of the lung cells, like rods and bands pulling and pushing, which makes us breathe. The process goes on without our thinking about it, and is therefore involuntary. We can, if we wish, stop the action of the muscles, that is, we can at will hold out breath, but when the will ceases to act, the work goes on as before.

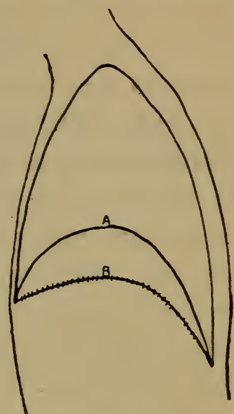


FIG. 2.—DIAGRAM SHOWING POSITION OF DIAPHRAGM.
A, at end of expiration; B, at end of inspiration.

A man sitting still, or walking slowly, breathes about twenty times a minute. If he runs, he must breathe faster. This is because, in running, the muscles and all the other tissues of the body wear out faster, and more air is needed to carry off the waste.

CORRECT BREATHING

On its way to the lungs, the air should always enter the trachea through the nose. The nostrils warm and properly moisten the air as it passes through them, and by means of thousands of little flesh hairs which line them, they also purify the air, straining out dust and microbes. This is important, for these particles of dirt are most injurious to the lungs. It may readily be seen that if we habitually breathe through the mouth, a great deal of unfiltered air will pass into the lungs, for the mouth and throat are not provided with the means of straining out the impurities, as the nostrils are.

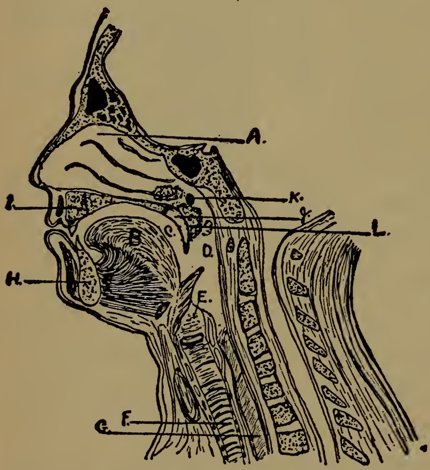


FIG. 3.—SHOWING AIR PASSAGES AND ADJACENT PARTS.

A, nasal cavity; B, tongue; C, mouth; D, pharynx; E, larynx; F, trachea; G, esophagus; H, I, jawbone; J, soft palate; L, adenoid growths, encroaching upon the Eustachian tube, K.

Whenever people snore in their sleep, they are breathing through their mouths. It is sometimes possible to overcome the habit of snoring by placing a bandage under the chin and tying it on the top of the head. This holds the mouth closed and compels the breath to pass through the nose.

Nose Tumors.—Sometimes growing children have little tumors in their noses, called *adenoid growths.* Such children hold their mouths open all the time, their voices have a more or less choked sound, and they do not hear well. They are "mouth breathers," as the doctors say. In consequence of this breathing through the mouth, they are not strong and healthy and of good color like other children. Any skillful physician can quickly, and almost painlessly, remove adenoid tumors, and they rarely return. Children with adenoids cannot study well, nor can they think well.

WHAT WE BREATHE

Composition of Air.—We shall now make a brief study of the air, which is our first and foremost necessity. The air of cities is not as pure as mountain or country air, so we take the composition of the mountain air as our guide. It is composed mainly of two gases in the following proportion:

Nitrogen	79%
Oxygen	21%

Even country air is found to contain a very little carbon dioxide, and in the cities, air contains, besides, several gases which are products of the burning of coal, such as ammonia, sulphurous acid, and nitric acid. Of course, these are present in small quantity, but they have a marked influence upon health. City air also contains more dust and more disease germs than country air. The greater purity of country air is one of the first reasons why, in the country, sickness and death rates are lower than in the cities.

In most cities, there are Fresh Air Missions conducted by charitable men and women, who search out sick mothers and sick children in the summer-time, and take them out into the country away from the impure air of the city. It is astonishing how fast these sick people improve. The change is due principally to the pure air. Pure fresh air is the greatest known medicine, good for all diseases.

There is a great difference in the air before and after it has been breathed. In each breath the inspired air loses twenty per cent, or one-fifth, of its life-giving oxygen, and poisonous matter is added. The following table shows the change:

	Inspired Air.	Expired Air.
Oxygen	20.96%	16.03%
Nitrogen	79.00%	79.00%
Carbon dioxide	0.04%	3.97%
Organic matter	0.00%	1.00%
	100.00%	100.00%

Exhaled air has an odor. This is caused by the organic, or waste matter, it has absorbed from the body while in the lungs, and it is this organic matter that makes a room seem stuffy when the ventilation is bad. To rebreathe such air injures the lung tissues. There is not enough oxygen in it to purify the blood, and the unpurified blood goes back from the lungs through the body unable to take up any more waste matter. When this waste matter is left in the flesh, muscles, brain, and other parts of the body, they are injured. The foul air that does such great harm to the whole body first shows its effect in dullness, sleepiness, and headache.

When the tone and strength of the lung cells, the windpipe, the bronchial tubes, and the pleura, have been lowered by breathing bad air, the minute disease germs, or microbes, of cold, catarrh, influenza, pneumonia, and consumption have an opportunity to grow. It is thus we acquire diseases of the respiratory system. One seldom "catches cold" in the open air, but rather in the house. Those who live in the open air do not have colds or pneumonia or consumption. These are known as *house diseases,* and the best cure for the sick person is to live in the open air. Indeed, the only known cure for consumption is not medicines, but continuous outdoor life, night and day.

Night air is purer than day air. It does not contain so many microbes nor so much smoke, dust, or carbon dioxide, as day air. The old notion that night air is unwholesome should be discarded. The chill of the night, if we are not warmly dressed, is what causes illness.

There is also error in the general idea that draughts of air are injurious. Unless we are warm and perspiring, a draught brings no harm. If, however, we are warm and perspiring, then a draught cools the skin too rapidly, closing up the pores and preventing their action. The shock lowers resistance, that is, it partly stops the healthy action of the skin. Then, again, the microbes of cold, influenza, and the like, have opportunity to grow and cause disease.

A person who is warmly dressed may ride all day in a buggy with draughts striking him, but he will not catch cold. It may make him chilly and stiff, and if he then goes into a house and huddles over a stove, he is likely to catch cold. He should bring back warmth and glow to the skin by exercising. And, if he has been out in the rain and his clothes are wet, he should remove the wet garments, sponge himself with cold water, and rub with a rough towel. Then, if he puts on dry clothes and sits down in a well ventilated room, he will not catch cold. Soldiers get wet and cold, and dry themselves by an outdoor fire, or perhaps their clothes are dried solely by the heat of the body; but colds and lung disorders seldom affect them. It is the outdoor life which keeps them from taking colds. Soldiers suffer more from other disorders than from either bullets or lung diseases.

Dust.—Consumption and other lung troubles are more likely to result from dusty air than from cold air. In spite of the filtering out of impurities by the little hairs of the nostrils, some dust gets into the lungs and can do much harm. Many illnesses, that were formerly explained in other ways, are now understood as the result of breathing in microbes and poisonous particles of dust. "Grinders' consumption" is a term used in connection with cases of consumption occurring among tool grinders. They breathe a great deal of dust which arises from the emery wheels used in sharpening tools, and this, together with the bad air of the unventilated shops, irritates the air passages, making it possible for the consumption microbes to grow and cause the disease.

The dust of cities and towns is more likely to produce disease than the dust of the country. This is because in a city there are more people in a given area, and the dust is more likely to become infected from spitting, and in other ways. By "infection" is here meant the addition of dried disease germs to ordinary dust. In many cities, it is contrary to law to spit on the sidewalks, in railway stations, in street cars, or, indeed, anywhere except in gutters. This is right, for through spitting, the germs which cause diseases of the breathing system are distributed. Besides this, it is a habit never formed by persons of refinement and good manners.

It has already been said that the health of people living in cities is not so good as that of people living in the country. The reason is that country people have more space to live in, more and better air to breathe; therefore, they meet with fewer disease-causing microbes. If all country people would build their houses at least three feet from the ground to keep out dampness and ground air, if they would all thoroughly ventilate their bedrooms at night and their living rooms in the daytime, sickness, even in the country, would be very much less than it is now.

Ground air is the name given to the air which fills the spaces, or pores, in the ground. It is very unwholesome, and has an earthy, musty odor, which we can smell after rains in houses which are built flat upon the ground. Dwelling houses should always be built on foundations which raise them at least three feet above the ground, and the space between the ground and the floor of the house should be well ventilated. This prevents the unwholesome ground air from being forced up into the house when the rains soak down into the ground. Such houses would also be dry, and damp houses are unhealthful. There are several real advantages in building dwelling houses at least three feet above the ground and ventilating well the space beneath the floor. They will be free from dampness, and there will be no ground air; they will last longer, and look better, in addition to being altogether more healthful.

BREATHING EXERCISES

Everyone knows that we must exercise in order to keep well. The muscles become strong from exercise, and in the same way full breathing makes the lungs strong. The following are good examples of simple breathing exercises such as all children should be taught.

First, stand straight, chest out and head erect, hands at the sides with heels together and toes pointing outward. Now close the mouth and slowly take a deep inspiration through the nose, expanding the chest to its fullest capacity; at the same time raise the arms until they extend straight out from the shoulders. Hold the breath long enough to count three, then breathe out while returning the arms to the sides, expiring somewhat more rapidly than when inspiring. Repeat three times.

The *second* exercise is like the first, except that the upward movement of the arms is continued until the hands meet over the head.

In the *third* exercise the arms are extended in front, with the palms of the hands touching each other. Now move them outward and commence to draw in the breath; by the time the hands touch behind the back the lungs should be full. Hold the breath again long enough to count three, and then expel the breath as the arms are moved forward to the first position. Repeat three times.

Still another breathing exercise is of especial benefit to those who stoop or whose shoulders bend forward. Stand as straight as possible, hands on the hips, with thumbs toward the front; then bend backward as far as possible, drawing in the breath at the same time. The breath is expelled when moving forward. All of these breathing exercises should be practiced at least twice a day by all school children. The best place to do this is in the open air; if the practice is indoors, the windows should be wide open.

VENTILATION

Ventilation is simply the bringing of air into a house and then taking it out again, but there are right and wrong ways of doing this simple thing. It is *hygiene* that teaches us why we must breathe pure air and how much we need, and it is *sanitation* which teaches us how to ventilate our buildings, so that pure air in sufficient amount may be secured.

The air in schoolrooms should be changed at least four times every hour, and every pupil should have not less than 180 cubic feet of space. If the length, breadth, and height in feet of the schoolroom are multiplied together, and the product is divided by the number of pupils in the room, the quotient should be 180 or more; otherwise each pupil has not sufficient space or air for good health. Crowded schoolrooms always cause more or less illness. It is impossible, in cold weather, to ventilate a schoolroom properly by windows and doors. If we try to introduce air through windows and doors in the winter time, the room becomes cold and draughty. This interferes with study and recitation, just as the bad air does, and both conditions cause sickness.

Every schoolroom should have a pipe, or duct, in the wall to bring in fresh air, and a second duct to take out the impure air. If these ventilating pipes are not practicable, and the room is heated by a stove, it is still possible, with care and judgment, to secure a fair amount of fresh air. During recess the windows should be opened and every child should remain out of doors. If it is raining at recess time, then, with the windows open, the breathing exercises already described should be practiced. When windows must be used for ventilation, it is a good plan to place a board five or six inches wide, and as long as the window is wide, under the lower sash, so that the cold air comes in through the space between the two sashes, is forced upward into the room, and does not reach the pupils until it becomes warmed.

If the room is heated by means of a stove it should have a sheet iron jacket around it. This will direct the heat upward and cause it to diffuse more evenly through the room. A jacket around the stove will also protect near-by pupils, keeping them from being overheated.

HEATING OF SCHOOLROOMS

Heating and ventilation belong together. The fact that hot air is lighter than cold air is taken advantage of in heating schoolrooms. A furnace, which is a large stove surrounded by either a brick or an iron jacket, is placed in the basement, and from the space between the stove and the jacket, pipes lead to the schoolroom. There is also a large pipe connecting this space with the outside air. The cold fresh air enters by this pipe, called the cold air pipe, passes over the hot surface of the stove, and so heated passes upward through the hot air pipes into the room. By this method the air which warms the room, though hot, is fresh, pure air. The objections to stoves in a room are, that they heat much of the same air over and over, and that the school is disturbed when fuel it put on the fire.

Experience, however, proves that schoolhouses which have more than eight rooms cannot be successfully heated and ventilated by furnaces. A better system for a large schoolhouse is the fan or forced system. This requires an engine or motor of some kind in the basement to propel a circular steel fan, which forces pure air from outside over hot steam coils and then through pipes into the schoolrooms.

If a schoolroom is heated by radiators in the room, there should be back of each radiator an opening in the wall to the outer air. This opening will bring in fresh air, which, as it passes over the radiator, will be warmed. Ventilating engineers and architects call this "direct-indirect heating." They call it "direct heating" if a room is heated by stoves or by radiators which have no opening in the wall to the outer air. This subject will be discussed more fully in the chapter on ventilation.

MOISTURE

Finally, it is important that there should be a certain amount of moisture in the air we breathe. If the air is dry and hot, it takes moisture from the nose passages, from the throat, and from the lungs. This is uncomfortable and may cause disease. The air of schoolrooms may be kept moist by water pans in the furnaces in the basement, and all modern furnaces are so supplied. It is an easy matter to keep pans filled with water on the tops of stoves, and thus keep the air moist. This matter is frequently neglected because its advantage is not understood, but neither it nor any other help to good air should be forgotten. The first thing that all of us do is to breathe, and only as long as we breathe are we alive, so it is truly necessary to consider how important to our welfare good air and correct breathing really are.

QUESTIONS FOR REVIEW

1. Why do we breathe?
2. Describe the process of breathing.
3. How does the air reach the blood to purify it?
4. Why should we breathe through the nose instead of the mouth?
5. What is air?
6. Why should not the same air be breathed more than once?
7. What makes a room smell "close" and "stuffy"?
8. Is it easier to catch cold indoors or outdoors? Why?
9. How does good ventilation help us in breathing?

CHAPTER III

THE SKELETON

The skeleton is made of hard bones. It acts as a framework on which the flesh and muscles of the body are supported, and serves also as an armor, or protection, for the heart, the kidneys, the lungs, and other organs. If a man had no skeleton, he could neither walk nor run; he would be as shapeless as a jellyfish, which has no bones. As long as a jellyfish remains in water, its body is supported by the water, but when it is thrown on land, it becomes a quivering, shapeless mass. A man's body would be just as limp except for the two hundred and six bones in his skeleton.

These bones are all neatly joined together, and each has its exact place. If even the smallest bone slips out of place, or gets out of joint, as we say, pain and swelling appear, and the bone has to be put back into place, usually a very painful proceeding. The skeleton is divided into four main parts, the skull, the trunk, the arms, and the legs.

THE SKULL

There are twenty-eight bones in the head, counting three small ones in the cavity of each ear. The eight bones that are called the skull bones are curved bony plates, fitted together to make the round shape of the top and back of the head, and to protect the brains, which are held as if in a box or cup.

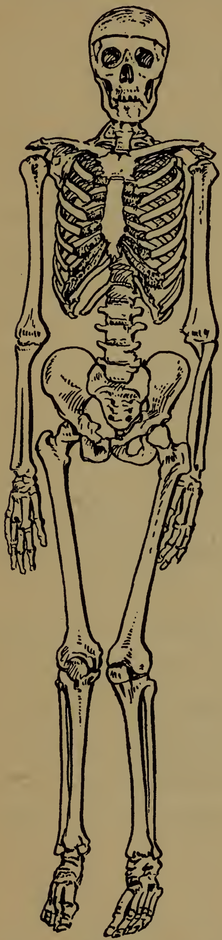


FIG. 4.—THE SKELETON.

The face has fourteen bones. The shape of some of them may be felt by the fingers, and, to some extent, may be seen.

THE TRUNK

In the trunk, or body, there are fifty-four bones, distributed as follows: twenty-four ribs, one breastbone, two hip bones forming the pelvis, the backbone, or spinal column, composed of twenty-six parts, called *vertebrae,* and a small bone in the throat just above the "Adam's apple."

THE ARMS

In each arm there are thirty-two bones. The five largest ones are above the wrist; the collar bone, or *clavicle,* connecting the shoulder with the sternum, or breastbone; the shoulder blade, or *scapula;* the *humerus,* or bone of the upper arm, and the two bones of the lower arm, the *ulna* and the *radius.* The advantage of having two bones in the lower arm is plain, if the right arm is placed on the desk with the palm of the hand down, and the hand is then turned over until the back of it touches the desk. The movements of the two bones can be felt by the left hand, and they show how this arrangement makes it possible to turn the hand in any direction.

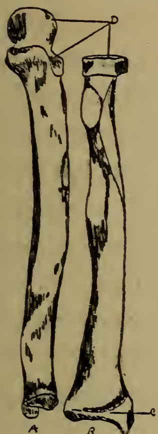


FIG. 5.—BONES OF THE LEFT FOREARM.

A, ulna; B, radius; C, part which helps to form the wrist joint; D, parts which help to form elbow joint.

Each hand contains twenty-seven small bones, of which eight are in the wrist, five in the palm, and fourteen in the fingers.

THE LEGS

There are thirty-two bones in each leg, including the foot. First, there is the thigh bone, or *femur,* which is the largest bone in the body, and extends from the hip joint to the knee. Then there are two bones in the lower leg, the *tibia* and the *fibula,* corresponding to the two in the lower arm. The kneecap, or *patella,* covers the knee. There are also six little bones in the ankle, one heel bone, five bones in the instep, and fourteen bones in the toes. The foot contains twenty-six bones, and the hand twenty-seven.

FIG. 6.—THE FEMUR, OR THIGH BONE.

A, head; B, shaft; C, part of bone which helps to form kneejoint.

COMPOSITION OF THE BONES

If a bone is burned in an iron pan, there will be left a white powder, called *bone ash*. This is the mineral matter, or hard part, of the bone.

Fig. 7.—Section of Bone Magnified.

The soft substance of the bone that holds this bone ash, or mineral matter, together is called *ossein*. It is this substance that makes the peculiar smell when bones are burned, and it has so much strength and elasticity that if boiled for a long time in water it becomes glue. Ossein forms about one-eighth of the bone, and is what is burned away when the bone is burned. On the other hand, if a bone is placed in vinegar, or any acetic acid, for a day or two and then examined, it will be found that the vinegar has dissolved out the ash, or mineral matter, and only the ossein remains. The stiffness is gone and you can tie the bone in a knot. It is soft and elastic. Children's bones are softer and more elastic than the bones of old people, because they contain more ossein.

Fig. 8.—Bone Tied in a Knot.

When a bone is boiled, grease appears on the water. This grease, or fat, was in the center, or hollow part, of the bone, and is called *marrow*. Marrow is a very important substance, for it helps to nourish the bone and to keep it alive. The bones are so constructed as to furnish great strength combined with lightness. These two qualities are secured by their hollow construction.

THE COVERING OF THE BONES

Periosteum.—The bones are covered with a tough, strong skin, or membrane, which is called the *periosteum.* It covers every part of the bones except the joints, which are protected by *cartilage.* The periosteum contains blood-vessels, through which the bones are nourished. The muscles, which enable us to move our skeleton, are attached

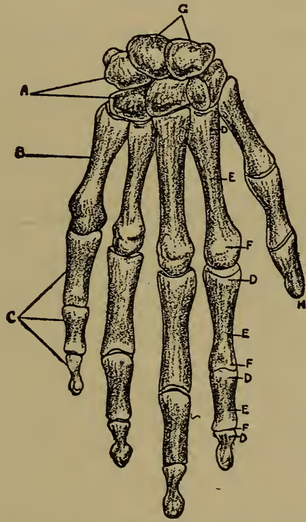


FIG. 9.—SHOWING THE BONES OF THE HAND AND WRIST.
A, wrist-bones; B, bones of the palm; C, bones forming the finger; D, base; E, shaft; F, head; G, bones which articulate with the radius; H, thumb.

to the periosteum. If by any accident the periosteum is removed, the bone will die, but if a bone is broken, or removed because of disease, it will grow again if the periosteum is not injured.

Cartilage.—Cartilage, which is sometimes called gristle, is found between the joints. It acts as a cushion, or pad, to prevent the hard ends of the bone from grinding against each other. If it were not for the cushions of cartilage the joints would wear and be painful. Cartilage can always be found on a boiled beef-bone, or on the end of a spare-rib. It is very tough, and, even if cooked, cannot be eaten as meat can.

QUESTIONS FOR REVIEW

1. What is the use of the skeleton?
2. How many main divisions of the bones are there? How many bones in all?
3. What is the largest bone in the body?
4. Why is the skull round?
5. Why is the hand made up of small bones?
6. What two kinds of substances can be found in bones?
7. How may each be found?
8. How are the bones covered and protected?

THE BONES

HEAD

Skull: Frontal, temporal, parietal, occipital, sphenoid, ethmoid.

Face: Superior maxillæ, nasal, malar, lachrymal, turbinated, palate, vomer, inferior maxillæ.

Ears: Malleus, stapes, incus.

The *hyoid bone*, at the base of the tongue.

BODY

Cervical vertebræ, true, false and floating ribs, thoracic vertebræ, sternum, lumbar vertebræ, innominata, sacrum, coccyx.

UPPER EXTREMITIES

Clavicle, scapula, humerus, radius, ulna, carpal, metacarpal, phalanges.

LOWER EXTREMITIES

Femur, patella, tibia, fibula, tarsal, metatarsal, phalanges.

CHAPTER IV

ORGANS, TISSUES, CELLS

By the word *organ* we understand any special part of the body which has a particular work to do. The stomach is an organ of digestion; the eye is the organ of sight. The kidneys, lungs, heart, liver, and spleen are all organs of the body, and are all composed of *tissues*, which are built up of *cells*.

THE TISSUES

Every one knows what liver looks like. Its color and general appearance when once known enable us always to tell liver from any other kind of matter. Liver material is called *liver tissue*. Muscle material cannot be mistaken for other material; it is called *muscle tissue*. So it is with skin tissue, lung tissue, brain tissue, bone tissue. Each tissue has an appearance and structure of its own. Lay side by side thin small pieces of dried beef, chicken meat, ham, and beefsteak, and notice how the tissue of each differs from that of the others.

THE CELLS

If we place a very thin slice of liver or any other kind of tissue under a microscope, we shall see that it is composed of countless tiny divisions, or *cells*. Just as houses are made up of rooms, so tissues are made up of cells. Cut an orange in half and, on the cut surface, observe the big cells which hold pulp and juice. Orange cells are very large; the cells of our tissues, however, are so very small that it is necessary to have a microscope to see them. Notice that each orange cell is formed by walls of thin tissue, and remember that even this thin tissue is itself composed of cells.

The cells of liver tissue have a form and appearance of their own, and so have the cells of muscle tissue, skin tissue, or any other kind. Some are round, some flat and thin, some are almost square; others have many sides, and all shapes and sizes may be found.

Growth of Cells.—Exercise of any kind, such as running, playing, or working, wears out the cells of the tissues, but in health they are immediately built up again. The cells in heart and lung tissues are wearing out all the time, for the heart and lungs work almost unceasingly. The only rest these organs get is to work less rapidly when we sit down, lie down, or sleep. To starve to death is to have our tissues waste away cell by cell for lack of food to build them up. Sometimes infants and very old people starve when there is no lack of food, simply because their stomachs, and other organs that build up the body, do not work properly. When cells are used up, they are cast out of the body by the skin, lungs, kidneys, and intestines. So new cells are constantly being constructed in our bodies to replace old ones.

PROTOPLASM

Inside of the cells is a material called *protoplasm,* or sometimes, *bioplasm.* Bioplasm means *life material.* Each cell has also what looks like another little cell inside it. These are called *nuclei.* One such speck in a cell is called a *nucleus.* Sometimes the nucleus contains a speck in it, and this is called a *nucleolus,* or little nucleus.

FIG. 10.—FATTY TISSUE. A, BLOOD VESSELS; B, FAT CELLS.

The bioplasm is a very curious material. It is largely water, but contains little grains, and is thick like cream. Sometimes there are found *granules,* or grains, in the cells, little drops of oil, and little particles which have color, and are called *pigment,* or coloring, bodies. Bioplasm is alive, for it moves and is constantly undergoing change. If the nucleus of a cell disappears, the bioplasm dies. This fact leads us to believe that the nucleus is the center which directs or controls the cell.

CELL ACTIVITY

It is the activity, or constant working, of the cells which causes every organ to do its special work. The liver cells are being torn down and new ones built up all the time, and in this way they do the special work which belongs to the liver. This is true of the muscles, nerves, heart, kidneys, brain, and all the other organs.

What makes the cells work? Why are they so constantly changing? This change and work is called *cell life.* We say it is an *energy,* a *force.* We do not know what electricity really is; we say that too is energy, or a force. We know a great deal about the way it works—that is, we see how it manifests itself—but what it is, no man knows. It is the same with life energy.

HEALTH AND DISEASE

When all the organs and their cells do their appointed work on time and properly the result is health. But the organs and their cells are very sensitive and delicate. It is only under certain conditions that they perform their tasks well. For instance, it is the work of the lungs by taking in oxygen to turn blue, or impure, blood into good red blood. Give the lungs plenty of pure, fresh air, and they will do their full duty. If, however, we are in an unventilated room, and by remaining there deny the lungs the good, fresh air they should have, then they not only fail to turn the blue blood into red blood, but the lungs themselves become discouraged, as it were, and may become diseased. This happens also if we keep the windows of our bedrooms closed at night, and lie hour after hour breathing our own breath over and over.

Another example of an organ that must be treated well is the stomach. It works well provided we send down to it fresh and well prepared food, which has been thoroughly masticated, or chewed. It should not be overloaded with food, nor too much water taken into it at mealtime. These conditions must be met; if they are not, the cells of the stomach lose energy, and we suffer.

If we abuse our lungs with foul air, and at the same time abuse our stomachs by overloading them, we are certain to be sick. Persistence in this wrongdoing, moreover, will finally make these organs permanently sick—that is, they will become diseased—and then we shall find time to think how foolish we have been. These are only instances, for other organs can also become diseased by mistreatment.

Disease, then, is the opposite of health. We must in some way violate the laws of health to be made sick or become diseased. A proper attention to the laws of health will keep our tissues in good condition, so that the cells may be promptly renewed, and the organs enabled to carry on their special duties, which make and keep us well.

QUESTIONS FOR REVIEW

1. Name two important organs of the body, and tell their functions.
2. Of what are the organs built?
3. What is a cell? How large is it? What shape has it?
4. How do cells perform their work?
5. What is protoplasm? What is the other name for it?
6. What does "nucleus" mean? Where can nuclei be found besides in the protoplasm?
7. What different kinds of tissues can you name?
8. What is meant by the term "energy" as used in connection with cells?
9. What is disease? How may it be avoided?
10. What is necessary to keep the lungs healthy? The stomach healthy?

CHAPTER V

MUSCLES, JOINTS, AND MOVEMENTS

THE MUSCLES

Our muscles are wrapped around our bodies in a very interesting way. Besides being organs of motion, they give the body form. Except in disease they are of a deep red color. They make up the lean meat, or flesh, of animals. All the motions of the body are effected through our muscles. They bind the bony frame together, and they cover nerves, bloodvessels, and cavities. The muscles of the heart, by extending and contracting, make it beat; and in the same way the muscles controlling the lungs make them expand to draw in air and contract to expel air. The muscles of the eyes move them as we wish, and those of the mouth, tongue, and throat, enable us to speak.

KINDS OF MUSCLES

Some muscles, such as those of the heart and stomach, work without being told by the mind. They are called *involuntary muscles.*

Other muscles, like those which move the organs of speech, and those which control the action of the legs and arms, do so only when they are told to by the mind. Such are called *voluntary muscles.*

The voluntary muscles are most of them attached to the bones, and the involuntary to such organs as the heart, stomach and intestines.

COMPOSITION OF THE MUSCLES

The voluntary muscles are made up of bundles of fibers, nicely wrapped in a peculiar membrane, or tissue. The smallest fibers are finer than the finest silk thread. These small bundles of fibers are again bound together to make larger bundles. If we pick to pieces a bit of cotton string, it will be found to be made up of a great number of little fibers. And if a piece of dried beef is soaked in water for an hour or two, and then it is picked to pieces with a pin, it will also prove to be composed of small fibers.

Involuntary muscles are made up of flattened bands of fibers, or of long fibers of a pale color. Each fiber con-

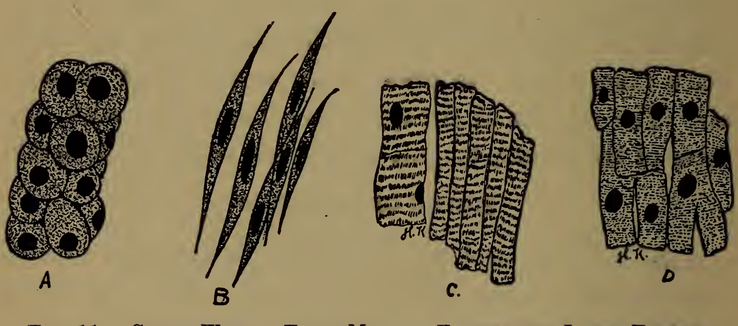


FIG. 11.—CELLS WHICH FORM MUSCLE FIBERS AND LIVER TISSUE. A, liver cells; B, muscle cells (involuntary); C, muscle cells (voluntary); D, cells of heart muscle.

tains a nucleus, which is rod-shaped. This kind of muscle forms the muscular coat of the stomach and intestines.

A considerable proportion, usually about three-fourths, of the total weight of muscle is water. The remaining one-fourth is composed of a lime-like substance called calcium phosphate and a strange substance called *myosin.* Myosin is also called *muscle-plasma.* Shortly after death animal

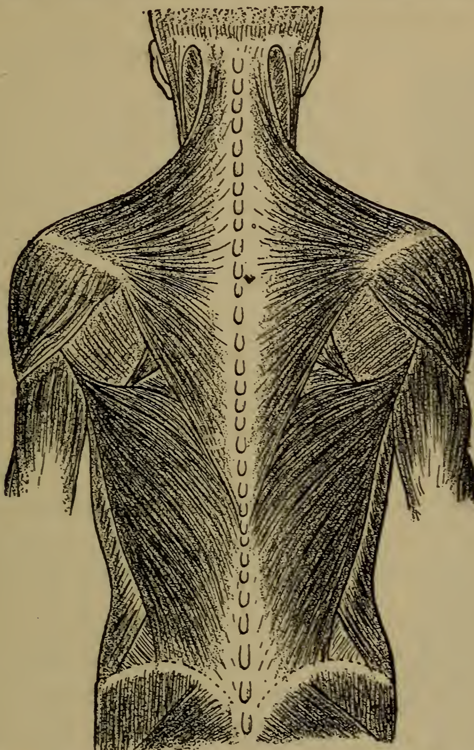


FIG. 12.—SHOWING THE MUSCLES OF THE BACK.

bodies become very stiff. This is caused by the myosin, which coagulates—that is, becomes solid and hard.

HOW MUSCLES WORK

Muscles have the power of shortening and again lengthening themselves. They are elastic and pliable. If the arm is drawn up so as to touch the chin, the outside arm muscles are lengthened, and, at the same time, the inside ones are shortened. In this they are obeying the command of the brain, which has sent a message to them by the nerves. We find also that the muscles will jerk if irritated, as occurs when the flesh is pricked by a pin. We do not fully understand how the muscles are able to move so quickly and so wonderfully, so we say the movement results from a *nerve stimulus.*

Fig. 13.—Showing the Muscles of the Arm.

Muscles will contract suddenly and with force, as when we throw out our arms to defend ourselves, or they will move very gently, as when we do some delicate work with the fingers. When we walk a long distance we feel tired, and if we are not accustomed to walking we shall grow more or less stiff when we rest. This is because the muscles are required to do more than they are prepared to do, and because their cells are not built up as fast as they are worn out.

The contortionist and the acrobat train their muscles to do most wonderful work. They can bend their bodies into strange and seemingly impossible positions, and it is all done by long practice in shortening and lengthening certain muscles as they will.

HOW MUSCLES ARE CONNECTED

Voluntary muscles are generally fastened to the bones by tough inelastic tissues called *tendons,* or sinews. They are also connected with cartilages, ligaments, skin, and other tissues.

One end of every face muscle is attached to some bone of the head, and the other end to the skin of the face. This arrangement enables us to give expression to our faces.

Tendons are not elastic, and so are serviceable for holding muscles in position. In children, the tendons are short and the muscles long, while in adults, the muscles are short and the tendons long. The tendons are not elastic, and the muscles are very elastic; this explains how a baby can roll itself into a ball, put its toe in its mouth, and perform many other feats which an adult cannot do.

HOW TO KEEP THE MUSCLES HEALTHY

To keep the muscles healthy it is necessary that they be exercised sufficiently. Attention, too, must be paid to resting them. But idle muscles waste away as well as overworked muscles. They must also have a proper supply of nourishment to renew the worn-out cells, and this means that they must be supplied with an abundance of pure blood.

THE JOINTS

To hold our skeleton in shape, the bones must join each other. The bones of the skull have saw-like edges, which fit each other like dovetail joints, and make the bones immovable. These joints are called *sutures.*

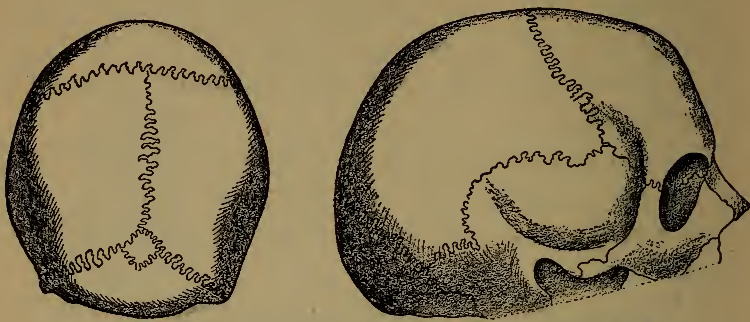


FIG. 14.—SUTURES SEEN FROM ABOVE AND THE SIDE.

Most of our joints, however, are movable. For instance, the shoulder, the elbow, the hip and the kneejoints, move easily in various directions. The knee and elbow joints are *hinge* joints; so are the joints of the wrists, ankles, fingers, and toes.

In the illustration of the hip joint may be seen the knob, or head, at the upper end of the femur. This head is connected with the main bone by a short piece called the neck. Notice how the knob fits into the socket in the pelvis, or hip bone. This is a *ball-and-socket* joint, and moves freely in any direction. The shoulder joint is also a ball-and-socket joint. Study the action of the joints of the hand and notice the many movements of which the wrist and fingers are capable. Such an ingenious and wonderful piece of work as the human hand no man ever contrived.

The skull rests and moves upon the topmost bone of the spinal column. This bone is named the *atlas.* The second bone of the spine is the *axis,* and a bone like a pivot extends from the axis through an opening in the atlas; on this the head turns. This is a *pivot* joint.

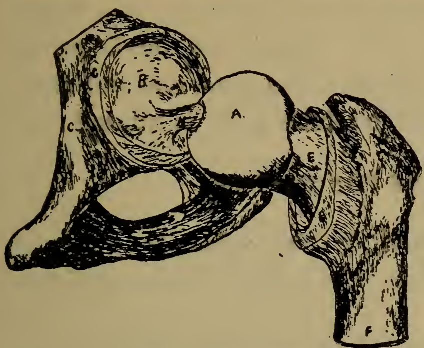


FIG. 12.—THE HIP JOINT (Ball-and-Socket).

A, head of femur (ball); B, the socket; C, D, parts of hip bone; E, neck; F, shaft; G, H, ligaments.

At every joint there are found strong, tough bands of fibrous tissue called *ligaments.* These ligaments, as well as muscles and tendons, hold the joints together. The skin also has something to do with the matter. There is cartilage between every two bones which form a movable joint, as well as a membrane secreting a fluid which lubricates or oils the joint.

MOVEMENTS

It is wonderful how easily we move. The pivot joint in the neck makes it possible to turn the head. The ability to turn the hand palm up, then palm down, is the result, as has been said, of the peculiar arrangement of the two bones in the lower arm. The movements of the two bones of the lower leg are like those of the lower arm.

If the body is bent forward and down, so that the hand may pick up something from the floor, all the joints of the spine are put in motion, in addition to the hip joints, the kneejoints, the ankle joints, all of the joints of the feet, and most of the joints of the arms. Simply in doing so ordinary a thing as to pick up a pin from the floor, we use at least fifty joints and a large number of muscles. They all move exactly in time with each other; the fingers go straight to the pin, and the thumb and forefinger do not act until the pin is touched. Man never did and never can make such a wonderful machine as he is himself.

QUESTIONS FOR REVIEW

1. What is meant by a muscle? What powers has a muscle?
2. How many kinds of muscles are there? Which kind controls our breathing?
3. What are muscles made of? How do they look?
4. Why do we feel tired and stiff after a long walk?
5. To what are the muscles fastened?
6. What is the difference between a muscle and a tendon?
7. What is a joint?
8. What is the difference between the hip joint and the sutures?
9. Why do not the joints creak and rub when we move?

CHAPTER VI

THE BLOOD, HEART, AND CIRCULATION

The blood has been spoken of as the nutritive fluid of the body, for it carries to the tissues nutritive materials prepared by the digestive organs. It also carries to the tissues oxygen, absorbed from the air in the lungs; it carries off from the tissues all waste products; the internal secretions of the glands are taken up by it; and it plays an important part in maintaining and keeping the temperature uniform. The blood is the only means of communication between the interior of the body and the outside world.

COMPOSITION AND STRUCTURE OF THE BLOOD

The blood, although a fluid, is really a tissue in itself. It is largely water, holding in solution salts, proteids, fat, fibrine, which is a white substance like albumen, and a red coloring matter called *haemoglobin.* There float in the blood also great numbers of minute bodies known as blood *corpuscles.* These corpuscles can be seen only through a microscope. There are three different kinds: the *red corpuscles,* the *white corpuscles,* and the *blood plates.*

When the corpuscles are removed, the fluid part of the blood has a slight yellowish tint. This fluid is called the *plasma* of the blood. The red color of the blood is due to the mass of red corpuscles held in suspension in the plasma.

Blood drawn from the body forms a soft jelly. Very soon the jelly hardens and forms a *clot,* and when finally the clot hardens still more it squeezes out a quantity of clear, slightly yellow fluid, to which the name *blood serum* has been given. It is the fibrine which causes the blood to clot. If blood is whipped with an egg beater, the fibrine is deposited on the wires of the beater in shreds.

If blood did not clot, bleeding would never stop, and a person would bleed to death, even from the slight cut. When the flesh is cut, or torn, we apply pressure to the place by means of a bandage, and very quickly the blood clots, and the wound ceases to bleed. A bruise-spot, which appears when a sharp, hard blow is struck on the flesh, is due to coagulated blood under the skin. Sometimes in disease a blood-clot forms in a blood vessel, and may stop the flow of the blood to some part of the body, and cause the death of that part. If a clot forms in the blood vessels of the brain paralysis results.

RED CORPUSCLES

A single red corpuscle does not appear red at all, but has a slight amber color. In the mass, however, these bodies are very red. The red corpuscles are minute, very elastic, circular discs, without nuclei. The average diameter of the red corpuscles in the blood of a man is about one-one-thousandth part of a millimeter, and they are, therefore, microscopic. Their minuteness can be better comprehended when we know that there are about 5,000,000 in a very small drop of blood. Under the microscope most of the red corpuscles appear like piles of grains of corn.

FIG. 16.—BLOOD AS SEEN UNDER THE MICROSCOPE.
A, white corpuscles; B, red corpuscles.

The principal task of the red corpuscles is to carry oxygen from the lungs to all of the tissues. Since there are many thousand millions in the blood of a grown person, they have a very great carrying surface. And because of their elasticity they are able to pass through the smallest capillaries. Sometimes they are obliged to go in single file, which causes them to present all their surfaces to let loose the oxygen they carry.

HAEMOGLOBIN

Each red corpuscle is an organized cell, but the finer structure is not known. When fresh, red corpuscles contain fully 60 per cent of water. Of their solid part 90 per cent is hæmoglobin which has the power of carrying oxygen to the tissues, and it does this through peculiar chemical powers of the iron it contains. Hæmoglobin has a dark purplish-red color, but when loaded with oxygen is a

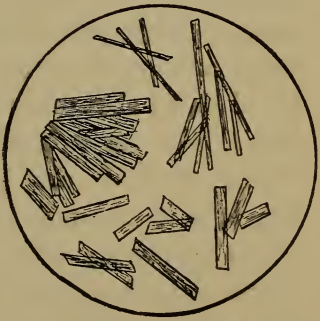


FIG. 17.—CRYSTALS OF HAEMOGLOBIN.

bright scarlet, and is then called *oxy-hæmoglobin.* Oxy-hæmoglobin is an unstable compound—that is, it gives up its oxygen readily to any tissue needing it. Hæmoglobin may be readily obtained and examined in crystals.

WHITE CORPUSCLES

The white corpuscles are a little larger than the red corpuscles, but are not so numerous; and they are called white, because they have no coloring matter in them. They are independent living cells, with the power of movement, and live in the blood-plasma. The average number in healthy blood is five to seven thousand in a cubic millimeter.

The white blood corpuscles are also called "wandering" cells. This name has been applied to them because they have the power to leave the blood and wander through the tissues. They have five duties to perform. First, they protect the body against bacteria that cause disease by digesting the disease germs. Such cells have the special name of *phagocytes,* a word which comes from two Greek words meaning an *eating cell.* A second work they do is to aid in the absorption of fats from the intestine. Third, they help in the absorption of *peptones* from the intestine. Fourth, they take part in the coagulation of blood. Fifth, they help to maintain the proteids in the blood-plasma.

The wandering cells are indeed busy as bees. In abscesses there is a great fight going on between them and the bacteria which cause the abscess. Of course, in the battle both cells and bacteria are destroyed. In the discharge from abscesses these cells are found in great numbers.

BLOOD PLATES

The blood plates are smaller than the red corpuscles and only about one-tenth as numerous. They have the power of motion like the white corpuscles, but what their work is, is not known.

SUMMARY

All of the facts just stated show the blood to be a marvelous tissue. It contains red and white living cells, fibrine, salts, serum, hæmoglobin, and blood plates. It is the sole medium of communication between the interior of the body and the outside. It carries oxygen and nourishment to the tissues and removes waste products. It maintains the temperature, holding it uniform. It keeps all the joints and tissues soft and moist and in good condition. It has cells which ward off disease, is the source of the gastric and pancreatic juices, of the secretions of the intestines, of saliva, bile, tears, sweat, and of everything else in the body.

HYGIENE OF THE BLOOD

We must have *pure blood* to be healthy. This we may secure by being sensible about our food, selecting it with care, preparing it properly, and chewing it well. We should breathe an abundance of pure air, night and day, and drink pure water. We should use coffee and tea, if at all, only sparingly. Above all, we should never fire our blood with whisky, brandy, or wine.

THE HEART

The heart is a hollow, muscular organ, really a strong pump, which forces the blood through its many and won-

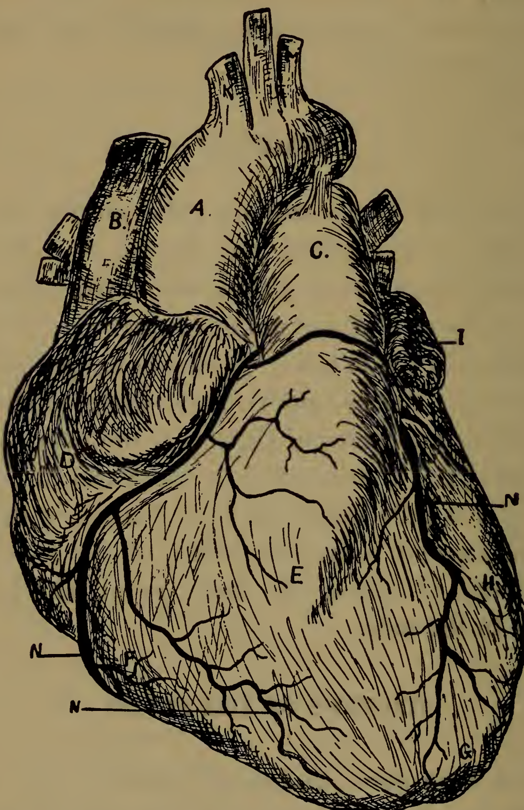


Fig. 18.—The Heart and Large Arterial Trunks.
A, arch of aorta; B, superior vena cava; C, pulmonary artery; D, right auricle; E, anterior surface; F, right ventricle; G, apex; H, left ventricle; I, left auricle; K, L, M, N, arteries.

derful channels. It is shaped somewhat like an egg, and is placed between the lungs. In a man the heart measures about five inches in length, three inches and a half in breadth in its broadest part, and two inches and a half in thickness, and weighs ten or twelve ounces. It is placed obliquely in the chest. The broad part is directed upwards and backwards to the right; the small end, or apex, is directed forward and to the left. The heart is said to be on the left side, which is not wholly true. The beating movement brings the apex against the left wall of the chest, and gives the impression that the heart is located there.

The heart is surrounded by a loose bag called the *pericardium,* which is fastened to the diaphragm. The lining of the pericardium is soft and velvety, like the lining of the mouth. A fluid in the pericardium keeps all the surfaces soft and lubricates the heart.

The heart is divided lengthwise by a muscular partition into two parts, which are called the right and left cavities. Each half is divided in turn into two cavities, the upper ones being called the right and left *auricles,* and the lower ones the right and left *ventricles.* The right auricle communicates with the right ventricle, and the left auricle with the left ventricle, but there is no direct connection between the opposite sides of the heart.

THE VALVES OF THE HEART

A pump must have valves, as well as cavities, or chambers, and the heart is no exception. There is a large valve between the left auricle and the left ventricle, and because it is shaped like a bishop's mitre, it is called the *mitral* valve. There is another valve between the right auricle and the right ventricle called the *tricuspid* valve.

There are three valves at the mouth of the aorta, and three at the mouth of the pulmonary artery, called *semilunar* valves. These open from the heart and prevent the blood from flowing backward into the heart again.

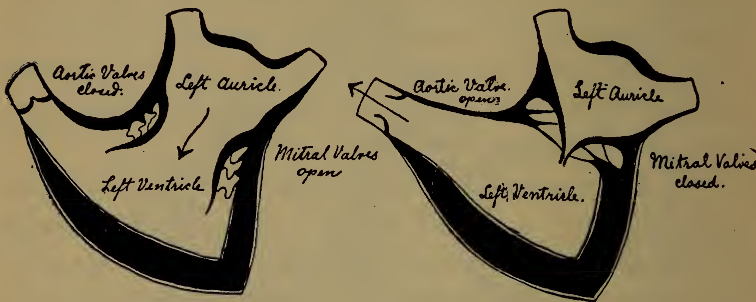


FIG. 19.—DIAGRAM SHOWING ACTION OF VALVES OF THE HEART.

To determine the state of health, the physician listens for the sounds of the heart. He places his ear on the chest over the region of the heart and listens carefully to the two sounds. In health the first sound, probably the closing of the mitral and tricuspid valves, is longer than the second. If the semilunar valves are out of order the second sound becomes a murmur. Any change from the normal sounds of *lubb-dup, lubb-dup,* is an indication that something is wrong.

THE PULSE

The beating, or throbbing, which occurs in all the arteries, comes from the action of the heart, and is called the *pulse*. The most convenient place to feel the pulse is at the wrist. The skilled physician obtains from the pulse valuable information concerning the heart and the circulation. When we are ill, and especially when we have fever, the pulse shows irregularities. The heart in a healthy man beats about seventy-five times a minute, and if at any time it varies greatly from this, disease, or at least excitement, exists. In early childhood, the pulse beats more than one hundred times a minute.

The regularity, or rhythm, of the heart beat should be perfect. If the aortic valves are diseased, or insufficient, through sickness, the pulse wave is more prolonged than normal. The pulse should be neither too feeble nor too strong.

THE ARTERIES

There are two kinds of blood flowing out of the heart: the arterial, which is red and full of oxygen from the lungs and which flows out from the left side; and the venous, which is loaded with the waste matter from the body and flows from the right side to the lungs for purification. The vessels carrying the blood to all parts of the body are called *arteries;* those bringing it back to the heart are called *veins.*

The largest artery in the body is the *aorta.* It starts from the left ventricle, arches to the left side, and runs downward to the pelvis, dividing there into two arteries, which supply the legs. The large arteries divide into smaller, and these into still smaller, until they are as small as fine threads, spreading to all the organs and parts of the body. From the arch of the aorta four branches lead to the upper part of the body, also dividing and subdividing into smaller ones.

The right auricle receives the blood brought by the veins. It then enters the right ventricle, and from thence it passes to the lungs through the *pulmonary artery.* This great artery divides into two branches like the aorta, one for each lung, and these divide and subdivide into unnumbered branches. From the lungs the blood is sent back to the left auricle of the heart, through that to the left ventricle, and from the left ventricle out into the arteries.

STRUCTURE OF THE ARTERIES

The arteries are round tubes, varying in size, and are made of tough, elastic material. They have three coats,

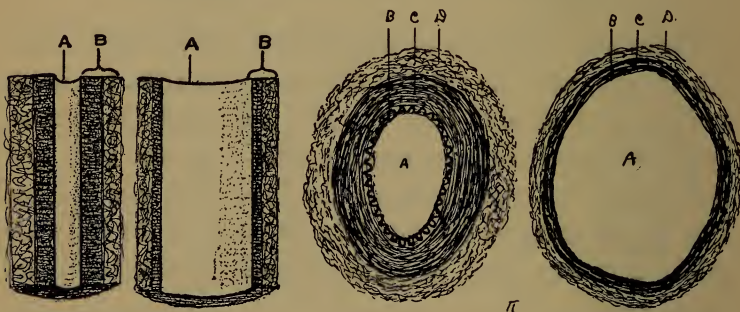


Fig. 20.—I. Artery and Vein, Longitudinal Section. II. Artery and Vein, Cross-Section.
Showing the Three Coats.

an inner one, smooth and delicate, a middle coat made up of muscular and elastic tissues, and a very tough and strong outer coat, made of fibrous, elastic, and semi-muscular tissue.

The small arteries have but two coats, and when the arteries become still smaller even the middle coat disappears, leaving only the delicate inner coat, through which the nutritious substances carried by the blood ooze into the surrounding cells.

As has been said, the outer coat of the large arteries is strong and tough. In case of a wound where an artery is severed, tying very tight with a cord does not break the coat, which is like rubber. However, tying breaks the inner coats, and the broken edges cause the blood to clot and the bleeding to stop.

The blood flows through the arteries very rapidly. This can be seen by fastening a frog near a microscope and tying his spread out webfoot under the lens. The arteries in the web are exceedingly small, but the blood can be seen rushing through them like water through a mill race.

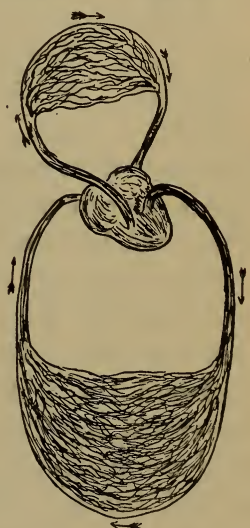


FIG. 21.—DIAGRAM SHOWING CIRCULATION OF THE BLOOD.

CAPILLARIES

All of the minute arteries finally end in the systemic *capillaries*, or net works of tiny vessels, which pervade nearly every tissue of the body. They are called capillaries from a Latin word capillus, a hair. From the cells the waste matter passes into the capillaries. Every organ and part of the body is a network of capillaries. In the lungs the capillaries supply oxygen for the blood and give out the carbon dioxide to the air, while in the *villi* of the intestines they take up the substances fit for food. Thus the capillaries carry in the materials for building up the body and carry away the waste materials.

THE VEINS

FIG. 22.—A VEIN, SHOWING VALVES.

The veins are pipes which serve to return the blood from the capillaries of the different parts of the body to the heart. The veins, like the arteries, are good-sized tubes at the heart, but they divide and subdivide, becoming smaller and smaller until they can hardly be traced in their final network. Also, like the arteries, they have three coats, but they have a larger proportion of firm connective tissue and less elastic muscular fibers.

FIG. 23.—SHOWING VEINS OF THE LEG.

Some veins, like those of the limbs, and those near the surface in the head and neck, have valves, which prevent a backward flow of blood. The veins are larger and very much more numerous than the arteries, making the capacity of the venous system much greater than that of the arterial.

Tiny veins also enter the systemic capillaries, and they collect the blood from them, and finally return it to the right side of the heart to be pumped to the lungs. The great vein which enters the right auricle of the heart is the *superior vena cava,* and it receives the blood which is conveyed to the heart from the whole of the upper half of the body. The *inferior vena cava* returns to the heart the blood from all parts of the body below the diaphragm. It passes close to the liver, then pierces the diaphragm, enters the pericardium, and ends in the lower and back part of the right auricle.

THE PORTAL CIRCULATION

The flow of the blood from the intestines and stomach, through the liver, and then through the inferior vena cava, is termed the *portal circulation.* When the blood has traversed the capillaries of the stomach and intestines, it is carried by the *portal* vein into the liver, and hence the name portal circulation. The healthy action of the digestive organs depends upon the proper activity of the portal circulation.

SUMMARY

The arterial blood, freighted with the life-giving oxygen, starts from the left ventricle. It passes out into the arteries through the aorta. The arteries divide, again and again, becoming continually smaller and smaller, until they terminate in the systemic capillaries. The tiny veins of the capillaries collect the blood unloaded into them from the arteries, which is now freighted with waste matter, and return it to the right side of the heart. The heart immediately forces it through the pulmonary artery into the lungs, to be made again into arterial blood. From here it enters the left auricle again, having completed the circuit of the body.

THE LYMPHATICS AND THE LYMPH

The lymphatics are very delicate vessels, with coats so transparent that the fluid contained is readily seen through them. They are found in nearly every organ of the body, with the exception of the brain, spinal cord, eyeball, nails, hair, cartilage, and tendons. The lymphatic vessels, like arteries and veins, have three coats, and also have valves. They carry the fats absorbed by the small intestines to the blood.

Lymph is a colorless liquid found in the lymph-vessels. All of the tissues are bathed in lymph. The lymph proceeds from the blood and is almost the same in chemical composition, except that it has no red corpuscles nor blood plates. As it does its work it changes in composition, just as the blood does, and finally returns to the blood. The lymph carries food to the cells, and to the blood, and brings back waste matters. The lymphatics of the small intestines are called *lacteals,* because there exudes from them a thin, white liquid, which has in some degree the appearance of milk.

The *thoracic duct* is a great lymphatic trunk, which receives lymph from the legs. It also receives the food materials taken up from the small intestine. It lies upon the spinal column, and empties its contents into the veins of the neck. This is the main lymph duct and plays an important part in nutrition.

QUESTIONS FOR REVIEW

1. What is the blood? Of what is it composed?
2. Describe the red corpuscles.
3. Why is pure blood necessary for health?
4. Describe the heart. How many divisions has it?
5. What are the mitral valves? What other valves has the heart? What kind of blood passes through the mitral valves?
6. What is meant by venous blood? by arterial blood?
7. Where is the aorta? the pulmonary artery? the inferior vena cava?
8. What is meant by the portal circulation?
9. What is the pulse? What can be discovered by the pulse?
10. What other organs have coats like the arteries?
11. What is the pericardium?
12. What is the lymph?
13. What connection is there between the lungs and the heart?

CHAPTER VII

THE ORGANS OF DIGESTION

The mouth is the first organ of digestion. As such it may be considered as a box containing grinding machinery, the teeth. The organs of swallowing are: first, the *fauces,* or back part of the mouth; then the *pharynx,* or throat; and last the *gullet,* or *esophagus.* Down a short distance is the stomach, which is an enlargement of the digestive, or *alimentary tract,* as all of the organs of digestion taken together are called. Beyond the stomach the tract becomes a long, soft tube, coiled around and around, called the *small intestine.* Finally (Fig. 24) the small intestine opens into the *large intestine,* which is not so long but has a greater diameter. This, too, is folded and coiled upon itself.

It is plain that the alimentary tract is a tube, commencing at the lips, and extending through the whole length of the body. There are other names for the alimentary tract, such as alimentary canal, and *digestive tube.*

The tract is about thirty feet long. It is lined throughout its whole length with a moist, soft, reddish lining called *mucous membrane.* A look in a mirror at the open mouth will show the character of the lining of the alimentary tract. The tube is constructed of muscular tissue, in layers, and these layers are held together by connective tissue.

Lying adjacent to the mouth are found spongy bodies, called *glands,* which supply a digestive fluid known as *saliva.* Other like bodies are placed at several points along the digestive tract. There are several kinds of them, and they supply various digestive fluids.

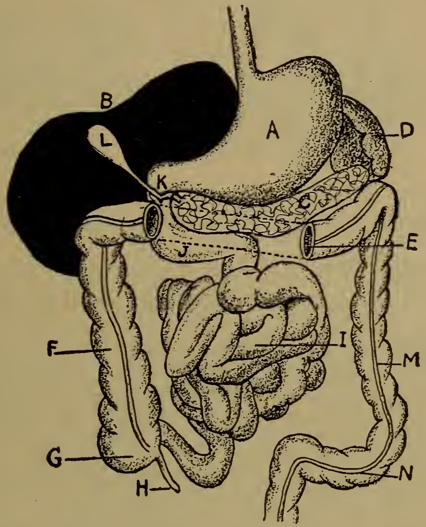


FIG. 24.—SHOWING ABDOMINAL VISCERA.

A, stomach; B, liver; C, pancreas; D, spleen; E, colon cut away to show pancreas; F, G, M, N, colon; H, appendix; I, small intestine; J, duodenum; K, bile and pancreatic ducts; L, gall bladder.

Glands are not confined to the digestive canal, for we have other glands, such as sweat glands, tear glands, and lymph glands. They are hollow or sponge-like organs, which are planted in the mucous membrane of the tract, or lie just outside of it, and communicate with it through minute tubes. Glands are made up of different kinds of cells, producing different secretions, but all glands are constructed on one or the other of two plans, known as *tubular* and *racemose*. The first is simply a tube and the second can best be thought of as resembling a bunch of grapes.

FIG. 25.—TYPES OF GLANDS IN THE HUMAN BODY.
A, simple tubular; B, coiled tubular; C, compound tubular; D, simple (sac); E, racemose.

THE MOUTH

Stand before a mirror in a good light, open the mouth, and take a look into it. First notice how perfectly the lips fit and how they open and close at will. Then notice that the cheeks cover considerable apparatus, among which the tongue and teeth appear prominently. Observe how the tongue is fastened to the back part of the mouth, while beneath it is an attachment to hold it down. Notice, also, how it can twist, turn, double on itself, curl up, and take as many positions as if it were made of rubber.

The tongue is our tasting organ, and it also serves to stir and mix the food in the mouth. The tongue is a network of cells, veins, arteries, nerves, and muscles. It is constantly moistened with saliva, and we suffer if it becomes dry. The small rough places on the tongue are called *papillæ*.

The top of the mouth, which is an arch and is covered with rolling, rough places, is called the *hard palate.* Hanging from the back part of the hard palate is a soft piece of tissue called the *soft palate,* and the cavity behind the soft palate is the *pharynx.* From the middle of the soft palate there hangs down a cone-shaped piece of flesh called the *uvula.* On each side of the uvula are two curved folds of mucous membrane made of muscular fibers which are called *arches,* or *pillars,* of the soft palate. Back of the soft palate are two glands, one on each side of the throat, which are the *tonsils.*

THE TEETH

The teeth are important parts of the mouth. They are embedded and bound tightly in the jawbone, and are partly covered by the gums. The teeth truly belong to the organs of digestion, for they do the first work necessary to this process. Food should be ground to a pulp and mixed with the fluids of the mouth before it goes any farther, and the teeth are the organs for this work.

Sound teeth are beyond any money value, because they promote digestion and preserve good health. We find out their full worth when they are lost. They have also an æsthetic value, filling out the lips and cheeks, and, if regular and clean, they add much to one's personal appearance.

We have two sets of teeth. One set appears in childhood and is called the *temporary,* or *milk,* teeth. They are twenty in number. The second teeth appear while we are still young, and they are more firmly fastened in the jaw. These teeth are larger and are the *permanent* teeth.

The first of the second set of teeth to come are called the six-and-one-half-year molars; then come the front teeth, or central incisors; then the teeth next to these, called the lateral, or side, incisors; then the bicuspid teeth, two on each side of both jaws, just behind the canines,

FIG. 26.—TEMPORARY TEETH.

eight in all. By the eleventh or twelfth year the permanent canines, or eyeteeth, come, and within a year or two after that the second molars. Last of all come the wisdom teeth, from the seventeenth to the twenty-first year, making altogether thirty-two permanent teeth.

The Structure of the Teeth.—Each tooth consists of three portions: the crown, which is outside the gum; the root, which is down deep in the jaw; and the neck, which is the part between the crown and the root. The roots are implanted in a layer of bone on the edge of the jaw. The front teeth, or incisors, are to bite through such food as bread, or apples; the eyeteeth, or canines, to tear tougher food; and the bicuspids and molars serve as grinders. Notice how the molars are adapted to grinding by their sharp corners and their broad, flat, irregular surfaces.

If we saw a molar tooth through lengthwise, a hollow cavity is found in the interior. This is the *pulp cavity,* and contains dental pulp, a soft, sensitive, porous substance, into which a nerve enters through the small hole in the point of the root. There are three distinct layers outside this pulp in the solid part of a tooth: first, the *tooth-bone,* or *dentine;* second, the *enamel,* which covers the dentine, and is as hard as flint; third, the *cement,* which is a thin, hard layer on the surface of the root, or fang.

FIG. 27.—SHOWING INCISOR, BICUSPID, AND MOLAR TEETH. A, crown; B, neck; C, root; D, enamel; E, dentine; F, pulp; G, cement.

The teeth are largely made up of mineral matter. Lime is the principal mineral, combined with phosphorus, and other substances. A curious substance called *fluorine* is found in the enamel, and makes it very hard.

Hygiene of the Teeth.—The care of the teeth is of great importance. Every person should have a good toothbrush, and should carefully brush the teeth night and morning. If the teeth are not kept clean, they decay. After every meal, we should in private pick from between our teeth any particles of food which may have lodged there. If this is not done the particles of food decompose and form acids, which are likely to start decay in the teeth. A quill or wooden toothpick should be used. A pin, or anything made of metal, should not be used. Clear, cool water is best to use on the toothbrush. It is well to touch the brush to good soap, or to dust it with clean chalk, before brushing the teeth. Either of these will help to clean the teeth and will neutralize any acid in the mouth, which, if left undisturbed, will surely dissolve a small hole in the dentine. A tooth which loses the protection of the dentine rapidly decays.

We should not eat much candy. A little candy is good for us, but if we eat it in excess acids are formed, the teeth are injured, and digestion is interfered with. Eat sparingly, too, of salads and pickles. They contain vinegar, and too much vinegar will dissolve the enamel on the teeth. If possible every person's teeth should be examined at least once a year by a good dentist, that he may remove any tartar which may have formed on them, clean them, and fill any cavities.

THE SALIVARY GLANDS

Three pairs of glands, called the *salivary* glands, supply the moisture, or saliva, to the mouth. They cannot be seen by simply looking into the mouth, for they are hidden in the flesh. The largest salivary gland is placed near the ear, and weighs from half an ounce to an ounce. This is called the *parotid* gland. Its secretion is poured into the mouth through a tube, or *duct,* and is known as the parotid saliva. This fluid is chiefly water, but it contains a little mucous and some salts.

Under the back of the tongue is the submaxillary gland, which weighs about one-fourth of an ounce. It is very irregular in form, and its saliva is much like that of the parotid gland.

Beneath the mucous membrane of the floor of the mouth, and immediately under the front of the tongue, is the *sublingual* gland. It is smaller than either of the other two, and its saliva contains, besides water, salts and mucous, a *ferment* called *ptyalin*. Ferments are formed by decomposition of different substances and are of various kinds. This ferment, ptyalin, changes starch into sugar almost instantly. Make the experiment of washing out the mouth with water, and then chewing a piece of cracker. Notice how quickly the cracker tastes sweet and is dissolved. This is the first step in digestion, and the dissolving of starch by the saliva is brought about by the ptyalin.

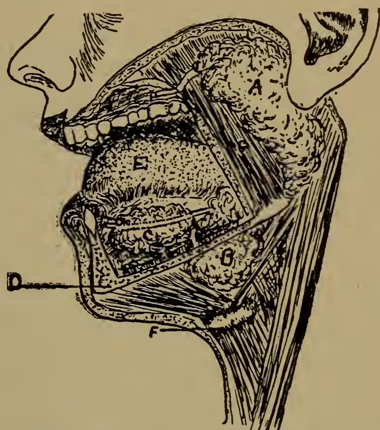


FIG. 28.—SHOWING THE SALIVARY GLANDS.

A, parotid; B, submaxillary; C, sublingual; D, lower jawbone; E, tongue, F, hyoid bone; G, muscle.

THE PHARYNX

The consideration of the pharynx brings us to that part of the alimentary canal which leads from the back part of the mouth. It is a sac, or bag, composed of mucous and muscle tissue, and is about four inches long. Seven openings communicate with the pharynx; two from the nose, two from the ears, one each from the mouth, the larynx, and the esophagus.

THE ESOPHAGUS

The esophagus is a tube leading from the pharynx to the stomach. In an adult it is about nine inches long, and it has three coats. The muscular layer, or coat, is made up of muscle-fibers running lengthwise, and others circling the tube. The inner layer is called the mucous coat, and the middle layer is the cellular coat. The cellular coat connects the outer muscular and the inner mucous coats. The mucous coat is thick and of a reddish color. Its surface is studded with minute rough papillæ, like those on the tongue. To keep the esophagus moist and lubricated there are numerous small glands along its sides, constantly discharging their secretions.

THE STOMACH

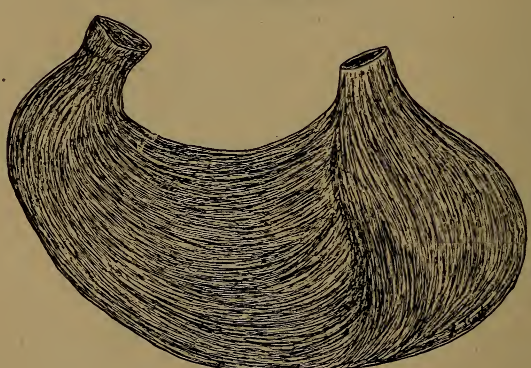


Fig. 29.—The Stomach.

The stomach is the principal organ of digestion. It is a dilated, or enlarged, place in the alimentary canal.

The small end of the stomach is toward the right side and the large end toward the left. The opening at the right, where the esophagus enters the stomach, is called the *cardiac orifice.* The opening which leads from the stomach is the *pyloric orifice.*

Coats of the Stomach.—The stomach consists of four coats, containing many bloodvessels and nerves. The four coats are named the serous, the muscular, the cellular, and the mucous coat. The serous coat is on the out-

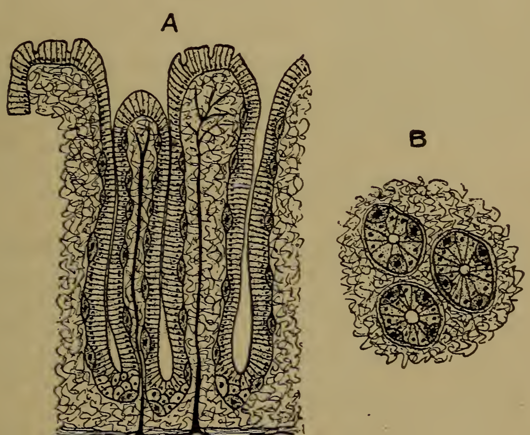


FIG. 30.—MUCOUS MEMBRANE OF THE STOMACH, HIGHLY MAGNIFIED. A, longitudinal section of glands; B, cross-section of glands.

side and covers all but a small part of the organ. The muscular coat is immediately beneath the serous and consists of three sets of fibers; one set running lengthwise, one around, and one diagonally. These fibers give the stomach strength and elasticity.

The mucous coat is thick and has a smooth, soft, velvety surface. It covers the entire interior of the stomach. When the muscles contract the stomach—that is, make it smaller by squeezing—the mucous coat is drawn into ridges, which generally run lengthwise. The mucous coat has a pecular honeycomb appearance, owing to the fact that it is covered with little cells. These coats of the stomach, and the cellular coat which connects the muscular and the mucous coats, have arteries, veins, and nerves running through them in every direction.

At the base of the cells in the mucous coat are the openings of minute tubes, which lead from the mucous glands. These glands secrete the *gastric juice.* In other parts of the honeycomb-like cells are the *peptic glands,* which secrete peptic juice, the most important digestive fluid.

THE SMALL INTESTINE

The small intestine leads immediately from the stomach at the pyloric, or smaller end. It is a round, tough tube, about twenty-eight feet long, coiled and twisted. The small intestine is divided into three portions; the duodenum, jejunum, and ileum.

The duodenum is the shortest and widest part of the small intestine, and bends around in a remarkable way. The secretions of the liver and of the *pancreatic gland* are emptied into the upper part of the duodenum. The small intestine, like the stomach, has four coats: serous, muscular, cellular, and mucous.

Projecting from the mucous, or inner, coat of the small intestine are little flesh hairs called *villi,* which give a velvet-like appearance to the inner surface. Each one of these villi is a network of minute bloodvessels, containing tiny floating cells and globules of fat. A great deal of food-digestion occurs in the small intestine, and from it, too, the digested food, made fit for building up tissues, is absorbed by the villi and is passed into the blood.

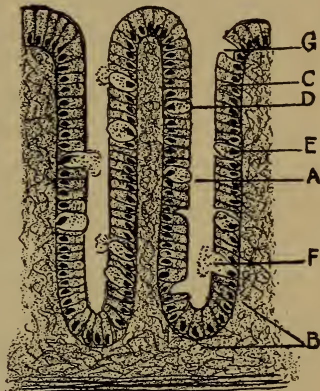


FIG. 31.—TUBULAR GLANDS FROM LARGE INTESTINE, HIGHLY MAGNIFIED.

A, opening; B, connective tissue; C, D, E, cells in different stages of forming secretion; F, cell discharging its secretion; G, cell after discharge.

THE LARGE INTESTINE

The large intestine extends from its connection with the small intestine to the surface of the body. It is about six feet long, and, like the small intestine, is divided into three sections.

To the first section is attached the *appendix,* a narrow, worm-shaped tube about four inches long. We do not know the uses of this little organ, but we do know that it is very likely to become inflamed and to cause what is now known as *appendicitis.* Appendicitis was called inflammation of the bowels before the doctors found out what the real trouble was. To cure the disease surgeons cut into the body and remove the appendix. A person so treated never has appendicitis again. Sometimes the appendix is only slightly inflamed and gets better or worse from time to time, causing more or less pain, and materially affecting the digestive processes. When this is the case the person's health improves greatly if the appendix is taken out. It seems, therefore, to do good to the body in some instances to remove this organ, just as it does good to remove a decayed tooth, or diseased tonsils. Appendicitis is caused by gorging, or overeating, by too rapid eating, or by failure to chew food well.

The *colon* is the largest and longest part of the large intestine. It first starts upward on the right side inside the cavity called the abdomen, in which the stomach and intestines are held. About half way up it crosses over to the left side and then descends.

The large intestine is a reservoir to contain undigested and indigestible parts of food, together with some waste matter and secretions from the digestive tract. These accumulations should be removed daily, if the best of health is to be preserved.

THE PANCREAS

The *pancreas,* or pancreatic gland, is a long, narrow gland, back of the stomach, which secretes a thin, alkaline liquid, amounting daily in a man to about two fluid ounces. It contains three fermenting substances, called pancreatic juices which act upon chyme, or food that has gone only as far as the stomach in the process of digestion, changing it into a form fit for the villi to absorb. Just as soon as the chyme passes from the stomach into the duodenum, the pancreas commences work and discharges its juices into the mass to do their part of the digestive work. The juices from the pancreas have the power of digesting proteids, or nitrogenous foods, carbohydrates, or starch and sugar compounds, and fats.

THE LIVER

The *liver* is a large organ lying directly under the diaphragm. It is made up of glands and plays an important part in the general nutrition, or feeding of the body. A large bloodvessel, called the portal, vein brings to it products absorbed from the alimentary canal, and before they reach the general circulation these are acted upon by the liver cells. The liver of a man secretes daily about two and one-half ounces of bile, an important digestive fluid.

The liver acts upon the blood in some way. The *hepatic artery* carries arterial blood, or blood from the heart, to the liver cells, and they make some change in it, just as they do with the blood from the portal vein. Then the fluid that results is poured into the small intestine by the bile duct, which opens near the duct that brings the pancreatic fluid. These two fluids do their part of the digestive work, helping the villi of the small intestine.

QUESTIONS FOR REVIEW

1. Name the organs of digestion in order.
2. How many of these are glands? What do you understand by a gland?
3. What part does the tongue play in the digestive process?
4. Name the kinds of salivary glands, and tell where they are placed.
5. What part of digestion is done by saliva?
6. How many permanent teeth are there? What is the difference between incisors and molars?
7. Describe the structure of a tooth.
8. What is the duty of the esophagus?
9. How many coats has the stomach? Which are most important?

CHAPTER VIII

DIGESTION AND ASSIMILATION

We have considered the organs of digestion. Now we shall study the process of digestion and how digested food is made to nourish the body.

In the first place, the food should be thoroughly masticated and mixed with the fluids of the mouth before it is swallowed. Food should not be eaten rapidly, nor moistened in the mouth with any liquid other than the saliva. The ptyalin should have time and opportunity to do its work. Overeating is quite a common mistake. It is better to stop before the appetite is fully satisfied. Care should be taken to use spices, vinegar, salads and pickles sparingly, because these things tend to create a false appetite. Plain foods are generally the most wholesome, and sunshine, fresh air, and exercise are the best tonics. It is well, also, to avoid eating much meat, but to depend upon bread, milk, eggs, peas, beans, and similar substances for the proteids required. Some fruit, fresh or cooked, should be eaten at each meal. An observance of these directions will promote good digestion and tend to maintain good health.

STOMACH OR GASTRIC DIGESTION

When the food has passed down the esophagus into the stomach, its arrival is a signal for gastric, or stomach, digestion to begin. The tubular glands in the honeycomb cells of the stomach walls become instantly active and commence to pour their pepsin fluids out on the food. The stomach is a willing servant, and if only a mouthful of food appears the glands put out enough pepsin to digest it and then patiently wait for more work to do. Even if we fail to masticate our food sufficiently, the glands and muscle coats of the stomach are not discouraged, but work all the harder.

The changing of the food begins with the first bite, and when the meal is over the process continues until the stomach and its gastric juice have done all they can do. However, all the time and as fast as any portion is digested in the stomach, it passes on into the small intestine.

The stomach digestion is an acid digestion—that is, the stomach juices contain acids. Gastric juice does not work well unless acid is present, but the stomach knows how much it needs and makes the proper quantity. If acid foods are taken regularly at the beginning of the meal the stomach learns to depend upon this and fails to supply the natural amount of acid juices.

If during a meal much water is poured into the stomach, it dilutes the gastric juice, which, therefore, cannot work properly. Consequently digestion slows up until the water is largely absorbed. Much coffee or tea has the same effect in retarding digestion. The rule is to chew food till it is very fine and never drink water or other fluids during a meal, except in small quantities. Ice water chills the stomach and work stops until it becomes warm again.

The stomach is stimulated by whisky or wine and works harder than is natural. It is not wise, however, to cause the stoamch to overwork, for it becomes exhausted and weakened by unnatural effort. The stomach of one who takes much alcoholic liquor soon becomes inflamed. The overworked gastric cells are broken down and are unable to do their work properly. Sooner or later one who indulges much in strong drink will find his digestion more or less impaired. At meals and at other times the use of alcoholic drinks should be avoided. In the end they do harm, no matter how much good they may seem to do at first.

The ptyalin, mixed with the food in the mouth, continues to work on starchy substances even in the stomach, but by far the greatest work is done by the gastric juice, which contains pepsin.

Very lately it has been discovered that the stomach has different kinds of gastric juices for different kinds of food. The relative quantity of juice required for different foods also varies. The secretion produced in the stomach by bread, for instance, is less in quantity than that required for meat.

The fats we eat, as we have learned, are not digested in the stomach. They are set free from other substances by the dissolving action of the pepsin upon proteids. Then they are liquefied by the heat of the body, and finally mixed with the chyme by the movements of the stomach.

This prepares the fats for the action of the digesting elements in the small intestine. The digestion, then, is not complete in the stomach. It is only partial, but the food not digested is prepared for final digestion in the duodenum.

DIGESTION IN THE SMALL INTESTINE

The most important digestive changes in food occur in the intestines. The intestinal digestion begins in the duodenum, which is the upper part of the small intestine, and is almost completed by the time the food arrives at the

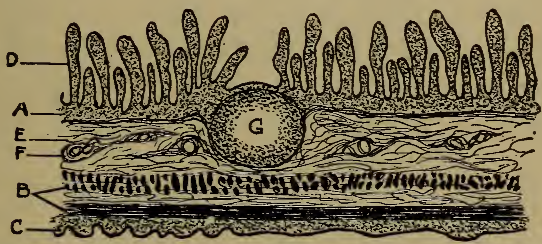


FIG. 32.—SECTION THROUGH WALL OF SMALL INTESTINES, HIGHLY MAGNIFIED.

A, mucous coat; B, muscular coat; C, serous coat; D, villus; E, connective tissue; F, artery and veins; G, solitary gland.

large intestine. There are three secretions which do digestive work in the duodenum: the pancreatic juice, furnished by the pancreas; the juice furnished by the intestinal glands; and the bile secreted by the liver. These digestive fluids are mixed with the food in the duodenum and all act at the same time.

The tubular glands in the small intestine give rise to a liquid secretion which is called the *intestinal juice*. This is produced in large quantities, a man secreting in a day about two quarts. The liquid is distinctly alkaline. This juice contains four or five digestive agents, but we know very little about them.

PANCREATIC JUICE

The secretion of the pancreatic gland is a thin, alkaline liquid, almost as clear as water. It is produced in considerable quantities, a grown person secreting about two ounces every day. Besides a substance like common soda, which makes it alkaline, it contains a small amount of proteid, which coagulates like the white of an egg.

The pancreas does not begin work until the acid chyme from the stomach enters the duodenum, for just as chewing excites the secretions of the mouth, acid excites the secretions of the pancreas.

The pancreatic juice, besides having the power of completing the acid digestion of the stomach, also has the power of turning starch into sugar and of digesting fats. Its action on the fats is to change them into a kind of thin soap-like substance. If a bit of fresh pancreas from a hog is mixed with butter, the butter changes quickly, for it becomes rancid, and can then be mixed with water. When fat is mixed with water, as cream is with milk, the mixture is called an *emulsion*. The butter, water, and juice from the pancreas makes an emulsion. If some soap or gum arabic be added, oil can be made to mix with water in emulsion by violently shaking them together. This is the way druggists make emulsions of cod liver oil.

BILE

Bile is the digestive secretion of the liver. It is also an excretion, for it carries off certain waste products. Its work is to prepare fats finally for absorption. Bile contains a great deal of water, some salts, coloring matter, bile acids, fats, and several less well-known substances. It is formed more or less continuously in the liver, but

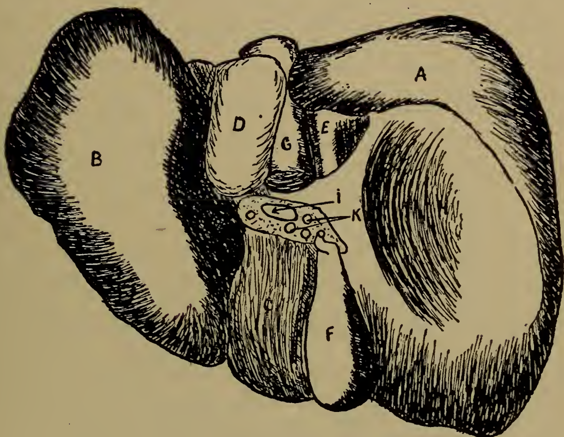


FIG. 33.—The LIVER AS SEEN FROM BEHIND.
A, right lobe; B, left lobe; C, D, E, lobes; F, gall bladder; G, vena cava; H, depression made by kidney; G, portal vein; K, I, hepatic ducts.

enters the duodenum only when there is digestive work to do. The bile that is made when digestion is not going on is stored in the gall bladder. This organ pays out bile into the duodenum as it is needed.

By the time the food has been acted upon by the villi, which absorb what will nourish the blood, it has been so altered that nothing remains but that part which will not digest, or be changed into something necessary for the body. This indigestible part is what is passed on into the large intestine, and becomes a waste product of the body. Everything that is digestible has been taken out by some one of the digestive organs and put to some good use.

ASSIMILATION

After food is thoroughly prepared by digestion it must be assimilated— that is, it must be taken up by the blood and be carried to the cells of the body to build them up.

In the stomach, water, salts, sugars, dextrine and probably some digested proteids, are absorbed to some degree by means of the coats of the stomach. The stomach walls also absorb drugs or alcohol which may have been swallowed. Fats are not digested in the stomach, nor does the stomach absorb them.

It is known that foods digested in the stomach, as well as the foods which are digested in the small intestine, are absorbed by the walls of the latter. By the time the mass enters the large intestine the products formed in digestion have largely disappeared. The villi lining the small intestine draw out the materials fit for building up the body from the digested mass, pass them over by means of the portal vein to the liver, and after this organ has acted upon them, they are sent out to the blood. While absorption is mostly effected in the small intestine, undoubtedly this takes place to some extent in the large intestine. The large intestine absorbs water freely, and this renders its contents less liquid than those of the small intestine.

THE ACTION OF BACTERIA

Bacteria are minute plants, consisting of a single cell. They are sometimes called ferments, for they bring about the process termed fermentation. When cider turns into vinegar, the process is called fermentation, and is caused by the growth in the vinegar of minute plants called vinegar ferments. The kinds of ferments are so many that they can hardly be numbered. They are everywhere, in the air, in dust, on fruits, on food, and in water. They are in our mouths and noses, and find their way into our intestines, where they cause fermentation. Sometimes bacteria cause gas to appear in the intestines, but usually they are perfectly harmless; indeed, it is believed by some that more or less bacterial action is necessary for complete normal digestion.

SUMMARY

It is interesting to trace a portion of food from the time it is taken into the mouth until the digestible portion becomes a part of the body. In the first place, the teeth masticate it thoroughly, and the tongue mixes it with the saliva, which begins the chemical change by dissolving the starch in the food into a form of sugar. Then the mouthful is passed down the esophagus, the circular muscles relaxing in front of it, and contracting behind it, until it reaches the stomach. In the stomach the gastric juice begins its work, which is mainly to change the proteids into more soluble form. Through the walls of the stomach some of this nutritive matter is taken into the blood.

So far the fats are not changed, but when the food is passed from the stomach into the small intestine, their turn comes. The intestinal juice, the bile from the liver, and most of all, the pancreatic juice, change the fat into such a nutritive form that it too can be absorbed into the system. The pancreatic juice also works on such proteids and starches as have escaped the other digestive fluids. Through the walls of the small intestine most of the remaining nourishment is absorbed. Water is absorbed by the large intestine. All the nutritive proteids, carbohydrates, and fats that the blood can carry have been absorbed and go to build up the various tissues of the body.

QUESTIONS FOR REVIEW

1. Name the different digestive fluids, tell which organ secretes each, and on what kind of food each has an effect.

2. Which is the most important organ of digestion? of assimilation? Explain why.

3. What is the effect of alcohol on the stomach?

4. What are bacteria? Do they play any part in digestion?

5. Trace the course of a mouthful of food until it is fully assimilated.

CHAPTER IX

ELIMINATION

The kidneys, skin, lungs, and bowels are eliminative organs. They throw out the waste matters of the body. If the worn-out matter is not cast out, it becomes poison to the system, and the sure result is sickness of one kind or another, and, unless the poison is removed, health cannot be restored.

THE SKIN

The *skin* is the outside tissue of the body. It protects the deeper tissues and is an important absorbing and eliminating organ. It consists of two layers, the *dermis,* or true skin, and the *epidermis,* also called the *cuticle,* or outside skin. Hair and nails are modified forms of the epidermis.

The Dermis.—The dermis is tough and flexible and consists of fibrous tissue, bloodvessels, lymph vessels, and nerves. The fibrous tissue forms the framework of the skin. The dermis, or cutis, has two layers, the surface, or papillary layer, and the *corium.* The papillary layer is so called from its numerous small, very sensitive points, the papillæ, which form the organs of touch. The papillæ are cone-shaped points blunted on top and connected by their base with the surface of the corium. The papillæ are numerous on the palm of the hands and sole of the feet, and at the finger ends, hence the great sensitiveness of touch on these surfaces. The sensitive nerve filaments are on the surface of the dermis, and deep in its tissues are the *sweat* glands, the *sebacious* glands, which secrete a kind of oil, and the roots, or *follicles,* of the hair.

The Epidermis.—The epidermis, or, as it is sometimes called, the *scarf skin,* is composed of a layer of minute cells or scales, perfectly fitted on the dermis. It varies in thickness in different parts of the body, and is a protective covering to the true skin. On the palms of the hands and the soles of the feet the cuticle is thick, hard, and of a horny texture. If we closely study the cuticle on the palms of our hands, we notice a network of lines marking out the surface into areas of different forms. Some of the lines or furrows are large and deep and some are faint. Upon the backs of the hands they are exceedingly fine, and cross each other in different directions. The color of the skin is due to the presence of coloring matter, pigment, in the cells of the cuticle, and of the dermis. The skin is supplied with arteries, veins, and lymphatic vessels the same as other living tissues of the body.

Nails.—Strange to say the nails and hair are modifications of the cuticle. Callous places on the hands, caused by pressure and friction in doing hard work, are made of material very much like nail material. The nails grow by new cells forming at the root and under the surface. The extreme end of the nail is composed of dead cells, and, hence, may be cut without causing pain or bleeding.

The Hair.—A hair is a slender thread composed of epidermis material. It grows on a special papilla placed at the bottom of a little pit. The little pit is called a *hair follicle.* Hairs are found on nearly every part of the body surface excepting the palms of the hands and soles of the feet. They vary a great deal in length, thickness and color in different parts of the body, and in the different races of mankind. The hairs grow long and thick on top of the head. They are very stiff on the eyelids, and are soft and usually curl on the eyebrows.

The root of a hair has a bulb. It is white in color and softer than the hair itself. The hair shaft is the portion projecting from the surface of the skin.

GLANDS OF THE SKIN

The *sebaceous glands* are small sacs in the substance of the corium. They are found in most parts of the skin, and are most abundant in the scalp and face, but are not found in the palms of the hands or soles of the feet. These glands secrete an oily substance, which is discharged through the hair follicle upon the surface of the skin, for the purpose of keeping the hair and skin soft and moist. On the nose and face the sebaceous glands are large, and often become further enlarged by the sebaceous matter becoming hard and distending them. Dirt gathers at the mouth of the gland over the sebaceous matter and makes what are called *blackheads.* A little pressure will force out the contents, leaving a pit, which soon fills up again.

The *sweat glands* are the organs which give off sweat and gaseous materials. They are found in almost every part of the skin, and are placed in little pits in the deep parts of the corium. There is generally some fat, *adipose tissue,* around the sweat glands.

There are over 2,500 sweat glands on a square inch of the skin in the palms of the hands. In the skin on the

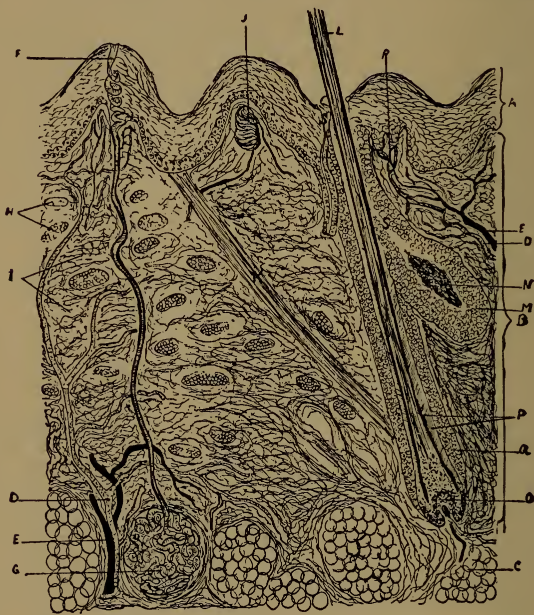


FIG. 34.—VERTICAL SECTION OF THE SKIN, HIGHLY MAGNIFIED.

neck and back the sweat glands are less numerous, only about 400 to the square inch. In the whole body surface there are over 2,300,000 sweat glands.

Figure 34 shows a highly magnified section through the skin. It shows a wonderful arrangement of glands, nerves and tissues. On the surface is the outer skin, the epidermis (A), and just below it is the true skin, the dermis (B), with still beneath that, the fatty tissue (C). The dermis is filled with arteries (D), veins (E), sweat glands (F, G), oil glands (M, N, S), and all are held together by the connective tissue (H, I). Besides, there are the hairs growing in the skin. The different parts of a hair (L) are clearly shown in the figure, the root and covering (O, P, Q). Then there is a wonderful little muscle (K) attached to the root of the hair, which has the power of making the hair stand up straight on the skin. This muscle acts in case of fright, or when the skin becomes cold. (R) shows a papilla of the skin containing many arteries and veins, and (J) shows a nerve end, where the sense of touch is located.

The perspiration, or sweat, is a transparent, colorless liquid, having a peculiar odor and salty taste. The amount of perspiration given off varies with the temperature and our activity. If we run or work hard the glands act freely, even in cold weather. In fever the sweat glands usually do not act. A grown man ordinarily perspires in a day about twenty-five ounces of sweat. When at hard work the amount may reach eighty ounces, about five pints. If the sweat evaporates as rapidly as it forms, it is called *insensible perspiration,* and if it stands out on the skin, it is termed *sensible perspiration.* Very much more passes off in the insensible form than in the sensible. Our skin feels sticky and uncomfortable if the weather is warm and the air humid. This is because the moist air does not take up the perspiration, and it remains in the skin.

In uræmic poisoning, when the kidneys do not act properly and carry off the poisonous urea, the skin may be made to do the work by causing it to sweat, which may be accomplished in various ways. The sweat ordinarily has a little urea in it.

The sweat also helps to keep the temperature of the body normal. On a hot day, or when we exercise freely, the glands pour out large quantities of sweat. As this evaporates on the skin heat is carried off and the body is cooled and kept at the proper temperature.

Dogs and oxen have no sweat glands. Dogs pant and in that way their mouths and tongues do the usual work of sweat glands.

SKIN DISEASES

There are a great many diseases of the skin. *Acne,* a common skin disease, is an eruption of the skin in the form of little red pimples, or *papules,* which may be many or few and are principally on the face. Sometimes there is considerable redness or skin inflammation in severe cases of acne. Indigestion and bad nutrition probably cause the eruptions. Lack of cleanliness is not a factor in causing acne, for its papules occur principally on the face, which is constantly being washed, but acne is evidence that proper food and slow eating with thorough chewing of food has much to do with the hygiene of the skin.

Ringworm is a contagious disease of the skin. It is caused by a vegetable parasite, and lack of cleanliness has much to do with its development. It is usually communicated by using towels, hairbrushes and combs which other persons having the disease have used.

Eczema is a very common and distressing disease of the skin. Exactly what causes eczema is not known. The disease always causes itching, and there is generally inflammation or redness of the skin. The skin weeps; that is, moisture, which is not sweat, forms, and the skin scales off. Some persons are more likely than others to have eczema. This is due, perhaps, to an inherent quality of their skin. The causes of eczema may be in a person's blood or the disease may be developed by the way in which one lives, but it is not contagious and is not the result of uncleanliness.

Itch is caused by the itch insect which burrows into the skin and causes inflammation. Uncleanliness opens the way for the itch insect to get into the skin.

Dermatitis is an inflammation of the skin, due to the direct influence of temperature, chemicals in contact with it, friction, or drugs taken internally. Sunburn is a form of dermatitis, and so is frostbite.

Chapped skin is caused by the wind and exposure to cold. When the hands are not well dried after washing them, and they are exposed to the wind, the skin chaps; that is, it becomes hard and dry and may crack open. It is sometimes quite painful. Chapped skin may be cured quickly by cleaning the skin with soft warm water, and good soap, and applying fresh mutton tallow, vaseline, or glycerine and water with a few drops of carbolic acid in it.

Bathing has already been spoken of, but now, with the increased knowledge of the construction and work of the skin, we can better understand its importance.

The secretion of the sebaceous glands and the solid, sticky residue left by the evaporation of the perspiration, form a coating over the pores of the skin, and seals them up. This stops their work, and the health suffers. Men have died from having the pores of the skin sealed up by tar, applied by mobs as a punishment.

Extensive burns over considerable skin surface are very serious, because the pores are destroyed. In such instances pieces of skin from other persons, or even frog skin, is grafted on. Our health is sure to be impaired unless the pores are kept open, and the way to do it is to bathe frequently. It is true some persons rarely, if ever, bathe and seem not to be injured, but close observation shows that they are not only offensive to sight and smell, but their general health is not good.

Apart from the duty of every one to be clean for decency's sake, there is attendant upon bathing the reward of increased vigor, better nutrition, better health and greater immunity from certain diseases, especially skin diseases.

THE HAIR

Care of the Hair.—The hygiene of the hair is also important. By using infected hair brushes we introduce *dandruff,* the disease which causes baldness. It is unwise to use the comb and brush of another, for, besides dandruff, other diseases may be communicated to the scalp in this way. The comb and brush should always be kept clean. The scalp needs to be clean as well as other parts of the body. The sebaceous glands secrete oily matter to keep the hair soft, and when dust from the air settles in the hair it is held by the oil and the scalp becomes dirty, and its pores are stopped up. A good wash for the scalp and hair is made by putting the yolk of an egg, a little good, mild soap, or a small amount of borax, in clear water, preferably soft water. After the application of the egg yolk or soap, the hair should be well rinsed with fresh soft water, and then dried. If the hair is hard and harsh, it would be well to rub into the scalp a little vaseline or a little of a mixture made of equal parts of glycerine and rosewater.

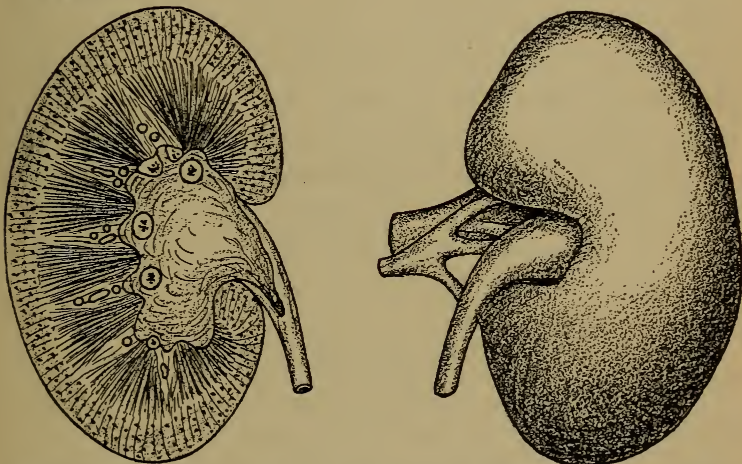


FIG. 35.—THE RIGHT-KIDNEY, AS SEEN FROM BEHIND; ALSO, THE LEFT-KIDNEY OPENED LENGTHWISE TO SHOW TUBES WHICH COLLECT UREA.

THE KIDNEYS

The *kidneys* are two glandular organs of a peculiar shape, situated at the back part of the abdominal cavity, which, it will be remembered, is the cavity below the diaphragm, and contains the stomach, liver and intestines. The right kidney is a little lower than the left, to make room for the liver.

The kidneys are usually surrounded by a considerable quantity of fat, and are held in their position by the vessels which pass to and from them. In a man each kidney is about four inches in length, two inches in breadth, and about one inch in thickness, the left one being a little longer and thinner than the right. The weight is about five ounces.

Each kidney is covered by a capsule, or sac of membrane, composed of tough fibrous tissue. This capsule is thin and very smooth, and may be easily removed. The kidneys are well supplied with blood vessels, nerves, and lymphatics. The interior portion is composed of minute tubes, embedded in connective tissue, and arranged in the form of pyramids. These tubes open at the points of the pyramids, into a cavity known as the *pelvis.* This cavity is connected with the bladder by a long duct called the *ureter.*

THE WORK OF THE KIDNEYS

A very great deal of blood passes through the kidneys; their secretion varies with the quantity of blood. In a minute's time an amount of blood equal to its own weight will flow through a kidney. This is from four to nineteen times as much as the average supply of any other organ, except the heart. The kidneys absorb from the blood, water, salts, and a waste substance named *urea,* and through the bladder these substances are cast out of the body. Urea is made in the body by the action of oxygen upon proteid material. If not thrown out of the body promptly it becomes exceedingly poisonous, causing *uremic poisoning.*

Indigestion, severe cold, and certain other diseases interfere with the work of the kidneys, and thus do great harm by causing the body to absorb its own poisonous products. This is called *auto-intoxication,* or self-poisoning. Similarly, when the bowels do not act properly, we suffer from self-poisoning.

The *lungs* have already been described and their functions given, and it is only necessary here to emphasize their importance as eliminative organs. It will be remembered that we can not stop breathing for more than five minutes and live. This is because we must have oxygen in a continuous stream, and because the carbon dioxide found in the body must be immediately eliminated. The lungs are the most important of the organs of elimination for we quickly die if they cease to work.

QUESTIONS FOR REVIEW

1. Name the organs of elimination.
2. Describe the structure of the skin.
3. Name and explain the uses of the glands of the skin.
4. Explain the importance of frequent bathing.
5. Name some diseases of the skin, and, when possible, explain the causes of each.
6. Give directions for the care of the hair.
7. Describe the kidney, and explain its function.
8. How do the lungs act as organs of elimination?

CHAPTER X

THE NERVOUS SYSTEM

Besides networks of arteries, veins, and lymphatic vessels, and winding and twisting muscles, our bodies have a network of nerves. The nerves are everywhere in the body. A prick with the finest needle, in any part of the body, will be felt by the nerves, because there is not a point in the skin which is not supplied with them. All the processes of the body, such as digestion, circulation, breathing, nutrition, elimination, motion, hearing, tasting, and feeling are made possible by the nerves. Both animals and vegetables have circulation, digestion, absorption, and breathing, or respiration; but only animals, including man, have consciousness, will power, voluntary motion, sight, and hearing, all made possible through the nervous system.

Man is superior to all other animals because his nervous system is of a higher order; that is, his nerves are more numerous, of finer fiber, and more delicately adjusted.

THE WORK OF THE NERVOUS SYSTEM

Each cell and each organ of the body has its own special structure, properties, and uses. In health all work together in beautiful harmony and co-operation, each doing its work promptly and regularly. If we run, more blood is needed for the tissues, and the heart immediately commences to beat faster to supply it. If an object approaches the eye, and touches the eyelashes, though not seen, the muscles of the lid will instantly contract and close the lid over the eye for protection. If the fingers touch a hot object, the muscles of the arm, although they are not hurt, will snatch the hand away. When food enters the stomach, the gastric cells pour their juice upon it, and the process of digestion begins. All of this co-operation is made possible by the nervous system.

The muscles and other organs have no special mind of their own, but all are controlled and directed by the central authority, through the nerves.

DIVISIONS OF THE NERVOUS SYSTEM

The nervous system has two divisions, the *cerebro-spinal* and the *sympathetic.* The brain and the spinal cord, and the nerves connected with them, and the *ganglia* seated upon these nerves, compose the cerebro-spinal division. It includes all the nervous organs with which the functions of the mind are connected, namely: all the nerves that supply the brain with sense impressions, and all those that produce muscular action which is controlled by the mind.

The *sympathetic system,* also called the *ganglionic* system, is less immediately connected with the mind. It is more concerned with such processes as digestion, breathing, the actions of the kidneys, which are all termed the *processes of organic life,* and which go on without our conscious knowledge. The sympathetic system consists of a chain of ganglia, or knots of nerve tissue, connected by nerve cords, which are placed along the spinal column and from which develop other nerves with ganglia.

NERVE TISSUE

FIG. 36.—A NERVE CELL, HIGHLY MAGNIFIED.

A, cell body; B, nucleus; C, nerve fibre.

There are two kinds of nerve tissue made up of nerve fibers and cells, namely, the *white* and the *gray*. These differ from each other not only in color, but in composition, structure, and mode of action.

The *white matter* constitutes the larger part of the whole system. It composes the larger part of the interior of the brain, and is found in large quantity on the exterior of the spinal cord. It is made up of minute, delicate threads, not over one two-thousandth of an inch in diameter. Under the microscope the fibers of nerve matter look like soft threads of glass, but tiny as they are, they are, nevertheless, composed of three layers. The outside layer is a thin, transparent sheath or cover, called the *primitive sheath;* next to this cover is a fat-like substance named the *medullary sheath;* and in the center is a core, or heart, called the *axis cylinder.* Along the fiber at short intervals are found nuclei. The nerves are made up of nerve fibers, and the function of nerves is to carry nervous impressions, just as telegraph wires carry currents of electricity.

The *gray matter* is so called because of its color. It differs from the white matter in being a mass of cells instead of fibers. It forms the external layer and part of the inner substance of the brain. It also constitutes the

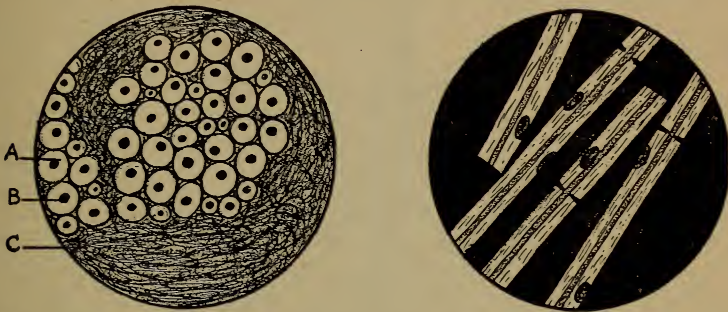


FIG. 37.—NERVE FIBERS, CUT CROSSWISE AND LENGTHWISE, HIGHLY MAGNIFIED.

center of the spinal cord, and the ganglia, or knots, of the cord.

The *ganglia,* or nerve centers, are groups of nerve cells, differing in size, shape, character and number of branches, but are much alike in appearance. They are independent, but connected with each other, with the spinal cord, and with the nerves. They are much smaller than the brain, and of less complex structure, and their work is to receive impressions from the nerves, and to pass these impressions on from one cell to another.

THE SPINAL CORD

The spinal cord is the great and wonderful nerve which fills the center of the spinal column. Its length is from sixteen to eighteen inches, and its weight about one and one-half ounces. The spinal cord is really an extension of the brain, and its construction is highly complex. A transverse section shows it to consist of both white and

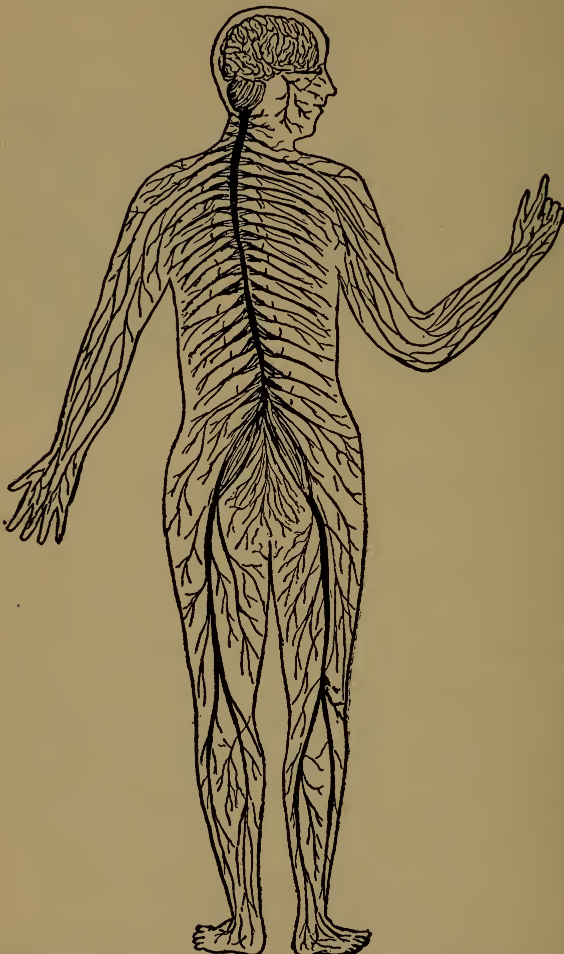


Fig. 38.—Diagram of Cerebro-Spinal System.

gray nerve substance. The white matter is on the exterior, and constitutes the greater portion; it consists of fibers running around, lengthwise, and obliquely, well supplied with blood vessels and held together by connective tissue. The gray substance, which is in the center, consists of small nerve fibers, nerve cells of various shapes and sizes, blood vessels, and connective tissues.

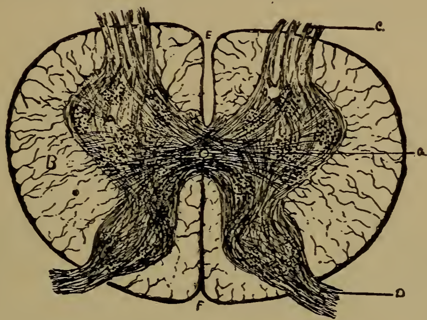


FIG. 39.—CROSS SECTION OF SPINAL CORD.

A, gray nerve matter; B, white nerve matter; C, D, nerve roots; E, F, median fissure; G, central canal.

The spinal cord is so delicate and of so much importance that it is carefully protected by thick bones on every side. These bones move slightly upon each other. A broken backbone is always very serious, for, if the person does not die, he is almost certain to be paralyzed, owing to the injury to the spinal cord.

The spinal cord is the pathway to and from the brain. Innumerable fibers bring impulses to the cord, and through the cord the impulses are carried to the brain. On the other hand, impulses of the brain are conducted downward through the cord to all parts of the body. There are, therefore, ascending and descending paths in the cord. Pleasurable and painful impulses pass up and down this great highway, with impulses of command and sensations innumerable. Through it, by way of the brain, the mind receives information and reports from all parts of the body, and through it the commands of the mind are carried to the various muscles. In some cases, as will be learned later, the attention of the mind is not needed, the nervous system doing all the work.

THE BRAIN.

The brain lies in the skull, and is incompletely separated by grooves and fissures into right and left halves.

FIG. 40.—SIDE VIEW OF THE BRAIN.
A, cerebrum; B, cerebellum; C, medulla oblongata.

Its substance is a peculiar, soft, grayish white tissue. It is enveloped by supporting membranes, and is composed, like the spinal cord, of white and gray matter. Injury to the brain substance does not give pain.

The three main divisions of the brain are known as the *cerebrum*, or forebrain; the *cerebellum*, or hindbrain, and the *medulla oblongata*, or spinal bulb.

The *cerebrum* is much larger than the other two put together and overlaps them. It consists of two large masses called the *central hemispheres.* The surfaces of these hemispheres are curved and rolling, forming convolutions, or folds, and the two are separated by deep depressions called *fissures.* In the lower animals the *cerebral-hemispheres* are not large, and the convolutions are not numerous or deep.

The cerebrum is the workroom of the mind. With it we do our thinking. It is the center of our intellect, will, and moral power, and it directs and controls the body. In it reason, judgment, and memory do their work. The brain, like other organs, develops and becomes strong through proper exercise and work.

The *cerebellum* lies back of and below the cerebrum. It is very much smaller than the forebrain, and the surface is grooved, not convoluted.

The work of the cerebellum is to regulate the movements of the voluntary muscles. If the cerebellum is injured or diseased, the muscles do not co-ordinate; that is, they do not move in harmony, and the person staggers as he walks. In the drunkard, alcohol affects the cerebellum and makes the gait unsteady.

The *medulla oblongata,* or spinal bulb, is located just below the cerebellum, and is the part which joins the brain proper with the spinal cord. The work of the medulla oblongata is to control the involuntary processes such as respiration, digestion, circulation of the blood, and the secretion of saliva and sweat. It has much the same arrangement of white and gray matter as the spinal cord.

Nerve fibers run through it to and from the cerebrum. The cranial nerves, or nerves of the head, start from the under surface of the medulla oblongata, while fibers from the cerebellum enter it.

The medulla is placed deep in the skull where it can hardly be injured, and, as it controls the beating of the

FIG. 41.—SECTION THROUGH BRAIN.
A, cerebrum ; B, cerebellum ; C, medulla.

heart and the breathing, it is possible for a person to be struck on the head and knocked senseless, while the heart and lungs keep right on with their work. Instant death, however, follows any marked injury to the medulla. Sometimes in diving head first from a considerable height, boys strike their heads on the water in such a way as to dislocate the atlas, or topmost bone of the spine. This is a fatal accident, for it breaks the neck and crushes the medulla.

THE SIZE AND WEIGHT OF THE BRAIN

The size and weight of the brain appear to have some relation to the intellectual capacity of the individual; that is, great men usually have large and heavy brains. Of all the animals, only the elephant and whale have heavier brains than human beings, but in these instances the weight of man's brain, in proportion to the weight of his body, is much greater than that of the animals named. The quality of the brain matter is of great importance, however, for the brains of some really great people have been found to be comparatively small. The grooves and ridges called convolutions, in number and depth, may have some relation to intellectuality. In young children, the brain is soft and imperfectly developed, and the convolutions are in the process of forming. Their mental powers are not strong, but, as they grow and learn and think, the convolutions increase, and the power to think is developed.

THE CRANIAL NERVES

The cranial nerves are twelve in number, generally spoken of as twelve pairs, and start from some part of the cerebro-spinal center, passing through openings in the base of the skull. We shall consider briefly only two of these pairs of nerves, the fifth and tenth.

The fifth pair of nerves, *trifacial,* are the sensitive nerves of the face and sides of the head. Each pair has three main trunks. They divide and subdivide into branches and reach all parts of the face and the sides of the head. When we know there are so many nerves in the face, there is no wonder that some persons have headache and neuralgia when they do not take proper care of themselves.

The *facial nerve* moves all the muscles of the face. Through it we smile, laugh, show apprehension, fear, anger, joy, and all of the expressions of the face. Actors have wonderful control over their faces through their facial nerves. Twitchings of the face are due to a diseased or injured condition of this nerve.

The *pneumogastric nerves,* the tenth pair, have a very extensive distribution, indeed, greater than any other of the cranial nerves. The organs of speech and respiration are supplied with motor and sensory impulses by this pair of nerves; and they also supply motor force to the stomach, esophagus, and pharynx.

The pneumogastric nerve is so immediately connected with the stomach, lungs, and heart that an over-full stomach is sure to affect breathing and the heart beat. Indigestion is very likely to make the heart irregular, and this frequently leads the sufferer to think he has heart disease. Shortness of breath is common after a hearty meal.

Sensory nerves carry impressions such as perception of heat and cold, hardness, softness, and the like to the brain to be recognized. The sensations are carried by the sensory nerve fibers to the sensory roots of the spinal nerves, and by these roots to the gray matter of the spinal cord, and then to the cerebrum. A person may hold his hand on a hot stove, and it may be consumed, yet there will be no pain if the sensory nerves are severed. It is a curious fact that when a sensory nerve is injured, pain is not felt at the point of injury, but is felt at the ends of the nerve filaments. This makes plain why, when the ulnar bone, which is called the "funny bone," of the elbow, is struck, the pain is felt in the outer side of the hand and the little finger. This is because the filaments of the nerve

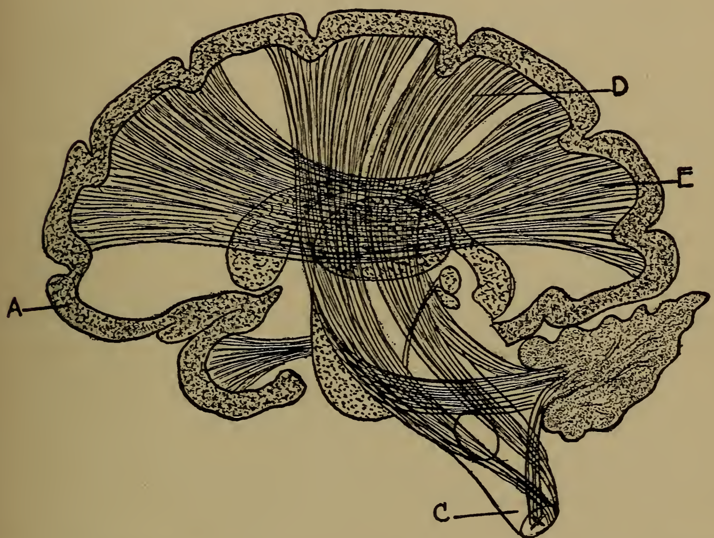


FIG. 42.—DIAGRAM ILLUSTRATING THE ARRANGEMENT OF THE NERVE FIBERS OF THE BRAIN.

A, gray matter; B, cerebellum; C, medulla; D, fibers running from the brain to the spinal cord; E, fibers which connect different convolutions of the brain.

connected with the ulna bone end where the sensation is located. If the arm "goes to sleep" when we lie upon it, the reason is that the pressure upon the nerve has cut off the force of the nervous current. When the arm goes to sleep, attempts to move it are without effect for a moment, because a short time is necessary to regain its working power.

REFLEX ACTION

If every movement of the body had to be willed each time, the burden upon the thinking brain would be too great to bear; hence, it is relieved by *reflex action*, or unconscious nerve action. We learn to play the piano by practicing upon the instrument. At first, the fingers move slowly, and attention must be kept upon the work, but gradually they learn to move faster and faster, and, in time, they strike the right keys with exact time and force, and the tune is mastered. The same thing occurs in walking. In the beginning the child toddles and holds out its hands to steady itself, but soon it learns how, and eventually it walks without seeming thought of the matter. We can chew and swallow without thinking about it, and we become so accustomed to writing that we do not have to think of the forms of the letters. This work is all done by the reflex action of the nervous system. Such life processes as respiration, the circulation of the blood, at least during sleep, would be impossible if the thinking brain was required to attend to the matter.

NERVE HABITS

It is clear from what has just been said that the nerves form habits; for many actions, at first performed slowly and with difficulty, such as walking or playing the piano, become easy and are executed without difficulty. It is difficult to learn to ride the bicycle, because every movement must be dictated from the brain, but with a little practice the habit is formed, and the act is performed without thinking about it.

A habit, then, is the result of training nerves to act without the aid of attention.

HYGIENE OF THE NERVES

Many persons complain of being "nervous." They are easily excited, irritable, have sick headache, are easily tired out. Evidently their nerves are in an unhealthy condition. Why and how did they become so? It takes a great deal of abuse to shatter and break down the nerves, but wrong living will do it in time. A simple, plain, and regular life has not been led. Excitement has been sought when quiet was needed, and rich and indigestible foods have been eaten; there has not been enough pure air and sunlight, or in some way the balance has been disturbed. The use of alcohol or other drugs, and the abuse of coffee and tea, will, sooner or later, break the nervous system. There is no greater enemy to the nerves than alcohol. A drink of whisky produces a feeling which some persons enjoy, but it is followed by depression and injury. Temperance, plain living, plenty of sunshine and out-door air will prevent, and may even cure, nervousness.

MENTAL HYGIENE

There is a mental hygiene as well as a nerve hygiene. As shown, the nerves form habits. Every thought and feeling is accompanied by a change in the nervous system. We should, therefore, form the habit of thinking good thoughts. We should think of beautiful and pleasant things as much as possible, and try to be cheerful. We should not allow ourselves to become impatient, or to scold, or to be uncharitable. Indeed, we would not allow ourselves to think bad thoughts or permit feelings of anger or revenge to rise if we stopped to think and tried to understand. No one loses patience or becomes angry with an insane person. This is because we understand the situation. We know the insane man is afflicted, and no matter what his acts, we pity him. We can only feel kindly and charitably toward him. In a like manner we should try to understand the acts of others, and impress upon our nerve centers the habit of thinking kindly. We should cultivate habits of self-control, calmness, patience, and self-reliance. It is these qualities that make men great and good.

If a young person yields to the inclination to do a wrong thing it is easier to do it next time, because the nerves tend to repeat the things they have done. If he continues to yield, he is lost. The nerves form bad habits as easily as they do good habits. We should, therefore, be careful and wise, and use our nerves and our body to our advantage. We should not simply seek for happiness and success, but rather do good work, be industrious, practice strict integrity, do good to others, establish good habits in our nerves and mind, and then success and happiness are natural results.

SLEEP

The health of the brain and nerves also require a proper attention to sleep. Sleep is nature's method of restoring strength to both mind and body, by replacing the tissues which have been worn out by the labors of the day. The time for sleep should be sacredly observed. The average adult requires from seven to eight hours in the twenty-four. Children need considerably more time for sleep. Failure to give the mind and body the necessary amount of rest in sleep, lowers the tone of the nervous system. There is no substitute for natural sleep. Drugs used to induce sleep are not only harmful in themselves, but in the end lead to conditions far worse than that from which relief is sought.

QUESTIONS FOR REVIEW

1. What is the structure of a nerve?
2. What is included in the nervous system?
3. What work is done by the nerves?
4. Describe the spinal cord. Explain its work.
5. What are ganglia?
6. Into how many parts is the brain divided? Which of these is the workroom of the mind?
7. What is the work of the cerebellum?
8. What is the importance of the medulla oblongata? Where is it situated?
9. What are the cranial nerves? Describe the functions of some of them.
10. Explain what is meant by reflex action of nerves.
11. What are some of the causes of "nervousness"?
12. Show the importance of forming right habits.

CHAPTER XI

THE SENSES

The message that the nerves carry to the brain is called sensation. There are certain definite sensations that are carried by nerves from certain organs of the body called *special senses,* because they belong only to special organs. We speak of them as *the senses.* They are the sense of sight, smell, taste, hearing, and touch. The organs to which they belong are the eye, the nose, the mouth, the ear, and the skin.

SIGHT

The *eye* is the organ of sight. It is contained in a cavity of the skull called the *orbit.* Here it is protected from injury by walls of bone, except in front, where the eyelid, together with the eyelashes, protect it. The muscles of the eye are capable of directing it upward and downward, to the right and to the left.

The eye is spherical in form, and its exterior is supported by a hard, firm membrane, called the *sclerotic coat.* This coat is white and smooth, except where muscles are inserted. It gives the whiteness to the outer margin of the visible eye, but its inner surface has a brown color. When the sclerotic coat is taken from the eye of an ox and boiled, it turns to gelatine.

The *cornea* is the outer transparent part of the front of the eyeball. It is curved on the outside, and hollow on the inside, like a watch glass. It is a continuation of the sclerotic coat, modified so as to make it transparent. There are no blood vessels in the cornea, nor does it contain lymphatic vessels, but it is supplied with numerous nerves.

The *iris* is the colored portion in the front of the eye. In its center is the *pupil*. The word iris means rainbow, and the eye is brown, black, blue, or gray, according to the pigment cells contained in it. The iris is really the curtain of the eye, for, by means of certain muscles, it is able to enlarge or reduce the opening in the middle of it, making the pupil large or small, and so letting in more or less sight.

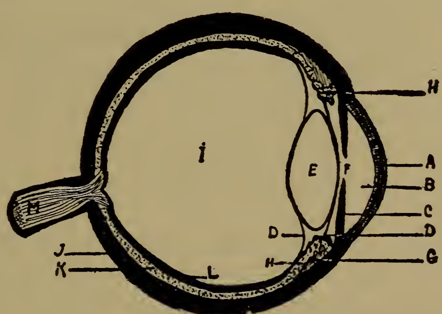


FIG. 43.—VERTICAL SECTION OF THE EYEBALL.

A, cornea; B, anterior chamber; C, iris; D, ligament; E, crystalline lens; F, pupil; G, H, muscle; I, posterior chamber; J, sclerotic coat; K, choroid coat; L, retina; M, optic nerve.

The *crystalline lens* is situated immediately behind the pupil. It is a colorless transparent body, firm in structure, and is doubly convex; that is, it bows out both front and back. It consists of concentric layers like the layers which compose the fleshy bulb of an onion. In the adult the lens is more convex in the back than in the front. In old persons the lens becomes flatter on both sides, is no longer perfectly transparent, has an amber color, and becomes quite hard. It is the work of the crystalline lens to bring the rays of light to a focus, or point, upon the back part of the interior of the eye.

The *vitreous body* fills four-fifths of the inside of the eyeball, the space between the lens and the retina. It is a transparent fluid of the consistency of thin jelly, enclosed in a delicate, transparent membrane. This vitreous fluid looks like pure water, but it contains some salts, and a little albumen.

The *retina* is one of the most important parts of the eye. It is a delicate nervous membrane, upon the surface of which the images of objects are received. The retina has ten layers, yet it is very thin, being only about one-eightieth of an inch in thickness. It is attached to the inside of the eyeball at the back.

The *optic nerve* leads from the retina to the brain. It is the special nerve of the sense of sight, and passes to the brain through a small hole in the back of the orbit. When light, which comes in waves, falls upon the retina, it sets up nerve impulses in the fibers of the optic nerve. The nerves then carry, by their impulses, an accurate description of the objects whose pictures are on the retina, to the seeing center of the brain. The mind takes full account of the description, and we have an accurate knowledge of what is before us, although the images are upside down on the retina. The mind receives the knowledge of the image on the retina; in some way it inverts the image, and we see it properly. Sometimes a disordered brain makes it impossible to see things properly.

Muscles of the Eye.—There are six muscles used in moving the eye. They are attached to the eyeball in such a way that it can be moved in any direction. Four of the

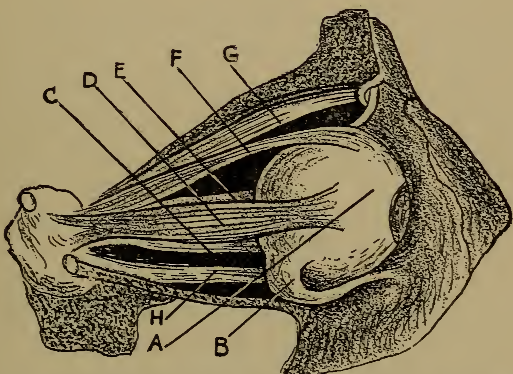


FIG. 44.—THE RIGHT EYE, SHOWING THE MUSCLES WHICH MOVE THE EYEBALL.

A, eyeball; B, G, oblique muscles; C, D, F, H, recti muscles; E, optic nerve.

muscles, called the *recti* muscles, are fastened to the eyeball near the edge of the cornea, and two, called the *oblique* muscles, are fastened to the eyeball behind the recti.

Accommodation.—When we suddenly go into the dark, we are unable to see for a short time. In a moment, however, we begin to see the objects before us in a degree. The eye must have time to *accommodate* itself to large and small quantities of light. In a strong light the opening in the iris contracts and the pupil is small; in the dark, the iris opens and the pupil is large. There are changes also in the roundness of the eye. This is necessary because we want to look at objects that are near us, and at those which are at a distance. The muscles relax to focus on distant objects, and contract to focus on nearby objects. Long continued looking at nearby objects strains the muscles of the eye and weakens them.

In a *normal,* or *perfect eye,* the parallel light rays focus on the retina when the eye is at rest. But if the cornea, or lens, or the shape of the eyeball is not normal, then the parallel rays will not focus on the retina, and the eye is imperfect. The vision is then said to be defective.

DEFECTS IN SIGHT

The eye is very delicate, and the least injury or slightest deviation in the shape of the lens, causes defects in vision. Bad circulation in the blood vessels of the retina may prevent good vision. There are so many troubles of the eye that we have physicians called oculists who give their whole time to studying and treating the eye. The man who makes spectacles is called an optician.

Color-blindness.—Some people do not accurately see certain colors. This defect is called color-blindness. It is said that about four in every one hundred persons are color-blind. It is vitally important for locomotive engineers and boat pilots not to be color-blind, as they must be able to see and to clearly distinguish colored signals. Hence, railroad and steamboat companies will not employ color-blind men. So important is this that they test every man employed by them.

Test for Color-blindness.—In testing for color-blindness a number of skeins of wool are used, and three test colors are chosen: (1) a pale pure green skein; (2) a medium purple or magenta skein, and (3) a vivid red skein. The person who is being tested is given skein number one and is asked to select from a large number of skeins of assorted colors those that have a similar color value. He is not to make an exact match, but to select those that appear to have the same color. If he is red-blind or green-blind, the test skein will appear gray, with some yellow or blue shade. He will select, therefore, not only the green skeins but the grays, or grayish yellow, and blue skeins. To ascertain red-blindness, the person is given the medium purple or magenta skein and the vivid red skein to match with other colors. With test two, medium purple, the person who is red-blind will select, in addition to other purples, only blues or violets. The green-blind person will select greens and grays.

Near- or Short-sight.—Some persons cannot see objects at a distance. To read they hold the page within a very short distance of the face. This is because the eyeball is too long, and this causes the rays of light to focus in front of the retina.

Near-sight is often hereditary, but may also be brought on by straining the eyes. Much reading of small type in a poor light will cause near-sightedness. Near-sight is also called myopia. It may be corrected by properly fitted concave glasses.

Long- or Far-sight.—When the eyeball is too short, the focus falls beyond the retina and causes far-sight. With far-sighted persons the print becomes blurred and foggy, if reading is too long continued. Far-sightedness shows itself in children by squinting when they try to see things close at hand. It may be corrected by properly fitted convex glasses.

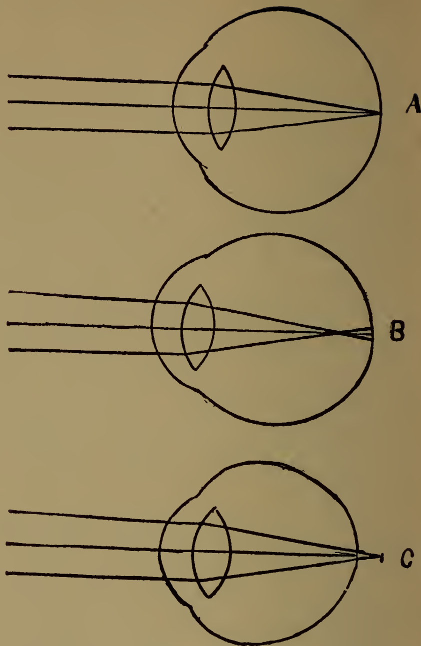


FIG. 45.—DEFECTS IN EYESIGHT. A, normal eye; B, near-sighted eye; C, far-sighted eye.

Old-sight. — When about forty-five years of age most persons put on glasses, even though their eyes have given no trouble up to this point. This is because there may be a loss of power to adjust the focus of the eye for near objects. Age causes the lens to grow stiff, and it cannot be focused on near objects. This may also be corrected by a properly adjusted convex lens.

Astigmatism.—Sometimes the various curved surfaces of the cornea or the lens differ, and persons so afflicted may readily distinguish perpendicular or horizontal lines, but not both kinds equally well at the same time. This condition is called *astigmatism.* Children who have astigmatism wrinkle their foreheads, and thrust their heads and shoulders into various positions, sometimes in this way helping to bring on spinal curvature, which deforms them and breaks down their health. It is rare to find a person who has absolutely perfect eyes. Perhaps such a person does not live, for there seems to be a small degree of astigmatism in all eyes.

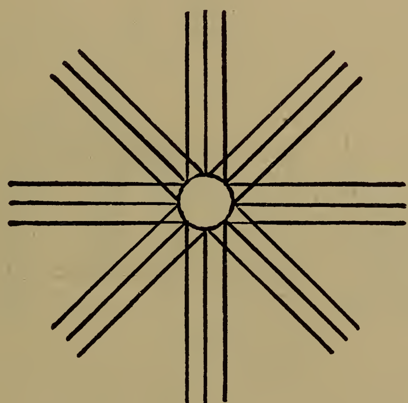


Fig. 46.

Astigmatism may be detected by looking at the center of Figure 46. If the eye is defective in this respect, some of the lines appear distinct, while those at right angles to them are blurred. This is because one that suffers from much astigmatism cannot focus distinctly at the same time lines that are at right angles to each other.

Children who have astigmatism suffer from eye-ache and headache. This makes them irritable, and the imperfection of sight retards progress in their studies. Every child should have his eyes examined by an oculist, for there are few eyes that are perfect. If the oculist finds any serious imperfections he will give directions how to correct them.

Fig. 47.—Faulty Position, Often Caused by Astigmatism.

Nature's Protection of the Eye.—The *eyebrows* are placed about the eyes partly for ornament, but also to prevent perspiration from flowing down into them. There are two movable curtains called *eyelids* attached to each eye. The upper lids are more flexible than the lower, but both have a line of hair called eyelashes which stand out straight upon their edges. The eyelashes are very sensitive to touch for their roots have nerves, and they give warning of the approach of any particles of dust, insects, or other foreign bodies. When such warning is received the eyelids instantly close and protect the eyes.

The skin is very loose on the outside of the eyelids, and their inner surfaces are covered with a thin, moist, mucous lining called the *conjunctiva.* A similar membrane also covers the eyeballs. The conjunctiva is very sensitive, and helps to protect the eyes. In the lids, between the skin and the conjunctiva, are cartilages which preserve the roundness and firmness of the walls of the lids. There are oil glands in these cartilages furnishing an oily substance which lubricates the lids. This keeps them from adhering to the eyeballs, and also prevents their edges from sticking together. The lids do much to regulate the quantity of light entering the eye, and they continually wash the surface of the eyeball with moisture from the tear glands. When we sleep the eyelids close and protect the eyes from the light and from any injury.

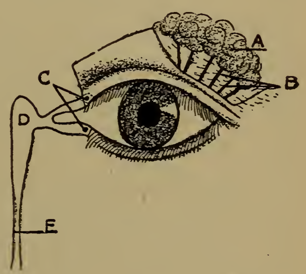


FIG. 48.—SHOWING THE TEAR GLAND OF THE EYE.
A, gland; B, tear duct; C, tear sac; D, duct leading to the nose.

The *tear glands* are located just above the external corner of the eye. Tears are constantly being secreted. Ducts lead from the glands to the inner corners of the eyes, and all the tear secretion which is not needed to keep the eyeballs moist and transparent, passes into the nose. If the eyes become dry because of disease, or from hot winds, they smart, and the sight is blurred. When we cry the tears run out of the eyes, because the ducts leading into the nose are not large enough to carry away the greatly increased discharge.

THE CARE OF THE EYES

The greatest of care should be taken of the eyes. Pain or smarting in the eyes is a warning that should be heeded immediately. If the eyes ache, parents and teachers should be told at once. In any case, *every child's eyes should be carefully examined.* The eyes are avenues to the brain, carrying knowledge of external things, and if they are deficient in any way, the wrong should be corrected if possible.

Never try to read or sew, or do any fine work in a poor light. Reading in the twilight is certain to injure the eyes. The sun should not shine directly on the book, writing, or sewing. If a light is glaring, shade it with ground glass or an opal shade or paper. If the light comes from behind, or from the right side, shadows are cast upon the book or paper. The light should always fall over the left shoulder. If the seats at school are so placed that the pupils are compelled to look into the light when looking straight ahead, or if the light is from the front or over the right shoulder, a change in the arrangement of the seats should be made, or the matter should be remedied in some other way.

An oil lamp is the best artificial light by which to read. The German student lamp makes an excellent light. If a gas light is used there should be placed over it an opal shade, or one that has a light blue tint.

If the type in a book or on a newspaper is small, or if it is even medium-sized type with pale letters, it should not be read. A great deal of harm results from reading newspapers, or books, poorly printed in small type.

It is injurious to read while lying down, or while walking, or riding. Reading on the cars is also very bad for the eyes, unless the type is large and the letters black. Bending over work for any length of time tires the muscles of the eyes. If the eyes smart or pain while reading, writing, or sewing, they should be closed for a short time, then rested by looking out at the grass and trees and at distant objects.

Washing in cold water, to which a pinch of salt has been added, is good for smarting or tired eyes. Never buy eyewashes, or any medicine for the eyes, which is not recommended by a physician. We should never neglect a sore eye, for if one eye becomes diseased the other is likely to become diseased also, through sympathy or by contagion. If a speck gets into the eye it should not be rubbed; lifting up the lid by the lashes will permit the tears to wash it out.

Any matter, or pus, in the eye is caused by disease, and great pains should be taken not to introduce matter from one into the other, for fear both will become diseased. Any one who has weak, watery eyes or inflamed lids, or who has matter in his eyes, should have a separate wash-basin and towels. Better let the face stay dirty than to use a towel which a person with sore eyes has used.

THE SENSE OF SMELL

The nose is the special organ of the sense of smell. Its nerves warn us against the inhalation of foul and poisonous gases into the lungs, and they assist the sense of taste in deciding the properties of food.

There are two openings to the nose, called the *nostrils,* which are separated from each other by a partition of cartilage called the *septum.* The nostrils lead into two quite large, irregular cavities, the fossæ, and these in turn open into the pharynx.

The nose is lined with a mucous membrane which is always moist. This membrane has hanging from it minute flesh hairs, or filaments, which are constantly vibrating from within outward. These are the air-strainers. They move with the incoming air current, just as grain waves in the wind.

We should always breathe through the nose, never through the mouth, for the nose strains and warms the air before it enters the lungs, and the mouth does nothing of the kind. Breathing through the mouth is certain, sooner or later, to introduce germs or dust into the lungs and to cause trouble.

FIG. 49.—THE OLFACTORY NERVE.

A, olfactory bulb; B, nerve filaments; C, hard palate.

The *organ of smell* is the upper part of the mucous membrane of the nasal fossæ. The nerve of smell is called the *olfactory nerve,* and its terminal filaments are distributed in the mucous membrane.

Substances have odor only when minute particles are given off into the air we breathe. A portion of rose oil too small to weigh can be discovered by the nose. Boiling coffee or broiling steak can be discerned out on the street, when cooking is going on in a closed kitchen.

Dogs have a keener sense of smell than men; horses can smell water. In hunting deer, the hunter must approach on the side from which the wind blows toward him, for if it blows from him toward the deer, they will scent him half a mile away, and escape. Some people are very susceptible to odors, so much so, indeed, that certain odors cause faintness, or bring on disease like hay fever.

The sense of smell becomes quickly fatigued, for it is very noticeable that after a few smells of a rose the odor cannot be noticed. When we enter a badly ventilated room, an odor is always perceived, but in a few moments we cease to notice it. A pungent odor like ammonia is perceived by the lower portions of the nose, but it is not really smelled.

Smell and taste are intimately associated. The qualities of certain foods, such as fruits and wines, are perceived by the sense of smell rather than by taste. When such food is swallowed, the back of the nose is shut off from the back of the mouth by the soft palate, but in the expiration succeeding swallowing, the odor of the food is noticed. Flavors are therefore perceived after the act of swallowing. If the nostrils are blocked, as when one has a cold in the head, foods lose much of their flavor. Simply holding the nose will destroy much of the flavor of fruits.

THE SENSE OF TASTE

The *tongue* is the organ of taste. It lies in the cavity formed by the lower teeth, and its inner surface is connected with the lower jaw by a muscle. The tip of the tongue, part of its under surface, its sides, and the top surface are free. The surface of the tongue is marked along the middle by a line which divides it into two equal parts. The front part of the tongue is rough on the surface, and is covered with small projections called papillæ.

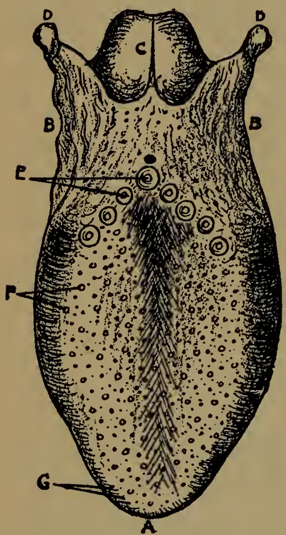


FIG. 50.—THE TONGUE.
A, tip; B, root; C, epiglottis; D, hyoid bones; E, F, G, papillae.

The mucous membrane of the tongue is provided with numerous follicles and glands. There are arteries to bring blood to the tongue, and it has three nerves in each half, two being nerves of taste, and the other a nerve to control the movements of the tongue. The tasting nerves lead directly to the taste center in the brain.

Taste sensations are very numerous, but there are only four fundamental tastes or sensations, namely: sweet, bitter, acid, and salty; all other tastes are combinations of these. The seemingly great variety of our taste sensations is largely due to the fact that we confuse, or combine, them at the time with certain odor sensations.

Alcohol, spices, and tobacco all lessen the sensitiveness of taste through over-stimulation. Tobacco smoke dries the nostrils, irritates the tongue, and benumbs the taste.

HEARING

There are three parts to the ear. The external ear, which stands out from the sides of the head; the middle ear, or *tympanum,* and the internal ear, or *labyrinth.* The external ear is a kind of funnel which collects sound-waves and directs them through the canal in the head, called the *auditory canal,* to the tympanum.

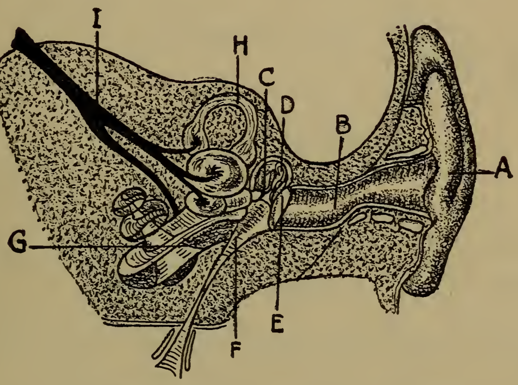


Fig. 51.—Showing Section Through the Left Ear.

A, external ear; B, auditory canal; C, middle ear; D, bones of the middle ear; E, drum membrane; F, eustachian tube; G, cochlea; H, semicircular canal; I, auditory nerve.

The middle ear is sometimes called the drum chamber, and is an irregular cavity in the temporal bone. The drum chamber is always filled with air, and is divided by a partition from the interior end of the auditory canal. There is also a canal, called the *eustachian tube,* leading from the middle ear to the pharynx. This tube allows air from the throat to enter the middle ear, thus balancing the pressure on the drum of the ear from the outside. If the eustachian tube becomes inflamed, or is stopped up with mucous, the air in the middle ear is absorbed, and the external air presses inward on the drum, causing an uncomfortable feeling and more or less deafness.

Three small bones called the hammer, or *malleus;* the anvil bone, or *incus,* and the stirrup bone, or *stapes,* stretch across the middle ear, from the drum membrane to the labyrinth, transmitting the vibrations of the drum to the liquid of the labyrinth.

FIG. 52.—THE BONES OF THE EAR.
A, malleus; B, incus; C, stapes.

The internal ear, or labyrinth, is the essential part of the hearing machinery. It is called the labyrinth because it is so complicated. It consists of three parts, the *vestibule, semi-circular canals,* and *cochlea.* In these bony cavities and tubes are membranous chambers and tubes, in which the fibers of the auditory nerve end. The auditory nerve leads into the hearing centers of the brain. The cochlea consists of a tube coiled up very much like a snail shell. Partitions divide it into three chambers filled with lymph. The membranous partition supports the *organ of corti,* and together they form a series of vibrating cords, which have a delicate nerve apparatus.

HOW WE HEAR

What we call sound is borne to us in the air. There can be no sound in a vacuum. When a guitar string is made to vibrate, sound is produced, and in the same way our vibrating vocal cords produce sound. Sound travels in waves. Loudness depends upon the extent of vibration, and pitch upon the rapidity. Slow vibrations give deep tones, and rapid vibrations shrill tones. The outer ear gathers the sound waves (vibrations), and conducts them into the auditory canal. They strike the drum, are carried by the ear bones to the labyrinth, and then into the cochlea, when they come upon the organ of Corti and the membraneous partitions which support this organ. From here the auditory nerve carries their message to the brain.

CARE OF THE EARS

The ears secrete a substance which hardens and is called *earwax.* Sometimes this wax accumulates and becomes quite hard, obstructing the auditory canal, or lies against the drum and prevents it from vibrating when sound-waves strike it. This causes one kind of deafness, and it is usually the result of uncleanliness. The ears must be kept clean by washing them, but a pin or other hard substance should never be put into them. Sometimes permanent harm is caused by picking the ear.

The hearing is sometimes affected by measles and scarlet fever, which may leave the middle ear diseased. Care should be taken to protect both the ears and the eyes during the period of these diseases. A person, with normal hearing, should hear distinctly a watch tick three feet away, and words spoken in low tones twenty feet away.

TOUCH

General sensations give a knowledge of the various parts of the body, such as fatigue, discomfort, faintness, aching, and burning.

The *sense of touch* is located in the surface of the skin. By means of it, we appreciate by actual contact the size, form and character of the surface of objects. Where the nerve endings are most numerous and their covering the thinnest, as in the tip of the tongue, under surface of the fingers, and edges of the lips, there touch is most sensitive.

The hands are most usually employed in the exercise of the sense of touch. The fingers are furnished with thousands of papillæ, and can be moved so freely, that we generally think of touch as being located only in them. Touch is the simplest of all the senses. The blind learn to distinguish articles by touch, the sense becoming so delicate by cultivation that they can readily read raised letters. They learn to distinguish plants, features, fabrics, and laces, by simply touching them.

THE MUSCULAR SENSE

The muscular sense enables us to distinguish weight and resistance. It is highly developed where the tactile or touch sense is most acute. The muscular sense depends to a great extent upon the muscular nerves. It makes it possible for us to appreciate resistance, elasticity, and immobility. Bankers sometimes gain such delicacy of the muscular sense, that they can tell instantly whether or not a coin is light, and sometimes whether or not a bill is counterfeit.

PAIN

Pain is a form of sensation that is useful to us, for through it we learn of destructive processes, of diseased conditions, and gain knowledge necessary for our preservation. When the natural limit of nerve stimulation or irritation is reached, then we have pain. A little tickling may not be unpleasant, but if continued it may become painful and even cause death. Fatigue causes the muscles to ache. Too much light in the eyes, as when looking at the sun, causes pain. Harsh and very loud sounds may cause pain in the ears. Pain in the head, commonly called headache, is a warning of something wrong somewhere.

TEMPERATURE SENSE

There are in the skin certain special nerve ends which are devoted to heat and cold sensations. This sense is distinguished from the sense of touch, and is known as the *temperature sense.* Some of these nerve ends are sensitive only to relatively high temperature, and are known as *heat spots.* Some others respond only to quite cold temperature, and are called *cold spots.*

QUESTIONS FOR REVIEW

1. What is meant by the senses?
2. How many are there? What are the corresponding organs?
3. Describe the eye. What gives it its color? What moves it?
4. Why is the retina an important part?
5. What are some of the most common defects of sight?
6. How is the eye protected?
7. Where is the sense of smell located?
8. Where are the nerves of taste situated?
9. How many different taste sensations are there?
10. Name the several functions of the tongue.
11. How is the tongue affected by fever?

CHAPTER XII

SPEECH AND THE VOICE

Only man can express thoughts in articulate sounds. Some of the lower animals can make varying sounds; birds can chirp and sing; the dog welcomes his master in one tone and threatens strangers in harsher tones, but many of the lower animals make no sounds.

There is a great difference as to the use of the voice among the higher and lower grades of men. The highly intelligent use their voices to better effect, and to a greater degree, than those of low intelligence. Probably no other one mode of manifestation is so sure a revelation of intelligence and culture as the voice. Idiots, although they have complete organs of speech, cannot pronounce distinctly, and sometimes resemble lower animals in their vocal sounds.

Speech is effected through the special senses, for through them we secure impressions which grow into ideas and thoughts, and finally are expressed in speech. Even the deaf, if intelligent, may be taught to speak.

THE LARYNX

The larynx is the principal organ of voice, but the trachea, lungs, breathing muscles, nose, pharynx, mouth, and tongue are all engaged in producing articulate speech.

The larynx is placed in the upper part of the air passage between the trachea and the base of the tongue. It is lined by the same mucous membrane which lines the pharynx. The framework of the larynx is composed of

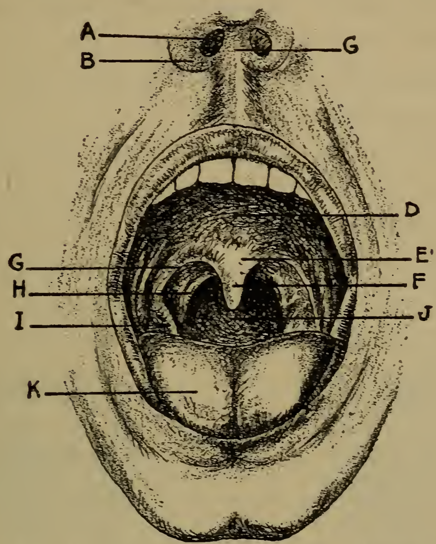


FIG. 53.—VIEW OF THE OPEN MOUTH.
A, B, nose; C, septum; D, hard palate; E, soft palate; F, uvula; G, H, pillars of fauces; I, tonsil; J, pharynx; K, tongue.

nine cartilages, connected by ligaments, and controlled by numerous muscles. The Adam's apple is one of these cartilages.

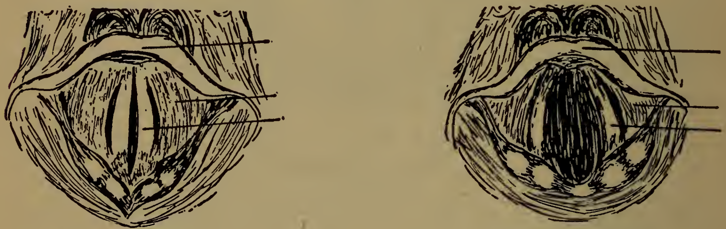
The *epiglottis* is a small leaf-shaped trapdoor which prevents the entrance of food into the larynx during the act of swallowing.

THE VOCAL CORDS

The vocal cords are most important in producing speech. These are elastic bands of ligament stretched across the larynx from back to front. They are so arranged as to vibrate when air passes over them, and are attached on three sides, only one edge being free.

In stringed instruments, the strings are attached by the ends only, and in organs the reeds are fastened at one end, and have three edges to vibrate. It is almost beyond understanding how man with two cords can produce so many different sounds.

The muscles of the larynx are many and under perfect control. At will, they loosen or tighten and produce the various differences of sound which make up the human voice. Some muscles of the larynx rotate and move outwardly and some inwardly, some regulate the tension of the cords, or control respiration, or move the epiglottis.



High Note. Quiet Breathing.

FIG. 54.—THE LARYNX IN DIFFERENT CONDITIONS.

Upper line shows epiglottis; middle line, the false vocal cords; lower line, true vocal cords.

Speech is produced only when we empty the lungs, never when filling them. As soon as an attempt is made to produce a sound, the vocal cords are all attention and ready to act. In making high notes or shrill sounds they become tense and get close together. When low notes are uttered they relax and separate. To produce clear vocal sound the cords almost touch edges. If not smooth and straight, or if they do not vibrate properly, or if mucous is in the throat, hoarse sounds are emitted. Stammering results from a loss of control over the diaphragm. The stammerer can manage his vocal cords, but his diaphragm acts spasmodically. A stutterer's trouble is in his lips and tongue. He can control his vocal cords and diaphragm.

Loudness and intensity of vocal sounds depend upon the elasticity of the vocal cords and the force of the escaping air. Differences in pitch depend upon the length of the cords and consequent rapidity of vibration. Quality or timber is that characteristic which enables us to distinguish the voices of different persons.

Vowel sounds are produced when the breath is not obstructed above the larynx in its outward passage. Consonant sounds result when the outgoing air is obstructed by the tongue, teeth or lips.

Voices may be cultivated to be soft and gentle, to modulate and inflect, and to develop power and range of sound. The high-pitched voice of children is due to the small size of the larynx and short vocal cords. At about fourteen a boy's voice usually changes. This is because the larynx increases in size, and the cords become longer. For a time the regulating power of the muscles is diminished. The voices of girls do not change so much as those of boys. They develop strength and compass, the quality not changing to any degree.

CARE OF THE ORGANS OF SPEECH

The organs of speech need fresh air as well as the lungs. Colds injure the voice not only temporarily but sometimes weaken it permanently. Singers are very careful in all precautions against taking cold. The general health is important. A sickly person, or one in pain, shows it in his speech. The voice should be used in a natural manner. Screaming and yelling are not to be absolutely forbidden, but should be severely controlled. Whisky and tobacco affect the voice. Huskiness of voice is frequently noticed in the drinking man. The smoke from tobacco sometimes sets up a troublesome cough through its irritant action.

Singing, practiced in the right way, is an exceedingly useful exercise in voice training. It gives control of the breathing organs, increases the capacity of the chest and lungs, trains and develops the vocal cords, and moderates and improves the quality of the speaking voice. But the voice should not be strained. Children should be encouraged to sing softly and with clear, pure tones, to strive for quality rather than quantity of tone.

QUESTIONS FOR REVIEW

1. By what organs is the sound of the voice produced?
2. What are the vocal cords?
3. What do the lips, tongue and teeth have to do with the voice?
4. How do we produce a loud sound?
5. What causes stammering? Hoarseness?
6. How may the voice be cultivated?
7. In what way is singing beneficial?

CHAPTER XIII

WATER

Water is the most important and abundant of all foods. It is a true food, for it is necessary to the composition of every cell and tissue of the body. We need several pints of water every day. Most foods, and especially fruits and vegetables, contain large amounts of water, and from these and from soups, milk, coffee, tea, in addition to drinking water, we secure the supply we need.

The flesh of old persons has less water in it than the flesh of children. It is the large amount of water in the flesh of young persons which gives them their freshness and roundness. Old persons become wrinkled, and lose their youthful appearance, in proportion as the water leaves their tissues. It has been said that the difference between youth and old age is only a little water. Even if old persons were to drink more water, it would not become a part of their tissues, because their cells are gradually losing activity.

PURE WATER

Pure water is not found in nature. From whatever source it is taken, it is found to have something dissolved in it. Water can be made pure, however, by *distillation.* Chemists, druggists, and physicians must have distilled water in their chemical work and in medicines, and they often distill it themselves by means of a *still.* A still, or boiler, is a tin-lined copper vessel connected with another vessel by tin pipes, which can be cooled. Water is placed in the still, and when upon heating, steam forms, it passes through the cooled pipes, condensing into water again, and is collected in the other vessel.

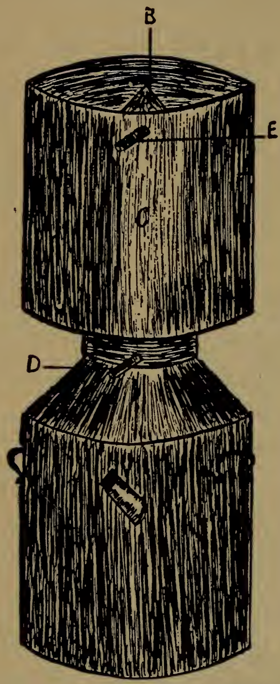


Fig. 55.—A Domestic Still.

Distilled water is the purest and best drinking water. In most large cities, there are companies which sell distilled water in bottles. The sailors on war vessels are supplied with distilled water, and so are the passengers who travel on large ocean steamers. Physicians prescribe distilled water for rheumatism and diseases of the kidneys.

RAIN WATER

Rain water is said to be soft, because it does not contain lime, magnesia, iron or other minerals. It is therefore better than hard water in which to cook vegetables. Rain water is best, too, for bathing and for washing clothes. In combination with soap, it quickly forms a lather, or soap suds, and is therefore excellent for cleaning. Rain water is so superior for bathing purposes that some people go to the expense of building tanks, or wooden cisterns, in the tops of their houses, and keeping them filled with it. From these tanks the water is conducted through pipes to bath rooms and wash stands.

Rain water is really distilled water, only it is distilled from the air by nature on a gigantic scale. It is fine drinking water, if it is collected properly. First, the cistern must be clean and tightly covered; second, the air, the roof, eave-troughs, and down-spouts must be clean. This may be brought about by not turning the rain water into the cistern until the rain has been descending for some time. In this way, the dust in the air and the dirt on the roof are not carried into the cistern, and so pure water is secured. Water collected in this way is most wholesome, and never contains anything to cause disease.

Typhoid fever is very frequently brought to us in well-water, which in some way has become polluted. If every house were provided with a drinking water cistern, which is carefully filled with rain water as described, there would be very much less typhoid fever, and the people would be far healthier.

WELL WATER

Well water is more or less *hard,* in proportion as it carries lime, magnesia, and other mineral matters in solution. These are dissolved from the earth as the water soaks through it. Sometimes wells furnish water too salty to drink; this is because there are large quantities of salt in the earth near by.

Hard water forms a curd with soap. It is impossible to dissolve the dust from our hands, or to wash the dirt out of clothes, with hard water, until the soap has made it soft, by combining with the lime and magnesia to make a curd. This insoluble curd materially interferes with bathing, for it is deposited on the skin, and fills up the pores. Moreover, hard water is not so wholesome to drink as soft water.

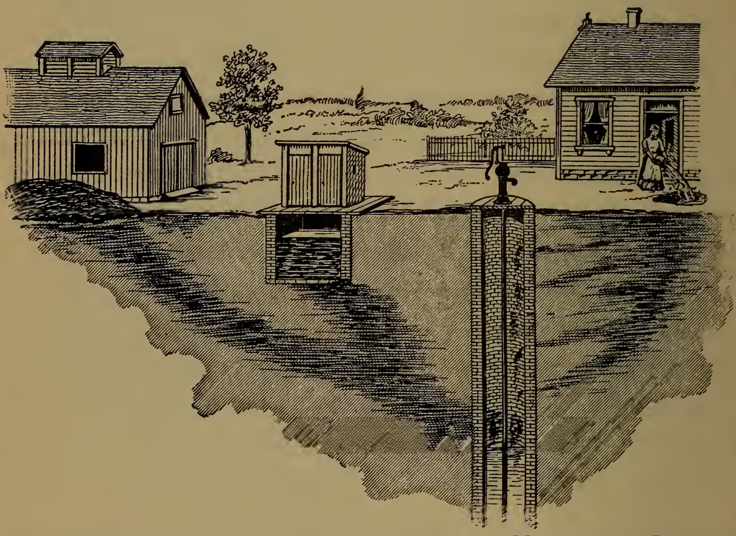


FIG. 56.—SHOWING HOW WATER IN A DUG WELL MAY BECOME IMPURE.

Dug wells often become polluted. The picture makes plain how this happens. Sanitarians say that all dug wells should be condemned and filled up, because they so frequently cause disease. If a dug well has a wooden platform, and no trough to carry away waste water, it is certain to furnish bad water, and no one should drink from it. Besides the danger from decayed wooden platforms, there is great danger that worms, rats, and mice may get into dug wells.

Deep-driven or *drilled* wells always furnish hard water, but it is rarely polluted, and is not so likely, therefore, to cause disease. The pipes of a drilled well pass through the layers of earth, finally piercing a stratum or layer of clay, and reach the gravel beneath, which is filled with clear and clean water. Surface drainage does not get into the water of deep wells which are drilled, as the clay or rock stratum stops the bad water from above.

SPRINGS

Springs are frequently praised as the very best source of drinking water. Spring water usually flows out of hills, high banks, or mountains. So long as the hills or banks are not cultivated, or are not roamed over by men and animals, this is true. The springs which flow from such hills will supply measurably pure water. It is like the water from well protected, deep wells.

RIVERS AND LAKES

River, creek, pond, and lake waters are very likely to be polluted, and should never be used for drinking water unless boiled or filtered. Cows stand in creeks and ponds in the summer time, and barnyards drain into them. Cities and towns drain their sewage into rivers and lakes. Pollution occurs in practically all surface waters.

PURIFICATION OF WATER

Boiling will destroy germs and other impurities in water. A practical way to prepare boiled water for a family is to boil it hard for at least twenty minutes; then pour it into a large stone jar, cover the jar with a clean cloth or stone cover, and let it cool. Considerable lime, magnesia, and flecks of other insoluble matter will settle to the bottom, and the clear water above may be dipped out to drink.

Besides destroying offensive polluting matters, boiling softens water, by causing much of the mineral matter to become insoluble. Boiled water has a *flat* taste, which is caused by the absence of mineral matters, and because the oxygen and carbon dioxide gas have been driven off by the heat. To remove the flat taste, take two pitchers, fill one with boiled water, and add a pinch of salt, then pour through the air from one pitcher to the other several times.

Hundreds of lives would be saved every year, if people would boil all drinking water which is taken from dug wells and from shallow-driven wells. Many cities have constructed great sand filters, at enormous expense, in order to procure pure water. The fine sand in filters strains out floating matter, such as leaves and dirt, and also destroys germs and dissolved impurities. The filter beds at Indianapolis cover several acres, and purify about 10,000,000 gallons of water every day.

QUESTIONS FOR REVIEW

1. Why should water be called a food?
2. What makes the skin of old people wrinkle?
3. What is distilled water? Why is it purer than spring water?
4. Which is easier to wash with, hard or soft water? Why?
5. How many kinds of well water are there? Which is better? Why?
6. Under what conditions is spring water not good for drinking purposes?
7. Why is the water of rivers, lakes, and ponds dangerous to drink?
8. How may it be made fit to drink?
9. What effect does boiling have upon the water?
10. Is there any way of purifying water besides boiling it?

CHAPTER XIV

FOODS

We must eat food and drink water to build up and maintain the body. New material is needed for growth in young persons, and for the renewal of muscles, flesh, bones, and nerves, which are continually wearing out through work and play. Grown persons need food principally to renew worn-out material, and to keep up the natural heat of the body.

Food tastes good at almost any time, but especially so when we are hungry. The sense of taste is principally in the tip of the tongue. Delicate nerves, finer than the finest silk threads, lead from the tip of the tongue into the brain, and these carry the sensation we call taste to the brain. Cut these tiny nerves, and we could not tell quinine from sugar. Sometimes we unwisely keep on eating, although we have had enough, simply to enjoy the sensation of taste. If we do this too frequently we are made sick. It is very foolish to keep on eating when we have had enough, for overeating is followed by many ills. It is an old saying that persons frequently dig their graves with their teeth. This means that overeating causes disease. If we wish to keep well we should never eat to excess.

There are several kinds of foods. We have animal foods, such as beef, chicken, eggs, milk, and fish; vegetable foods, as potatoes, beets, peas, and beans; and fruits, as apples, peaches, grapes, and tomatoes; lastly we have water, which is the most important of all foods, for it is a part of every cell in the body. The cells cannot live and work without water. In a person weighing one hundred pounds there are at least seventy pounds of water.

MILK

Of all foods milk is the best. It is the only food which will alone support life for a long time. Bread is called "the staff of life," but no one could live long and be strong with only bread to eat. Children and old persons should always have milk to drink, and it is good for persons of any age. Milk contains butter, a kind of sugar called milk sugar, curd, a substance like white of egg called albumen, salts, and water. The butter in milk is finely divided, and appears as drops of fat floating around.

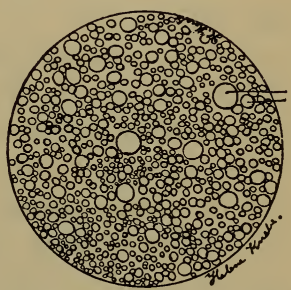


FIG. 57.—A DROP OF MILK, MAGNIFIED, SHOWING FAT GLOBULES.

Only the milk of healthy and clean cows should be used. If the cow is covered with dirt, and if the cow yard and cow barn are filthy, it is impossible to get clean milk. The person who milks the cow should have clean hands; the pails, pans, cans, bottles, in fact everything used in connection with milk, should be as clean as possible.

The barns where cows are kept should be scrupulously clean. The walls should be whitewashed at intervals, and accumulations of dust and cobwebs prevented. Hay and straw should not be handled just before milking, because it tends to fill the air with dust. Before milking begins the body and flanks of the cow should be brushed to remove all dust and loose hairs. Then the milker should have clean hands and clean clothes, and above all, the milk pails and cans should be fresh and clean to receive the new milk. Washing the cans and pails and wiping them dry is not enough. In addition, they should be scalded with boiling water and placed out in the sun after each milking to kill the germs and microbes. The sun is the arch purifier.

Another point of great importance is to cool the milk rapidly, as soon as it is drawn from the cow, and then keep it cold. If this is not done the milk will not only sour, but what is still worse, it will become actually poisonous. Every summer in cities, great numbers of babies and young children are made very sick from drinking poisonous milk. This condition makes one of the most important food problems in large cities, for it is difficult to procure clean, fresh, pure milk. Milk is poisoned by very tiny plants called germs, or microbes, which get into the milk with any particles of dirt which may fall into it.

Milk should be taken into the stomach very slowly. It will not do to pour a quantity of milk directly into the stomach, for it there forms a solid lump of curd, which digests very slowly. The proper way to drink milk is to take a little into the mouth, stir it with the tongue in order to taste it and to mix it with the fluids of the mouth, and then swallow it. In this way a soft and broken up curd appears in the stomach, and is promptly and easily digested.

Butter is made from cream, the rich part of milk, and is an important food, provided it is fresh and sweet. Oleomargarine or butterine is made of fat from the bodies of cattle. If oleomargarine or butterine is made of fresh, clean, healthy fats, and under conditions of perfect cleanliness, it is almost as wholesome as pure butter, but should never be sold fraudulently as butter.

For the preservation of health the human system requires a certain amount of fat food. Good butter supplies this in one of the best forms, because it is very easily digested by even children or invalids, and is entirely wholesome. Good bread quite thickly spread with butter is a nearly perfect food.

Cheese is also made from milk. It is a valuable food, but it should always be eaten with bread or crackers, and not in large quantities, for it is very rich and does not digest easily. Babies and very small children should not eat cheese.

MEATS

Animals that are killed for meat should be healthy, and the meat should be prepared for market in a very cleanly way. It should be carefully kept, too, so that it does not spoil. Sometimes dishonest butchers wash spoiled meat in chemicals, which makes it look fresh and destroys the bad odors. Only sweet fresh meat should be eaten, or meat properly salted, as salt pork, or salt fish, or meat properly cured by salting and smoking, as ham or bacon.

The various kinds of meat differ in their value as food, and in digestibility. *Fish,* for instance, is a very wholesome food, and should be eaten more generally than it is. But, to be good food, fish must be quite fresh or properly cured while yet fresh.

Beef, mutton, lamb and *poultry* are very nutritious, and are all easily digested. Beef especially is good meat, but many people eat too much of it. Children and old persons, especially, should be careful to eat beef in small quantities.

FIG. 58.—TRICHINA IN PORK.

A, muscle fibres; B, C, trichina embedded in a capsule.

Veal is not so easily digested as beef or mutton, and many persons consider it unwholesome.

Pork is hard to digest. It should be thoroughly cooked, and eaten sparingly. Ham, bacon, and sausage are all pork meat, but are considered good foods. There is a little worm called *trichina,* which is sometimes found in pork, and which makes the meat poisonous. That is why the government inspects or examines pork.

Eggs are excellent food. They contain albumen, fat, water, and salts. They are most digestible when they are soft-boiled, or poached soft. Hard-boiled eggs are not so easily digested. Fried eggs are good, but frying is not the best method of cooking them.

BREAD

Bread is the most abundant, and one of the best of all foods. It is made by mixing water, milk, salt, and flour together, and then working in yeast dissolved in water. The yeast is a minute plant, and when it grows in dough, it forms carbon dioxide gas, which lightens the dough, and causes it to rise. When light and just right, the dough is made into rolls of proper size, and baked into loaves.

Poorly baked bread is unfit to eat. All the yeast must be killed by baking, and every particle of the bread should be baked thoroughly, to make good digestible food. Frequently doctors find children, and even grown persons, who have indigestion from eating poorly baked bread.

Biscuits are made light by baking powder, a substitute for yeast, and crackers are simply flour, water, salt, and lard or other fat, well worked together and baked. Corn bread, or bread made from Indian meal, is both delicious and wholesome.

VEGETABLE FOODS

Vegetable foods include fruits, all kinds of garden produce, and all kinds of grains. Grains are called cereals, and by the term cereal foods is meant any food made out of any grain. Wheat and corn are the grains most used in the United States, although a great deal of oatmeal and rice is also used. The Chinese, Japanese, and Hindus regard rice as their staff of life. The Scotch eat large quantities of oatmeal, while the Irish use potatoes extensively.

If we chew wheat for a little while, a sort of wax is left in the mouth. This is *gluten,* the nourishing part of grain. There is a large amount of gluten in oats, and not so much in corn. Rice has very little gluten in it. Very fine white flour is considered by many persons the very best kind, yet it is really not so desirable for food as flour which is not so fine, and which has a very slight yellow color. Whole wheat flour is generally considered the most wholesome.

GARDEN PRODUCE

Under this name are classed, Irish potatoes, sweet potatoes, peas, beans, beets, onions, parsnips, cabbage, and all such vegetables. Irish potatoes are very popular, principally because of their pleasant taste, and the peculiar starch they contain. When properly cooked they are an excellent food. Sweet potatoes are also wholesome. They contain more sugar than our common potato. Beans contain a large amount of *vegetable albumen,* which is very much like the white of egg, and is highly nutritious. They should be thoroughly cooked, however, otherwise they may cause indigestion. Beets, onions, parsnips, cabbage, and greens are important articles of diet, though they do not contain much real nourishment, but they give bulk to the mass of food. This keeps the surface of the digestive organs spread out and promotes their work.

FRUITS

Fruits are very wholesome. They do not contain much nourishment, but their juice, sugar, agreeable acids, and salts are important additions to other foods. The apple is the king of fruits. It is good raw or in almost any form that it may be cooked. Apple butter and apple sauce are especially wholesome, while baked apple with cream is an excellent dessert. Oranges and bananas are healthful, especially when cut up together, and eaten with sugar. Dates are nourishing enough to form an important food in Turkey and other eastern countries. Stewed prunes are also very excellent food. A dish of stewed prunes with bread and butter, a soft boiled egg, and a glass of milk, make a good breakfast. It is very favorable to good health to have some fruit at every meal.

NUTS

Nuts contain oil, and are rich in tissue-forming substances. They are, therefore, wholesome, nutritious food; but they should not be eaten in large quantities, and should be thoroughly masticated. A little salt taken with nuts makes them more digestible.

CONDIMENTS

Condiments are such things as salt, pepper, mustard, horse-radish, and vinegar. They should be used only in very small quantities. Some doctors advise against the use of all condiments, except a small amount of salt.

WHOLESOME DRINKS

Young people should have no other drink than pure cool water and pure milk. They should avoid coffee, tea, and all alcoholic drinks. *Soda water,* as usually found in the drug stores, is not a wholesome drink. No great or lasting harm results from an occasional drink of soda water, but it is rarely made and handled with the proper degree of cleanliness. The water from which it is made is often polluted, the syrups are preserved with chemicals and colored with aniline dyes. The ice cream is all too frequently made of materials which should not be used, such as milk or cream from dirty dairies, gelatin, starch, saccharine, and so forth. It sometimes happens that left-over ice cream from a soda fountain is allowed to melt and stand until it becomes more or less poisonous, and then is frozen again. The bad material used, the frequent uncleanliness, chemicals, coloring matter and spoiled cream are the causes of the nausea or sickness of the stomach so frequently felt after taking soda water.

Soft drinks are the common five-cent red, pink, and yellow drinks sweetened with saccharine which are sold everywhere. They are not wholesome, for usually the water they contain is not pure. They are colored with dyes, flavored with artificial flavors, and almost always put up amid uncleanly surroundings. Other five-cent bottled drinks, some of them known as coca-cola drinks, are very unwholesome. Some of them contain cocaine, which is worse than whisky and opium in its final effects upon the human system. It is safer and wiser to avoid all these drinks.

Root beer, if made at home, is a good summer drink, and so is a first class ginger ale. It is possible to procure both of these articles of high grade in the stores, but, as just said, the usual soft drinks are bad.

Lemonade, when properly made, is an excellent drink. In public places it is frequently composed of impure water, tartaric acid, and saccharine. We should carefully avoid drinking lemonade in public places.

The rule regarding drinks is: Avoid everything which stimulates. Be sure the water in soft drinks is pure, and that they do not contain chemicals and aniline dyes. This rule practically leaves us only pure water and pure milk, and they are good and abundant.

Coffee and *tea* are not really foods, and much injury to health results from their excessive use. Coffee contains a drug called *caffein,* and tea contains one called *thein,* both of which stimulate the heart, and do great injury to the nerves, especially when those drinks are used in excess. They should never be used by children, and even for older persons, the most healthful drinks are milk and pure water.

Chocolate and *cocoa* are drinks that are really nourishing and wholesome foods. A cup of chocolate with milk, some crackers, and an apple make an excellent luncheon or light meal. Light meals of simple foods are most conducive to good health, vigorous activity, and long life.

DIET

This bring us to the question of diet, which means the selecting of the kinds and qualities of foods that are best suited to us. Different conditions of life require different diets. For instance, men who do heavy work, out-of-doors, need more food than merchants, or lawyers, or other men who work indoors or at a desk. The outdoor work, which requires so much strength and activity, wears out the tissues and cells of the body faster than inactive life, and laboring men need so much food to renew these worn-out tissues that they can eat large quantities of almost any kind of food, and feel no bad effects. If a clerk, or any one who works all day at a desk or indoors, should eat such a dinner as a brick mason or teamster can, it is very likely that he would be ill in consequence.

Seasons have some influence on diet. In the winter we require more meat, and solid nourishing foods, than in spring or summer. In the north or colder countries, the people eat a great deal of fat. They need it to keep up the heat of their bodies. The Esquimaux drink whale-oil, and they have been known to eat candles. The people of India, on the contrary, avoid the use of fat. They live chiefly on rice and fruits. An Esquimau diet would kill them, while the Esquimaux could not live on vegetables and grains alone.

As a rule, women do not require so much food as men. This is because they do not, as a rule, do such heavy work, and, besides, men are generally larger than women. Infants require only milk for the first year, and cannot digest even bread until they have teeth to masticate it. Young persons who are still growing need more food than older persons. The tendency of many persons is to eat too much. Rheumatism and gout may result from continual overeating. The tissues of the body become unhealthy, and are easily attacked by disease germs.

It is well, too, to be regular in our eating. The stomach should not be kept working all the time; it needs some rest. It takes about four hours to digest a meal thoroughly, and as the stomach should have at least one hour for rest, it is plain that we should not eat oftener than every five hours. If we are out-of-doors, or exercising vigorously, we may need food sooner, but it is not a bad thing to endure a little hunger rather than start the stomach working when it should rest.

Scientists have made a study of the diet problem, because of its importance in our daily life. A bad diet may not only make us uncomfortable, but even ruin our digestive system. In order to understand the importance of diet, it is necessary to know something about the substances in different foods.

CARBOHYDRATES AND PROTEIDS

It is evident that foods like some vegetables and grains which contain sugar, or starch, are very unlike eggs and meat. Sugar and starch contain carbon, hydrogen, and oxygen, only the hydrogen and oxygen are always in such proportion as to form water. Such foods are called carbohydrates. On the other hand, eggs and meat contain nitrogen, as well as carbon, hydrogen, and oxygen, and are named proteids. Proteids are sometimes called *nitrogenous foods,* the name coming from the fact that nitrogen is their characteristic ingredient.

Every particle of carbohydrate food comes from the vegetable kingdom. Plants alone have the power of making carbohydrates. It is true we find carbohydrates in animal food, but the animal did not make them; it got

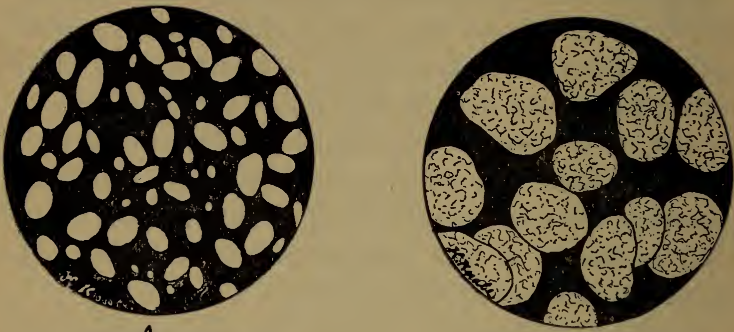


FIG. 59.—A, starch grains from a raw potato; B, the same from a boiled potato. Magnified 250 times.

its supply from the plants it ate. Wheat, corn, and other cereals contain a great deal of starch (carbohydrate), and only a comparatively small amount of proteid. Beans and peas are rich in proteid. Meat and eggs contain a little carbohydrate, principally in the form of sugar, but they are for the most part proteid.

PROPORTION OF CARBOHYDRATE AND PROTEID IN CERTAIN FOODS.

Name of Food.		Per cent Proteid.	Per cent Water.	Per cent Carbohydrates.
Cereals	Rice	7	13	77
	Corn	10	13	68
	Wheat flour.....	11	13	75
Animal Foods	Eggs	13	74	a little
	Cows' milk.....	4	88	5
	Beef	21	77	a little
Vegetables	Potatoes	2	75	21
	Cabbage	2	90	5
	Green peas......	7	75	17

In the table it is interesting to note the large amount of water in eggs, milk, and beef. Cereals contain comparatively little water, but vegetables contain as much as meats. The illustration below gives a graphic idea of the amount of water and other constituents in an Irish potato when boiled.

The small division represents the proportion of fiber, mineral matter, and proteid. Even an egg, which is semi-fluid, contains no more water than a potato. The difference in cell structure of the two foods makes this possible.

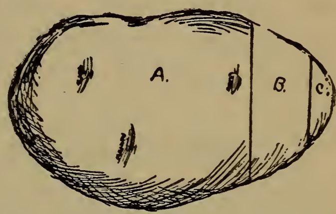


FIG. 60.—SHOWING PROPORTION OF WATER AND NUTRITIVE MATERIAL IN A POTATO.

A, water; B, starch; C, proteid and mineral matter.

PROPORTION OF FOOD ELEMENTS

It is evident from these comparisons, that a variety of foods is a good thing, so that we may get the proper proportion of proteid and carbohydrate foods. This proportion will vary according to the climate and kind of work done, as has been explained in an earlier part of this chapter. Each man, to keep his health, should get each day in his food a certain amount of proteids, carbohydrates, fats, salts, and water. No one of these alone will support life for any length of time.

The salts, such as lime, iron, and sodium compounds, of which common salt is one, are contained in all kinds of food. We often add more salt to our food at the table, and in proper quantity, it is a valuable aid to digestion. A grown man requires about one hundred fifty grains of salt each day, but too much salt, like too much milk or any other food, is injurious.

The amount of water required varies with the season. In hot weather we need more than in cold weather. Not less than three pints of water a day are required by a man in good health. When working at hard labor in the summer time, a man will sometimes drink from ten to fifteen pints of water in a day, without any injury to himself.

An English scientist, Hutchison, who has studied the matter of diet, says that the following bill of fare will well nourish a man at moderate labor:

Breakfast—
- 2 thick slices of bread well buttered
- 2 eggs

Dinner—
- 1 plateful of good soup
- 1 large helping of meat with some fat
- 4 moderately large potatoes
- 1 thick slice of bread well buttered

Supper—
- 1 glass of milk
- 2 slices bread well buttered
- 2 ounces of cheese

Of course, the man should sometimes have fruit, and the kind of meat should vary from day to day, as beef, chicken, mutton, or pork. Besides, other vegetables than potatoes should sometimes be added.

QUESTIONS FOR REVIEW

1. What enables us to taste anything?

2. Name three animal foods; three vegetable foods. What other kinds of foods are there?

3. Of all foods, which is most important? Why?

4. What happens to milk if it is not kept clean and cold?

5. What is butter?

6. What are the best kinds of meat?

7. Why do we put yeast in bread?

8. What is a cereal?

9. If we chew wheat, what is left in our mouths? What has made the substance?

10. Why is it injurious to drink much coffee or tea?

11. What is meant by diet?

12. Should all persons eat the same quantity and kind of food? Explain why?

13. Why should we not eat between meals?

14. What is the difference between a carbohydrate food and a proteid food? Name examples of each.

15. What substances do we find in a potato?

CHAPTER XV

COOKING

The value of fire, as an aid to man in the preparation of his food, was a great discovery. Man is the only animal that cooks his food. That is because he cannot easily digest wheat, or corn, or many of the vegetables in their raw state. He can digest fruits without cooking them, and they are often just as good for him in the raw state as when cooked. Horses and cows can digest uncooked cereals, as well as hay, and straw; and hogs can digest any kind of food, cooked or uncooked.

Cooking makes food softer and more delicate. It develops flavors, produces important chemical changes, and destroys parasites, like trichina. The different modes of cooking are roasting, baking, boiling, stewing, broiling, and frying.

COOKING MEATS

To cook meats properly, they should be introduced into a hot oven if they are to be baked, or roasted; into boiling water if they are to be boiled; or into a hot frying pan, or skillet, if they are to be fried. Unless meat is heated quickly the juices will ooze out as the heat is applied.

Roasting.—When a piece of beef, a turkey, or a chicken is put into a hot oven to be roasted, all surface cells are instantly sealed by the heat. This keeps most of the juices in the mass of the meat, and the delicious flavors which develop are prevented from escaping. The meat is thus made sweeter, more toothsome, and more digestible. When roasting is being done, it greatly helps matters to open the oven door occasionally, and with a long-handled spoon dip up the juices which ooze from the meat, and pour them over it again. This is called *basting*. Basting improves the flavor and digestibility of all roasted meats.

Boiling.—If a piece of meat for boiling is put into cold water, and then put over the fire, the water, as it gradually becomes hot, extracts all the juices from the meat and makes a good soup. The meat, however, is left a mass of flavorless fiber difficult to digest. When the meat is desired for food, it should be put into boiling water for the same reason that the roast is put into a hot oven.

Frying.—In frying, meat is cooked very hard. The fat is drawn out of it, and the proteid does not undergo the proper chemical changes. For these reasons frying is not considered a good method of cooking meats. An exception to this rule is bacon, which is mostly fat, and has very little proteid to be made hard and tough.

Broiling.—Broiling over coals, or over small blue gas flames, is the best method of cooking steaks and chops. There is a marked difference in flavor, taste, tenderness, and digestibility between meats which have been broiled, and those which have been fried. This is because of the difference in the methods of applying the heat. In broiling over coals, or blue gas flames, the outside cells are instantly sealed over, and the juices and flavors, as in the case of roasting, are kept in the meat. More of the fat is also retained, and this makes the fiber of the meat tender and digestible. In frying, the heat is not direct, but is applied through iron, and as the juices and fat run out of the meat, it soaks and sizzles in them, and the proteids are made hard and indigestible.

BREAD BAKING

Bread must be well baked to kill the yeast in it, to change the raw starch into soluble starch and into a gummy substance called dextrin, and to make the gluten digestible. If the interior of a loaf of bread smells of yeast or is heavy and sodden, it is unfit to eat.

Toast is bread baked a second time. It is more digestible than even well-baked bread, because the toasting, or second baking, insures the killing of every yeast cell, and also turns more of the starch into dextrin, which is sweet and soluble.

COOKING VEGETABLES

Most vegetables should be cooked in soft water and for a long time. It is almost impossible to cook vegetables properly in hard well water, for the lime in the water hardens them, and prevents the flavor from developing. Such vegetables as cabbage, turnips, and carrots can hardly be cooked too long to make their tissues soft enough to be easily digested.

Potatoes may be baked, boiled, stewed, or fried. They are good food prepared in any of these ways, but baking seems the best method. Potatoes are often made unwholesome by cutting them into small pieces and frying in fat, because the starch grains become coated with fat and the saliva cannot act upon them.

Dried *beans* and *peas* should be soaked in soft water for several hours before they are placed over the fire. The water in which they are boiled should be soft, and should have a little salt in it. They should be slowly cooked for several hours, for in no other way can they be made soft, and the starch and proteid they contain be made digestible. Beans may be baked after they have been well boiled, and this gives them a very pleasant flavor.

Rice should be soaked for several hours, and finally cooked slowly in a steamer or double boiler. Oatmeal and breakfast foods should also be cooked in a double boiler.

Tomatoes are fruit, for they contain within their meat or pulp, the seeds which are the real fruit. They are, however, usually regarded as vegetables. They are wholesome either raw, baked, or stewed. They make an excellent sauce for meats because of their delicate flavor.

Turnips, to be cooked properly, should be peeled, cut into small pieces, and slowly stewed until perfectly soft.

Onions also must be slowly stewed until soft, and if a cream made of milk and flour is poured over them, they make an excellent dish. Some persons do not like onions in any form, but they are, nevertheless, a thoroughly wholesome and nutritious food.

Cabbage, cooked, is not as digestible as it is in the raw state, though a little cooked cabbage is not harmful, and working men with strong digestion can eat it with advantage. It is singular that cooking does not improve cabbage as an article of diet.

SOUPS

The value of soups as an article of diet is well known. There are many varieties of soups, and many methods of making them. Vegetable soup is the most common. The first step is to boil some beef in water, putting it in before the water has reached the boiling point, for the warm water better extracts the juices. This is the very thing we do not wish to have happen when the meat is boiled to be eaten. The pot and contents are then set aside for a time, when the grease is skimmed off. The liquid which remains contains the flavors and extracts from the beef. Into this is put chopped potatoes, peas, cabbage, or, indeed, any soup vegetables desired. After boiling again the soup is ready for the table.

Bouillon is made simply by heating, not boiling, meat in water. When it is boiled, only the extracts are taken from the beef, and no proteids pass into the solution; they are coagulated, that is, hardened and made insoluble. Beef tea which has been boiled, contains very little nutrition; it is simply a stimulant.

A good soup may be made of tomatoes by gently stewing together with water or milk, tomatoes, flour, and butter.

Soups are exceedingly wholesome, and we do well to begin our dinner with them. They furnish an excellent way of supplying water to the system. Of course, we can supply water by drinking it, but the water in soups and milk also, is intimately associated with nutritive material, and in such association it has an especial value as food. For the water in our cells is not simply soaked up, as by a sponge, but it is an intimate part of the cells. It is said to have become *organized.*

PRESERVED FOODS

Meats are preserved by salt and smoking. Ham and bacon are so prepared and are wholesome foods when eaten in moderation. Beef is *corned,* or preserved, by soaking it in strong salt water.

All kinds of foods may be preserved by canning. Cooked foods will soon spoil unless put while very hot into cans, or jars, and quickly sealed up. When this is done they keep well. Foods spoil because moulds and germs fall upon them from the air. These moulds grow in the foods, making them sour and mouldy and sometimes even poisonous. The idea in preserving is to kill all the germs by heat, and then keep other germs from coming into contact with the foods. The salted and smoked meats keep because germs cannot grow in salt, nor in the products of smoke.

Drying will preserve foods. The Indians keep venison by drying it. If apples and peaches are dried they will not spoil. There are plenty of germs on these, but germs cannot grow unless they have water. This explains why dried fruit keeps so long.

Use of Chemicals.—The laws of most states forbid preserving foods by means of chemicals. This is because the chemicals used in preserving are injurious to health. Formaldehyde, borax, and various acids are used, the first named being the least injurious. In spite of the law, the greed and avarice of some men lead them to preserve milk with formaldehyde. The courts punish such men severely, when they are caught and proved guilty.

Preserving by Cold.—Ferments, moulds, and germs cannot live when the temperature is cold, and therefore we can preserve foods by keeping them away from heat. Refrigerators furnish the means of keeping foods where the temperature is low. In the cities there are great cold storage warehouses, in which eggs, butter, meats, fruits, and other perishable foods, are preserved until wanted. The railroads have refrigerator cars, and steamboats and ships have cold storage rooms for transporting meats and fruits to market. Food preserved by cold storage is wholesome, unless by carelessness, accident, or ignorance it has been spoiled.

Pickling.—Vinegar and spices will not support the life of moulds or germs, and therefore they are used for preserving. Cucumbers are most commonly treated in this way, but peaches and meats are also pickled. When eaten in moderate quantities, pickles are not unwholesome.

Adulteration.—When butter has a good deal of water churned into it, when maple sugar has had glucose added to it, when ground pepper has been mixed with ground cocoanut shells, they are *adulterated.* Adulteration is not generally injurious to health, but it is always fraudulent and wrong, and is forbidden by law. Water in milk does not cause ill health, but it is against the law to sell water as milk. There are, however, some adulterants which are injurious to health. Among these are chemical preservatives like borax, salicylic acid, and formaldehyde, and the aniline dyes, which are sometimes added to jams, jellies, wines, catsups, and canned fruits. This subject will be dealt with more in detail in another chapter.

QUESTIONS FOR REVIEW

1. Why should we cook our food?

2. How many ways of cooking meat are there? Describe the process of roasting.

3. In how many ways may a piece of meat for boiling be treated? What is the result in each case?

4. Why is fried meat not so wholesome as roasted meat?

5. In how many ways may food be preserved?

6. What is meant by ''adulteration''? Is it ever the same as ''preserving''? Explain.

CHAPTER XVI

ADULTERATED AND IMPURE FOODS

Dishonest and avaricious men resort to all sorts of means to get money without giving an equivalent value for it. One of the common ways of doing this is to adulterate food materials, that is, to mix some cheaper stuff with good food material.

MILK

Milk is one of the things most commonly adulterated. It is so easy and simple to put water into milk that it is frequently done. This, of course, does not make the milk directly injurious, but the nutritive value of the milk is reduced. Children fed such milk are not properly nourished, do not grow well, are pale and bloodless, are, in fact, slowly starved.

Milk sours easily, and every care must be taken to prevent this. The right and only admissible way, is to cool it down to not less than forty degrees immediately after it is drawn from the cow, and then keep it cool. This is troublesome, hence chemical preservatives are sometimes added. It has been found that formaldehyde, which is very cheap, will prevent milk from souring when added in very small quantities. Other substances such as borax will preserve milk. These are injurious to the health, and are forbidden by law, but dishonest men will evade the law, if they can, or they are willing to take the chance of having to pay a fine out of their unjust profits. In cities, where so many frauds are practiced, milk inspectors are constantly at work securing samples of milk and taking them to the chemist for analysis.

Great as is the evil of adulterating milk with water, and of adding chemical preservatives, still greater is the collecting of milk in an uncleanly way. Milk taken from a sick cow, or one that is covered with barnyard filth, is unfit for human use. If the milk vessels are not perfectly clean and sweet, the milk may become poisonous. Unclean and improperly kept milk causes severe sickness in infants, and thousands of infants die every year from poisonous milk.

Poisons occur in unclean milk through the growth of bacteria, which fall in from the air of foul stables and barns. They also drop from the filthy flanks of the cow. Wherever there is a cow barn that is not clean and cows covered with filth, there are conditions which cause poisonous milk, and such milk causes bowel diseases, and that common child's disease, cholera infantum, which kills infants by the thousand.

Butter is adulterated by mixing it in emulsion with cooked starch, or by treating milk with pepsin the milk forms a soft solid jelly, which may be emulsified with butter. Butter is also adulterated with sweet tallow oils, or oleomargarine, which are cheaper and more abundant than butter fats.

Cheese is adulterated with starch or flour. Sometimes the cream is taken from milk of which the cheese is to made, and a cheaper fat like cottonseed oil is substituted.

Flour and corn meal are not now mixed with other substances. At one time these were adulterated not a little, but men found that for many reasons it did not pay, and now the only adulteration practiced is to mix them with inferior grades of flour as meal.

White sugar is rarely, if ever, found to be adulterated. This is because all efforts to do so successfully and profitably have failed. Brown sugars are adulterated with water to make them weigh heavier.

Candy is often highly colored and the coloring materials used are sometimes poisonous or at least unwholesome. Cheap candies, having much color, should, therefore, be avoided.

Syrups, Molasses.—Maple syrup is so commonly adulterated with ordinary molasses and glucose that it is almost impossible to find the pure article in stores. The addition of cane molasses and glucose does not make it unwholesome, but it is a fraud. If a person wants one thing and the merchant substitutes another, the purchaser is swindled. Syrups and molasses purchased in bulk are likely to be mixtures, but are not unwholesome.

Jams, Jellies, Fruit Butters.—These goods are commonly adulterated. Indeed, it is most difficult to purchase pure articles of this character in stores. They must be made at home if they are wanted pure. The cheap jams and jellies are not jams and jellies at all. They are simply glucose colored to imitate the fruit whose name they bear. The fraudulent food purveyor, in order to make cheap raspberry jam, simply takes thick glucose, colors it red, and adds a little hay seed.

Canned and Preserved Fruits.—These are very likely to be colored with aniline dyes and treated to make them appear better than they really are.

Catsup.—This food is often adulterated. The cheaper grades are made of tomato peelings boiled to a pulp, then thickened with flour, colored with aniline dye, and preserved with chemicals. Cheap catsup is unfit to eat.

Canned Meats.—First-class, high grade meats, are rarely put up in cans. The use of low grade meats for canning makes it necessary to color them, to add substances to give them flavor, and to treat them in different ways to make them appear good. Canned meats should be avoided, for they rarely are good, and sometimes are actually poisonous, because of the existence in them of ptomaines. Ptomaines are poisons produced by germs growing in meats.

Adulterants and Preservatives.—Substances injurious to health are rarely used for adulterants. It obviously would destroy one's business to put substances into food which would cause immediate sickness. However, some things are used which are unhealthful, such as plaster of paris, or white earth, in baking powder. The coloring matters usually used cannot be said to cause sickness, but they are foreign, and no person would color jams, jellies, and fruit butters at home. Chemical preservatives, excepting some such as salt, smoke, and sugar, are certainly unwholesome. Adulterations as now found are to be objected to principally because they are fraudulent.

Plain, Simple Food.—The lesson to be drawn from a study of prepared foods is to live plainly. Milk, flour, rice, hominy, oatmeal, sugar, potatoes, eggs, fresh fruits, good dried fruits, fresh beef, chicken, fish, ham, and bacon may always be had. These furnish all the elements we need to live well. Fruits and vegetables properly put up at home are undoubtedly good food.

QUESTIONS FOR REVIEW

1. What is adulteration of food?
2. Why are foods adulterated?
3. Is watered milk injurious?
4. Why is it wrong to sell watered milk?
5. How should milk be cared for after it is taken from the cow?
6. Why should the cow barn be kept clean?
7. Why should a cow be brushed before milking begins?
8. What can be said of colored candies?
9. What are the objections to canned meats?
10. What are the best and safest foods?

CHAPTER XII

CLOTHING

Clothing is used primarily for protection. It protects the body from heat and cold; from the effects of wind; from rain, hail, or snow; and from external injuries and discomforts. It also helps to conserve the body temperature by keeping the pores of the skin open, and preventing interference with their natural functions.

The character of the material of clothing is important. We must consider its texture, its color, its relation to moisture, its power of conducting heat, and its special adaptability to the particular uses to which it is to be put.

Texture.—Impenetrable materials, such as leather and rubber, are wind proof, and are very warm. They are excellent protective materials, but they retain the body moisture and prevent ventilation of the skin.

Materials of loose texture hold a large amount of air, and as air is a poor conductor of heat, a loosely woven fabric prevents loss of body heat in still air, but its openness permits the wind to pass through. Furs make warm clothing for two reasons. The skin part is practically wind proof; and the fur holds a thick layer of air, which is a nonconductor of heat, and prevents its escape.

Effect of Color.—White colored goods absorb heat slowly and so the people in hot countries use them a great deal for clothing. The Hindus in tropical India wear white clothing. Black fabrics absorb heat more rapidly. So, also, do those colored green, blue or brown, but in a less degree. Heat is reflected most by white and in a decreasing degree by shades of yellow, red, green and blue.

Power to Conduct Heat.—Cotton and linen are the best conductors of heat, and wool and silk are poor conductors.

Behavior Toward Moisture.—Water may be absorbed directly into the substance of the fine fibers of cloth, or it may be retained in the spaces, or interstices, between the fibers. The moisture held in the substance of the fibers cannot be wrung out, and it is known as hygroscopic moisture. The moisture held in the spaces can be expelled by wringing. When clothed in woolen underwear, a perspiring person feels less chilly sensation on resting than if he were clothed in linen or cotton cloth. This is because materials of animal origin, like wool, are more hygroscopic than those from the vegetable kingdom. Linen or cotton goods cling to the moist body, but woolen goods do not.

CLOTHING MATERIALS

Skins and leather were the materials first used by man for clothing. We use leather for covering our feet and hands, and our furs are made from animal skins. Leather shoes are found to be excellent covering for the feet. Leather is hygroscopic and takes up perspiration from the feet to be given off to the air. This is not true of patent leather, and it, therefore, is not so healthful as ordinary leather.

Fur is warm and impenetrable. It makes rich and elegant outer clothing. The furs made from the skins of seals, beavers, and silver foxes are highly prized.

Woolen fabrics are poor conductors of heat, and are best for general purposes in all climates where wide and sudden changes in temperature occur. Wool and cotton are much woven together and thus the advantages of both are measurably gained. Cotton costs less than wool, and is added sometimes as an adulterant. For men, the outer clothing is quite generally made of woolen materials, even for summer wear. Women more frequently wear outer clothing of cotton goods.

Cotton fabrics are made of the soft, curly fibers from the pods of the cotton plant. It is pure cellulose, the material which forms the skeleton of plants. It is easily spun into thread, and then woven into cloth. For general purposes cotton is the best of clothing materials. Its fibers hold but little moisture, it is a good conductor of heat, and does not shrink in washing.

Linen is a fabric woven from the soft, pliable fiber from the outer covering of the flax plant. It is especially excellent for sheetings, shirtings, handkerchiefs, towels, and outer garments.

Silk is produced by silkworms. It is very hygroscopic, a poor conductor of heat, and a nonconductor of electricity. It takes and retains dyes of the most beautiful colors, tints, and shades. Silk is much adulterated with linen, cotton, and woolen fibers. Chemists have succeeded in making artificial silk, which is really a useful fabric. Silk has a beautiful luster, and is esteemed as the richest and finest of fabrics.

Rubber is obtained from the milky juice of the rubber tree, which must be treated with chemicals and heat before it can be used for clothing. Rubber coats, overshoes, hat covers, and gloves are for special and not general uses.

THE HYGIENE OF DRESS

Clothing should fit the form. Comfort is the first consideration. Clothing should be as light as the season will permit and it should be dry, clean, and properly ventilated. The quantity should be no more than is necessary to keep the body warm. It is not wise to take off our woolens too early in the spring, nor should we put them on in the fall until they are actually needed.

The idea as to quantity of clothing, is not to have so much as will be a burden and make us too warm, nor so little as to leave us cold and uncomfortable. The throat should not be wrapped except when the cold is very severe. The throat will stand exposure almost as well as the face, and if too much protected it is more liable to disease. The clothing should fit properly, but freedom of movement and circulation must be secured. Heavy thick head coverings should never be worn except in severely cold weather. The weight of the clothing should in the main be upon the shoulders.

Tight clothing around the waist restrains the movements of the lungs and heart. This is, of course, very unhygienic. Among the effects of tight lacing are headache, shortness of breath, dyspepsia, constipation, faintness, cold feet, and many derangements of functional organs.

Boots and shoes are of the greatest importance. There is hardly to be found among civilized adults such a thing as a normally shaped foot. This is because of the faulty boots and shoes that are worn.

Shoes should fit comfortably. If too large much discomfort results, for blisters, corns, and bunions form. If too small not only the corns and bunions appear, but pains in the feet and sometimes actual deformity. High heels, and heels placed toward the middle of the foot are an abomination. Shoes so made should not be worn. It throws the weight of the body forward upon the toes, the ligaments are strained and the spinal column, ankles, and knees forced into wrong positions. Severe lameness has resulted from wearing high heeled shoes.

Stockings and socks should fit properly. If too large, folds press upon the foot, causing abrasions, with discomfort, and the folds may press upon nerves bringing ill effects. The feet should be kept clean. Shut up as they are in close leather shoes, they should be bathed frequently. People who bathe daily need no advice about washing their feet, but those who bathe less frequently should have the wisdom to wash their feet at least as often as every other day.

Tight or poorly fitting shoes sometimes cause a callous growth to form in the skin of the feet. These growths are called *corns*. Corns are quite troublesome, but can usually be avoided by care in selecting shoes of the proper size. Shoes that are either too tight or too loose are likely to produce corns. The shoes should be just roomy enough to allow the toes to assume their natural position, and they should be close-fitting around the ankle and instep, so as not to allow of chafing. Care in these respects, together with frequent bathing of the feet, will generally prevent corns.

QUESTIONS FOR REVIEW

1. What is meant by the texture of clothing?
2. Name five different materials used for clothing.
3. Discuss color as a quality of clothing.
4. How do different materials behave toward moisture?
5. What is hygroscopic moisture?
6. What things should be taken into consideration in determining the amount of clothing to be worn?
7. What is the best kind of clothing to wear in a variable climate? Why?
8. What precautions are necessary in dressing the feet?

CHAPTER XVIII

BATHING AND CLEANLINESS

Personal hygiene is very important. Our bodies must be kept clean if our skin is to be healthy, so that it can do its proper work, and we are to have good health. Besides, an unclean skin is always offensive in appearance and odor. The perspiration secreted by the sweat glands in the skin is constantly evaporating from the surface of the body, and fine particles of the skin are being continually cast off. These are enclosed by the salt and other waste matters brought out by the sweat, and if all this matter is not washed off, it fills up the pores and causes sickness. Frequent bathing is necessary to keep the skin clean, and its pores clear of obstruction.

HYGIENE OF BATHING

Bathing, since it cleans the skin, helps it in the work it has to do. A dirty skin cannot perform its functions. Bathing helps to maintain the freshness of the skin; it also tones up the whole system and increases our strength. There need be no fear of catching cold from bathing. On the contrary, bathing, by keeping the skin active, relieves the mucous surfaces, and prevents colds. Bathing is such an excellent preventive of colds that many persons, for that purpose, take cold baths every morning. It also prevents skin diseases, fevers, and internal disorders. If the skin is dirty, the nutritive effects of food are greatly lessened.

It is generally best to bathe before retiring at night. One should never bathe immediately after a meal. Some persons delight in a cold bath when they get up in the morning. They enjoy the cold water, and feel more vigorous after it. A cold bath is attended with somewhat

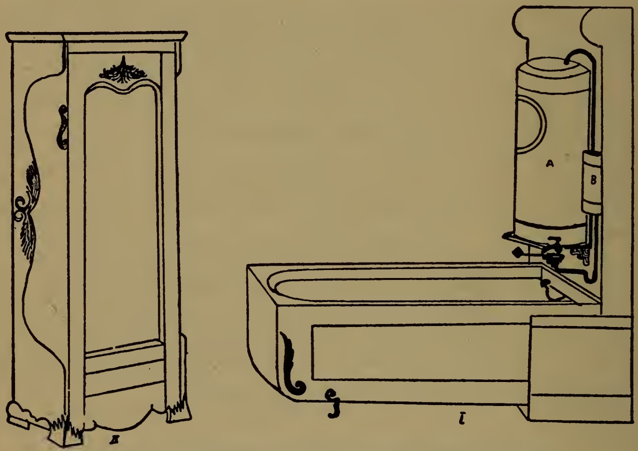


FIG. 61.—FOLDING BATH TUB WITH HEATER.
I, open; II, closed.

of a shock, the reaction from which generates a pleasant glow. But a cold morning bath is likely to prove too stimulating for weak persons.

In houses not provided with a bathroom, a good substitute can be secured in the folding bath tub, which does not take up much space in a room. It is usually provided with a convenient arrangement for heating the water. Every house should be provided with a bath tub of some kind, and it should be used frequently.

KINDS OF BATHS

Baths may be either hot, cold or warm, salt water or mineral water baths, Russian or vapor baths, Turkish baths, or shower baths.

Salt water bathing has a decided tonic effect. At seashore watering places, thousands bathe daily. It is considered great sport, and, unless a person stays in the water too long and becomes tired, only good results.

Mineral water baths can be taken at mineral springs. Mineral waters contain salt and other minerals which stimulate the skin, and have a tonic action. Such baths are much used for rheumatism, and skin diseases.

The *Turkish bath* is highly esteemed by many. It commences with a sweat in a very hot room, followed by a shower of warm water, which gradually becomes cold. Then after drying and rubbing briskly, the bather lies down on a good bed with clean sheets, and rests, or takes a nap.

The *Russian bath* is a steam bath, followed by a plunge into cold water and brisk rubbing down, with a rest afterwards.

The *shower bath* is the cleanest and most satisfying bath. Clean water continually flows over one in the shower bath, and the cleansing is very satisfactory. The shower comes from perforated pipes overhead, or at the sides, and the bather stands in a shallow marble basin, from which the water is rapidly drained away.

Swimming is a fine combination of bathing and exercise. A swim every day in the summer time is "just the thing," as most boys can testify.

PUBLIC BATHS

The Romans and other ancient nations must have known the value of bathing, for they constructed both private and public baths. Some of these baths were built of marble, and were great buildings in themselves. Not only did the rich bathe in their own elegant marble bath houses, but the government provided public baths for the common people and the poor. In this day, cities have public baths, where people can take a good bath at small cost. The city owns them, and they are kept for the people, just as streets are made for the people. Boston and other cities have such public baths.

PERSONAL CLEANLINESS

"Cleanliness is next to godliness" is a wise saying. A person who is not clean in his person is hardly likely to be clean in his heart and mind. To be clean we must not only bathe the body, but we must look to the hair, nails, ears, and mouth. Dirty hands and dirty finger-nails tell other persons much about one. Sometimes disease germs get under the finger-nails, and, if we scratch open the skin with them, a sore results. The nails should be kept clean, so that such a thing may be impossible.

The teeth should be brushed night and morning with a toothbrush, and the mouth should be washed out several times a day. A clean mouth promotes health. There would be less diphtheria, and fewer coughs and colds, if all persons kept their mouths clean, by washing with a mild antiseptic twice a day. Good antiseptic mouth-washes may be purchased of any druggist.

CLEAN BEDCLOTHING

Clean bedclothes are very necessary to health. Sheets and pillowcases should be changed frequently, blankets should be washed whenever soiled, and pillows, mattresses, and comforts should be aired every day, and very frequently placed in the sun. The sunshine and the air are the greatest disinfectants and purifiers.

A CLEANLY PEOPLE

Travelers tell us of the cleanliness of the Japanese. Every Japanese, even the laborer, who does the roughest work, bathes daily. Their clothes are clean, and they take off their shoes when they enter the house, to keep from carrying in dust and to avoid scratching the polished floors. Not only are the Japanese scrupulously clean in their persons, but they keep their houses and dooryards in the same condition. "In all Japan," says a traveler, "there cannot be found a dirty back yard."

QUESTIONS FOR REVIEW

1. Why is cleanliness necessary to health?
2. Describe some of the different kinds of baths.
3. What precautions are necessary in bathing?
4. What are public baths?
5. In what respects are the Japanese especially a cleanly people?

CHAPTER XIX

STIMULANTS AND NARCOTICS.

ALCOHOL

Alcohol is the best known stimulant. It is made by fermenting sugar with yeast. The manufacturer cooks ground grain, usually corn, to a mush, then adds malt, which turns the starch to glucose. He then adds a pure culture of yeast, and allows the mass to ferment. When fermentation is over the liquid is distilled—that is, it is passed through an apparatus called a *still* and the alcohol obtained. The object of distillation is to separate the light and volatile matters from those not wanted.

In making *whisky* the product from the still is colorless and poisonous, but by storing it in barrels it takes up color from the wood, and the poisonous matters are destroyed by the oxygen of the air. *Brandy* is made by distilling wine, and *wine* proceeds from the action of ferments upon the sugar in grape juice. *Ale* and *beer* are made by fermenting malt which has been cooked with hops. The hops give to ale and beer a flavor and a slightly bitter taste.

All of these substances owe their popularity to the stimulant, alcohol, which they contain, and they all do far more harm than good. The secret of the healthy life is plain and temperate living. Stimulating and rich food, with alcoholic liquors, break the health of all who indulge in them, and thousands are killed by them.

Because a drink of whisky exhilarates one, causes stimulation and increased heart action, the mistaken idea prevails that muscular power and working ability are increased. There is no truth in this, but, on the contrary, there is a loss of muscular power and working ability. Alcohol is a frequent cause of unhappiness and loss to those who use it in any of its various forms. It is true that some persons use spirituous liquors for years with seemingly no marked ill results. This is only seeming, for close investigation shows that even the moderate use of alcohol does damage to the heart, the nerves, the bones, the stomach, the liver, the kidneys, the skin, and all other tissues.

Spirituous liquors are never needed by persons in health and they are exceedingly dangerous to young persons. It is unwise to take them in moderate, or even in small quantities, for alcohol so frequently creates an appetite for its use in increasing quantities and ruins the life. The constant use of alcohol lowers intelligence and degrades the moral nature, often making a person mean and brutal.

So well is it known that even moderate drinking brings loss of strength, loss of intelligence, loss of judgment and loss of moral power that railroad companies discharge employees as soon as they find that they use strong drink. Who would consent to ride in a train knowing that the hand of the engineer was weak and trembling from drink, and that the senses were dulled and judgment clouded? There is only one wise way, and that is never to drink spirituous liquors even in moderate amounts.

Drunkards are always made gradually. The young person starts out feeling that whisky will never master him, but the mastery comes so gradually and so insidiously that, before he knows it, he is powerless to resist.

If one yields to temptation because he wants to be a good, sociable fellow, he shows a weakness. Stupidity cannot usually be helped, for, as with the color of the hair, one's stupidity is born in him, but the moral weakness which leads one to commence the drinking of spirituous liquors can and should be avoided. Total abstinence is the only safety for young and old.

NARCOTICS

Narcotics are drugs which generally soothe and dull the actions of the nerves and cause a tendency to sleep. They may also be stimulating. Alcohol is at first stimulating and then narcotic. The drunken man goes to sleep after the first effects of the liquors have worn off.

Opium is a very dangerous drug. *Morphine* is contained in opium, and is the principle which produces sleep and the narcotic effects of opium. *Tincture of opium* or *laudanum* is simply opium in liquid form. Opium causes sleep and dulls the nerves. It is a drug that should be greatly feared. Its effect is always quite soothing and pleasant, and weak people are prone to use it to dull pain and relieve trouble, but it only leaves them weaker and likely to use it again. Its use, even only a few drops, may produce a craving for it that makes the victim ever after a slave, and may wreck both his health and his character.

The habitual opium or morphine user is a pitiful object.

He can have no comfort, no sleep, no enjoyment of life, unless he has taken the awful drug. He loses all sense of moral obligation, and generally becomes addicted to lying. Better by all odds suffer even severe pain than take morphine.

Chloral is another pernicious drug. It is a real poison. Its effects are similar to those of morphine and it kills more rapidly.

Cocaine is a worse narcotic than opium, alcohol, or chloral. It is an exceedingly dangerous drug. Its victims are most miserable wrecks. It is most enticing in its effects at first, but finally its action is so longed for that the victim would even commit murder, and murder has been committed, to secure it. Cocaine has its medicinal uses, but only skilled physicians should administer it. It should never be taken on one's own judgment.

HEADACHE POWDERS

We should beware of *headache powders.* They contain *acetanilid,* which is a heart depressant. Patent medicine men mix acetanilid with bicarbonate of soda and caffein, the active principle of coffee, make them into powders or tablets, and sell them as a sure cure for headache and pain. These tablets do ease pain, but they have another effect which makes them dangerous. Some have formed the habit of using these powders or tablets, and find it hard to break away. One dose may cause serious symptoms and even death.

The best rule is to avoid all drugs. They are sometimes dangerous even in the hands of doctors.

TOBACCO

Tobacco is a very generally used narcotic, and it does much harm. The active principle of tobacco, *nicotine,* is a rank poison. Its effect in small quantities at first is to sicken one, cause him to vomit, and dizziness and paleness result. After a few doses, as secured in smoking a cigar or pipe, the nerves become accustomed to it, and, now being depraved by its drug action, begin to crave it. There can be no question about its ill effects particularly on young persons.

The smoking and chewing of tobacco is useless, harmful and unnecessary. It does not act as a food, nor does it serve any useful purpose. It does reduce the strength and health of the nerves; it checks the proper development and growth of young people; it often causes heart trouble; and it also sometimes injures the air passages. *Cancer* on the tongue and in the throat have been attributed to tobacco.

The use of tobacco is an expensive habit, and, as its use is certainly deleterious, it is an extravagance. The money spent for it could be better expended where it would give more pleasure and profit. The user of tobacco carries disagreeable odors in his clothing and his breath. His smoke fills the room and befouls the air, which should be transparent and sweet. If he chews, his spitting makes him very offensive to refined people, and his breath, too, is offensive. The only excuse one can make for the use of tobacco is to confess that he has depraved his taste and his nerves, and that he now longs for the comfort it brings to the depraved conditions and appetites.

SOME SPECIFIC EFFECTS OF THE USE OF ALCOHOL AND TOBACCO

It is now well known from extended observation and careful experiments that the use of alcohol or tobacco prevents normal growth and development of the body. It is said that breeders of small dogs, "toy dogs," as they are called, begin early to feed the puppies small quantities of wine or whisky in order to stunt the growth. In these days, when so much importance is attached to the proper development of our bodies, when every boy wants to be strong and athletic, this alone should be a reason sufficient to deter any sensible boy from the use of alcoholic drinks in any form. Indeed, so far reaching are the known effects of stimulants and narcotics that children of parents who are intemperate in the use of these poisons often fail to develop into manhood or womanhood. They may not be deformed, but their growth and development is arrested. They remain small in body and childish in character.

The *bones* of persons who use these stimulants and narcotics do not grow to be of normal size. The bone tissue is lacking in strength and power of resistance so that their bones are more easily broken than those of persons who abstain from these things. When broken or otherwise injured they require a much longer time to heal than they otherwise would. When union does take place it is often faulty; in some cases the fractured parts fail to unite and a special operation is necessary.

The *muscles* are made weaker in proportion to the amount of alcohol or tobacco used. It is true that when a small amount of wine or whisky is taken there seems to be, for a short time, an increase of muscular energy, but when the stimulating effect has passed away the muscles are left weaker than before. If the use of the stimulant is repeated frequently the muscular force fails.

With most persons the habitual use of alcoholic drinks has another bad effect upon the muscular system. The drinker becomes fleshy, fatty tissue becomes mixed with the muscle tissue, and the strength of the muscle is weakened.

The fact that an athlete in training is never allowed to use stimulants or narcotics of any kind shows how well known is the effect of these things upon the muscles.

The *heart* is peculiarly affected by both alcohol and tobacco. Alcohol stimulates its action—makes it beat faster. But as soon as the first excitement passes there is a reaction, the heart is weakened, is tired from overexertion, the alcohol reaches the muscle fibers of the heart and arteries and saps their strength. All are weaker than before. The day after having drunk much alcoholic liquor a man always feels weaker, depressed, "not up to the mark." Frequent repetitions of these excesses will weaken the heart.

Just as the use of alcoholics develops fatty tissue in the other muscles, it does in the muscular tissues of the heart, and the consequence is "fatty degeneration of the heart," a very dangerous form of heart disease.

Tobacco has a depressing effect on the heart. It weakens its force. This is especially true in the case of those who begin the use of tobacco while young. What is known as "tobacco heart" is common among users of tobacco, and the results are often fatal.

Digestion is seriously interfered with by the use of alcohol or tobacco. Alcohol has a strong affinity for water. If a small slice of beefsteak be placed in even diluted alcohol for two or three hours, it will be found hard and shrunken. The alcohol has taken the water out of the meat. It does precisely the same when taken into the stomach. To make up for the water taken out of the mucous lining by the alcohol there is an increased flow of blood to that part. This produces inflammation, or congestion, of the stomach. An inebriate usually suffers from indigestion, dyspepsia, or even neuralgia, of the stomach. In time ulcers are formed in the mucous coat. These spread over the surface and destroy the glands. Sometimes they eat through the stomach and cause death.

The liver, pancreas and small intestines also suffer from the effects of alcohol. But in the liver, especially, there are marked changes owing to the continual state of congestion produced. At first it becomes enlarged and soft, and later it hardens and contracts. The tissues lose their power to work properly. The bile secreted becomes unnatural and fails to do its share in the process of digestion. Biliousness is common among drinkers, and inebriates often have the liver so hardened and lumpy that it is called "hob-nail liver."

The effects of the use of tobacco upon digestion are similar, though not so marked. Indigestion and loss of appetite is a common result of the use of tobacco.

The *eliminative organs* suffer with the rest of the body by the use of alcohol and tobacco. The kidneys are very delicate organs, and in the eliminative process some of the poison passes through them and injures the tissues. One of these diseased conditions is known as Bright's disease. When the work of one set of eliminative organs is interrupted extra work is thrown upon the others, or the waste matters are retained as poison in the system.

The drinking of alcoholic liquor increases for a time the action of the heart and forces more blood into the arteries. At the same time the muscular tension in the coats of the bloodvessels is relaxed so that the small bloodvessels at the surface of the body are distended. There is an increase of blood in the skin; hence the face becomes flushed. Frequent use of alcohol causes a constantly flushed condition of the skin, until in certain parts, especially the face and hands, the bloodvessels become permanently dilated. This accounts for the characteristic "toper's nose." In other parts of the body the skin assumes a dark brown color. In this condition the skin is more susceptible to disease and much more difficult to treat.

The *nervous system* is especially susceptible to the influence of stimulants and narcotics, because it is through the brain and nerves that these drugs act. It is said that alcohol is deposited in the brain and liver more than in any of the other organs. In its effect upon the nervous system there seem to be several stages.

First—Stimulation through increased circulation and consequent flushing of the skin. This is attended by more or less mental excitement, with a tendency to talk more freely and rapidly. This stage is injurious in proportion to the frequency of the repetition.

Second—When more alcohol is taken into the system the voluntary muscles become affected. The mind acting through the nerves can no longer control the muscles. The drinker becomes unsteady on his feet and his speech is indistinct. There is also loss of mental balance, lack of judgment and common sense. The drinker does and says what he would not do or say when not drinking.

Third—There is further loss of control. The mind is obscured; the drinker talks and laughs immoderately, becomes silly, or perhaps quarrelsome and passionate. His movements are more unsteady. If he attempts to walk he reels and falls helpless wherever he may be.

Fourth—The victim becomes "dead drunk"—that is, passes into a condition of drunken stupor in which the senses are practically all dead. Only such nerves and muscles as control the process of respiration and circulation are active, and these in a very weak and imperfect way. In this stage death may occur at any moment, through failure of the life processes; and in his utterly helpless condition the drunkard is exposed to death from accident in many ways.

The net result of even a moderate use of alcohol on the nervous system is, therefore, weakness, lack of control, a tendency to resort to the stimulant more frequently and in larger quantity, and ultimately an irresistible craving for liquor that has come to be regarded as a disease known as *alcoholism*.

The action of tobacco on the nerves is that of a narcotic poison, nicotine, a very strong and fatal poison. A single drop of nicotine will kill a rabbit in a few minutes. It is the nicotine which makes the beginner in the use of tobacco sick. By beginning gradually the system learns to withstand a certain amount of this poison, but in doing so the organs are weakened, and the power of the body to resist the attacks of disease is lessened. The effect of the use of tobacco is well shown when the user tries to do without it for a time. He becomes nervous, impatient, irritable and depressed. He cannot do his work as well as usual. His hand is unsteady, his heart-beat is irregular, his mind is not clear; he probably suffers from headaches and loss of appetite. The younger the person the more marked are all these effects.

The use of cigarettes is especially to be condemned, because the smoke is commonly so mild that it is unconsciously taken into the lungs, and the nicotine finds its way at once into the blood. Moreover, cigarettes sometimes contain opium, and, hence, a double dose of poison.

QUESTIONS FOR REVIEW

1. What is alcohol? How is it produced?
2. Name several liquors containing alcohol.
3. Why do some persons drink alcoholic liquors?
4. How are drinkers regarded by many employers of labor?
5. What is a narcotic?
6. What is the effect on the senses of using tobacco?
7. What can be said regarding the expense of using tobacco regularly?
8. What are the effects of alcohol and tobacco upon the muscles?
9. Why does alcohol seem to make one warmer and stronger?

CHAPTER XX

HABITATION AND SCHOOL BUILDINGS

Our homes and school buildings should be healthful. It is not wise to erect buildings without due regard to hygienic and sanitary conditions.

Houses should be free from dampness, ground air should be excluded, and the heating, ventilating, and lighting should be the best that can be secured.

The Site.—Farmers have the advantage over those living in cities when it comes to selecting a site for a house. They can usually choose an elevated location which is drier than the lower areas, and which may be easily drained. Further, they can have light and air from all sides, most important matters for health and abundant life. Not to have dry ground upon which to build a house is indeed unfortunate, for damp earth means damp house, and a damp house means rheumatism and respiratory diseases for those who live in it. Lord Bacon said: "He who builds a fair house upon an ill seat committeth himself to prison."

Trees close to a house are objectionable, for they prevent the free access of air and light, and favor dampness.

Building Materials.—The building materials at our command are wood, stone, brick, and concrete, and these are all excellent. The early pioneers built their houses of logs with great fireplaces in the rooms. Such houses were well ventilated but usually poorly lighted. Out on the plains and prairies the first houses were made of sod, and were called sod houses. They were not sanitary, but they gave protection.

The Foundation.—When the site and building materials have been selected, then the next step is to construct the foundation and basement. It is best to have a dry, cemented cellar under the whole house. However, the house will be passably sanitary if the cellar, dry and cemented, extends under part of the house, and the house is at least three feet above the level of the ground. Thorough ventilation must be provided for the cellar and all underneath areas. All of this is necessary in order to prevent ground air from entering the rooms above. Ground air contains gases and odors produced by the decomposition of organic matters in the ground. This objectionable air is pushed upward into the house when it rains, for the water sinks into the ground and displaces it. All have noticed that in houses built flat upon the ground there is a musty or queer smell shortly after it rains; this is the ground air and it is unwholesome.

In considering foundations it is well to remember that ordinary brick is very porous and absorbs water freely, and that therefore it will not do for foundation work unless certain precautions are taken. If the foundation is ordinary brick there should be a layer of slate, stone, cement, or vitrified brick, just above the ground level. This will prevent the moisture of the ground from rising into the house through the brick, because, when it comes to the layer of impervious material, it cannot rise further. Upon such a foundation it is permissible to build any kind of house. Stone and concrete make the best foundations.

Frame houses are cheaper than brick, or stone, and can be made as warm and sanitary. The first sanitary requirement, even in dry well drained ground, is to build the house well up above the ground. The outside walls should first be covered with ordinary dressed boards, *sheeting,* then with building paper, and after that with weather boarding. The two layers of boards with the thick paper between make a good armor to keep out cold in winter and heat in summer. The best inside covering for walls is wall plaster. This is used alike for frame, brick, and stone houses.

The plaster may be finished by wall paper, which aids in keeping out cold, although it is very thin; and, it is also ornamental. Cellar walls, if not finished with cement or plaster, should be regularly whitewashed. Plaster may also be finished with oil paint. Painted walls are especially good in kitchens, bathrooms, and laundries, for such walls are nonabsorbent, are not injured by steam, and may be washed off.

Wall paper, if it has green color upon it, is likely to contain arsenic, for some greens are made with this poison. There is, however, little danger nowadays from arsenical wall papers, for the dealers and makers know that they are condemned.

Windows should open directly into the open air. It is a grave hygienic error not to have plenty of window space in each room. It is only through windows that light enters, and through them, too, we secure the air we so much need. It can be determined whether a room has sufficient window space by measuring the floor area and taking one-sixth of it. The quotient will be the area the windows should have. By measuring the windows, their area may be determined. A little room up under the roof with a little gable window, is not a sanitary bedroom. Sleeping in such rooms, which do not receive enough sunlight in day time and enough air at night, induces consumption.

Floors should be of hard wood, if possible, and made smooth and tight. The wood should be filled with wax to make it impervious. Such floors can be kept clean and free from dust.

Carpets which are tacked to the floor are not sanitary, for they soon become filled with dust. It is best to have tight, smooth, hard wood, waxed floors, and use rugs. Rugs may be easily taken out and the dust and dirt beaten out of them in the open air.

The *dust* must be banished from our houses as completely as possible to gain sanitary surroundings. Dust carries germs, ferments, and moulds, and it must be kept down. Dusting should be done by wiping with a slightly damp cloth, for to use a feather duster is simply to drive the dust back into the air, where it is far more objectionable. On floors, woodwork, and furniture, a feather duster or dustbrush should never be used.

Sweeping as ordinarily done is very unsanitary, for the dust is raised. If fastened-down carpets are to be swept, the broom should be dampened and damp tea leaves, which have been used, should be sprinkled around on the carpet before sweeping begins. These leaves will keep down dust and brighten the carpet. Mechanical sweepers with revolving brushes to force the dust and dirt into a tight box are valuable.

SCHOOLHOUSES AND SCHOOL HYGIENE

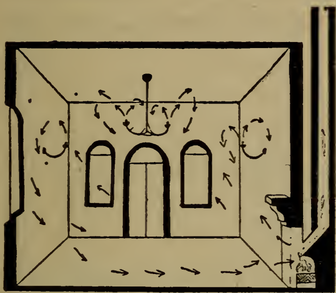
As in the case of the dwelling house, the schoolhouse site should be high, dry, and well drained. Made ground, that is, land that has been filled in with ashes, rubbish, and the like, is bad ground on which to build any kind of a house. The air and moisture arising from such ground is foul with bad gases. When possible a good gravelly soil should be secured. The schoolhouse should have an abundance of light and air on all sides, and hence the site should be at a distance from other buildings, and especially away from noise-making industries.

The Schoolhouse.—It is unnecessary here to consider more than the hygienic conditions and sanitary arrangements which should exist in every schoolroom. All schoolhouses should have dry, well ventilated cellars beneath them. This is true for even one room schoolhouses. It is unfortunate that so many schoolhouses do not have cellars. Cellars are necessary in order to keep out ground air and to keep the floor warm. Schoolhouses, also, should be at least three feet above the ground level. Of whatever material, they should be well constructed and kept in good repair. The foundation should be of stone or concrete, but if of brick, there should be a layer of slate or vitrified brick to keep the moisture down. Vitrified brick are burned very hard and until a glaze forms over them. They are impervious and make good foundation material.

The schoolroom should have high ceilings, not less than twelve feet from the floor. The floors should be hard wood and oiled or waxed to keep the dirt and dust out of the wood pores and cracks. The windows should be on one side of the room only, and their glass area should be not less than one-fifth of the floor area. They should, whenever possible, be on the left side of the pupil, and should reach almost to the ceiling. By this method cross lights are avoided, and an abundance of light secured for the entire room. Light should fall over the left shoulder to avoid shadows on the paper while writing. Cross lights, that is, light entering from both sides of the room, sometimes cause eye strain. There should be adjustable shades of some neutral tint at all windows. They are necessary in order to temper and properly regulate the light. It is harmful to the eyes and the general health to be compelled to look into the light, hence, there should be no windows at the ends of the schoolroom. Pupils should not sit where they are compelled to look continuously into the light.

The walls of schoolrooms should have a neutral tint of green, yellow or blue. They should not be a glaring white, as it hurts the eyes. Blackboards should be a dead black, for glossy surfaces reflect glinting light, and hurt the eyes. Slate blackboards are good.

Warming and Ventilating.—The warming of schoolrooms by stoves should be prohibited. They warm the same air over and over and every time fuel is supplied the school is disturbed. Besides this, they do not warm the room



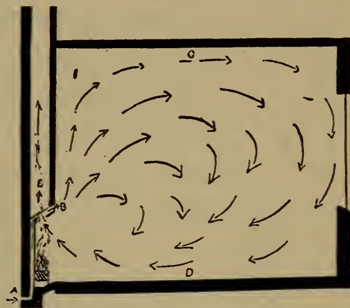


FIG. 62.—Showing movement of air currents in a room with fireplace and gas jets.

Showing circulation of air in a room having a fresh air duct, A B, and a fireplace.

evenly, and, while the children near the stove are too warm, those away from it are cold, all are uncomfortable, and hence cannot study and progress as they should. For these reasons stoves are bad and not economical.

Many kinds of ventilating stoves have been invented. But they all take up valuable space and must be fed and attended to in the schoolroom. A sheet iron jacket around the stove prevents the overheating of those near the fire, and also insures a better distribution of the heat throughout the room. And, if a pipe leads through the floor from an opening under the stove out into the open air, then fresh air enters through this duct and is warmed and distributed. In this way, conditions are slightly improved.

Furnaces and Steam Coils.—Schoolhouses should be heated and ventilated by furnaces, or by steam coils over which fresh air from the outside passes, is warmed, and then delivered by pipes into the rooms from the registers at least seven feet above the floor. Warm air rises to the ceiling, and this happens no matter where the register is placed. If the register is in the floor, dirt falls through it into the pipe when the floors are swept, or by walking over it; and, besides, those who sit near are made too warm. The floor is not the place for a hot air register.

FIG. 63.

The diagrams show the movement of warm air when introduced into a room in one place and removed at different places. In all but one it is seen that the air circulates in only a part of the room, leaving certain areas unwarmed and unventilated. In this one the circulation is general. The experiments, therefore, show that the hot air should be introduced at about seven feet above the floor, and the foul air taken out on the same side near the floor. In all schoolhouses of over eight rooms there should be an engine to force air over steam coils and into the rooms. Where air is forced in in this way, the system is termed *forced ventilation;* and when the air is conducted in by simply allowing it to rise in the pipes, the system is called *gravity ventilation.*

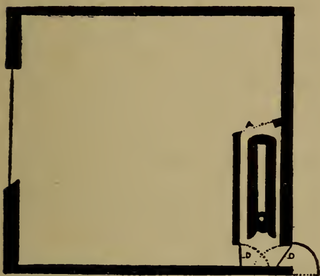
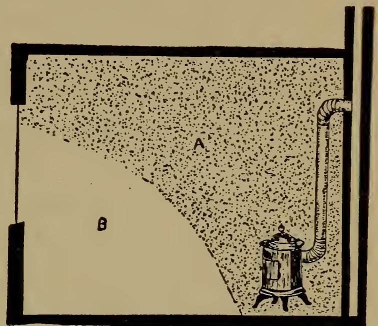


FIG. 64.—Showing Plan of Direct-Indirect Heating.



Showing How a Stove Heats a Room.

Heating by steam radiators in the room is as wrong as heating by stoves. This is called *direct* heating, windows and doors being depended upon for ventilating. Health authorities condemn direct steam heating of schoolrooms, and also stove heating. If behind each steam radiator there is a pipe through the wall to introduce fresh air which must pass over the hot pipes, some good is done. This system is called *direct-indirect* steam heating. It is not recommended by sanitarians for schoolrooms.

QUANTITY OF AIR AND HUMIDITY

Each pupil should have thirty cubic feet of air every minute, and it is impossible to give this quantity by windows and doors, without causing draughts. Air is absolutely necessary to health, and to supply less than each pupil requires is to violate nature's laws. In the chapter on breathing this is all made plain. The space required by each pupil is not less than 180 cubic feet. Measure the room, multiply the length, width, and height together, and divide this by 180. The quotient will be the number of pupils that should be allowed to be in this room. Crowded schoolrooms are very bad. It is not economy to crowd children into schoolrooms. It is a wrong to the children, for it imposes conditions of ill health upon them. In crowded schoolrooms headache, eye ache, coughs, and colds abound. Diphtheria and scarlet fever are more likely to break out in small rooms. If a schoolhouse is old, and there is no provision for ventilation except windows and doors and leakage of air through cracks, the air is certain to become foul. When the nose, after one has been out-of-doors, detects the least odor in the air of a schoolroom, then we may be sure the air is bad. When the air is bad, a look around the room will discover tired looking children, gaping, listless and sleepy. Perhaps the teacher, too, will become tired and impatient; all are disqualified for work. And it is no wonder, for the bad air causes just such conditions.

When these conditions prevail, study and recitations should stop; the windows should be raised, and all should engage in arm and body exercises, with deep breathing, until the room is flooded with fresh air. This will brighten up every one, and tend to ward off any sickness which the foul air might induce.

HUMIDITY

Humidity has reference to the amount of moisture the air contains. It is necessary for health that the air contain moisture, for if it is quite dry, it takes moisture from our throats and noses, making us more liable to catarrh and head colds. The absence of water vapor in the air frequently causes the overheating of schoolrooms. This is because, when the air is too dry, the tendency of the body is to make up the deficiency. The increased perspiration is rapidly evaporated and this cools the body. The person feels cold even though the temperature of the room is high. This is conducive to colds and rheumatism and general sickness. It is an abnormal condition which causes derangement of the bodily functions.

Measuring Humidity and Temperature.—Air holds varying quantities of moisture according to the temperature, and whatever the amount may be at any time, that is the *absolute humidity.* Warm air is capable of holding more moisture than cold air. When the air becomes saturated, that is, when it can hold no more, it is said to be at the *dew point.*

Relative humidity is the degree of approach to saturation at any given temperature. Thus 30 degrees relative humidity, means that at the observed temperature, the air holds but 30 per cent of the amount it is capable of holding.

By experiments it has been learned that, if the relative humidity is 60 degrees, we are perfectly comfortable in a temperature of 65 degrees. If the relative humidity is 30 or 40 degrees, we are chilly, although the temperature is 75 degrees. Now to raise the temperature ten degrees in a room requires fuel, and the cost for fuel to secure this increased heat is about 12 to 14 per cent above the amount required for heating a room to 65 degrees. If there is no attention paid to seeing that the humidity and temperature of the schoolroom are what they should be, then the conditions for sickness exist, and the cost of heating is more than it should be. It is always health and economy to obey nature's laws. We are practical only when we do so.

Watery vapor exerts a most important influence. In the daytime it tempers the sun's heat, and at night it acts as a protecting blanket to the earth by preventing too great loss of heat by radiation. On mountains, where the blanket of vapor is usually thin, the fall in temperature is rapid and marked. If watery vapor is absent from the air, the cooling process begins as soon as the sun goes down. The first frosts of autumn, and those which come occasionally in the middle and later parts of spring, occur only on very clear nights, when the relative humidity of the air is low. The belief that night air is unhealthful proceeds in some degree from these facts. It is the rapid cooling, as explained, which causes chill, and when one is suddenly chilled the pores are closed, the cells are contracted, and more or less discomfort results.

The relative humidity of the air in a room should not be allowed to drop below 60 per cent. All furnaces are provided with a shallow tank in which water is placed for the purpose of evaporation. Where stoves are used for heating, a dish containing water should be kept on the stove. This will tend to keep the relative humidity of the air in the room at the proper point. The instrument used to measure the humidity of the atmosphere is called a hygrometer.

Temperature.—All bodies receive or part with heat as their conditions change from time to time. If we pass around a room placing a thermometer on various objects, we find they have different temperatures. That is, a piece of glass will have a lower temperature than a cushion, or the wall a lower temperature than a curtain. Temperature as we measure it on the thermometer is a relative matter, for we have in this instrument an arbitrary standard which is indicated by the expansion and contraction of mercury in a tube. It is very convenient, and gives us valuable data. But on the thermometer we simply have a numerical expression which is arbitrary and which gives us a valuable figure with which to convey our ideas. It alone does not tell us the condition of the atmosphere. The thermometer and hygrometer, taken together, are very valuable means of acquiring knowledge regarding the air we breathe and in which we live.

The temperature of the school room in winter should not be above 68 Fahrenheit degrees, and it should never fall below 60 degrees.

SCHOOL DESKS AND SEATS

Desks and seats should not be supplied with reference to age, but according to the size of the children. Only adjustable desks and seats should be used.

If desks and seats are not adjusted to the size of the child, harm will result. The school period is the formative period of life. The bones of children are soft; and they are assuming positions they will afterwards maintain. Hence, they should not be permanently bent out of shape, which will happen if a child sits day after day at a desk which is too high or too low.

FIG. 65.—FAULTY POSITION—DESK TOO HIGH FOR PUPIL.

The spine may be curved by ill fitting seats and desks. If the spine is twisted or bent, then follows a train of ills. It will be remembered that the great spinal cord, really a part of the brain, passes up the spine. If the spine is bent, the cord will almost certainly be pinched by the slightly displaced vertebrae, and then come nervous troubles, indigestion, headaches, sleeplessness, malnutrition. The lives of hundreds have been ruined by ill fitting desks and seats.

If the seat is right, the child sits back firmly, the feet flat upon the floor, and the upper and lower leg form a right angle. The back of the seat should have the right curve to fit the back of the pupil, and should not

FIG. 66.—FAULTY POSITION—DESK TOO LOW FOR PUPIL.

be higher than the lower border of the shoulder blades. If it is higher, the free movement of the arms and shoulders are interfered with.

Adjustable seats and desks cost a little more than the stationary kind, but they are well worth the additional cost. School authorities should never run the risk of maiming children. Bad positions in sitting induce bad positions in standing, and then follow round and stooped shoulders. The eyesight is sometimes affected by bad sitting positions, and, again, bad eyes sometimes cause children to assume wrong positions, although the seats are right. The cure for this is to have the eyes examined and the eye defects corrected with proper glasses.

Fig. 67.—Correct Position—Desk of Proper Height.

QUESTIONS FOR REVIEW

1. What is the best site for a dwelling house?
2. Name the common building materials.
3. What can be said of cellar and foundation?
4. How much window space should each room of a house have?
5. Describe a simple system of ventilation.
6. Why is not heating school rooms by stoves a good thing?
7. Where should heat from a furnace enter the room? Show why this is so.
8. What is meant by humidity?

CHAPTER XXI

DUST, MICROBES, AND INFECTION

Dust, in greater or less quantity, is always in the air. The individual dust particles are small, but they vary greatly in size. Some are plainly discernible to the eye, and some are too minute to be seen as single particles. Dust is mostly composed of fine, dry, earthy particles, but frequently it is mixed with soot, powdered horse manure, dried spittle, minute pieces of vegetables, fiber, seeds, pieces of insects, powders of all description, and, lastly, with *microbes.*

In foundries, woodworking factories, paint, cotton, tobacco, and other manufactories, and in places where much grinding is done, the dust is a grave matter, frequently affecting the health of workmen most seriously. It is harmful to breathe dust at any time, and we should always try to keep it down, and keep out of it all that we can. Floor dust in schoolrooms is very bad. The floors should be hard wood, closely and neatly laid, and should be oiled or waxed. Then they should be wiped daily. The laws now generally require that proprietors of factories shall take every precaution to keep down dust. Dust making machines, such as grindstones and emery wheels, or band and circular saws, should have pipes with suction fans to carry away the dust to a dust box, or to a furnace, where it is burned. In cities, fortunes are spent each year in cleaning and sprinkling the streets to keep down the dust.

When a person is absolutely compelled to work in a dusty place, he can keep the dust out of the lungs by tying a sponge, slightly moistened, over the nose and mouth and breathing through it. The sponge serves to supplement the work of the hairs in the nostrils as a strainer of the air, and the dust particles will be kept from entering the lungs. This is a simple precaution and one that is quite effective.

Dust should always be wiped off furniture with cloths slightly dampened with kerosene. Feather dusters and dust brushes are only a means of scattering dust, and should never be used. Sweeping should be so conducted as to make as little dust as possible. Clothes, rugs, and carpets should be beaten and shaken in the open air.

Foul gases are produced by our breathing and also by evaporations from the skin. Sewer gas comes from sewers and foul effluvia, that is, bad smelling gases, proceed from cesspools, barnyards, barns, livery stables, and unclean slaughter houses. Certain factories discharge foul and poisonous gases into the air.

Smoke is a visible gas containing minute particles of carbon in suspension. Smoke, immediately from the stove or chimney, cannot be breathed, for it so greatly irritates the nose, throat, and lungs. It causes us to cough and strangle and our eyes to water. A few full breaths of thick smoke will kill a person. We can breathe smoke if it is well diluted with air, and this is done by thousands in manufacturing cities. It is, however, injurious to health. Those who live in smoky air have more or less sore throat continually. The mucous lining exposed to the air passages becomes dark with particles of carbon, and the eyes often are injured.

The "smoke nuisance" is cried out against in all manufacturing cities, and although we know how to build furnaces which will so thoroughly consume coal as to leave no smoke, they are, as yet, not much used. Smoky atmosphere certainly affects the general health of those who live in it all the time.

Chemical works produce gases which are unwholesome and dangerous to breathe. Examples of these are ammonia, and certain compounds of sulphur, nitric acid, and chlorine. The people generally have little to fear from these gases. It is the workmen who are immediately exposed and for whom every safeguard should be provided.

The workers in the manufacture of phosphorus and mercury suffer greatly. In brass foundries fumes are given off which cause what is called "brass-founders' ague." Brass founders suffer from bloodlessness, cough, headache, neuralgia, disordered digestion, and eruptions on the skin. Lead colic affects painters and those who make lead salts.

MICROBES

The word microbe means small life. The word micro-organism means the same thing. These terms are applied to any minute plant or animal which can be seen only with the aid of a microscope.

Bacteria are vegetable microbes, and *protozoa* are animal microbes. The bacteria play an important part in the world, and in our lives. Microbes make our bread, vinegar, wine, and alcohol. They cause milk to sour, and create the flavor of butter and cheese. They also prepare the soil for crops. It is impossible to raise corn, wheat, or vegetables unless microbes work in the soil. Microbes cause certain diseases as diphtheria, scarlet fever, measles, and consumption. There are, therefore, good and bad microbes.

But the greater number of microbes are useful and harmless; only a few cause disease. We call those bad which cause us trouble or threaten our lives. A common term used to describe the good, or useful, microbe is *benign,* and for the bad, or disease-producing microbe, *malign.* The protozoa are also good and bad. Minute animals help prepare the soil to grow crops, and they cause diseases, also, just as do the bacteria. Malaria and yellow fever, and probably smallpox, are caused by protozoa.

Distribution.—Microbes are distributed everywhere in nature. They cling to the surface of any substance, and are found in greater or less numbers in the air, water, and dust. They inhabit our mouths and digestive tract; are found under our finger nails, in our hair and skin. But they are not to be feared, because comparatively few microbes are harmful to us.

To prove the presence of microbes in the air, slice a raw potato, place the slice on a piece of writing paper, cover with a glass tumbler, wait a few days, and watch it. Even when you have exposed the potato slice for a moment only, bacterial colonies will appear.

Anton van Leuwenhoek of Delft, Holland, in 1675, constructed a microscope and was the first to see minute organisms in water, putrefying fluids, and saliva. His discovery was indeed a great one, but the world was slow to take up the matter, and it was almost one hundred years before others studied bacteria. At last we have realized that the microscopical world is as wonderful, and, in some ways, as important, as the visible world.

Structure and Types of Microbes.—Under the microscope it can be seen that microbes vary in shape and size just as large plants and animals do. They are translucent bodies, having only one cell, and are, for this reason, termed *unicellular organisms.* The large plants and animals we see, including ourselves, are termed multi-cellular organisms, because they are made up of numerous cells.

Unicellular organisms do not have a natural duration to their life as we have. We die in time, even though we escape disease, simply wearing out through old age. But the unicellular organisms must be killed in some way, otherwise they live forever. We, too, may be killed by accident or disease, but we should in time die naturally. The one-celled organism does not die a natural death. It is probably in this fact that we find explanation of the perpetuation of plants and animals.

Many are globular, or oval-shaped, and appear as dots either standing alone or arranged in groups or chains.

The rod-formed microbe is called a *bacillus*, which means rod. The corkscrew shapes are called *spirilla*.

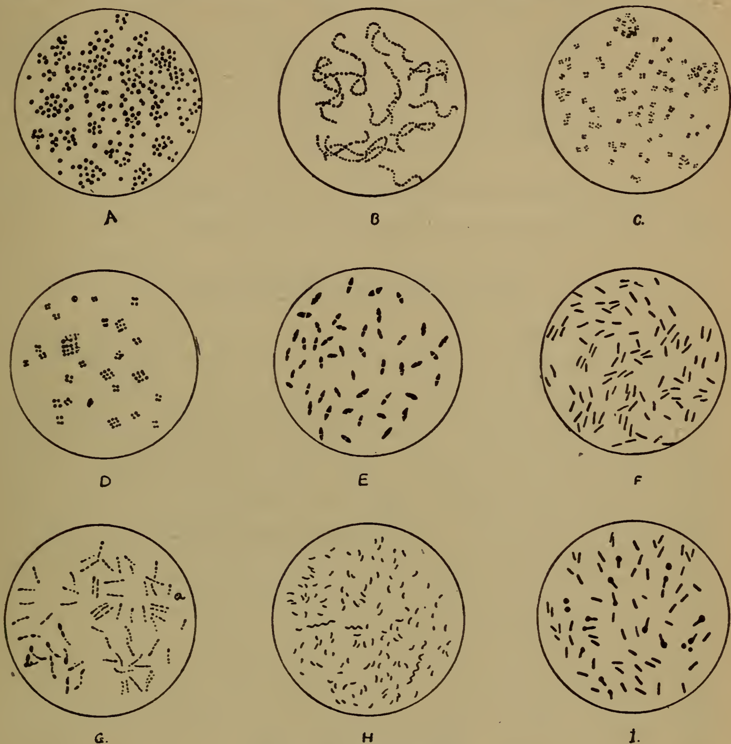


FIG. 68.—BACTERIA.

A, B, found in pus; C, in sputum; D, in the stomach; E, pneumonia; F, typhoid; G, diphtheria; H, cholera; I, lockjaw.

Size of Microbes.—They are so small it is almost impossible to measure them. We can say that they are never more than 1-50,000 of an inch long; and 400,000,000 of them would be required to cover a square inch.

How They Grow.—Some bacteria grow by *fission*. That is, one bacteria splits into two, and these split again, and so on. First, a slight constriction appears in the middle of the rod, just as if a thread were tied around it, and shortly there are two rods, and so on. Some grow by *spores*. Spores, or spots, form in the bacteria and finally break away, forming a new organism. Spores grow in these in turn and form still others.

Protozoa grow through a *larval* condition, that is, they pass through several stages, like a butterfly.

THE WORK OF MICROBES

The work done by microbes has already been stated in part. In addition to causing fermentation, souring, making the soil productive, and causing disease, they also cause putrefaction and decay. Putrefaction is always accompanied by bad odors, and its products are poisonous. Putrefying meat has an offensive smell, and if a pin be stuck into it, and any part of our body scratched with the pin, swelling and pain results. This is called blood-poisoning, and it sometimes causes the loss of a hand, or arm, and even of life. The rotting of a log is a type of the process called decay. Decay is a kind of burning. Strictly speaking, burning is a chemical process where the carbon of wood, or other fuel, unites directly with the oxygen in the air. They rush together with such energy as to cause heat and light. Decay differs from burning in that microbes slowly carry oxygen molecules to the carbon molecules and they unite chemically. No light is given off, but there is just as much heat, only it is produced over a long period of time, and is unnoticed.

MICROBE DISEASES

It is very probable that we are continually meeting with disease-causing microbes, but we have a power to fight them off, and it is this power which saves the human race from being extinguished. Every person is invaded at times. Every cough or cold indicates the presence of disease microbes. Few infants escape having intestinal troubles, and most children have whooping cough, measles, and chickenpox. Grippe, or influenza, seems to visit every human being sooner or later. Consumption and pneumonia carry off thousands, and so do diphtheria, scarlet fever, typhoid fever, and other microbe diseases. Soldiers in the army suffer greatly from microbe disease. In the Civil War, five times as many died from disease as were killed by bullets. In the Spanish War, the generals and military authorities did not listen to the sanitarians, and, in consequence, typhoid fever killed several thousand men. In the war between Russia and Japan, the Russians suffered fearfully from disease, but the Japanese did not suffer one-tenth as much. This was because the latter were careful about sanitary conditions. They were clean in person and in their camps. The men bathed every day, when possible, and went to great trouble to keep their clothes clean, and to destroy garbage and sewage. The Japanese knew how to do these things and they put their knowledge into actual practice. In other words, they were practical. The Russians knew as much as the Japanese about keeping well, and holding disease at a distance; but they were not practical, for they did not apply their knowledge.

METHODS OF SPREADING INFECTION

By the term *infection* is here meant the organisms which cause disease. The infection of diphtheria is the diphtheria germ, the infection of scarlet fever, or of typhoid fever, is the germ which causes these diseases. They come to us largely in the air with dust. They may be transferred directly from one person to another. A person who has never had small pox, or has never been vaccinated, is almost certain to get small pox if he gets into a room where a person lies sick with the disease. He is likely to get it, too, if he handles the clothing from a smallpox case. We *think* that the small pox infection is usually breathed in, but we *know* positively that it may be scratched into us by taking a needle and dipping the point in smallpox matter, and then piercing the skin with it. This is called inoculation. We can eat or drink infection which has fallen in dust from the air upon our food or into our milk or water. This is the usual way by which we acquire typhoid fever and dysentery.

Infection is carried by insects. Malaria, chills and fever, are brought to us by mosquitoes, and so is yellow fever. Flies frequently bring disease germs on their feet from nasty places, and, when walking over our food, leave them for us to eat. Fleas and bed bugs may come into contact with infection and bite it into us. Rats and mice may carry infectious diseases. If a cat has played with a child who has scarlet fever, that cat may carry the microbes to other children. In fact this has been known to happen.

IMMUNITY AND RESISTANCE

Some diseases, such as whooping cough, measles, chickenpox, scarlet fever, smallpox, and others, are not likely to attack a person a second time. Any one who has had these diseases is said to be *immune.* If a person is vaccinated, that is, has cow pox deliberately imparted to him, he is made practically immune to smallpox. We can also make a child immune from diphtheria for a few weeks by injecting a little diphtheria antitoxin into his circulation. Antitoxin is a substance found in the serum of horses after they have been given diphtheria many times and recovered. If a guinea pig is injected with diphtheria poison, it is certain to die, but if at the same time antitoxin is injected, it will not even be made sick.

Natural Immunity.—Some animals are naturally immune to certain infectious diseases. A chicken, even a little chick, is immune from the disease known as *anthrax,* which kills cows, sheep, and even men. Hogs, dogs and most lower animals are immune from typhoid fever. Measles is seldom a fatal disease among white people, but when it was introduced to the Indians living along the Amazon, in 1749, it almost extinguished them. It seems, therefore, that white people have some resistance, or immunity, against measles.

Resistance is a vague term, but we mean by it that some persons, even if exposed to infection, do not develop disease. It is certain that a vigorous, healthy person, one who has good digestion and nourishes well, cannot have consumption. His health and strength give him resistance, and, no matter how many consumption microbes he takes in, he goes free. When soldiers enlist in the army surgeons examine them to see if they are healthy, strong and well; for, if they are not, they are more subject to disease. Strong, healthy men resist disease.

CONTAGION

Contagion is a word that means almost the same as infection. In talking they are used indiscriminately, but there is some difference. A contagious disease is one gotten by contact with a person who is sick—that is, the infection is directly transferred. An infectious disease is acquired by breathing the germs from the air, drinking them in water or milk, or eating them in food. The word transmissible is a good term and much used, for it covers both of the others.

Mild attacks of all diseases are frequent, and this must be remembered. We may have diphtheria in so mild a form that it passes as a cold, or it may be so severe as to cause severe illness and death. This is true also of scarlet fever and typhoid fever. Even small pox may be so mild that no eruption appears, and a person never knows that he has had the disease. Children have gone through scarlet fever and scarcely shown they were ill; their slight sickness being regarded as a cold or slight stomach trouble.

In studying what follows, do not forget that every case of transmissible disease has come from another case, and remember, too, that only a few diseases are caught from animals. It is sick people who transmit disease, and especially those who are mildly sick. All the excretions of the sick must be disinfected or destroyed. Coughing is a fertile method of transmitting disease. When we cough we spray small particles of saliva into the air, and they contain the disease-causing germs. Others breathe the germs, as well as the fine spray, and unless health and vigor give them resistance they are endangered. Grippe or influenza, is transmitted in this way, also consumption and pneumonia. When we cough we should cover the mouth with a handkerchief, or better, if we have a cold or other disease of the air passages, we should carry special handkerchiefs and use them to catch the mouth spray.

We should never spit on the floor, nor on the sidewalk. If disease compels us to spit we should at least be as decent about it as possible. Spitting is largely a matter of unclean habit. Refined women do not spit, and this proves conclusively that it is an unnecessary habit. They may spray disease germs into the air when they cough, but even that may be avoided. As men do all the spitting, they are more largely responsible for the spread of diseases in that way. In accordance with these facts many cities have passed laws fining men who spit on floors and sidewalks.

QUESTIONS FOR REVIEW

1. Why should dust be avoided?
2. What occupations are sometimes injurious on account of dust?
3. What precautions should be taken against inhaling dust?
4. What can be said in this connection of foul gases and smoke?
5. What are microbes?
6. What can be said of their size and number?
7. What is infection?
8. How is infection spread?
9. Discuss immunity and resistance.

CHAPTER XXII

INFECTIOUS DISEASES

Only four school diseases will be considered. They are measles, diphtheria, scarlet fever, and consumption or tuberculosis.

MEASLES

Measles come to the school and home at all seasons, but generally in the cold months, when people crowd together and breathe bad air in badly ventilated rooms. Measles stand next to scarlet fever as a cause of death among children. Pneumonia often follows measles, and consumption often follows pneumonia. Sometimes a person has measles twice, but usually one attack gives immunity.

After measles, it is not uncommon to have abscesses in the ear, also sore eyes, making them weak and sometimes causing blindness. Catarrh often follows measles, not only appearing in the head but in the intestines, causing feeble digestion, which troubles the person ever afterward. All of these facts prove measles to be a dangerous disease and one that should not be treated lightly. It is not necessary for every one to have measles. At one time it was thought every one must have such diseases as measles and scarlet fever, but this idea is abandoned now.

The microbe of measles is unknown, but we do know something of the method of infection. One case of measles always develops from another case. It is believed that the infection is transmitted by coughing, thus spraying it into the air and causing others to acquire the disease. The spray may fall upon bedclothes, or personal clothing, and, becoming dry, the fine dust may fly in the air and be breathed. The nose secretions and expectorations of a measles patient should be collected carefully and burned.

DIPHTHERIA

Diphtheria is caused by a microbe which is well known. It likes to live and grow in the throats of young children. Whenever diphtheria, in severe form, appears among school children, it is certain the disease has existed for sometime in a mild form, and has not been discovered. To discover mild diphtheria it is necessary for the doctor to examine under a microscope the mucous found in the throat.

Diphtheria may be so mild as to pass as a "simple cold." We know this to be true because examinations of children's throats have again and again discovered the germs to be present when the diagnosis was "a little cold," or "a mild tonsilitis."

Many times diphtheria germs have been found in the throats and noses of children when no complaint was made, when there was no fever, and when no sign of illness could be discovered. Why all the symptoms of diphtheria do not appear under such circumstances may be due to the child's resistance (good health), or because the germs themselves are weak. It is found that these germs, when cultivated, produce a poison which will kill guineapigs or rabbits. It is further found that, if "weak germs" are transferred from one child to another, they frequently grow strong and produce unmistakable diphtheria. Before this discovery was made, the doctors thought it was necessary for spots, or a membrane, to appear on the tonsils and the walls of the throat before the case could be diphtheria. No up-to-date physician thinks so now. Very frequently the mistake is made of calling a case tonsilitis when it is diphtheria. The fact is, hundreds of cases of diphtheria are called sore throat, tonsilitis, or something else, and all such errors may, and frequently do, spread diphtheria. This is how it happens that people frequently say, "I can't see where my child caught diphtheria, for there have not been any cases around here," while many undiscovered cases were on the streets or in school all the time.

Antitoxin.—A little has already been said about antitoxin. It is the best remedy for, as well as the best preventive of, diphtheria.

MANAGEMENT OF DIPHTHERIA

It is very difficult to determine in the beginning whether or not the sickness is diphtheria. It is wise, if diphtheria exists in the neighborhood, to be on the safe side and take it for granted that when any one has sore throat, foul breath and fever, it is diphtheria. Separate such person from all others except the necessary nurses, and call a physician.

If possible, persons sick with diphtheria should be placed in a large, light, airy room. Remove carpets, curtains, table covers, plush chairs and all articles which are not needed. Heat with an open fire, if it is possible, *and give the patient an abundance of fresh air, night and day.* No one should enter but the nurses and the doctor.

Clean cloths should be used to absorb the discharge from the mouth and nose of the patient, and should be immediately burned after use.

All plates, knives, forks, spoons and glasses used by the patient must be boiled at once in water.

All clothing, sheets, pillowcases, towels, blankets and other cloth articles, should, before they are taken from the room, be put into a pail or tub half filled with a solution of chlorinated lime. Then they must be taken out very soon and boiled for at least twenty minutes.

If the house is small and the patient can not be isolated, then no member of the family should leave the yard. In tenement houses or in houses sheltering more than one family, the health officers will give special orders. Supplies can be brought to the gate or door, and in instances where poverty demands, the township trustee will furnish food.

A person who has had diphtheria may spread the disease for six to eight weeks from the beginning of the attack. Danger of spreading exists so long as diphtheria germs remain in the throat. The physician should make culture tests to determine this point, and no person, after recovery from an attack of diphtheria, should associate with others, nor go to church or school, nor appear on the streets until the throat no longer shows disease germs upon culture.

When cultures can not be made the physician will have to use his best judgment in deciding whether or not the patient may safely go out.

Diphtheria germs have been frequently found in the throats of persons who were quite well and who were not afterward brought down with the disease. Some people seem not to be susceptible to diphtheria, and the germs, although present, do not grow and cause the disease. A high authority tells of a nurse who carried diphtheria germs in her throat for a long time and introduced the disease into five families. This fact explains, in a degree, how it is possible for diphtheria to appear when there seems to have been no exposure, and it also teaches us to be very sure that recently recovered patients are free from diphtheria germs before they are allowed again to go out.

All the clothing of the sick person should be disinfected before it is worn again, not neglecting what the patient had on when taken sick.

SCARLET FEVER

Scarlet fever, or scarlatina, is a very dangerous contagious disease. It usually attacks children under ten years of age, but adults sometimes have it.

It is caused by a special contagion or poison which may be conveyed from the body of a person afflicted with the disease, by personal contact, by infected clothing, rags, hair, paper, dishes, or any article, or by the discharges. The disease may be communicated from a person recovering therefrom so long as the usual subsequent scaling or peeling of the skin continues, which sometimes is not completed before the lapse of seventy or eighty days. The poison may remain in clothing for years, especially if packed away in drawers, boxes or trunks.

Mild cases are as much to be feared as severe attacks, so far as communication to others is concerned, for the disease may as easily be taken from a mild as from a severe case.

The discharges from the throat, nose and mouth are extremely dangerous, and those from the skin, eyes, ears, kidneys and bowels are also dangerous, and remain so for a considerable time.

Filth, uncleanliness and imperfect ventilation increase the danger of spreading the disease and make recovery more difficult.

After exposure to the contagion of scarlet fever, a susceptible person will develop the disease in from one to fourteen days.

During the existence of scarlet fever in a community, all cases of sore throat, with fever, are to be looked upon with suspicion until their innocent character is established.

If a child who has not previously had an attack of scarlet fever, should unfortunately be exposed to a case, it should be carefully watched during the following two weeks. Upon the first symptoms of shivering, lassitude, headache, frequent pulse, hot, dry skin, flushed face, furred tongue, with much thirst and loss of appetite, the child should immediately be separated as completely as possible from other members of the household and all other persons, until a physician has seen it and determined whether it has scarlet fever. All persons known to be sick with this disease (even those but mildly sick) should be promptly and thoroughly isolated from the public. This is of quite as much importance as in a case of smallpox.

In general, the management of a case of scarlet fever should be the same as that of a case of diphtheria.

CONSUMPTION

Consumption is always caused by a minute organism or microbe. Without the presence of the germ there is no consumption. The disease is never inherited, and the old idea that it is, must be dropped, for it is certainly false. It is true, consumption is a family disease. Whole families fall victims to it. Father, son, and grandson get it. But still we say, *it is not inherited.* Accurate, careful study of thousands of cases by scientific men over periods of many years discloses that what seems to be heredity is always infection. A child may inherit weak lungs just as it may inherit weak eyes, and the lungs being weak, the consumption germ gets hold. Even though the lungs be weak, still the germ cannot get hold, if the person by right living, keeps up his vitality, which means—maintains his resistance. It is unlikely that anyone escapes taking the germs of consumption into his body. They are carried into us by the air we breathe, and by certain foods we may eat. Why, then, does not everyone have consumption? This would be the case if there were not residing in the healthy body a resisting force.

HOW WE GET CONSUMPTION

The germs of consumption may enter our bodies in three ways: by the lungs, by the stomach, and by the skin. The invasion is believed to be most frequently by the lungs, yet some recent experiments on animals indicate that the stomach, or better, the intestinal tract, is the most frequent port of entry. In order to enter by the skin, there must be cuts or abrasions. Consumption of the lungs is the most frequent form, and then comes consumption of the bowels. Every organ and tissue of the body is attacked by consumption. In order to get to the brain and the bones, the germs must be carried by the blood current, or, they might traverse the soft tissues. Certainly they find their way somehow, and produce the disease in all tissues. It is plain, then, that consumption germs can get into us with ease, and it is also plain that they fail to grow and produce disease in a large proportion of instances. Still they succeed so frequently as to cause one in every seven deaths, and so make consumption the most to be feared of all diseases.

LOWERED RESISTANCE

As already said, if it were not for the resistance which the consumption germs meet in the body we would all have consumption. The word resistance is a term which covers our ignorance. We do not know fully what it is, nor how it acts, but we do know pretty well how we can acquire it and how it may be lost. By far the most frequent way by which resistance is lowered is by *breathing* foul air. Foul air occurs in schoolrooms, in tightly closed bedrooms, living rooms, offices, court rooms; always indeed in houses. Resistance may also be lowered by lack of good food, slow starvation, anxiety, sorrow, intemperance, and by typhoid fever and other diseases. But, as said, *the breathing of impure air is the most frequent method.*

Not a little consumption is induced in our schoolhouses. We send our children to schoolrooms which are not supplied with enough pure air. Day after day they breathe poison, gradually lowering their resistance, and then follow coughs, colds, catarrh, headache, languor, loss of appetite, nervous breakdowns, and consumption. The consumption may not appear sometimes until five or ten years after school days are over, but the lungs are made weak while in school, and although nature tries hard to put off the disease, the person at last succumbs.

A sure way to acquire consumption is to shut the air out of your houses, especially out of your bedrooms. The sure way to avoid it is to open the windows wide and let in God's pure air. We should not be afraid of night air. It is purer, sweeter and more healthful than day air. It is chill which makes people take cold in the dark hours, not a mysterious something in the air. We should protect ourselves against sudden chill and the night will not cause us to catch cold, but on the contrary, will give us health.

CONSUMPTION IS A HOUSE DISEASE

Only those who live in houses have this disease. Hunters and trappers, and others who live outdoors are free from it. They have an abundance of air, and rarely meet consumption germs. The germ of consumption is a plant, not an animal, and it is in every sense a house plant. In the house there exists the most favorable conditions for protecting, transplanting, and growing this plant. Houses which are occupied by consumptives not only are breeding grounds for consumption during the lifetime of the person afflicted, but for a long time after his death, unless thoroughly disinfected. To neglect to disinfect a house which has contained consumption is to invite the disease to attack the succeeding occupants. In the act of coughing, consumptives spray spittle into the air, and this spittle contains germs. By coughing and spitting the germs get upon the walls, furniture, carpets, hangings, and bedclothes, in the form of dust. They retain life for a long time on account of the absence of sunlight, and the stagnation of the air.

HOW TO PREVENT CONSUMPTION

Having learned that we must lower our resistance before the consumptive germs can grow in us, and knowing that destroyed germs cannot cause consumption, we have plainly before us the means of preventing the disease.

The first step is to teach and compel all consumptives to place paper napkins before their faces when they cough, to catch the spray and sputum. The napkins may be immediately burned or put into a paper bag, and the bag burned when convenient. The prevention of the spread of the seeds of consumption everywhere is simply a matter of decency, and may be accomplished.

The disease may be cured by the patient's simply staying in the open air, night and day. Sunlight and fresh air, together with plenty of pure, wholesome food is the only known cure for consumption.

CHAPTER XXIII

MANAGEMENT OF THE SICK ROOM

The speedy recovery of the sick depends to a large extent upon the care and good judgment exercised in the management of the sick room. The simple directions which follow ought to be observed by those who have charge of the sick.

1. Remove all carpets, drapery, clothing, and furniture not needed.

2. Ventilate well. Keep windows open all of the time. If you do not ventilate the sick room thoroughly, recovery is greatly delayed, for bad air of itself makes well persons sick, and good air is better than any medicine.

3. The room, nurse, and patient should be kept perfectly clean. Cleanliness greatly aids recovery.

4. Admit no visitors without permission of the physician. Visits should be brief, quiet, and cheerful.

5. Keep out flies, mosquitoes, and other insects, by screens and all practicable methods. Insects worry the patient, thus preventing recovery, and they very frequently carry disease in their bite.

6. Never allow a bad odor to remain in the room. If free ventilation, sunshine and cleanliness do not keep out bad odors, then sprinkle dilute formaldehyde (1 part

formaldehyde to 50 of water) onto the carpet, or spray it into the air with an atomizer.

7. All body or bed clothing, towels, napkins, cloths, bandages, sponges, and all dishes which have been in the sick room, should be disinfected before being taken from the room.

8. Discharges from the patient, whether from the mouth, bowels or bladder, should always be received in a vessel containing a disinfectant, and allowed to remain in contact with the disinfectant at least one-half hour before being buried.

9. Consider that everything that has been brought into the sick room has become infected, and carefully disinfect before removing it. Never leave a sick room, or take food, without first washing hands with carbolic or other antiseptic soap.

DISINFECTION

Whenever a room has been occupied by a person sick with consumption, diphtheria, scarlet fever, typhoid fever, smallpox, measles, or whooping cough, it should be carefully disinfected. All clothing and articles which have been in contact with the patient should also be disinfected. Old mattresses, old carpets, and like articles, should be burned. If this were always done there would be much less sickness, because the germs of the disease would be killed.

HOW TO DISINFECT

Washable Articles.—Into a tub, or other receptacle of appropriate size, put enough water to cover the handkerchiefs, towels, napkins, sheets, blankets or other washable articles, and to each gallon of water add one fluid ounce (two tablespoonfuls) of 40 per cent formaldehyde solution. Stir the water and formaldehyde together and then put in the articles. Let soak for not less than one-half hour, then laundry as usual.

Unwashable Articles.—Quilts, comforts, pillows, mattresses, carpets, clothing, etc., may be disinfected by placing them in a tight room, or in a room that is itself to be disinfected, and then burning sulphur therein or filling the room with formaldehyde gas.

HOW TO DISINFECT A ROOM

Preparation of Room.—Carefully close all windows and doors, except one door for exit. Paste paper over stovepipe holes, and paste paper strips over all windows, transom or door cracks. In a word, seal the room tightly from the inside.

Open closet doors, drawers, trunks, boxes, etc. Suspend clothing and bed clothes upon lines stretched across the room, or spread out on a chair or clotheshorse. Books must be opened and the leaves spread. In short, the room and its contents must be so disposed as to secure free access of gas to all parts and all objects.

The next step is to make the air in the room damp. This is absolutely necessary for disinfection, either by sulphur or by formaldehyde. Dampness may be produced (a) by boiling water on a gas or gasoline stove; (b) by pouring boiling hot water from a tea kettle into a tub; (c) by pouring hot water onto hot bricks or stone, or by dropping hot bricks or stones into vessels containing water. Under no circumstances is efficient disinfection possible without, in some way, making the air of the room quite damp.

Measure the room and multiply the length, breadth and height in feet together and divide by 1,000. This gives the number of thousand cubic feet in the room.

Disinfection by Sulphur.—Place in the room a tub containing about two inches of water. Put two bricks in the tub and on them place an iron or tin pan or a stone crock, and in the pan or crock place three pounds of sulphur for every 1,000 cubic feet. Now fill the room with steam. When the room is full of steam, pour a spoonful of alcohol or coal oil onto the sulphur and set on fire. Immediately leave the room and close the door. The sulphur is burned to a gas, and this gas, in the presence of the steam, kills all infection. Sulphur gas without steam is worthless. Do not, on any account, leave out the steam.

Disinfection by Formaldehyde.—Measure the room, and for each 1,000 cubic feet use two pints of formaldehyde and thirteen ounces of commercial permanganate of potassium. Place a large washbowl, crock, tin dishpan or galvanized iron pan or tub in the center of the room. Put in the required amount of permanganate of potassium and, lastly, pour in the required amount of formaldehyde. Permanganate must go in first. Retire immediately after pouring on the formaldehyde, for the formaldehyde gas is promptly released and is injurious if breathed in any quantity. Keep the room closed for at least three hours, then open, air thoroughly, and clean in the usual way.

Disinfection of Clothing, or of a Few Articles.—Take an empty trunk, wooden box or wash boiler. On the bottom lay any article, say a coat, cover with an old towel or a piece of wash goods, and sprinkle thereon two tablespoonfuls of 40 per cent formaldehyde solution. Then put in another article, cover as before, and again sprinkle two tablespoonfuls of formaldehyde. If there are enough articles, the boiler or trunk may be filled in this way. Finally, put on the cover to the boiler, or close the trunk, and in ten hours open and hang out in the air and sunshine. If the smell of formaldehyde persists, a little aqua ammonia sprinkled on the clothes will remove it.

A Standard Disinfectant.—Dissolve chloride of lime of the best quality in pure water in the proportion of six ounces to the gallon. Keep in a stone jar or jug. Use one quart of this solution for each discharge from a patient suffering with any contagious or infectious disease. Mix well and leave the vessel for an hour or more before emptying. Treat vomited matter in the same way. For a very copious discharge, especially in typhoid fever, use a larger quantity; and for solid or semi-solid matter, use the solution in double strength. Discharge from the mouth and throat should be received into a cup half full of the solution, and those from the nostrils upon soft cotton or linen cloths, which should be immediately burned.

QUESTIONS FOR REVIEW

1. What can be said regarding air in the sick room?
2. What should be done with the furniture and draperies?
3. What are some of the duties of a nurse?
4. What is disinfection?
5. When should a room be disinfected?
6. Describe the process of disinfecting a room.

CHAPTER XXI

EMERGENCIES

One can often be very useful who knows what to do for the injured, or for those who may become suddenly ill. In many such instances life may be saved, or still greater injury prevented, by prompt and intelligent action, without the attendance of a physician, or before a physician can be called. In cases of severe accidents, or severe illness, a physician should be called.

WOUNDS

Surgeons classify cuts, or incisions, of greater or less depth, as *incised* wounds. *Punctured* wounds are made by thorns, splinters, nails, rods, and the like. *Poisoned* wounds are caused by bites of snakes, dogs, rats, spiders. *Contused* wounds are made by crushing injuries, and are more or less bruises, while *lacerative* wounds are produced by tearing or mangling.

BLEEDING

We need not be alarmed at bleeding unless the blood comes by throbs or spurts, in which case it is from an artery, and must be speedily stopped. But a small amount of blood will stain much clothing and make a showing beyond its importance.

What to Do.—Frequently, also, very free bleeding may be stopped by the simple pressure of the finger on the vein. But in any case, we should keep cool. One cannot think or act with judgment if agitated or alarmed. It should first be observed whether the bleeding is arterial or from veins, and note should be taken of the location, size and kind of wound.

Pressure is of great importance to stop bleeding. It is futile to try to stop the bleeding of an artery of any size with drugs like alum and tannin. Pressure is the force to apply. A place as near to the wound as possible should be selected. If the bleeding is from a leg or arm, elevate it, tie a knot in a handkerchief or suspender or cloth, place the knot over the main artery, and twist it with a stick until the artery is closed. Do not attempt to remove dirt from a wound until the bleeding is stopped. Pick out any gravel or other foreign matter and then wash the wound and adjoining parts. If possible put a little carbolic acid in the wash water, one teaspoonful to the pint, or add two or three teaspoonfuls of salt.

In *lacerated* wounds the torn parts must be replaced as nearly as possible before the edges are brought together. Cold or hot cloths, wet in water containing antiseptic, should be applied. Then the parts should be fastened firmly.

Punctured wounds are usually more dangerous than incised wounds. Splinters and rusty nails frequently carry infection into a wound. Especially is this true if the nail or splinter is in a stable. This is because *tetanus* (lockjaw) germs are found in stables. Sometimes erysipelas and poisoning attend punctured wounds; hence it is important that old planks and boards with nails sticking up from them should be not allowed to lie around dooryards or barnyards.

If the cause of the injury is still in the wound, remove it. Splinters, pins, needles, or nails, must be pulled out of the wound. Do not think that they will work their way out. If the wound is from a rusty nail, or toy pistol, lay it open with a sharp knife, let it bleed freely, and then pour in strong solution of carbolic acid or peroxide of hydrogen, and lastly bandage it with antiseptic bandages. It will not do to trifle with wounds of this kind. It is far better to lay open a wound with a knife and cauterize it than to run the great risk of lockjaw.

If a splinter is forced under a finger or toe nail, and cannot be pulled out, scrape the nail thin immediately over the splinter until it can be removed. Sometimes a splinter or needle is so firmly embedded that it becomes necessary to remove it by making an incision. Fishhooks make ugly wounds and are hard to remove. It is better to push the barb on through the tissues, and cut off the barb with a nippers, than to try to draw it back and out. If pushing through is not the best, then cut down upon it to effect removal. Always dress wounds with antiseptic dressings.

Infected Wounds.—If pus appears in a wound it is infected. This is poisoning, and should be attended to by a surgeon.

Choking.—In case of choking, a sharp blow upon the back, if applied soon after the foreign body lodges in the throat, will frequently aid in its expulsion.

Sometimes little children and hysterical persons introduce peas, beans, pins and other small bodies into the ears or nose. Insects also sometimes find entrance to these cavities. Syringing with warm water is to be used, unless the body can be seen and easily removed with pincers or the round end of a hair pin. Sweet oil may be poured into the ear, the person lying down with the affected ear upward, and afterward the ear syringed with warm water and castile soap.

Foreign bodies in the nose may usually be expelled by filling the lungs with air and suddenly expelling it through the nostril that is obstructed, holding the finger over the other nostril. Sometimes giving snuff to cause sneezing will be effective.

Specks in the Eye.—Do not rub the eye. Lift up the lid by the lashes, holding it up and letting the tears wash off the eyeball. If the speck is embedded in the lid, turn it back and wipe it off with a point made by twisting the corner of a handkerchief, or twist a few fibers of cotton on the end of a match and use it to remove the speck. The same procedure will also serve to free the eyeball from specks. Never buy advertised eyewashes or eye-salves, and never, without medical advice, use anything in the eye except warm soft water containing a little common salt.

Sprains and strains are essentially the same. The first term is used when ligaments, cartilages, muscles or nerves about the joint are bruised or torn. The second is sometimes used as meaning merely the result of stretching the muscles. Rest is nursing for sprains and strains. Bathing in cold, or perhaps better, in hot water, and applying cold or hot water by bandages gives relief and aids recovery.

Bruises are produced by blows, by pressure, or by falls. Black and blue spots are caused by blood oozing from broken vessels underneath the skin. Apply cloths wrung out in hot water.

Frost Bites.—A really frozen member or place on the body is destroyed the same as if burned, but a frost bite is like a slight burn, only injuring, not destroying, the tissues. The part affected by frost becomes bluish or white. Gently rub the part with snow, ice, or cold water. Bring the person to a warm room and gradually induce reaction. Stimulants will sometimes be found useful.

Fainting is caused by a weak heart. The sight of blood, or bad news suddenly imparted, may cause one to faint. Medicines like phenacetin and acetanilid, and other coal-tar derivations, depress the heart and sometimes cause fainting.

Lay the person down flat on the floor or upon a bed. But do not carry the fainting person any great distance to a bed. Do not place a pillow under the head or in any way raise it. Rather raise the rest of the body higher than the head. Dash cold water in the face and hold a handkerchief or towel to the nose of the patient, pouring on a few drops of ammonia. Smelling salts are also good. The fainting person may recover quickly, but if he does not, proceed as directed above, and if the hands and feet become cold, chafe them. Cover the patient in warm blankets and put a hot water bottle, or hot sadiron, or hot brick, to the feet.

Fits or Convulsions.—Epilepsy is an affection of the nervous system characterized by attacks of unconsciousness, with or without convulsions. In children convulsions may be caused by undigested food or by congestion of the brain.

Do not try to hold or restrain the patient. Simply try to prevent him from being harmed. If the tongue is bitten or in danger of being bitten, place a cork or piece of wood between the teeth. Cover the patient with a blanket when the convulsions cease and let him rest. If it is an epileptic attack, do not dash water onto the patient, nor indeed do anything more than to prevent self injury.

Sunstroke and Heat Exhaustion.—Sunstroke occurs chiefly in persons who are working hard in the sun. It happens, too, almost always when the stomach is full. Heat exhaustion may occur out of the sun, but after exposure for a long time to high temperature combined with physical exertion. The skin is usually cool, the pulse small and rapid, and the temperature below normal.

In sunstroke the person is hot and must be placed in the shade in a cool place. Rub the body with ice and apply ice to the head. If ice is not at hand, use cold water. In heat exhaustion the pulse is weak and skin cool. Use stimulants.

Burns and Scalds.—Severe burns and scalds may be attended with serious shock, or cause inflammation of internal organs. If near the region of the vital organs, or if the area injured is considerable, then not only intense suffering will result but sometimes even death.

If a person's clothing is on fire, seize the nearest coat, rug, table-cover, blanket, comfort, or like article, and, holding it before you to protect yourself, wrap it around the burning area. Keep the flames as much as possible from the face and prevent, all you can, the entrance of hot air into the lungs. Water, of course, may be used, and if no coats or blankets are near, roll the patient over and over, bringing the burning spots between the patient and the floor or ground.

When the fire is out, remove all clothing near the injured part by cutting with knife or shears, being careful not to tear open blisters. Any pieces of cloth that adhere to the skin should be treated with water to soften them. Wet the injured area well and freely, and apply ordinary baking soda. Afterward mix soda, glycerine and water together to form a cream, adding a little carbolic acid. When ready wash away the first application and spread on the *soda cream.* This may be removed and re-applied from time to time. Lard, oil, or tallow, may be applied, or a mixture of one teaspoonful of carbolic acid and one tablespoonful of glycerine in one pint of olive oil, will be found excellent. Shake this mixture thoroughly when applying it. Cream, dampened starch, flour, or vaseline, are useful until better means can be supplied. Cover the treated surface with soft linen or cotton cloth. It is an easy matter to puncture blisters with a needle and draw out the watery contents.

Burns made by acids should be treated as ordinary burns after washing away the acid. Alcohol and glycerine added to the wash water will materially help to remove acids.

POISONING

If, after a person has taken food or drink, he is taken suddenly ill, has pain and repeated retching and vomiting, we usually suspect poisoning. If the poison is arsenic, pain, vomiting and purging will result; if strychnine there will be spasms with more or less unconsciousness. Opium and morphine produce deep sleep, commencing with dullness and drowsiness. If the poison is carbolic acid, it may be detected by odor; if a strong mineral acid, like sulphuric, muriatic, or nitric acid, the burned appearance of the mouth and lips will be indications.

What to Do.—If the poison is an acid, use baking soda and large quantities of water to neutralize it, and then cause vomiting. Vomiting must be caused in all forms of poisoning. A handy emetic is a glass of warm, not hot, water with a teaspoonful of salt and the same amount of mustard mixed with it. If this does not act promptly, tickle the throat with a feather or the finger. If the person is unconscious or will not swallow readily, pinch the mouth and pry the mouth open with a stick or clothespin, and depress the tongue with a spoon or stick. By pressing on the jaws at their joints the mouth will be forced open.

Antidotes are substances which directly neutralize or combat poisons; such are lemon juice, weak vinegar and bicarbonate of soda, for acids. Common salt and the white of an egg are antidotes for corrosive sublimate and nitrate of silver. Tincture of iron with ammonia added, until the odor of ammonia can be detected and the iron is precipitated, is an antidote for arsenic. Strong coffee is opposed to opium or morphine, and olive oil, milk, cream, butter, castor oil, flaxseed tea, white of an egg are good mechanical antidotes in that they coat the stomach temporarily and thus protect it.

IN CASE OF DROWNING

The first thing to do is to remove any water from the air passages. To do this loosen the clothing of the patient and lay him face downward. Clear the mouth of any mucous by wiping it out. Draw the tongue forward by grasping it with the fingers wrapped with a handkerchief, and proceed as follows: With the patient lying on his face, stand astride his hips with your face toward his head, and raise him suddenly two or three times, the hands being clasped below the stomach.

Instead of proceeding as above, a roll of clothing may be placed beneath the stomach. Pressure should then be exerted on the back over the stomach. Do not roll the patient on a barrel or hold him up by the heels. Water rarely enters the lungs, but is usually in the air passages.

Artificial Respiration.—The water having been gotten rid of, if respiration has not yet started, then, without delay, commence artificial respiration. It may be necessary to continue this for an hour or two, and all the time try to restore heat by rubbing and chafing, and by the application of hot blankets. Do not for an instant stop the artificial filling and emptying of the lungs.

A good method to produce artificial respiration is known as the *Michigan State Board of Health Method.* After getting rid of the water in the air passages place the patient face downward, keeping the position astride the body. First, take firm hold of the clothing over the shoulders, or, if the body is naked, under the armpits, with the thumbs over the points of the shoulders. Raise the chest until the forehead just touches the ground and count slowly one, two, three. Second, lower the body to the ground, placing the bent arm of the patient beneath his forehead, with the neck straight, and the mouth and nose free and open. See to it that the tongue has not fallen back and closed the windpipe. Third, place the elbows against the insides of the knees and, with hands upon the sides of the chest over the lower ribs, press downward and inward while you slowly count one, two, three.

Suddenly let go, seize the shoulders as at first and raise the chest again, and repeat first, second and third movements over and over, doing this at least twelve times a minute, and at the same time do not forget to have some one to restore heat while you work. Boys who live near the water should practice this artificial respiration method with each other, both as exercise and to become familiar with it.

After restoration put the patient to bed and see to it that he is warm. Give very slowly teaspoonfuls of hot coffee, or hot water with whisky or brandy. Five drop doses of ammonia in water will be found to be a good stimulant. The room must be well ventilated, the patient kept quiet and sleep encouraged.

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