New-World Health Series
BOOKS II AND III

* * *

NEW PRIMER of SANITATION & PHYSIOLOGY

CONSISTING OF
PART ONE, "PUBLIC HEALTH"
A PRIMER OF SANITATION
AND PART TWO, "PERSONAL HEALTH"
A PRIMER OF PHYSIOLOGY

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"Our national health is physically our greatest asset. To prevent any possible deterioration of the American stock should be a national ambition." These words of Theodore Roosevelt express the idea that has actuated authors and publisher of New-World Health Series. The texts explain the means by which young Americans can lay the foundations for sane and vigorous lives. They stand preëminent among Books That Apply the World's Knowledge to the World's Needs. This particular volume, which combines the second and third books of the series, teaches the essentials of sanitation and physiology. The conservation of individual and national health is the purpose of the series

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PREFACE

The purpose of teaching hygiene and sanitation is to influence human conduct, and school instruction in this subject fails if it does not succeed in establishing in the lives of the children habits that will lead to health. The control of conduct, upon which volumes have been written, is too broad a subject to discuss here, but attention will be called to one fact that must be kept in mind by those who would influence the actions of the child.

The instinct of opposition is a part of the original nature of man. With its practical workings every parent and teacher is familiar, and it is only recording a simple fact of experience to state that this instinct is especially likely to be aroused in either children or adults by new or untried ideas, and by commands or suggestions as to personal conduct that are given without an adequate explanation of the reasons therefor. Since the first purpose of teaching hygiene is to modify personal conduct, and since any text that embodies what is now known to be most valuable in the conservation of health must include unfamiliar material, it follows that one of the great problems of the writer of a book of this character is to secure a whole-hearted acceptance of the ideas presented. Experience shows that this can be secured, generally speaking, only after an examination of the evidence for the statements made, and that we must depend on conviction from within rather than on exhortation from without to furnish the motive for the acts necessary to translate knowledge of hygiene into practices that will result in health. Each chapter of this book, therefore, as far as possible, has been made to carry its own credentials, and much care has been taken to make the subject as a whole seem sensible and reasonable to the pupil who uses the text.

For the considerable amount of new material introduced, and for the decided changes in the emphasis placed on certain topics, the advance of knowledge must be held responsible. In the selection and presentation of new matter, accuracy and conservatism have been striven for, and it is believed that the ideas advanced are in accord with the best knowledge and judgment of our day. It is hoped that the confident spirit of modern hygiene will appeal to the courage and optimism of youth, and that a sufficient understanding of its principles will be gained by the users of the book to enable them to apply the facts they have learned to the ever varying conditions of life.

The teacher who desires a more complete knowledge of the topics treated in this volume will find the following works useful:

Hill. *The New Public Health.* (The Macmillan Company, New York.) A splendid and spirited work on the possibilities and methods of controlling communicable diseases.

Rosenau. *Preventive Medicine and Hygiene.* (D. Appleton and Company, New York.) An authoritative and readable volume, giving much detailed information on practically all topics of public health.

Jordan. *General Bacteriology.* (W. B. Saunders Company, Philadelphia.) One of the best bacteriologies for a lay reader.

Fisher and Fisk. *How to Live.* (Funk & Wagnalls Company, New York.) Authorized by the Hygiene Reference Board of the Life Extension Institute. It discusses the hygienic measures that leading health authorities and the great insurance companies consider most important in the prevention of illness and the prolongation of life.

McCollum. *The Newer Knowledge of Nutrition.* (The Macmillan Company, New York.) An excellent presentation of modern ideas on nutrition and diet.

In the preparation and teaching of some of the lessons, the author's *Human Physiology* (World Book Company, Yonkers-on-Hudson, N. Y.) and its accompanying *Laboratory Manual* may prove useful.

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PUBLIC HEALTH

CHAPTER ONE

WEEDS IN THE GARDEN OF HEALTH

WHEN the spring winds blow soft and the buds swell on the trees, the spirit of the garden comes into the heart. Then we love to remove the dead stalks and leaves, to dig and rake, and to bury the seeds in the soft earth. Later the plants begin to appear. We watch the leaves unfold, the buds open, and we think of the flowers and fruits that will reward the labor of our hands.

But soon weeds spring up in our garden. They threaten to overgrow our plants; they rob them of their food and water, and poison them with noxious substances from their roots. We are forced to clear away these intruders; and when the summer is gone and our crop is harvested, we have come to understand that fighting the wild and hardy plants that grow out of their proper places is one of the most important tasks of a gardener.

Little plants and animals that grow in the body. Did you know that there are little plants and animals that grow in the human body? It has been found that this is true; that infectious diseases like colds, measles, whooping cough, and typhoid fever are caused by tiny plants and animals that flourish in our bodies as weeds grow in a garden. These little forms of life are so small that we can see them only with a microscope, and because they poison our bodies and make us ill they are called disease germs.

An encouraging discovery. Scientists have learned that many of our worst diseases can be prevented by keeping the germs that cause them from spreading from one person to another. This great discovery already means much to the health and happiness of the world; for many severe diseases like cholera, plague, leprosy, and yellow fever have been practically banished from among us; many other diseases, as typhoid fever, malaria, scarlet fever, and tuberculosis, are rapidly going the same way; and the great majority of other germ diseases also are being checked. No longer do we blame the body when we fall sick, nor do we look for the causes of illness in the air or think that the kindly earth is our enemy; for we have come to know our real foes.

An important subject. A considerable part of the work of a gardener is to protect his plants from weeds, and a great part of caring for the body is to protect it from germs. It is important for you to understand about germs, because a knowledge of this subject would each year prevent hundreds of thousands of cases of unnecessary illness that is still among us. It is well that you understand it for your peace of mind also; for many persons who do not know where germs live and how they pass from one person to another foolishly imagine that the world is filled with them. In this book we shall therefore study about germs and how to prevent the sickness that is caused by them.

POINTS TO BE REMEMBERED

1. Many diseases are caused by very small plants and animals that grow in the body.
2. Many of these diseases are rapidly being controlled, and there is reason to hope that in time all of them will be banished from the earth.

CHAPTER TWO

THE CELLS OF THE BODY

As a house is built of bricks and a heap of sand is composed of a multitude of small grains, so is the human body made up of a great number of very small

FIGS. 1 and 2. When we look at a house from a distance we cannot see the bricks in the walls. But when we stand close to the house, we can see the bricks of which it is built.

parts called *cells*. These cells are so small that we cannot see them without a microscope, but if you could examine a small piece of skin or other part of the body under a microscope, you could very easily see the cells of which it is composed. The skin, the muscles, the liver, the stomach, the brain, and all the other body parts are built of these little cells.[1]

The cells are alive. Each one of the little cells of the body is alive; each must have food and oxygen and all the things that the body as a whole needs. When we study how to keep the body in health, therefore, we are

[1] The cells of the body are exceedingly small. So small are they that it would take about 2500 of them placed side by side to make a row an inch long. There are 5,000,000 cells in a drop of blood the size of the head of a pin, and according to one estimate, the average human body is composed of 400,000,000,000 cells.

only studying how to keep the cells in health; for health means that the cells are in good condition, and sickness means that there is trouble among the delicate little parts of which the body is built.

The cells bathed by lymph. The cells of the body are built together as stones are built into a wall, but all among our cells there are spaces and openings that are filled with a liquid which escapes from the blood. This liquid is called the *lymph*, and the cells are surrounded by it and bathed in it, as a fish is bathed in the water in which it swims. We think of ourselves as dry land animals, but the living parts of our bodies spend their lives under water as truly as do the fishes of the sea.

FIG. 3. When we look at the body, we cannot see the cells of which it is made. But with a microscope the cells of the body are easily seen.

Pure lymph necessary to the health of the cells. If you had hundreds of small fish in a pail of water, you would be compelled to take great care in keeping the water fresh and in feeding them, lest they should die.

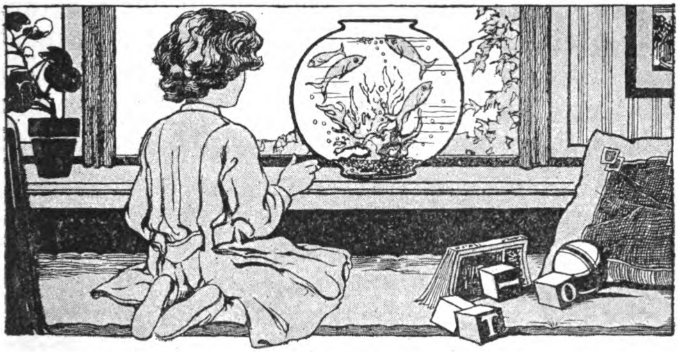


FIG. 4. As clean water is necessary for the health of the fish, so is pure lymph necessary for the health of the cells.

So with the cells crowded together as they are in our bodies, it is necessary to keep the lymph pure and clean and to supply it with the food and oxygen that the cells need. We therefore have a stomach and other organs for preparing food for the cells; we have lungs for taking in oxygen and for breathing out the waste carbon dioxid; we have kidneys for taking other poisonous wastes out of the body; and we have many other organs, each of which does its part in keeping the lymph rich and pure for the cells. When these organs do their work, our cells are like fishes living in pure, clean water where there is an abundance of food, and we are strong and well. If any organ fails in its work, either the cells will lack something that they need or the lymph in which they live will become impure, and the body will fall ill. *Pure and rich lymph is necessary for the health of the cells.*

Health the natural condition of the body. From the great colony of cells that we call the body a very wonderful machine has been made, and if the cells are allowed to live as nature intended them to live, it is natural for them to remain in health. But when germs set up their growth in the body, the cells are like plants in a garden that is overgrown with weeds; they are poisoned

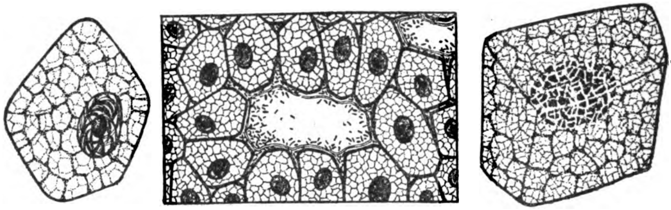


FIG. 5. On the left is a single cell as it appears under the microscope, and on the right a cell drawn to show that it has thickness as well as length and breadth. In the center is a group of cells with small blood vessels among them. Germs may grow in the blood vessels or in the small spaces between the cells, or in some diseases even within the cells.

and overgrown by the strangers that have made their home with them. This is the most common of all causes of sickness, and in the next chapter we shall learn more about these small germs that are of so much importance to us.

POINTS TO BE REMEMBERED

1. The human body is built of very small cells.
2. The cells are alive.
3. To keep the body in health we must keep the cells in health.
4. To remain in health the cells must have food and oxygen, and they must not be poisoned or injured in other ways.
5. Disease germs cause sickness by poisoning the cells.

CHAPTER THREE

DISEASE GERMS

SUPPOSE you had a garden and were raising musk-melons in it. Suppose that the soil was rich and damp and well-cultivated, and that your plants were flourishing. Then suppose that suddenly some of the plants began to droop and die. What would be the cause of the trouble? If you should examine one of the sick plants with a microscope, you would find that the vessels of the stem were filled with germs, — tiny plants that cause the "wilt disease."

FIG. 6. A muskmelon plant that has been attacked by wilt bacteria.

Germs as a cause of human illness. Germs not only cause disease in plants, but they are also the chief cause of illness in men. To get an idea of the sickness, sorrow, and loss that are caused by these small creatures, imagine a land where no colds, catarrh, consumption, influenza, diphtheria, or pneumonia ever could come; a land where boils, blood poisoning, and tetanus (lockjaw) are unknown; where there is no rheumatism, smallpox, measles, scarlet fever, whooping cough, or mumps; a land without typhoid fever, malaria, cholera, leprosy, yellow fever, or plague; a land free from appendicitis, tonsillitis, infantile paralysis, meningitis, and many of the other ailments that afflict mankind. Picture to yourself a country free from all these diseases, a country where many of the inhabitants pass from childhood to old age without sickness or disease, and you will have an idea of what a land without disease germs would be like.

Disease germs small plants and animals. In water and in the soil there are millions of little plants and animals — plants and animals so small that they can be seen only with a powerful microscope. The body of one of these little plants or animals is composed of a single cell. The little one-celled plants are called *bacteria* (singular, *bacterium*). The little one-celled animals are called *protozoa* (singular, *protozoön*). *Bacteria and protozoa that grow in the body and poison the cells are called "disease germs."*

Bacteria. Bacteria are so small that millions of them have plenty of room to swim in a drop of water. Twenty-five thousand of them placed side by side would make a row only an inch long. Examined under a microscope that would cause a man to appear as high as Mt. Washington or Mt. Mitchell, these small plants look about as large as periods and commas in ordinary print. So exceedingly small are they that they can pass through the pores of a brick as easily as a man can pass through the doorway of a house.

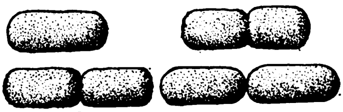


FIG. 7. A diagram showing the way a bacterium multiplies by pinching in two.

The multiplication of bacteria. Bacteria multiply by simply pinching in two. Some of them can divide and each half become full-grown, all within fifteen or twenty minutes; but this, of course, is very rapid, even for bacteria. They can easily divide once an hour, however, and at this rate one bacterium even in a single day can increase to a multitude. It is this power of rapid multiplication that makes disease germs so dangerous to man.

The shapes of bacteria. Bacteria are cylindrical, spherical, or spiral — shaped like a firecracker, a marble, or a corkscrew.[1] The shapes of bacteria have nothing to do with the diseases which they cause, but when we

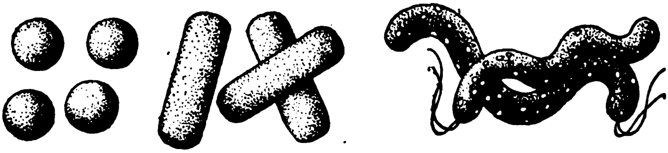


FIG. 8. The three shapes of bacteria.

examine germs with a microscope, we can often distinguish between different kinds by their shapes.

Where bacteria are found in nature. Bacteria are blown about in the air, clinging to particles of dust. They abound in the upper layers of the soil, but in ordinary soils do not live deeper than six feet below the surface. They are very abundant in the waters of streams, ponds, lakes, springs, and shallow wells, a quart of ordinary well water having in it about a million of them. They flourish especially on the skin and in the mouth, nose, throat, and intestine of men and animals, and they are always found on our clothing and on all the things that men and animals touch.

Useful bacteria. About fifteen hundred kinds of bacteria are known, and some of them are among the best friends of man. They break down dead animal and vegetable matter and turn it into food materials for plants; they cause the souring of milk and the ripening

[1] The cylindrical bacteria are called *bacilli* (singular, *bacillus*). The spherical bacteria are called *cocci* (singular, *coccus*), and the spiral forms are called *spirilla* (singular, *spirillum*).

of butter and cheese; they increase the fertility of the land by taking nitrogen from the air and storing it in the soil; and they have a part in the making of vinegar, the tanning of leather, and many of our other household and industrial processes. About forty kinds of bacteria grow in our bodies and make us ill, but we

FIG. 9. The bacteria of decay are our friends; but for them the dead bodies of all the plants and animals that have lived in the world would be lying about us.

must not condemn the whole group because of the harm done by a few members of the tribe.

The spores of bacteria. Certain kinds of bacteria form *spores* when hard times come upon them. A spore is formed by the living matter of a bacterium gathering itself into a dense little ball that rests, like a little seed, until food, moisture, and other good conditions for growth return. Then it takes in food and grows again into an ordinary soft bacterium, which goes on growing and multiplying and leading an active life as before.

So very difficult are bacterial spores to kill, that some of them have been found alive after having been dried for ten years, and others are not killed by boiling them for several hours. Fortunately for us, the germs of none of our most common diseases produce spores, and these germs may be killed by drying or by a very moderate amount of heat.

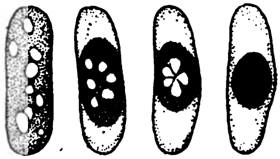


FIG. 10. The living material of the bacterium is gathered into a dense ball to form a spore.

Protozoa. The bacteria are the smallest of all plants. The protozoa are the smallest of all animals. The smallest protozoa look like tiny specks under the most powerful microscope, and are no larger than very small bacteria. The largest of them are much larger than any bacteria, but they can barely be seen with the naked eye.

Many kinds of protozoa live in the bodies of animals; in fact, almost every animal, from worms and insects up to man, suffers from diseases that are caused by them. Among the protozoan diseases of man are malaria, sleeping sickness, and several other diseases that are spread by insects. As we should expect, these diseases are more common in the warmer parts of the earth, where insects are most abundant.

Very small disease germs. Bacteria and some protozoa can pass through the walls of a vessel made of ordinary clay or earth, but a filter made of the very finest earth will strain bacteria or protozoa out of a liquid that is passed through it. There are certain diseases, however, the germs of which must be very small indeed, for the blood serum (page 50), or the saliva or some other secretion from a patient, will cause the disease, even after it has been passed through the finest filters.[1] Some of the germs of this kind appear as mere points under even a powerful microscope, and most of them have not been seen at all.

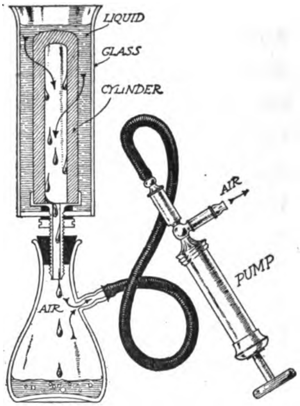


FIG. 11. A filter of the kind used in bacteriological laboratories. The cylinder is made of the finest earth and the liquid is sucked through it by drawing the air out of the flask below. Some disease germs are so very small that they pass through a filter of this kind.

About forty diseases are now known to be caused by these very small germs. One of them (mosaic disease of tobacco) is a plant disease. Many of them are animal diseases, of which hog cholera is the most important in our country. Among the human diseases that probably belong in this class are influenza, smallpox, rabies, yellow fever, and infantile paralysis. The germs of epidemic colds, mumps, and measles may also be of this kind. Fortunately for us, we have learned how to prevent some of these diseases, even though we know little about the germs that cause them.

The importance of clear ideas in regard to disease germs. It will help you greatly in your study of this subject if you can get clear ideas in regard to disease germs

[1] These germs are called *filterable viruses*, — "filterable" because they pass through a filter, and "viruses" because, long before the germ theory of disease was understood, physicians called that which passes from one person to another in an infectious disease the "virus" of the disease.

and what they are really like. You should understand that they are little masses of soft living material; that like yourself they must have food and that they use for their nourishment the food materials in the lymph or sometimes even our cells themselves; that while the bacteria of the soil can withstand drying and live in dust, disease germs are fitted to grow in the body, and like delicate moss from a damp forest, most of them will die if they are dried; that bright sunlight kills them almost instantly; and that strong poisons like mercury, copper, and carbolic acid are fatal to them as they are to other living things. You must also remember that, even though you do not see them, disease germs really exist. If you could see them, there are, as it were, great forests of bacteria growing on your skin and clusters of bacteria hanging to particles of dirt and to the legs of flies.

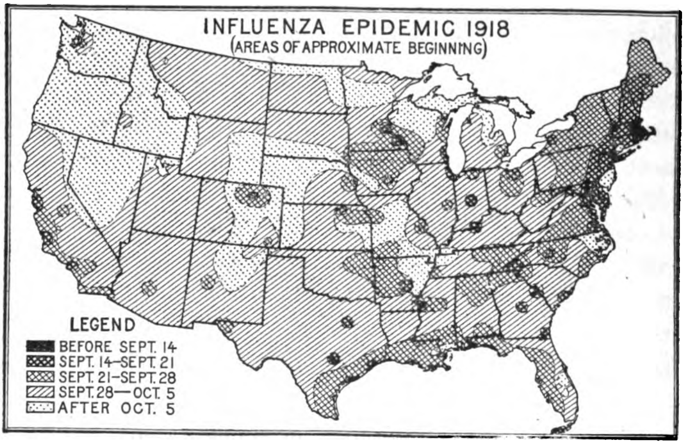
POINTS TO BE REMEMBERED

1. Many of our worst diseases are caused by germs.
2. Disease germs are little one-celled plants and animals that grow in the body and poison the cells.
3. The one-celled plants are called bacteria, and the one-celled animals are called protozoa.
4. There are millions of bacteria and protozoa in the soil and in water, but only a few kinds can cause disease.
5. Some disease germs are so small that they pass through the finest filters, and some of them cannot be seen with the most powerful microscope.
6. Disease germs are living things, and most of them are killed by drying and by strong light.

CHAPTER FOUR

KEEPING DISEASE GERMS OUT OF THE BODY

In the early days of September, 1918, cases of influenza began to be reported from Boston and a few other places in New England. In a month the disease



After U. S. Public Health Service

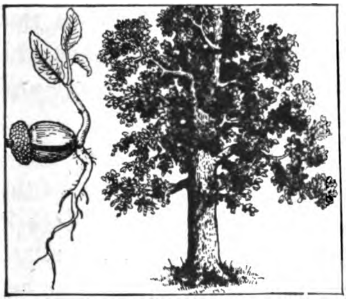
FIG. 12. Map showing spread of influenza in the United States in the autumn of 1918. In six weeks the disease reached practically every village in the land.

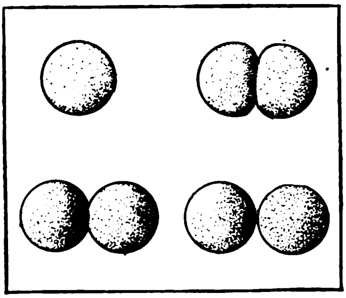
had reached all parts of the country except the rural sections of a few states, and by the middle of October it was in practically every village of the land. No such epidemic had ever before visited the United States. During the following six months probably thirty millions of persons had the disease; doctors and nurses could not be found to wait on the sick; and in the large cities it was impossible to bury from day to day those whom the pestilence swept away.

Where did the germs that caused the influenza epidemic come from? How did they travel from place to place? How did the germs pass from one person to another and what could have been done to prevent the spread of the disease?

The origin of disease germs. A germ is a living plant or animal, and it comes only from another germ of the same kind. The germs that started the epidemic of influenza came from some person who had influenza. Doubtless they were brought from Europe, where a severe form of the disease had been prevalent for months. Certainly *the germs that caused the influenza epidemic came from some person who was ill with the disease;* for as an oak tree can come only from an oak tree, so a germ can come only from another germ of the same kind.

Naturally we inquire where the first germ of any particular kind came from, but we might as well ask where the first hen or the first dandelion came from. We know that at present germs and hens and dandelions are here and that other germs, hens, and dandelions spring only from those that already exist.





FIGS. 13 and 14. As an oak can come only from the seed of an oak tree, so a germ can come only from another germ of the same kind.

How germs travel. Influenza germs and most other germs travel *in people.* Epidemics spread no faster than people travel, and if people did not travel epidemics would not spread at all. At present germs can travel at express-train speed. Soon we may expect them to

FIG. 15. The great outdoor world is practically free from germs.

use airplanes; indeed, it is believed that already the germs of rabies (in dogs) have entered England in this way. As travel becomes swifter and more common, the problem of controlling germ diseases becomes more and more important and more and more difficult.

The world not swarming with disease germs. One fact that you should understand from the very beginning of your study of this subject is that the world is not filled with disease germs that are lying in wait to attack us.[1] It is true that bacteria and protozoa are abundant in water, that bacteria are swarming in the

[1] Many persons call all bacteria and protozoa "germs" without distinguishing between the harmless and the disease-producing kinds. In this book the word "germ" is used to mean only those bacteria, protozoa, and filterable viruses that cause disease.

soil, and that they are constantly being blown about in the air. But of all the many hundreds of kinds of bacteria and protozoa that are in the world, only a few cause disease. The others are harmless, and even when they get into our bodies, it is not we, but the bacteria and protozoa, that suffer. The germs of most diseases quickly die outside the human body. Even in water they die in a few days or a few weeks at the most. It is a great mistake, therefore, to think that every breath of air is dangerous, and that all food and water contain disease germs. The winds that blow over the meadows, the rain that falls from the clouds, the trees of the forest, the grass in the pasture, and, in general, the great outdoor world, are practically free from germs. We cannot, therefore, look for the causes of disease in the world about us; we do not eat and drink and breathe germs every hour of our lives.

FIG. 16. Nearly all the germs that attack us come from the bodies of the sick.

The human body the home of disease germs. It is in the human body that disease germs have their home. From the bodies of persons who are sick come the germs that attack us. On the hands of persons who are sick with germ diseases, on articles that the sick have used and touched, and in places where the wastes from the bodies of the sick go, there, and in most cases there only, are disease germs to be found. *Nearly all the germs that attack* *us are spread from the bodies of persons who are sick with germ diseases.*[1]

The first great rule for the prevention of germ diseases. The first great rule for the prevention of germ diseases is: *Destroy the germs that come from the bodies of the sick.* If all the diphtheria germs that come from human throats could be destroyed, there would soon be no more diphtheria. If all the smallpox germs that come from the bodies of persons who have the disease could be destroyed, there would soon be no more smallpox. It is easier to destroy germs as they come from the bodies of the sick than it is to destroy them after they have been spread abroad, and a little intelligent care used in keeping germs from being scattered would every year save many thousands of lives.

FIG. 17. The first great rule for the prevention of germ diseases is: *Destroy the germs that come from the bodies of the sick.*

How germs enter the body. In a few cases germs may pass through the unbroken skin, but *nearly always they enter the body through wounds, or through the mouth or nose.* In later chapters we shall learn what germs get into the body through cuts and sores; we shall study

[1] In some cases germs are spread by insects and other animals or by healthy human germ carriers. These cases will be discussed later.

about biting insects (mosquitoes, flies, ticks, fleas, and bedbugs) that pierce our germ-proof armor (the skin) and place germs directly in the wounds that they make. We shall read of other germs that enter the body by way of the nose, and we shall learn how in many cases very dangerous germs reach the mouth from the hands, from flies, from drinking cups, in food and water, and in many other ways. Here we wish only to call your attention to the fact that the gateways through which disease germs get into the body are wounds, the nose, and especially the mouth.

The second great rule for the prevention of germ diseases. The second rule for the prevention of germ diseases is: *Take care of wounds, protect yourself from biting insects, and guard the mouth and nose.* The first rule aims to keep disease germs from being scattered abroad. The second rule aims to keep out of the body the germs that do get scattered abroad. If we neglect either of these laws, we cannot hope to escape the diseases that are caused by germs.

POINTS TO BE REMEMBERED

1. A disease germ can spring only from another germ of the same kind.
2. Nearly all the germs that attack us come from the bodies of persons sick with germ diseases.
3. The first great rule for the prevention of germ diseases is: *Destroy the germs that come from the bodies of the sick.*
4. Germs enter the body through wounds and through the mouth and nose.
5. The second great rule for the prevention of germ diseases is: *Take care of wounds, protect yourself from biting insects, and guard the mouth and nose.*

CHAPTER FIVE

THE STRUGGLE BETWEEN THE BODY AND THE GERMS

In spite of the greatest care that we can use, all of us are certain at times to get disease germs into our bodies. Between these germs and the body a warfare then begins. The germs try to grow in the body and use it for food. To defend itself the body kills the germs. In this chapter we shall learn how the body resists its small foes.

How germs cause sickness. Some disease germs, when they grow in the body, produce poisons that are called *toxins*. These toxins are set free from the germs, and when they are carried through the body in the blood, they cause sickness by poisoning the cells. A little group of tetanus (lockjaw) germs in a small wound, or a small patch of diphtheria germs growing in the throat, may produce enough toxin to poison and kill the whole body. In diseases of this kind, *it is not the germs themselves, but the toxins (poisons) that the germs produce that cause the sickness.*

Other disease germs produce no free toxins that can be discovered, but in some way they injure the cells. In many diseases (for example, pneumonia, typhoid fever, and malaria) there are hundreds of millions of germs in the blood or among the cells, and it is not strange that the presence of so many little plants or animals in the body should have a great effect on the health.

How the body destroys toxins. When germs produce poisons in the body, the body produces antidotes for the poisons — substances that make the toxins harmless and keep them from poisoning the cells. These substances are called *antitoxins*. *An antitoxin does not kill germs ;*

it destroys the toxin, and thus protects the cells until in other ways the body can kill the germs.[1]

The white corpuscles and the germs. If you should examine a drop of blood with a microscope, you would find a very great number of cells floating in the liquid part of the blood (Fig. 18). These cells are of two kinds. Most of them are red in color, and these are called *red corpuscles.* Their work is to carry oxygen through the body. The other kind of cells in the blood is the *white corpuscles.* These are the soldiers of the body, and *their work is to kill disease germs.*

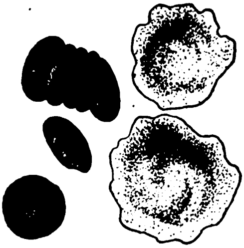


FIG. 18. The red and white corpuscles of the blood as they appear under a microscope.

A white corpuscle approaches a germ and flows about it, or swallows it, as shown in Figure 19. Then the corpuscle tries to digest and kill the germ, while the germ tries to grow in the corpuscle and use it for food. When our corpuscles are victorious, the germs are destroyed; but if the germs are very numerous or very powerful, it may be the corpuscles that will be killed.

The protective substances of the blood. In addition to the white corpuscles, there are certain substances in the blood that aid in the battle against the germs. The action of these substances is not well understood.

[1] There are different toxins and antitoxins in different diseases. For example, the toxin and antitoxin in diphtheria are different from the toxin and antitoxin in tetanus. The body can produce substances (antitoxins) that will protect it against snake venoms, the poisons of scorpions and spiders, and many vegetable poisons, as well as against the poisons of germs.

Some of them prepare the germs to be taken up by the white corpuscles.[1] Others prevent the growth of the germs, or perhaps destroy them. There are always small amounts of these protective substances in the blood, and when disease germs attack the body, greater amounts of them appear. Different defensive substances are produced in different diseases, just as different toxins and antitoxins are produced in different diseases. A person, therefore, may have a great power of killing the germs of one disease and yet will fall an easy victim to some other disease.

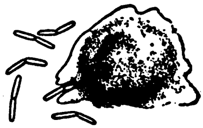


FIG. 19. A white corpuscle taking in a bacterium.

Why we have certain diseases only once. When the germs of a disease attack us, the body manufactures more of its protective substances to destroy them. More and more of these substances are formed, and the blood becomes stronger and stronger in its power to kill the germs. Finally, if the body is successful in its struggle with its enemies, the defensive substances and the white corpuscles get the upper hand of the germs, and recovery begins. After a patient recovers from some diseases (for example, smallpox, measles, and whooping cough), a large amount of the protective materials remains in the blood for years, or even for

[1] The substances that prepare the germs for the white corpuscles are called *opsonins*. These unite with the germs and make them more appetizing to the corpuscles, just as sugar and cream make a breakfast food more pleasing to the human taste. Unless the opsonins are present the white corpuscles do not take up the germs. How far our resistance to germs depends on opsonins, and how much of it is due to other substances in the blood, we do not yet know.

life. Any germs of these diseases that get into the blood are therefore promptly killed, and a person is seldom attacked by one of these diseases more than once. After other diseases (for example, colds), the increased defensive power of the body quickly disappears, and we may have these diseases again and again.

Increasing the defenses of the body by vaccination. Vaccination has been employed as a protection against smallpox for more than a century (page 88), and of recent years it has been used with more or less success to increase the resistance of the body to the germs of rabies, boils, typhoid fever, plague, and many other diseases. In vaccination, weak or dead germs of the kind that cause the disease are introduced into the body. This, like an attack of the disease, causes the body to manufacture its protective substances, thus providing a defense against the living germs that cause the disease. Vaccination is very important in protecting us against certain dangerous diseases; for up to the present time we have found no other way to make the body produce increased amounts of its defensive substances before the growth of the germs in the body begins.[1]

Good health and the resistance of the body to germs. Caring for the health will not raise the resistance of the body to germs beyond a certain natural point, and we cannot in this way make the body able to resist the germs of diseases like measles, whooping cough, influenza, diphtheria, typhoid fever, or epidemic colds.[2] At the same

[1] There can be no protection without infection. — SIMON.

[2] Studies made on soldiers who suffered from typhoid fever during the Spanish-American War showed that those attacked were certainly as strong as those who escaped the disease. In the recent influenza epidemic consumptives suffered far less than those in good health.

time, you should understand that overwork, exposure to cold, wet feet, hunger, worry, lack of fresh air, or lack of sleep — anything that injures the health — lowers the natural defenses of the body and takes away the powers

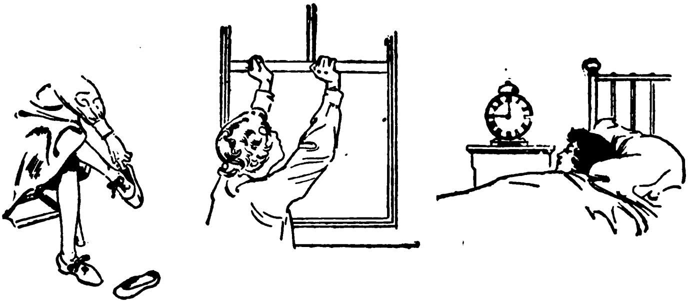


FIG. 20. Dry feet, fresh air, and plenty of sleep help to keep up the power of the body to kill germs.

of resistance that we have. Proper care of the body, therefore, may at times save us from attacks of certain diseases (especially pneumonia and tuberculosis); and we must also remember that after the body is attacked by germs, it still has before it the problem of overcoming them. In this fight sufficient time to produce the protective substances is an all-important factor, and a strong body may fight its way to victory when a weaker one would have succumbed to the disease. It is well, therefore, for us at all times to guard our health; for health and vigor may be a great aid in the battle with the germs.

Alcohol and resistance to germs. Experiments on animals prove that alcohol lessens the power of the body to kill germs. When alcohol is given to rabbits, it is not possible to save them from rabies (hydrophobia) by the Pasteur treatment (page 109). Other experiments show that the germs which cause boils and blood poisoning are able to attack rabbits that have had alcohol more easily than those that have had no alcohol. Still other experiments show that animals that have been given alcohol cannot resist the germs of cholera, tetanus (lockjaw), and other diseases, as well as animals that have not been given alcohol. Experiments like these leave no room to doubt that alcohol taken into the body lessens the power of the body to protect itself against germs. Many physicians have long believed that this was true, for they have known that drinkers suffer far more from many germ diseases than do those who use no alcohol.

The relation of the body to germs. We have spoken of the human body as being "attacked" by germs, but you should not think of a germ as leaping on its prey like a wild animal and killing it. Perhaps you will get a more nearly correct idea of the relation of the body to germs, if we compare the body to a fertile field and a germ to a weed that is capable of multiplying enormously if it gets into this field. The white corpuscles may then be compared to field hands whose duty it is to destroy the weeds, and the germ-killing substances to materials in the soil that are poisonous to the weeds but not to the crop plants.

If you think of the subject in this way, you may be able to imagine what would happen if the white corpuscles, because of exposure of the body to cold or fatigue, or for some other reason, should not be able to attend to their work. It may also help you to understand why the germs of many diseases die out in the body after a short time and the person recovers; why people have certain diseases only once; and what physicians are trying to do when they vaccinate people, or treat them with serum after they become ill. And if you will imagine also that there are certain weeds which the field hands do not molest and against which in most fields there are naturally no protective substances, you may be able to understand why measles and influenza spread so rapidly among those who have not previously been exposed to them.

POINTS TO BE REMEMBERED

1. Dangerous germs often get into the body in spite of the greatest care that we can take.
2. These germs cause disease by producing toxins that poison the body.
3. The body produces antitoxins that destroy the toxins.
4. The body kills germs by means of the white corpuscles and the defensive substances of the blood.
5. We have certain diseases only once, because after recovery from these diseases the protective substances remain strong in the blood.
6. By vaccination the power of the body to kill certain germs can be increased.
7. The germ-killing power of the body should not be allowed to run low, because at any time we may be attacked by germs.
8. Alcohol lessens the power of the body to kill germs.

CHAPTER SIX

BACTERIA THAT ENTER THE BODY THROUGH THE SKIN

If we had not the skin to protect us, it is probable that bacteria would swarm into our bodies in such numbers that in a week there would not be a living human being in the world. We know that this is true, because when even a single cut or tear is made in the skin, the body is sometimes hardly able to hold back the germs. Because the bacteria that infect wounds are the most widespread of disease germs, it is important to use care when the covering of the body is broken.

THE PUS-FORMING BACTERIA

The pus-forming bacteria grow on the human skin, where they feed on the dead cells and other matter on the skin. They are hardy germs, and they are often found in the soil about the dwellings of men and animals and are common in unclean water. There are several different kinds of these bacteria, but they all cause inflammation and form pus, the thick, creamy, liquid matter that is found in boils and infected wounds.

Diseases caused by pus-forming bacteria. - The pus-forming bacteria may grow in almost any part of the body and cause inflammation of the part that is attacked. In wounds they cause pus to be formed. Often they work down through the hair follicles and sweat glands (the weak places in our armor of skin) and cause pimples, boils, carbuncles, and erysipelas (page 28). Very commonly they invade the walls of the throat or intestine and cause tonsillitis, sore throat, inflammation of the bowels, or appendicitis. Occasionally they attack the membranes around the brain and cause meningitis, or set up their growth in the lungs and cause pneumonia. In like manner they may grow in the lining of the heart, or they may spread through all the body and cause blood poisoning.

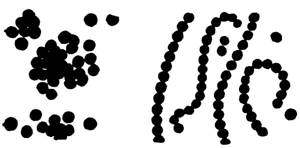


FIG. 21. The two most common pus-forming germs.

The different kinds of pus-forming bacteria. The most common of the pus-forming bacteria is a small coccus that grows in bunches or clusters (Fig. 21).[1] This coccus is the usual cause of pus in small wounds, of pimples, boils, and carbuncles, and of inflammation and ulcers in the bones. It may also cause blood poisoning, and is sometimes found in other cases of inflammation.

Another common pus-forming bacterium is a coccus that grows in chains (Fig. 21).[2] By making a wide-spreading growth in the skin, this germ causes erysipelas, in which the skin has an angry, red appearance over the infected part. It is sometimes found in small sores and boils, but it more commonly attacks the inner parts of the body. It is often the cause of rheumatism, sore throat, tonsillitis, appendicitis, and blood poisoning, and more commonly than any other germ it is found in inflammation of the middle ear.[3] It also causes meningitis and pneumonia more frequently than do the other pus-forming bacteria, and many cases of chronic disease

[1] *Staphylococcus* (pronounced stăf′ĭl-ō-kŏk′kŭs).

[2] *Streptococcus* (pronounced strĕp′tō-kŏk′kŭs).

[3] The running ears that are common among children demand prompt medical attention, both because there is danger of injury to the hearing, and because there is danger that germs will work their way from the ear to the brain and cause meningitis, or an abscess in the brain.

of the arteries, heart, and kidneys are due to slow-growing races of this germ.

A third pus-forming bacterium is a slender bacillus that sometimes gets into wounds and causes bluish green pus to be formed.[1] This germ may also be a cause of diarrhea and of epidemic colds, but it is not so common in the body, nor is it so dangerous, as are the other kinds of pus-forming germs.

FIG. 22. A pus-forming bacillus.

Weak and strong races of pus-forming bacteria. Some varieties of the pus-forming germs seem to be entirely harmless. Others are exceedingly dangerous, and whenever they have the opportunity to do so, produce the most violent cases of inflammation and blood poisoning. None of them should be allowed to enter the body when it can be prevented; but germs from a carbuncle, an old abscess, a case of erysipelas, or a case of blood poisoning are far more to be feared than germs of the same race from the skin or from some other source outside the body. It is a common thing for a person with a boil to scratch the germs into the skin with his finger nails and thus cause a whole crop of boils in different parts of the body.

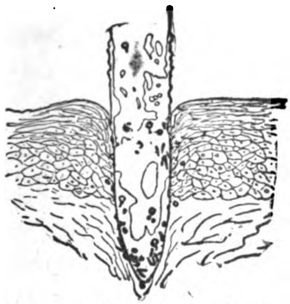


FIG. 23. If a nail or other instrument is driven through the skin, it will carry germs down and leave them among the cells.

Care of wounds. For our protection against pus-forming bacteria it is very important to care for wounds.

[1] *Bacillus pyocyaneus* (pronounced pī-ō-sī-ā′nē-ŭs).

A clean wound may be tied up without any treatment, but a wound that has been made with anything unclean should be cleansed and treated with a good disinfectant.[1]

FIG. 24. A solution of iodine is excellent for treating a wound.

It is not best, however, to wash a wound with an irritating disinfectant, for a disinfectant of this kind injures the cells in the wound and weakens their resistance to the germs. To a considerable extent our resistance to pus-forming bacteria depends on the number of attacks we have undergone from them, and a person who has done rough work and suffered many wounds in his skin is able to resist these germs better than a person who has always been shielded from them.

TETANUS (LOCKJAW)

The germ of tetanus is a rather long bacillus. It grows very commonly in the intestine of the horse, and is less frequently found in the intestine of the cow, sheep, and other grass-eating animals. It forms spores that may be dried for years without killing them, and great numbers of these spores are in the manure from infected animals. The tetanus germ is, therefore, very common about stables, in soils that have been enriched by barnyard manure, in the dust of streets, and in other places where the droppings of animals are spread.

The germ of tetanus. The tetanus germ does not cause disease when it grows in the intestine of an

[1] A five per cent solution of iodine in alcohol or ether is excellent for this purpose. A new disinfectant called dichloramine-T is perhaps even better.

animal, but if it gets into wounds either in animals or in man it may cause a most severe illness. One peculiar thing about this bacillus is that unless other bacteria are present, it cannot grow except when shut away from the air. Along with other germs, however, it sometimes grows in an open wound. The incubation period is from four to fourteen days, and man and the horse are most frequently attacked by it.[1]

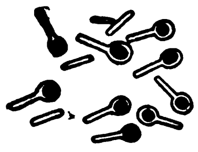


FIG. 25. Germs of tetanus. Most of them have formed spores.

How the tetanus germ enters the body. The tetanus germ enters the body through wounds, sometimes through wounds so small that they are not noticed. It is most frequently found in wounds made by unclean instruments, because such wounds are most likely to get tetanus germs into them, and because dirt and other bacteria are left in wounds of this kind.[2] It grows best of all in small, deep wounds, like those made by an unclean nail, because such wounds readily close over and leave the tetanus germ, with other germs and dirt, buried deep in the flesh. The percussion caps used in toy pistols, blank cartridges, and firecrackers also make dangerous wounds. The tetanus spores are in dust on the skin, and the small, sharp flying particles of the cap, the wads of the blank cartridge, or pieces of the firecracker, cut deep into the flesh and drive down these spores along with other bacteria and dust.

[1] The *incubation period* of a disease means the time from the entrance of the germs into the body until the appearance of the symptoms.

[2] Wounds where the cells are much bruised and crushed are especially favorable to the tetanus germ. Dirt in a wound always crushes and kills the cells about it, and in this way makes a favorable seed bed for the germs to start their growth.

Protecting wounds from the germs of tetanus. Wounds on the feet of barefooted children should receive especially careful attention, since these come in contact with the earth and may get tetanus germs into them. Wounds received about stables are especially dangerous. It is best to have a physician look after wounds from which there is unusual danger of tetanus; for usually the disease develops suddenly and without any symptoms, often days after the injury is supposed to be healed. Wounds should not be closed with court plaster, for this shuts out the air and creates conditions favorable to the growth of the tetanus germ.

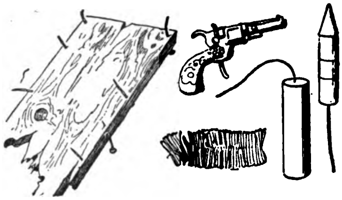


FIG. 26. Wounds made by these are especially likely to cause tetanus.

The toxin of tetanus. The tetanus germ makes only a very little growth in the body, but it produces a toxin of tremendous power. This toxin is for man a poison twenty times as strong as dried cobra venom and almost three hundred times as strong as strychnin, and a very small group of tetanus germs may produce enough toxin to cause death. The toxin attacks the nervous system especially, and this causes all the muscles to be thrown into contraction. One of the first symptoms of tetanus is a stiffness of the muscles of the jaw and neck.

Tetanus antitoxin. An antitoxin for tetanus is prepared from the blood of the horse, but it has not proved very effective in curing the disease, except when used in the early stages and in large doses. It is very valuable, however, in preventing the disease, and a dose of the antitoxin should be given to any person who has received a wound that is likely to bring on tetanus. This remedy is also of great use in protecting valuable horses against the disease.

Other germs that infect wounds. In addition to the pus-forming bacteria and the tetanus bacillus, there are a number of other germs that often infect wounds in which the tissues are badly crushed and into which dirt or other foreign matter has been carried. During the recent war great advances were made in the treatment of wounds of all kinds, and a physician who understands the new methods of preventing infection should be called to attend to any severe wound.

POINTS TO BE REMEMBERED

1. The pus-forming bacteria may grow in almost any part of the body.
2. These bacteria cause inflammation, pus-formation, pimples, boils, carbuncles, erysipelas, sore throat, tonsillitis, appendicitis, blood poisoning, and many other diseases.
3. There are weak and strong races of pus-forming bacteria, and the strong races are greatly to be feared.
4. Wounds should be cared for to keep germs from growing in them.
5. The resistance of the body to pus-forming bacteria may be raised by vaccination.
6. The tetanus bacillus is common in the soil and often gets into wounds.
7. Tetanus antitoxin will usually prevent the development of the disease.
8. A physician should be called to attend to any severe wound

CHAPTER SEVEN

RESPIRATORY DISEASES

Before the troops were called to the cantonments in the recent war, the Surgeon General of the army knew that the diseases most to be feared were those of the respiratory organs. In his experience with the laborers on the Panama Canal he had found the most troublesome disease to be, not malaria or yellow fever, but pneumonia, and he therefore urged the importance of providing sufficient air space for each man and of not crowding the camps more than was absolutely necessary.

The later sanitary history of the army showed how well founded these fears were; for during the six months from September, 1917, to April, 1918, the death rate from pneumonia in the cantonments was 12 times as high as in civil life, the diphtheria death rate was twice as high, and the deaths from meningitis, measles, and scarlet fever (in which diseases the germs are spread in the secretions from the mouth and nose) were respectively 45 times, 19 times, and 6 times greater proportionately than in civil life. Colds and sore throats were also common, and later all the cantonments were swept by the influenza. All together, the infections that modern sanitary science proved least able to control were those of the air passages and lungs. In civil life also these are our most common and important diseases, about one fourth the total number of deaths in the colder parts of our country being due to them (page 157).

Infectious diseases of the air passages and lungs. The most common germ diseases of the air passages are colds, catarrh, sore throat, influenza, tonsillitis, bronchitis, diphtheria, and whooping cough. The most dangerous diseases of the lungs are pneumonia and tuberculosis, which in the United States stand at the head of the list of germ diseases as causes of death. The air passages are infected in measles, scarlet fever, and smallpox also; and in mumps, meningitis, and infantile paralysis the germs are in the discharges from the mouth and nose. As will be seen, this is a formidable list of infections, and their control is now the most pressing problem in public health.

FIG. 27. Kiss the baby on the cheek, not on the mouth. If it isn't your own baby, do not kiss it at all.

How the germs of respiratory diseases are spread. The germs of respiratory diseases leave the body and also enter the body through the mouth and nose. It is believed that usually they reach the mouth or nose in one of three ways:

1. *By the hands.* Typhoid germs have been found on the hands of typhoid carriers, diphtheria germs on the hands of diphtheria carriers, and streptococci on the hands of streptococcus carriers. A number of men were asked to wash their hands in warm clear water for 30 seconds. On warm days they left in the water an average of four million bacteria each; on cold days two hundred and forty million. The increased number of bacteria on the hands on cold days was believed to be due to the greater flow of mucus from the nose and

mouth on these days; there were more colds, with coughing and sneezing that covered the hands with bacteria. Such hands leave germs on doorknobs, banisters, streetcar straps, books, and other objects that they touch. Other hands become contaminated from these objects and then carry the germs to the mouth and nose.

2. *By eating utensils and drinking cups.* In eleven different army camps, among 32,624 soldiers who washed their eating utensils in common tubs of warm water, there were in two weeks 251 cases of influenza for each 1000 men. Among 33,452 men who used eating utensils that were boiled, there were in the same time 51 cases for each 1000 men. Among 14,850 workers in the kitchens and dining rooms of department stores, hotels, and restaurants where the dishes were washed by machines in boiling water, there were 13 cases of influenza per thousand; at the same time, in the same city, among 3125 kitchen and dining room workers, where the dishes were hand washed, there were 85 cases per thousand. These facts are not surprising, for dishes have an opportunity to become contaminated both by mouth and hand. All public eating places should be required by law to wash their utensils in boiling water, and the use of dishwashers even in families is highly commendable from the sanitary point of view. Long ago most states abolished the public drinking cup. They cannot abolish the public dishes in restaurants and ice-cream parlors, but they should require that such dishes be made safe for public use.

3. *By droplet infection.* In coughing, sneezing, laughing, singing, and to a certain extent in talking, small droplets of saliva or mucus are sent out into the air from the mouth and nose. These droplets may fly to a dis-

tance of several feet (3 to 10). The larger ones at once fall downward through the air; but some of them are so fine that they are said to float for as long as 20 minutes. When a person is suffering from a disease like influenza, pneumonia, or consumption, the droplets which he sends out into the air are, of course, filled with the germs of the disease.

FIG. 28. When a person coughs or sneezes, he should hold a handkerchief before his face.

The spreading of germs in this manner is called "droplet infection," and in recent years this method of infection has been considered of much importance. Some persons think that the chief danger in coughing and sneezing is that the hands, objects that other persons will touch, and even the faces and lips of other persons may be sprayed with the germs. Others think that the infection is spread more by the breathing in of the fine droplets. How important droplet infection is we do not yet know, but it is probable that it is responsible for many cases of respiratory diseases. One health officer conducted a state-wide campaign based on the two simple ideas of smothering coughs and sneezes and keeping the hands away from the face, and he believes his records show that through this campaign he reduced the respiratory infections in this state by 30 per cent.

Preventing respiratory diseases. Probably the following measures for the prevention of respiratory diseases are as effective as any that can now be advised:

1. *Covering coughs and sneezes.* When a person coughs or sneezes he should hold a handkerchief before

his face. He should also turn his face downward so that the droplets will not be thrown up into the air and blown to other persons.

2. *Not spitting in public places.* The germs in sputum that is exposed to flies or left where it may get on shoes, are likely to reach the mouths of other persons.

3. *Keeping away from persons who are suffering from respiratory diseases and turning away from a person who is coughing or sneezing.*

4. *Not shaking hands unless it is necessary.* When two Chinese meet, each shakes hands with himself. This method of handshaking, like the salute of the soldier, offers no opportunity for the transfer of germs.

5. *Not touching objects that are likely to be infected.* One should not touch books, handkerchiefs, or objects that are handled by others, when it is not necessary to do so. The hands should be kept from public banisters and public doors as much as possible, and it would seem sensible to wear gloves when it is necessary to hold to seats and straps in street cars. In army hospitals it was found that unless the most extreme care was used, the germs of respiratory diseases were carried from patient to patient *on objects*—the clothing of nurses and physicians, basins, dishes, etc.

6. *Keeping the hands away from the face.* This is most important, for, in the opinion of many sanitarians, germs reach the mouth from the hands more frequently than in any other way.

7. *Washing the hands frequently with soap, especially before eating.* In washing the hands with soap, the germs and the dirt in which the germs are caught slide off the hands, thus, in a measure at least, freeing the

hands of germs. Soaps are valuable because of their disinfecting power also.[1]

8. *Avoiding public drinking cups and soda fountains, ice-cream parlors, and public eating places where the eating utensils and glasses are not sterilized.* Washing soda-fountain glasses in a pail and using them again is a most effective way of spreading infection. If paper cups are used, the spoons still require attention. On the bowl of one spoon used by a streptococcus carrier twelve million bacteria, many of them streptococci, were found.

9. *Avoiding crowds.* Whenever people are crowded together respiratory diseases always become worse, and it is easy to understand why this is true. Crowded houses, cities, street cars, schools, offices, and all other crowded places make the spread of respiratory diseases easy, and if one can do so he should keep away from them. Yet a certain army medical officer has said that it is not the crowding of people together, but the crowding together of people to eat, that is dangerous. Those who hold this opinion consider restaurants and soda fountains far more dangerous than churches and theaters.

10. *Wearing masks.* These can be used to prevent patients from coughing out droplets into the air, and to protect the faces of those who must wait on persons ill

[1] In one of the army cantonments it was found that Ivory soap quickly killed a certain germ, while the seemingly much stronger yellow soap that was being used in washing the dishes did not kill it. A germ may be killed by one disinfectant and yet resist a disinfectant that is much more powerful for another germ, and it is probable that germs differ in their resistance to soaps in the same way. If we knew which soap to use, it might be possible to free the hands from any particular germ with it, but like hundreds of other questions in sanitation this one needs to be investigated.

with respiratory diseases. To be germ tight the mask must be made of several plies of closely woven material.[1] Masks have proved effective in preventing physicians and nurses in hospitals from becoming germ carriers, and there is little doubt that if properly made and worn they help to check the spread of respiratory diseases. At the same time, many sanitarians consider them of little value when used by the general public. They must be changed frequently, must not be turned inside out after being worn, and to give protection from the coughing and sneezing of others they should protect the eyes as well as the mouth and nose, since any germs that get into the eyes can easily pass down into the nose. One medical officer has said that the great value of the mask for general use lies in the fact that it keeps the hands out of the mouth.

11. *Washing out the nose and throat with disinfectants.* Some experiments in preventing measles by this method have given encouraging results, and disinfecting the nose and throat seems to shorten the time required to free meningitis carriers from germs. A new disinfectant called dichloramine-T promises to be very useful for this purpose. Irritating disinfectants cannot be used, as they injure the tissues. In many diphtheria and streptococcus carriers the germs are located deep in the tonsils, which must be removed before the throat can be freed from the dangerous bacteria.

12. *Vaccination.* Vaccination is supposed to be of value in preventing pneumonia and whooping cough.

[1] A set of experiments indicated that a three-ply mask made of a finely woven gauze (bleached absorbent bandage gauze, thread count 44–40, which is known as "butter cloth") is effective.

Australian and New Zealand troops seemed to be protected to a considerable extent against the colds and catarrhs of England by vaccination, and some believe that a vaccine is of value in protecting influenza and measles patients from pneumonia and other troubles that often follow these diseases. Perhaps in time we shall learn to prevent respiratory diseases by vaccination, as smallpox and typhoid fever can now be prevented.

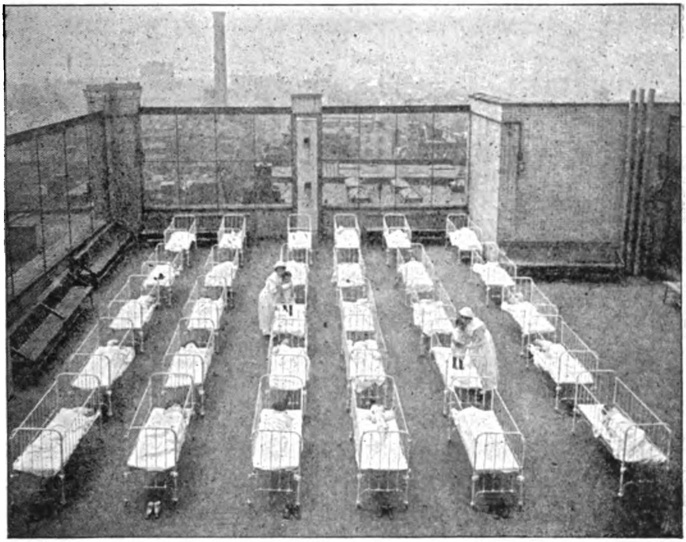
13. *Isolation of cases of respiratory disease.* Certainly persons suffering from pneumonia, measles, scarlet fever, and whooping cough should be isolated and if necessary quarantined. Our health departments should be provided with a greater number of workers to find the persons who are carrying dangerous germs and prevent the infection of the public by them. No other public health work promises results so quick and so great as this, and health officers have a work to do in controlling respiratory diseases that people cannot do for themselves. Of course the time for them to do their work is when the very first cases appear. It is now evident that it would have been wise to make great efforts to isolate the first cases of influenza in the epidemic of 1918–1919, instead of allowing the infection to sweep uncontrolled over the whole land.

14. *Keeping up the health.* During the assembling of the troops in 1917 and 1918, the germs of sore throat, colds, pneumonia, and other infections were constantly brought into the cantonments, and if allowed to spread they always found plenty of material to work on. At the same time the army surgeons had reason to believe that fatigue, exposure to cold, or anything else that lowered the health was favorable to the spread of respi-

ratory diseases. In one camp, for instance, it was reported that the number of pneumonia cases increased with each winter thaw and the consequent dampening of the men's feet. These and other facts prove that proper care of the health will prevent some cases of respiratory diseases, and every case prevented helps to prevent others. For it should always be remembered that the germs of infectious diseases are handed on and on and on, and one case prevented may mean that a whole series of cases that would have come from it has also been prevented. A person who is vaccinated does not protect himself alone from smallpox; he makes sure that he will not give the disease to others. Persons who care for themselves so that they escape disease, are therefore protecting not only themselves but many others as well.

An important factor in keeping up the resistance of the body is fresh air. Recent experiments prove that fresh air increases the resistance of animals to germs, and all experience indicates that outdoor life, outdoor sleeping, and good ventilation are most important in building up the defenses of the body. Fatigue and exposure to cold lower the defenses of the body, and the avoidance of them is important in keeping the body in condition to resist germs.

Other important factors in keeping up the body defenses are good food, clothing that is dry and warm, exercise, sleep, cold baths and sponging the chest with cold water in the morning, and the avoidance of alcoholic drinks. The tonsils are often the breeding places of germs, and any one who is suffering from infected tonsils or adenoid growths should have them removed at once.



Children's Aid Society

FIG. 29. Outdoor sleeping quarters for children.

POINTS TO BE REMEMBERED

1. In the colder parts of our country, one fourth of all deaths are due to respiratory diseases.
2. Usually the germs are spread by the hands, by eating utensils and drinking glasses, and by droplet infection.
3. Coughs and sneezes should be covered; objects that may be infected should not be touched; the hands should be kept away from the face; and public eating places where dishes and glasses are used without sterilization should be avoided.
4. Cases of the severer respiratory diseases should be isolated for the protection of the public.
5. Because the germs of respiratory diseases are widespread, it is important to keep up the health as a defense against them.

CHAPTER EIGHT

DIPHTHERIA

SOME cases of diphtheria are so severe that death comes in a day or two. Other cases are so light that they are mistaken for colds in the head or for simple sore throats. The disease is most common in children, and there is always an increase in the number of cases when the children come together in school after the long vacation.

FIG. 30. The bacillus of diphtheria.

The germ of diphtheria. The diphtheria bacillus grows most frequently in the throat. The infection usually starts on a tonsil, often on a tonsil that is infected with pus-forming germs. The diphtheria bacillus can also grow in the mouth, nose, and larynx,[1] on the lips, on the lining of the eyelids, and in other parts of the body. It is killed by thorough drying, but when it is protected by matter about it, it can live on pencils and similar objects for some time. It multiplies in milk without changing the taste or appearance of the milk.

How diphtheria germs get into the body. Diphtheria germs may be coughed out into the air and inhaled. They are certain to be on the handkerchiefs and hands of the persons who are carrying them; they have been found on public drinking cups; they may be on pencils, chewing gum, pieces of candy, toys, or any of the other objects that are handled and passed around by children; great numbers of diphtheria epidemics have been caused by milk (page 143). Cats may carry the germs on their

[1] Diphtheria of the larynx is the disease often called "membranous croup."

fur, and they themselves sometimes suffer from the disease.

Difficulties in controlling diphtheria. In spite of quarantining and the use of antitoxin, there were more than 14,000 deaths from diphtheria in the United States during 1916. The chief difficulty in stamping out this disease is that the germs often linger in the throat for four or five weeks, and occasionally for several months, after recovery from an attack of it. The germ is found also in the throats of a considerable number of healthy persons (usually in those who have been in contact with cases of the disease),[1] and in the noses and throats of persons who seem to be suffering only from ordinary colds or from light cases of sore throat. As a fire sometimes bursts forth into flames again after it seems to be dead, so diphtheria, after it seems to have disappeared, often breaks forth anew from these germ carriers. For at any time one of these persons may pass on to others virulent germs; or, if his resistance to the germs runs low, he himself may be overcome by them.

FIG. 31. Diphtheria germs have been found on pencils that had touched the lips of pupils in the early stages of the disease.

[1] Investigations indicate that when diphtheria is in a city or town, from three to five healthy persons in every thousand carry virulent diphtheria germs in their throats. These germs are capable of causing the most severe cases of diphtheria, and if the persons who are carrying them did not have a high resistance to them, they would at once be attacked by the disease.

Quarantining in cases of diphtheria. To control diphtheria, every one who is carrying virulent diphtheria germs must be shut up in quarantine, whether he be sick or well. It is not possible to tell by looking at the throat whether or not it is free from diphtheria bacilli. To determine this, a microscopical examination for the germs must be made. It often happens that during a diphtheria epidemic as many as ten per cent of the pupils in a school are carrying the germs.[1] The way to control the epidemic is not to close the school but to take cultures from the throats of all the pupils and isolate those who are dangerous to the public health. A protective dose of antitoxin is often given to those in whose throats the germs are found.[2]

FIG. 32. One way in which diphtheria germs may be passed from one person to another.

Diphtheria toxin. The diphtheria germ occasionally produces death by causing the throat to close, but the

[1] In October, 1912, the Indiana state health officials examined 1426 pupils in schools where there had been one or more cases of diphtheria. Among these pupils, 98 healthy carriers were found.

[2] The antitoxin used in the treatment of diphtheria or tetanus is prepared in the following manner: The germs are placed in beef broth, where they multiply and produce great amounts of toxin. A little of this toxin is then injected into the blood of a horse, and the horse begins to work up antitoxin to destroy it. A larger dose of toxin is then given to the horse, and still more antitoxin appears in the blood. More and more of the toxin is injected, until the blood of the horse is made as strong in antitoxin as

usual cause of death in diphtheria is the very powerful toxin. So poisonous is this toxin that a patch of diphtheria germs the size of the thumb-nail growing on the tonsil may produce toxin enough to cause death. The toxin attacks especially the nervous system, the kidneys, and the heart. During recovery from an attack of diphtheria, the heart is weak, and violent exercise should not be taken.

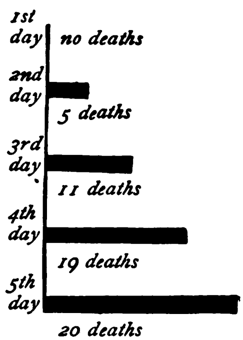


FIG. 33. Diagram showing the number of deaths in 100 cases of diphtheria when antitoxin is used on the first, second, third, fourth, and fifth days. The sooner antitoxin can be used in this disease, the better. (*Figures from experience of the London hospitals.*)

The antitoxin treatment for diphtheria. In a former chapter (page 20) we learned that when disease germs produce toxin in the body, the body manufactures an antitoxin to destroy the toxin and save itself from being poisoned. Working in accordance with this principle, scientists have learned how to get this same diphtheria antitoxin from the blood of the horse, and it has proved of wonderful value in the treatment of the disease. It is very important that the antitoxin be given in the early stages of diph-

possible. Then the horse is bled occasionally (practically without pain or injury to the horse), and the blood is allowed to clot. The thin yellow liquid (serum) that appears around the clot contains the antitoxin. After being freed from certain impurities, the serum is sealed up in glass containers and sold as antitoxins.

Serums for a number of other diseases are prepared in this same way, except that dead germs instead of a toxin are injected into the horse, and the serum contains substances that destroy the germs or increase the activity of the white corpuscles instead of antitoxins. These serums have not proved so valuable as the antitoxins.

theria, before the toxin has poisoned the cells of the nervous system, kidneys, and heart. Antitoxin is also very useful in preventing diphtheria, and when a person has been exposed to the germs, a dose of antitoxin often is given to prevent the development of the disease. It should be understood that the paralysis that sometimes follows diphtheria is not caused by antitoxin, but by the disease itself. In most states, under arrangements made by the State Board of Health, a physician can obtain antitoxin free, for use in cases where the patient or his family are not able to pay for it.

Persons with diseased tonsils are especially likely to become diphtheria carriers, and it is believed that diseased tonsils make one more liable to the disease. Great numbers of persons are immune to diphtheria, and by a simple skin test it is possible to determine who these are. In the great epidemic of 1918 those in robust health and in the prime of life were especially subject to attack.

POINTS TO BE REMEMBERED

1. The diphtheria germ is transferred from one person to another in many different ways.
2. It is often found in the throat long after the patient has recovered, and occasionally is found in the throats of healthy persons.
3. Every one who is carrying virulent diphtheria germs should be quarantined, whether he be sick or well.
4. The diphtheria germ produces a very powerful toxin that poisons especially the cells of the nervous system, the kidneys, and the heart.
5. By injecting diphtheria toxin into a horse, the blood of the horse can be made very strong in antitoxin.
6. If this antitoxin is used when a person is attacked by diphtheria, it saves the body from being poisoned.

CHAPTER NINE

PNEUMONIA

Up to about 1900, consumption caused more deaths in all parts of our country than any other germ disease.

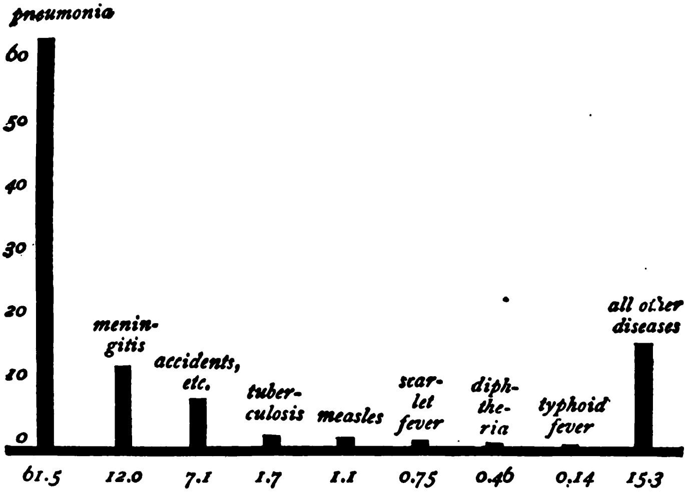


FIG. 34. Diagram showing death rate in U. S. Army for seven months (September, 1917, to April, 1918) from pneumonia as compared with other diseases.

Since then a better understanding of how to avoid the germ of tuberculosis, and a better knowledge of how to treat the disease, have lessened the death rate from consumption until in some of our northern states it is now the pneumonia germ that claims more victims than any other of our microbe enemies. Pneumonia is much more common in cities than it is in the country, because in a city people are crowded together, and the germ is more easily passed from one person to another. The disease runs a swift and severe course, the crisis coming usually in from three to eight days. Each year in the United States pneumonia causes about 125,000 deaths.

The germ of pneumonia. Any germ that grows in the lungs causes pneumonia, and the cases of the disease that follow measles, influenza, and other diseases may be due to any one of several germs. There is, however, a small coccus [1] that causes most cases of the disease that occur independent of other infections. This germ grows not only in the lungs but also in the nose, mouth, throat, and air passages; in children it is a very common cause of inflammation in the middle ear, and it is sometimes the cause of meningitis. The germs are in the sputum and often in the discharges from the nose of a pneumonia patient; they are passed from one person to another in all the ways by which the germs of other respiratory diseases are spread abroad (page 35); and they enter the body through the mouth and nose. The germs are killed by drying, and outside of the body they quickly die.

Varieties of the pneumonia germ. Recent investigations indicate that there are four races, or types, of the pneumonia germ. Three of the races are very dangerous and are commonly found only in the bodies of pneumonia patients or in the mouths of persons who are living with these patients and taking care of them. Germs of these three races cause nearly 80 per cent of all cases of pneumonia and more than 90 per cent of all deaths from the disease. These virulent types of germs, like the diphtheria germs, may remain in the mouths of patients for a long time (twelve to ninety days) after the onset of the disease.

[1] Pneumococcus (pronounced new-mo-kŏk′kus).

The fourth group of pneumonia germs is widespread, and is composed of several different strains that are less dangerous than the first three types. They are found in the mouths of about 60 per cent of healthy persons and usually do these persons no harm. If for any reason, however, as through fatigue, exposure to cold, or the use of alcohol, the defenses of the body are lowered, they may invade the lungs and cause the disease. About 20 per cent of pneumonia cases are due to this group of germs, but usually the attack is mild, and only about 6 per cent of the cases end in death.[1]

Preventing pneumonia. The first precaution to take in preventing pneumonia is to keep up the health so that the body will have a high resistance to the germs. This will help to ward off the mild germs that may already be in the mouth, and it may even enable the body to combat virulent races of the germs successfully. One should be especially careful of one's health during epidemics of influenza and colds, and since many cases of pneumonia begin as colds, it is of utmost importance that colds be given prompt attention.[2]

[1] The above figures include only cases of lobar pneumonia, and are based on studies made in the Rockefeller Institute for Medical Research in New York City. In some of the army cantonments streptococcus was a very common cause of pneumonia.

[2] The belief that one ought not to "give up" to an attack of sickness is a most pernicious error. In cases of typhoid fever where the patient has kept at his work during the first days of his illness, the death rate is far above the average, and many of the colds that run on into serious attacks of bronchitis and pneumonia could have been broken by a single day's rest in bed. Germs are killed by our white corpuscles and defensive substances, and not by our "will power," and if we expose ourselves to cold or fatigue when germs attack us, we are allies, not of our defenders, but of our enemies.

A second important point in the prevention of pneumonia is the avoidance of crowding. The laborers on the Panama Canal had to be removed from barracks and placed in cottages on account of the prevalence of pneumonia among them. Among the workers in the diamond mines of South Africa it is the most troublesome disease. In the army cantonments, during the

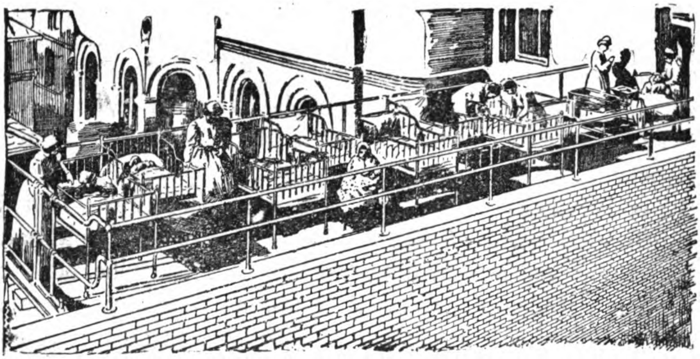


FIG. 35. Pneumonia patients being treated in the open air. (*After photograph of patients in the Presbyterian Hospital, New York.*)

recent war, it led all infections as a cause of death. Perhaps medical science will some day teach us how crowds can be brought together with safety, but at present, in all climates, we find that pneumonia always follows the bringing of many people together. One of the fundamental sanitary problems of every nation is how to provide adequate housing for its people and sufficient space for its office and factory workers.

The third step in dealing with pneumonia is to isolate pneumonia patients and prevent the spread of the germs from them. This is the most important step in preventing the disease, for as long as the germs are spread abroad, they will always find plenty of persons whom they are able to attack.[1] No persons should enter the room of a pneumonia patient except those who are caring for him, and in combating the disease it must be remembered that many of those who wait on patients become carriers of the germs.

A fourth method of preventing pneumonia, which at present seems very hopeful, is by vaccination. In one army camp 12,000 vaccinated men were almost entirely protected from pneumonia for the ten weeks they remained in the camp, and it is claimed that a vaccine has been very successfully used among the native workers in the South African diamond mines. A serum has been prepared that is of great value in treating cases caused by certain types of the germs.

POINTS TO BE REMEMBERED

1. Pneumonia is a crowd disease.
2. It causes more deaths in our country than any other germ disease except tuberculosis.
3. There are three very dangerous races of the pneumonia germ that are present during epidemics of the disease.
4. A fourth and less dangerous race is found at all times in the mouths of many healthy persons.
5. Many cases of pneumonia may be prevented by keeping up the health, avoiding crowds, and isolating patients.
6. Vaccination against pneumonia seems to be a success, and a serum useful in treating certain cases is now available.

[1] A physician reports the following as occurring in a rural community: An elderly woman suffered a severe attack of pneumonia. Two women from neighboring families who helped care for her contracted the disease. The husbands of these women were next stricken, and two other persons also were attacked. Two of the seven cases ended in death.

CHAPTER TEN

INFLUENZA AND COLDS

INFLUENZA

Influenza is an ancient disease, but it was little known in the United States until 1889–1890, when a great epidemic swept over the country. Then it gradually subsided, but each year it caused on an average some 12,000 to 15,000 deaths. There were more than 20,000 deaths from it in 1907 and more than 25,000 in 1916. Suddenly, in the late summer of 1918 it broke out with great virulence, and in six months it attacked probably one third of our entire population and caused more than 600,000 deaths, — a loss more than two fifths as great as that which France suffered during the entire four years of the Great War. In most other parts of the world the disease assumed the same deadly character, and it is estimated that during the six weeks ending the middle of December, 1918, six million people died of it.

The germ of influenza. Formerly influenza was believed to be due to a small bacillus that is found in many cases of the disease, but it now seems probable that the cause is an undiscovered filterable virus. The disease is probably the most infectious known. The germ produces a powerful toxin that has a profound effect upon the whole body; it does not poison the body so acutely as does the toxin of the diphtheria germ, but it causes depression and weakness that often last for months. The incubation period is probably quite short. There is reason to believe that the infectious period is in the very early stages (before the person has become ill), and that a patient is perhaps not infectious after the disease is thoroughly established.

Complications with influenza. A serious feature of influenza is that it so weakens the tissues of certain parts of the body that any one of a half dozen bacteria may set up their growth in them, causing pneumonia, bronchitis, pleurisy, eye and ear infections, or tuberculosis; and it may leave the stomach, heart, kidneys, or the nervous system in a weakened condition. Because it is so widespread and because of the many serious troubles that may accompany or follow it, influenza is a much dreaded disease. One attack is believed usually to give immunity for a time at least, but a patient may relapse or have a second attack before he has recovered from the first, as may happen also in pneumonia.

FIG. 36. A letter carrier during the great influenza epidemic.

Vaccination against influenza. If the cause of influenza is an undiscovered germ, it is of course not possible to vaccinate against the disease. Many physicians believe, however, that the most dangerous features of the disease are due to the bacteria that attack the body after it has been weakened by the influenza germ.

Therefore they think it advisable to use a mixed vaccine, made up of a number of the bacteria that most often cause pneumonia, bronchitis, and other complications in cases of influenza. This would not prevent the influenza, but some authorities claim that it makes the disease mild and guards against the danger of complications. At present we are not certain how valuable vaccination is in this disease. Some persons still believe that influenza is caused by the "influenza bacillus" and can be prevented entirely by vaccination; others consider the vaccine of no value.

Preventing influenza by isolation. Much advice has been given the public as to the best methods of avoiding influenza germs. Doubtless individual effort does prevent some cases, and it probably slows the spread of the epidemic. But in spite of all that private efforts can accomplish, a disease like influenza reaches every village in the land, and in the end it is probable that in cities and towns at least, nearly every one who is susceptible to the disease suffers from it. It would seem that to isolate the first cases that appear and quarantine for a short time those who have been in contact with these cases must be the most hopeful method of dealing with influenza. This plan would require more health officers than we have now, and the work would have to be supervised by the national authorities, who could see that the germs were not carried across state or city lines. It would also require the expenditure of more money than is now being used for health work; but we should find it an economy to pay even very large sums to be freed from epidemics like that of 1918–1919. In the past, after widespread epidemics of influenza, smaller epidemics have for several years broken out in various places, and for some years to come we shall probably have many cases of this disease in our country.

COLDS

Colds are caused by germs that are transferred from one person to another. They are the most common of all the germ diseases of temperate climates and the most

FIG. 37. The germs of colds pass easily from one person to another.

difficult to avoid. The germs pass easily from one person to another, and during an epidemic it is astonishing how quickly they can spread through a community. In many epidemics of colds the pneumonia germ or the "influenza bacillus" is found; often pus-forming bacteria (especially streptococci) are present; and sometimes other kinds of bacteria occur in great numbers in the air passages. There is reason to believe, however, that the real cause of epidemic colds is an undiscovered filterable virus, and that the bacteria that are present in colds are "secondary invaders"; that is, they are germs that are able to set up their growth in the walls of the air passages only after these have been damaged by the attack of the tiny germ which starts the disease.

In a later chapter the question of colds will be further discussed (page 22). It is probable that many of the epidemics people have called "grip" are severe colds and not true influenza.

POINTS TO BE REMEMBERED

1. The epidemic of influenza in 1918–1919 was the worst pestilence ever known in the United States.
2. The disease is probably caused by an undiscovered filterable virus.
3. Influenza is one of the most infectious diseases known, and it would seem rational to isolate the first cases, and not allow it to become widespread.
4. Epidemic colds are highly infectious, and the infection is spread as in other respiratory diseases.
5. Such colds are probably caused by a filterable virus, with different kinds of bacteria as secondary invaders.

CHAPTER ELEVEN

TUBERCULOSIS

PROBABLY from the earliest times mankind has been afflicted with tuberculosis, for a great Greek physician named Hippocrates wrote a treatise on consumption in 400 B.C., and in the lungs of Egyptian mummies the scars of tuberculosis have been found. At the present time *Bacillus tuberculosis*, or the *tubercle bacillus*, as it is sometimes called, is the most deadly of all the bacterial enemies of man. In our own country, more than one tenth of all deaths are caused by this germ, which means that the "Captain of the Men of Death" is killing our fellow-countrymen at the rate of 150,000 a year, more than 400 a day, and one every three and a half minutes. Because tuberculosis selects its victims especially from those who are in the active working years of their lives, and because it is a lingering illness, it costs us far more in money than does any other disease.[1] One widely accepted estimate places the cost of tuberculosis to the United States at $1,000,000,000 a year, or $10 a year for each inhabitant of the country.

The germ of tuberculosis. The germ of tuberculosis is a slender bacillus. It is a slow-growing bacterium, but it is a very hardy one, and often it resists all attempts of the body to kill it and grows steadily on until it causes death. Outside the bodies of men and animals it does not grow at all in nature, and light and drying kill it. Yet in a dark, damp house the germs in the sputum of a consumptive may live for several months or perhaps for a whole year. It is very important that

[1] One third of all deaths between the ages of fifteen and forty-five are from tuberculosis.

a room or house that has been occupied by a consumptive shall be disinfected, but away from the habitations of men and animals the tubercle bacillus is not found.

Different forms of tuberculosis. The tubercle bacillus may grow in almost any part of the body and cause tuberculosis of the part attacked. Tuberculosis of the lungs, or consumption, is the best-known form of the disease and causes by far the most deaths. Tuberculosis of the bones also is a common trouble, and most of the lame and crippled people that we see have been deformed by tuberculosis of the spinal column or of the bones of the hips, legs, or feet. Tuberculosis of the bones is especially common among children, as is also scrofula, or tuberculosis of the lymphatic glands. Tuberculous meningitis, which causes more deaths than any other form of tuberculosis except consumption, is more common among children than among older persons. The skin, kidneys, intestine, larynx, and other parts of the body also may be attacked by this germ; and when the tubercle bacillus is growing anywhere in the body, it is always possible for it to be carried by the blood to the lungs.

FIG. 38. The bacillus of tuberculosis.

Tuberculosis contracted by living with consumptives. In Indiana in 1910 the state health officials investigated more than 900 new cases of consumption and found that in more than half of them the patient had been living with a consumptive or closely associated with one. In 1913 in Minnesota it was found that in forty city families, in each of which a consumptive had been living for a year or more, at least one other person was infected.

All together, there were in these forty families 207 persons living with consumptives, and of these persons 138 had contracted the disease. At the same time, fifteen families in which there were no consumptives were investigated, and in these families only two persons out of eighty were found to be infected. Other studies in the rural parts of Minnesota seemed to show that parts of counties where no consumptives had lived were entirely free from the disease, and that where it had been introduced into a community, it had spread to the families living on the farms close to the consumptives. It was also concluded from these studies that the danger of infection depends on the amount of exposure to the germs; that the danger from a chance meeting with a consumptive, or from living in a house with him for a few days, is not great, but that there is great danger of infection if a person lives with a consumptive for a long period of time and is exposed to great numbers of the germs day after day.[1]

The need of hospitals for consumptives. Up to the present time, the two successful methods of checking germ diseases that have been discovered are vaccination and preventing the spread of the germs. We are not able to vaccinate against tuberculosis successfully, and this disease we must therefore combat by keeping the millions of germs that come from the lungs of consumptives from reaching those who are not infected with the

[1] It is now believed that when a number of the members of a family die of tuberculosis, the trouble is not so much a matter of inheritance as of long exposure to infection by the germs. Children that are born into a consumptive family are exposed to infection from their birth, and it is this condition that must be changed to control the disease.

disease. To carry out this plan, hospitals for advanced cases of consumption are necessary, and in many of our states these are now being built in great numbers.[1] Owing to the long incubation period, it is difficult to determine when or where a given case of tuberculosis was contracted; but it is believed that many of the cases of consumption in adults are due to germs that were taken into the body in childhood. It is especially important to shield children and young people from the infection. Even though they pass through early life without signs of infection, they may be carrying dormant germs that will later spring into activity.

Preventing infection in the home. In case a consumptive must remain at home, he should live apart from the other members of the family. His room, or separate little house or tent, should be light and well ventilated, to kill any germs that may be free in it. He should have his own dishes, and these should not be washed with other dishes or allowed to come into contact with them until they have been boiled for at least five minutes. A consumptive should hold a paper napkin or a handkerchief before his face when he coughs, and these napkins or handkerchiefs should be burned, or placed in

[1] Some of our states have for years been maintaining hospitals, or sanatoria, for the care of consumptives, and recently many cities and counties have appropriated funds for this purpose. It is hoped that the national government will give its aid to the work, and that soon all cases of consumption needing it can be given hospital care. Yet the task is a heavy one, for, including beds in the new army hospitals, there are only about 60,000 beds for tuberculosis patients in the United States, while recent studies have made it seem probable that among our population there are 2,000,000 active or arrested cases, and 500,000 "open" cases (cases where the germs are being given off) of the disease.

a disinfectant, or kept in water until they can be boiled. He should wash his hands in a disinfectant occasionally, and he should not shake hands with visitors who come in to talk with him. His clothing should be boiled before it is washed, and his bedclothes and furniture should be exposed to the sunlight as much as possible. This can be done most easily if the sun shines directly into the room. The sputum should be destroyed, of course; for in an advanced case of consumption several billions of germs are daily thrown off from the lungs. It need hardly be added that a consumptive should have nothing to do with the preparation of food that is to be eaten by others. Circulars are issued by all State and City Boards of Health explaining what a consumptive should do to prevent the spread of the infection to others. These should be secured and their directions carefully followed out.

FIG. 39. A good badge for all boys and girls. Write the National Crusader Executive, 381 Fourth Avenue, New York.

TUBERCULOSIS IN ANIMALS

Tuberculosis is a common disease of chickens and turkeys, but the tubercle bacillus of birds does not seem to be able to attack man. Many domestic animals also suffer from tuberculosis, the disease being especially common among cattle and among hogs that have run in barn lots with tuberculous cattle or have been fed on milk from infected cows. The tubercle bacillus of cattle and of hogs (the "bovine type" of the germ) is able to grow in the human body. It attacks children much more frequently than it does older persons, and it usually grows in the bones, in the lymphatic glands, or in the walls of the intestine, rather than in the lungs.

Tubercle bacilli in milk. The tubercle bacillus may at times get into the body from meats, but infection from milk is much more common. Where the disease is allowed to run uncontrolled, from 15 to 30 per cent of dairy cattle have it, and from 5 to 9 per cent of the milk sold in certain of our cities has been found to contain living tuberculosis germs.

Danger from the bovine type of the tubercle bacillus. The bovine variety of the tubercle bacillus is fitted for growth in the body of the cow rather than in the human body, and it is believed to be much less virulent for man than is the "human type" of the germ that is usually found in the sputum of a consumptive. The question of tuberculosis among cattle is an important one, however; for 10 per cent of all deaths from tuberculosis among children under five years of age are due to the bovine type of the germ, and many thousands of other persons are being infected by these germs each year. A very simple and certain method of testing cattle for tuberculosis has been discovered, and even if there were no danger of man's getting the disease from milk, tuberculous cattle should be separated from those that are free from the disease. This is economy; for by taking out of a herd all the animals that have tuberculosis, the spread of the disease in the herd can be stopped. Milk from a dairy that is not known to be free from tuberculosis should be pasteurized before it is used (page 144).

THE TREATMENT OF CONSUMPTION

The steady manner in which consumption often runs on and on has caused many persons to think that it is an incurable disease. This is a great mistake. It is a very common occurrence for the tubercle bacillus to start its growth in the lungs and to be checked by the body without the person who is attacked ever knowing what is happening. If consumption is taken in hand before the germs have gained a secure foothold, the body can often be made to hold them in check and the progress of the disease can be stopped.

The importance of early treatment. In the treatment of consumption, everything depends on beginning in the early stages of the disease. One who has symptoms of consumption, therefore, should not try to persuade himself that his symptoms have no existence, for this will not stop the growth of the germs.[1] He should not lose valuable time experimenting with patent medicines, for there is no medicine known that will cure consumption. The only sensible thing for him to do is to be examined at once by a physician who thoroughly understands the disease. Then, if he finds that the germs have gained a foothold in his lungs, he should give himself the best possible treatment without delay.

Important factors in treatment. In the successful treatment of consumption, rest, proper food, and out-

[1] The most common symptoms of consumption are cough, loss of appetite, gradual loss of weight and strength, fever in the afternoon, night sweats, and blood spitting. The cough may be absent in the very early stages of the disease, or it may be troublesome only in the early morning and after going to bed at night. Any one who loses weight or finds himself becoming tired easily, should have himself examined at once, even though he has no cough.

door life are the important factors. In general, dry, cool climates are beneficial to consumptives and hot, moist climates and high altitudes are injurious to them. It has been found, however, that the question of climate is of comparatively little importance (far less than was formerly supposed), and unless a person has money enough to support himself without work and to give himself proper care, he should not leave his home for a distant state; for in many places consumptives are not welcomed, and it is better to be at home and have the proper care than to be without money or friends in the best climate in the world.

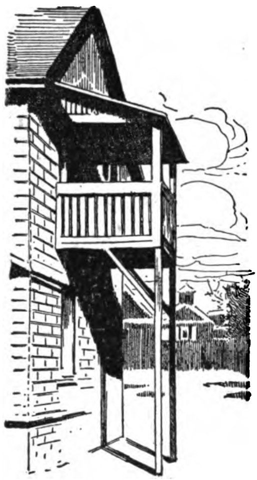


FIG. 40. An outdoor sleeping place, of a kind that most consumptives can have.

A consumptive should have at all times the guidance of a skilled physician who has made a special study of the disease. He should also secure some of the many excellent books and circulars that have been written on consumption and its treatment and learn how to live in a way that will give him the best possible chance for recovery.[1] Usually it is better for him to go to a sanatorium where every hour of the daily life of

[1] Hawes' *Consumption: What It Is and What to Do about It* is an excellent little book for a consumptive. It is published by Small, Maynard & Company, Boston, and the mailing price is 60 cents. By writing to the Secretary of the State Board of Health at the capitol of his state, or to the State Society for the Prevention of Tuberculosis, a consumptive can obtain trustworthy advice as to the best course for him to follow. *The Journal*

the patients is planned to strengthen them in their fight against the germs.

Hygiene and tuberculosis. A very infectious disease like measles or smallpox cannot be prevented by hygienic

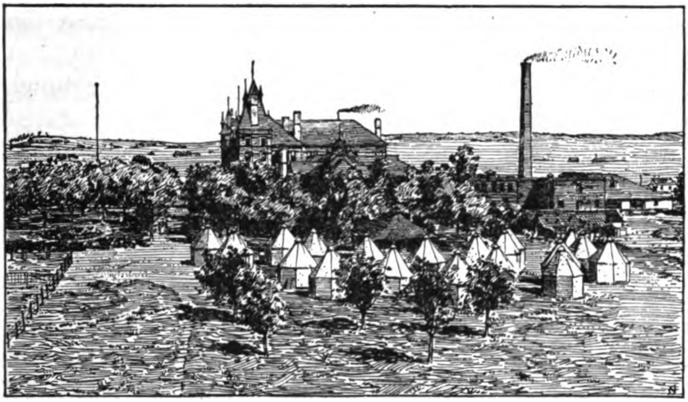


FIG. 41. Union Printers Home and Tuberculosis Sanatorium at Colorado Springs, Colorado. (*After a photograph furnished through the courtesy of the Superintendent.*)

living; the germs will attack us successfully if they get to us, and they multiply so rapidly that the disease is on us in full force before the body has time to manufacture substances to kill them. In tuberculosis the situation is very different. The tubercle bacillus is one of the most slow-growing of all germs, and the body has plenty of time to work up its defenses against it. It follows, therefore, that good food, good houses, reasonable working hours, well-ventilated factories, offices, and schoolrooms, and

of the Outdoor Life, New York City, is invaluable to consumptives. It carries advertisements of sanatoria and of clothing, chairs, and other articles for the use of consumptives.

correct habits of living will enable many persons who may have been slightly infected to hold the germs in check. We cannot eradicate tuberculosis germs by healthful living, but poverty and bad hygiene are allies of tuberculosis, and improving the conditions under which we live is a part of the fight against the disease.

Alcoholism and tuberculosis. In a former chapter (page 24) it was stated that alcohol lessens the power of the body to kill germs. The death rate from consumption is several times as high among brewers as among ministers, and we should like at this time to call attention again to the fact that the person who uses alcohol makes himself more liable to tuberculosis. So closely connected are the use of alcoholic drinks and tuberculosis that the International Tuberculosis Congress at the 1905 meeting in Paris adopted the following resolution: "*We strongly emphasize the necessity and importance of combining the fight against tuberculosis with the struggle against alcoholism.*" Not only does alcohol directly lessen the defensive powers of the body, but it also causes those con-

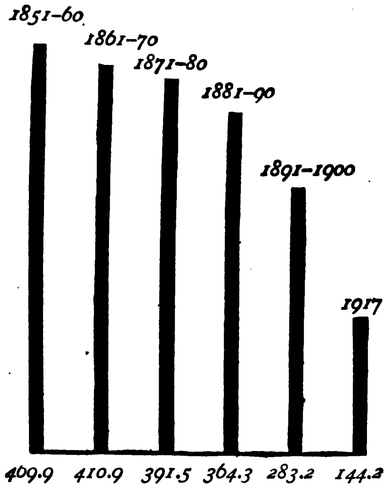


FIG. 42. Diagram showing the tuberculosis death rate in Massachusetts since 1851 for each 100,000 inhabitants.

ditions of poverty and want that make for widespread infection with the germs and for a lack of all those things that strengthen the body in its fight against the disease.

Progress in the prevention of tuberculosis. As we have seen, no germ has so spread itself through all society and has so extended its ravages to all parts of the world as has the tubercle bacillus. Yet the world is not full of tubercle bacilli. The air of the fields and woods, the streams of the forests and mountains, and the soil of the fields are free from them. The millions of people who in the past have died of tuberculosis germs got these germs from either sick cattle or sick men. Practically all the millions of people now living who are carrying these germs in their bodies were infected either by human sputum or by milk. Some persons, some cities, some states, and some nations have to a greater or less degree known these facts for several years, and in some places a warfare on the Great White Plague has been started. This warfare has been most successful. Examine Figure 42 and you will see that the death rate from tuber-

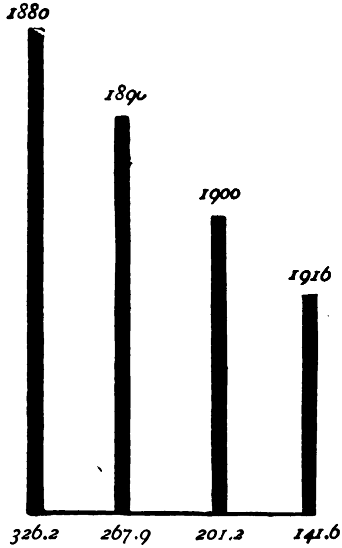


FIG. 43. This diagram shows the gradual decrease in the number of deaths from tuberculosis in the United States. The numbers given are the deaths per 100,000 in the part of the United States where statistics have been carefully kept.

culosis in Massachusetts is not one third as high as it was in that state sixty years ago. Examine Figure 43 and you will see that what is true of Massachusetts is true also, to a great extent, of other parts of the United States; and Figure 44 shows that not only in our own country but also in other countries has this great enemy of mankind been checked. "Tuberculosis is communicable, preventable, and curable," is the battle cry of the anti-tuberculosis host, and in that host hope swells high in every breast, for already in many places the battle line of the enemy has been broken, and his forces are being driven back. Much of the work that is being done has as yet hardly begun to show its effects, but the results prove clearly that it is not necessary for people to die of tuberculosis as they are dying now.

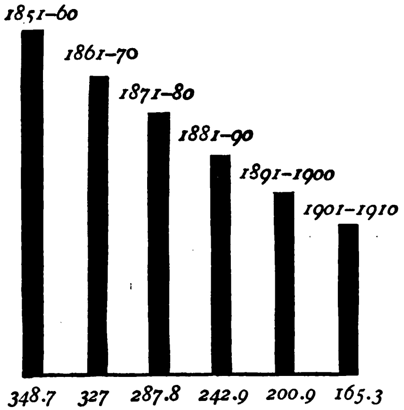


FIG. 44. This diagram shows the decrease in deaths from tuberculosis in England and Wales.

POINTS TO BE REMEMBERED

1. Tuberculosis costs the United States 150,000 citizens each year, and it is estimated that its annual cost in money is $1,000,000,000.
2. The tubercle bacillus is slow-growing, but it is very difficult to kill.

3. In tuberculosis any part of the body may be attacked, but consumption is by far the worst form of the disease.
4. Many cases of consumption are contracted by living or working with consumptives.
5. Hospitals for consumptives are needed to prevent the spread of the disease.
6. The bovine type of the germ can attack man, and milk that may contain tubercle bacilli should be pasteurized.
7. In curing consumption, the most important point is to begin treatment in the very early stages of the disease.
8. Rest, food, and fresh air are the important factors in the treatment of tuberculosis. Climate is not so important as was formerly supposed.
9. Sanatoria are to be recommended because in them the patient can have the care that he needs.
10. Unhygienic living and alcohol are allies of the tubercle bacillus.
11. Great progress has been made in the war against tuberculosis, and those who are fighting the disease are very hopeful for the future.

CHAPTER TWELVE

GERM DISEASES OF THE INTESTINES

In recent years improved sanitation and vaccination against typhoid fever have greatly decreased the number of cases of disease that are spread through the intestinal wastes. Yet all together about 115,000 deaths in the United States, or about one thirteenth of all the deaths that occur in our country, are each year caused by them. Among the diseases that are caused by germs of this class are typhoid fever, dysentery, diarrhea, and food poisoning.

TYPHOID FEVER

Typhoid fever is found in all climates and in all countries where man dwells. It is usually a severe disease, but during some cases ("walking typhoid") the patient is hardly ill enough to go to bed. In the United States it is rapidly decreasing, but every year there are still almost 200,000 cases of typhoid fever, and nearly 20,000 deaths from it.

Bad after-effects of typhoid fever. The Metropolitan Life Insurance Company of New York has recently made an investigation of the death rate among 1574 of its policy holders who suffered from attacks of typhoid fever in 1911. Of these 1574 persons, 146 died of the disease and 1428 survived; but during the next three years fifty-four of these survivors died of other diseases, twenty-one of them of tuberculosis. This gave a death rate more than twice as high as was to be expected among persons of this age.[1] In the same way, bad

[1] It is estimated that in the United States 178,200 persons survived attacks of typhoid fever in 1914, but that 7781 of these survivors would die inside of three years, because of the damage done them by the disease.

after-effects follow measles, diphtheria, scarlet fever, influenza, pneumonia, and other germ diseases, and to take no account of these after-effects is like not counting the wounded when reckoning the losses in war.

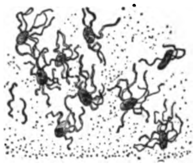


FIG. 45. The typhoid germ.

The typhoid germ. The germ of typhoid fever is a plump bacillus. It is fitted to live in a liquid and swims freely. It enters the body through the mouth, gets into the blood, and grows throughout the whole body. Meningitis, pneumonia, and ulcers in the bones may be caused by this germ, and the "rose spots" that appear on the abdomen in most cases of typhoid fever are caused by small colonies of the germs growing in the skin. In the later stages of the disease the walls of the small intestine are especially attacked, and on this account the diet of the patient is of great importance. The germs leave the body in the discharges from the bowels and kidneys,[1] and occasionally in matter vomited by a typhoid patient. They may be in the perspiration, and if they are growing in the lungs, they will be found in the sputum. The incubation period is usually about two weeks, but may be from seven to twenty-one days.

How typhoid fever is contracted. Persons in the same house with a typhoid patient may get the germ on their hands by handling bedding or in a hundred other ways.

[1] In about 25 per cent of typhoid fever cases the germs are in the urine, sometimes in enormous numbers (100,000 to 500,000 in a cubic centimeter, or 5000 to 25,000 in a drop). Unless the urine is carefully disinfected, it will prove a most dangerous source of infection.

Flies will carry the germs in great numbers if all wastes from a typhoid patient are not carefully destroyed. Occasionally the germs are in oysters that have been grown in polluted waters. In a large number of cases, the typhoid germ has been carried in milk where some one having the disease has handled the milk, or where the milk vessels have been washed in water containing the germs. In many other cases typhoid fever is contracted from water. In a later chapter we shall discuss the subject of disease germs in drinking water (page 79).

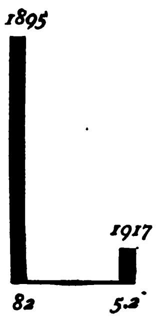


FIG. 46. In 1895 Chicago ran its sewage into Lake Michigan and used the polluted water for drinking purposes. A drainage canal now carries most of the sewage away from the lake. The diagram shows the decrease in deaths from typhoid fever following the improvement of the water supply and other sanitary advances.

Healthy germ carriers. It has been found that a considerable number of persons (three or four in a hundred) who have typhoid fever carry the germs long after recovery from the disease. The germs usually locate themselves in the gall bladder and keep on passing into the intestine. One cook in New York City gave the disease to twenty-seven persons in four widely separated houses. In one case the germs were found in the discharges from the body forty-two years after recovery from the disease. As yet it has not been possible to free these persons from the germs, and they are a constant source of danger to all about them.

Preventing typhoid fever. Every case of typhoid fever ought to be quarantined or isolated like cases of diphtheria or scarlet fever. The wastes that contain the germs should be carefully destroyed, and the patient should be examined to see that he is free from the germs before he lives with his family or takes up his work again. Pure drinking water, a well-guarded milk supply, and a safe method of disposing of human wastes are also necessary to prevent the disease. In small villages and on farms one great cause of typhoid fever is the leaving of human wastes exposed to flies.

Vaccination against typhoid fever. By vaccination against typhoid fever, it is possible to increase the resistance of the body to the germs to such a degree that the disease will not develop. By this method, typhoid fever, which was formerly the most dreaded of all camp diseases, has practically been wiped out in armies, and vaccination is now extensively practiced among physicians and nurses, in families where a member has the disease, in communities where it is unusually prevalent, and among those who for any reason may run the risk of exposure to the germs. In vaccination dead germs are injected into the body, and this causes the protective substances to appear in the blood. The effects of vaccination are mild, but a person should select a time for vaccination when he is in good health.

DYSENTERY AND DIARRHEA

Diarrhea and inflammation of the intestine are important causes of death, especially among young children. All together these troubles cause in our country almost one hundred thousand deaths a year. They are most to be feared during the hot summer months.

Chronic dysentery. This disease is caused by a protozoön that is much larger than most germs. It is called an *ameba*, and in many ways it resembles a large white blood corpuscle. Its life outside the body is not well known, but there is abundant evidence that the disease is usually contracted by drinking impure water. Infection seems to come also, at times, from eating raw vegetables that have been grown in polluted soil. Chronic dysentery is more common in the southern than in the northern states, but cases of it are found in all parts of the United States. The germs are in the intestinal wastes, and these should be safely disposed of to prevent the spread of the disease.

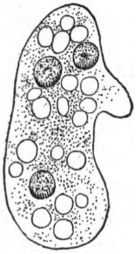


FIG. 47. The germ of chronic dysentery. The dark bodies in the germ are red blood corpuscles, on which the germ feeds.

Acute dysentery. The sudden attacks of *acute* dysentery, which sometimes runs in epidemics, are caused by a bacillus that differs very little from the typhoid bacillus.[1] This is a severe disease and very infectious, and is greatly feared by armies. In different parts of the United States there are epidemics of it every summer. Many of the cases of severe diarrhea, or cholera infantum, in babies are due to the dysentery bacillus, and young children should be carefully shielded from infection with this germ. The germs are in the intestinal wastes, and the infection is spread by flies, by water, by milk, and in all the other ways that typhoid germs are spread. Since this is a very dangerous disease, the wastes from a dysentery patient should be carefully destroyed and every care taken to prevent the spread of the germs.

Diarrhea. It seems probable that any one of several different kinds of bacteria may cause diarrhea and in-

[1] Acute dysentery is often called *flux*.

flammation of the intestine. In some cases pus-forming bacteria (sometimes streptococcus, sometimes Bacillus pyocyaneus) are present in great numbers. In other cases the colon bacillus, a bacterium that at all times grows in great numbers in the large intestine, has been thought to cause the disease. Recent investigations, however, point to the bacillus of dysentery as the most probable cause of infant diarrhea, and the disease is to be regarded as a very serious one.

Isolating the patient and disinfecting the body wastes has proved the most effective way to check the spread of diarrhea. Flies carry the germs of this disease especially, and soiled napkins should be kept away from them. Whatever germ may be the cause of it, *diarrhea is infectious, and any person who is caring for a little baby should keep the baby away from the disease.* The relation of impure milk to cholera infantum will be discussed in a later chapter (page 144).

FOOD POISONING

Food poisoning (often called *ptomaine* poisoning) is caused by at least two different germs. One of these is a bacillus of the typhoid group that attacks cattle, horses, hogs, and goats. The germ is in the flesh before the animals are killed.

A second form of food poisoning is caused by a bacillus that is a relative of the germ of tetanus. It gets into meat and also into canned fruits and vegetables from the earth and produces a most violent toxin. As this bacillus forms spores that are not killed except by steam pressure, fruits and vegetables canned after being merely boiled may still be infected by it. It is the toxin that has already been formed in the food, and not the germ, that does the damage. The toxin is destroyed by boiling, and any canned food that seems softer than is natural, or smells soured or spoiled in the least, or has gas in it, should be cooked before it is even tasted. The food can be made quite safe by boiling.

The sudden attacks of illness that sometimes follow the eating of cheese, ice cream, fish, and other articles of food are not well understood; it has been thought that some of them are caused by bacteria that are related to the typhoid bacillus. A number of these germs are common in animals, and food should be kept away from dogs, cats, rats, and mice.

POINTS TO BE REMEMBERED

1. In the United States there are 200,000 cases of typhoid fever and 20,000 deaths from this disease each year.
2. The after-effects of typhoid fever and of other germ diseases are very bad.
3. The typhoid germ leaves the body chiefly in the wastes from the bowels and kidneys.
4. The germs are spread by fingers, flies, foods, milk, and water.
5. Some persons carry the germs for years after an attack of typhoid fever.
6. Chronic dysentery is caused by a large ameba.
7. Acute dysentery is caused by a relative of the typhoid bacillus.
8. Diarrheas are caused by several different germs.
9. These diseases are infectious, and the germs in the intestinal wastes of the patients should be destroyed.
10. Food poisoning is caused by a number of different germs.

CHAPTER THIRTEEN

DISEASE GERMS IN WATER

THE germs of certain diseases will live for a number of days in water, especially if the water is clean and clear. This makes any water that is polluted by sewage or human wastes dangerous, and many cities that have been supplied with impure water have found it possible to save thousands of their citizens from sickness by filtering the water through beds of sand or freeing it from germs in other ways. When the city of Vienna changed from the polluted Danube River water to a water supply that came from the melting snows of the mountains, the death rate from typhoid fever soon fell to one thirtieth of the former rate; and in certain Philippine towns that now use artesian water the number of deaths from all causes is only about one half as many as it was when water from surface wells was used. Intestinal diseases are those most frequently contracted

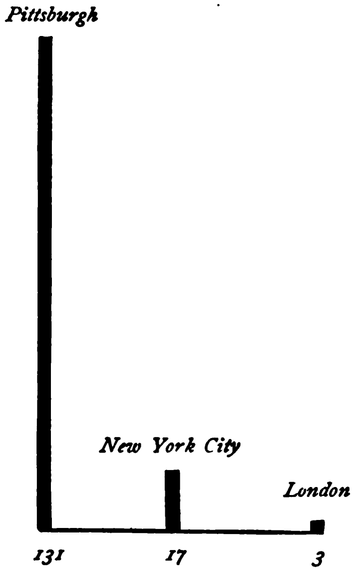


FIG. 48. Diagram showing the number of deaths from typhoid fever for each 100,000 inhabitants in Pittsburgh, New York, and London in 1907. At that time the people of Pittsburgh were drinking the polluted Ohio River water, New York had a good water supply, and London was using Thames River water filtered through beds of sand.

FIG. 49. The water from springs and streams is the most dangerous of all waters.

from water, but a marked decrease in the number of deaths from pneumonia, tuberculosis, and several other diseases also often follow changing from an impure to a pure water supply.

Safe waters. In general, waters that do not come from the surface of the ground are safe. Deep artesian wells usually furnish water that is absolutely safe.[1] Rain water that is caught and stored in tanks above the ground is safe also. Underground cisterns that are thoroughly cemented are much safer than wells. Care must be taken, however, to keep surface water from entering a cistern at the top, and if part of the

[1] In mountain regions germs may make their way into artesian wells through crevices in the rocks, and near Indianapolis, Indiana, polluted water was found to be draining into a well 400 feet deep. In the Indianapolis case surface sewage was draining into abandoned gas wells and then flowing through the clefts in the rocks to the artesian well.

pipe that carries the water from the roof is underground, bacteria from the soil may be washed into a cistern through this pipe.

Dangerous waters. Any water that comes from the surface of the ground is likely to contain disease germs. Springs and streams are the most dangerous of all waters, because they are often polluted by sewage or have germs washed into them from polluted ground.[1] It is not safe to use water from these sources, no matter how clear and pure it may seem; for in mountain regions, where the people drink from the most beautiful clear springs and streams, typhoid fever is a great scourge.

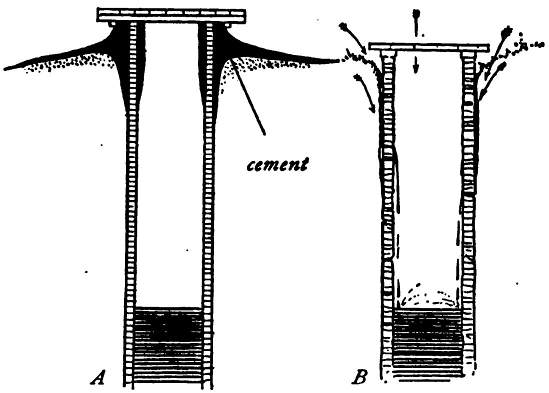


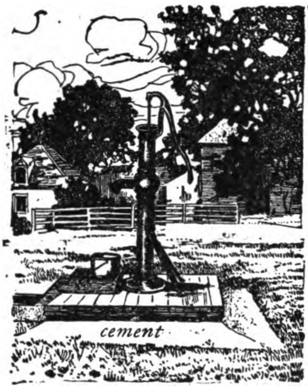
FIG. 50. *A* shows a well so arranged that surface water and germs are kept out of it. *B* shows how surface water and germs get into a well.

Keeping germs out of wells. In cities and towns some other water supply than wells should be provided. In country regions, however, wells will probably be the principal source of drinking water for many years, and

[1] The bottled spring waters sold in some cities are more dangerous than the regular city water supply. This, of course, is not true of all such waters.

it is important that they be made as safe as possible. In guarding a well from dangerous germs, the following are the chief points to be kept in mind:

The location of the well. A well should be on high ground and as far as possible from closets, cesspools, and sewer pipes. For purposes of cleanliness it should



FIGS. 51 and 52. From which well would it be safe to drink the water?

also be at a distance from pigpens, stables, and other buildings where animals are kept.

Keeping surface water out of wells. In ordinary soil, few bacteria live deeper than six feet beneath the surface, and water, as it comes from the ground into a well that is as much as twenty feet deep, is usually free from germs. In many cases the pollution of the water in such a well comes from the surface water getting into the well when it rains and carrying with it germs from the upper layers of the soil. To prevent surface water from entering, a layer of tough clay should be spread around the mouth of the well and packed thoroughly so as to form a water-tight layer over the soil. A still better method is to lay a circle of cement over the surface of the soil, as shown in Figure 51. The platform should be wide enough to keep any surface water whatever from running down behind the wall into the well.

Keeping germ carriers away from wells.[1] No person who is sick or who is caring for a case of infectious disease should work with well buckets or about a pump. Neither is it safe to use water from a well where many people handle the rope and buckets, for we are finding that germ carriers among healthy people are so common that there is always danger that one of them may have been about the well. Any person who walks over ground that has been polluted with human wastes (as many dooryards are) and then stands on a well platform, may carry disease germs on his shoes and leave them where they will get into the water. For this reason, a well should always have a clean, water-tight platform (made of iron, cement, or two layers of boards), and the pump should be so arranged that water will not run back into the well around it. A well that is covered by a small house and from which water is pumped by a windmill is much easier to make safe than an unsheltered well, from which the water is drawn by buckets or with a hand pump.

Wells and springs in limestone regions. In limestone regions caverns in the rocks are dissolved out by the water, and in these regions it is common for streams to run long distances underground. These underground streams may at times appear as springs, or they may supply the water that is drawn from wells. Often closets

[1] The matter in this paragraph applies equally to cisterns.

FIG. 53. In limestone regions streams often run for miles underground.

and cesspools drain into them, and where the soil is underlaid with limestone, well and spring waters are notoriously unsafe. In such regions a water supply should be pronounced safe by health authorities before it is used for household or dairy purposes.

Wells in sandy soils. In some places a supply of water may be obtained by driving a pipe down to an underground stream. Where the underground water is flowing through gravel or very coarse sand, germs can make their way for long distances through the crevices between the soil particles, and a well driven in sandy soil does not always furnish a safe water supply. An examination by the state health officials will show whether or not the water is fit for drinking purposes.

Freeing water from disease germs. It is the duty of every city either to secure pure water for its inhabitants or, by filtering or in some other way, to remove dangerous germs from the water that it supplies to the homes of its people. Some cities fail to do this, however, and when impure city water must be used, or water from an unsafe well or spring, the best plan is to boil it. Simply bringing it to the boiling point will kill all dangerous germs. Ordinary house filters are almost useless, and some of them are worse than useless, for they catch and hold the matter in which bacteria breed and multiply, and the bacteria pass through the pores in most of them. Filtering through animal charcoal takes certain coloring matter out of water and makes it look clear and bright, but it does not remove germs. It is always to be remembered that to use fruits, vegetable dishes, or milk vessels that have been washed in impure water may be as dangerous as to drink the water.

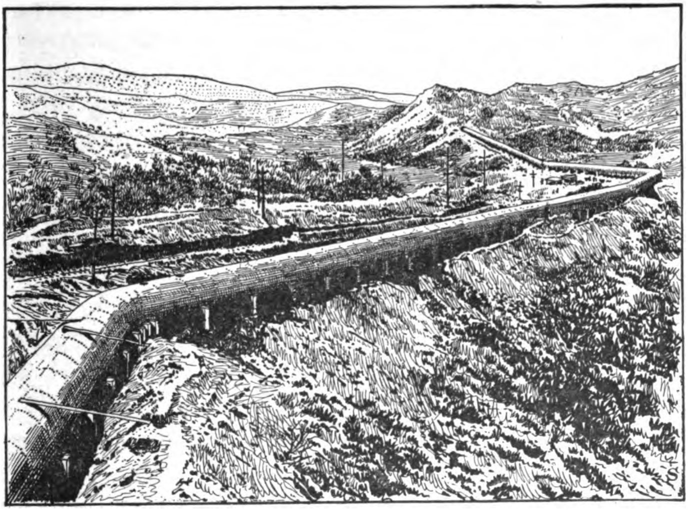


FIG. 54. The great aqueduct which carries pure water from the mountains to Los Angeles, California, a distance of 209 miles.

POINTS TO BE REMEMBERED

1. A pure water supply is very important in preventing germ diseases.
2. Usually water from deep wells and from roofs is safe; water from the surface of the ground is unsafe.
3. Wells may be made safe by keeping out surface water and by keeping sick persons and other germ carriers away from them.
4. In limestone and sandy regions many wells and springs are unsafe.
5. Disease germs in water may be killed by boiling the water.
6. Cities should supply their citizens with pure water.

CHAPTER FOURTEEN

SMALLPOX

Up to about a hundred years ago, smallpox was one of the most terrible diseases known to man. It is estimated that in the eighteenth century it killed 60,000,000 people, and that 6,000,000 of the 12,000,000 inhabitants of Mexico died from it when it was introduced into that country by the Spaniards. In Europe nearly every one sooner or later had to undergo an attack of the disease. "It was always present, filling the churchyards with corpses, tormenting with constant fears all it had not yet stricken, leaving on those whose lives it spared the hideous traces of its power, turning the babe into a changeling at which the mother shuddered, and making the eyes and cheeks of the betrothed maiden objects of horror to the lover." Fortunately for us, a method of preventing smallpox has been discovered, and in civilized countries it has now become a rare disease.

The germ of smallpox. Smallpox is caused by a small germ that lives in the skin and in the lining of the mouth, throat, and nose, and sometimes in the trachea and esophagus. The germs cause pustules, or sores, to form in the deeper layers of the skin. These break through to the surface of the skin, and in the later stages of the disease the matter from the pustules dries as scabs over the body. The incubation period of smallpox is from seven to twenty-one days.

Some races of smallpox germs are weak and produce a type of the disease so mild that it is often mistaken for chicken pox. Other races are very virulent and cause smallpox of so malignant a type that numbers of the victims die and many of those who recover lose their sight.

How smallpox germs are spread. The germs of smallpox are abundant in the matter on the skin of the smallpox patient, they are in the discharges from the mouth and nose, and they are found in great numbers in the scales that come from the skin during recovery from the disease. The germs may be scattered about by the patient's coughing or sneezing, they are left on anything he touches, they may be carried on the feet of flies, and it is possible that they are at times blown for short distances through the air in the light, dry scales that come from the skin. Smallpox germs may be dried for months without being killed, and on clothing, books, letters, old rags, and many other things, they are sometimes carried about. It is therefore very important that a smallpox patient should be quarantined and that everything about him should be thoroughly disinfected (page 138).

VACCINATION

To very few human beings has nature given white corpuscles and germicidal substances that can resist the smallpox germ. Up to the time vaccination began to be practiced, more than 95 per cent of all persons suffered from it, and people considered it a disease that every one must have, just as we look on chicken pox and mumps as diseases that most of us will probably have to go through with sooner or later. About the year 1800 vaccination began to be practiced, and smallpox at once began to decline. Now vaccination is more or less compulsory in every civilized country in the world. Where it is thoroughly carried out, smallpox has almost ceased to exist; but where the people are not vaccinated, or a considerable number of them are not vaccinated, it is still impossible to prevent the spread of the disease. This is because mild cases escape quarantine, because the germ withstands drying for a considerable period of time, and because it is so powerful a germ that if 100 unvaccinated persons are exposed to it, from 95 to 98 of them will be attacked by the disease.

FIG. 55. Edward Jenner, who in 1797 discovered vaccination, the greatest medical discovery the world has ever known.

Vaccination an almost perfect protection against smallpox. In science the important question about any proposition is whether or not it is true. It makes no difference how we should like to have things or how we may think they might be. The facts decide, and we make progress by fitting ourselves and our ideas to the real world and not to an imaginary one. When we examine into the question whether or not vaccination protects against smallpox, we find that it really does protect, and the following are a few of the facts that lead us to this conclusion.

When the Americans went to the Philippines in 1898, from 30,000 to 40,000 Filipinos were dying from smallpox each year. A great vaccination campaign was carried out, and by 1907 there were only 300 deaths from smallpox in all the Islands. From time to time certain persons in England have opposed vaccination, and for a while the center of this opposition was in Gloucester. In 1895 that city had a population of 42,000, among whom were a very considerable number of persons who had not been vaccinated. In the last weeks of 1895 smallpox broke out, and a great epidemic of 1979 cases occurred, with 439 deaths. An attempt was made to control the disease by quarantine and careful disinfection, but this was an entire failure. In January, 1896, there were 28 cases, in February 146 cases, in March 644 cases, and in April 744 cases. By the end of April more than 36,000 of the inhabitants had been vaccinated, and Gloucester was the best-vaccinated city in the world. The epidemic at once began to decline, and by August it had disappeared.

FIG. 56. Dr. Benjamin Waterhouse, who introduced vaccination into America in 1800. He insisted on the importance of using pure virus and of keeping the wound clean.

In Philadelphia there was a considerable epidemic of smallpox during the years 1901–1904. During this period more than 3500 cases were admitted to the Municipal Hospital, and of these 3500 cases not one had been successfully vaccinated within five years. During this time many physicians and nurses were employed in the hospital, and more than 700 medical students were taken to visit the patients. Not one of all these persons contracted smallpox except one student who was opposed to vaccination and untruthfully said that he had been vaccinated. At one time it was necessary to enlarge the hospital, and fifty or sixty workmen were employed to do this. All of them were vaccinated except two, and these two and no others took the disease. Again it was necessary to enlarge the hospital, and another squad of workmen was employed. For some reason two of these were not vaccinated. These two were attacked by smallpox, while again all the workmen who had been vaccinated escaped. Thus within the hospital all of the hundreds of persons who had been vaccinated escaped the disease, and all five of those who had not been vaccinated contracted it.

FIG. 57. Thomas Jefferson, one of the most broad-minded and far-seeing Americans of his time. In 1806, writing to Edward Jenner, he said, "Future nations will know by history only that the loathsome smallpox has existed and by you has been extirpated."

Many pages could be filled with similar statistics showing that vaccination almost surely prevents smallpox. Yet many persons seem never to have heard of these facts, for there are still in our country societies that actively oppose vaccination. Some people think that among those who do not believe in vaccination are some of the prominent physicians of the country. This is a great error, for none of the physicians who oppose vaccination have any prominence in their profession. The leaders of medicine for the last hundred years have believed in vaccination and have practiced it, and today there is not a prominent medical man in America who is opposed to it. On this point the Medical Society of the State of

Pennsylvania has said: "We know of *no physician of eminence in this country* who is not a believer in — nay, even an ardent advocate of — vaccination."

FIG. 58. Diagram showing how vaccination protects against smallpox. During 1912, 1913, and 1914, health officials in the United States secured the vaccination histories of 12,880 smallpox patients. Of these, 11,236 had never been successfully vaccinated; 1104 had been vaccinated more than 7 years before the attack; and only 540 had been vaccinated within the last 7 years before the attack. (Data from *United States Public Health Report* of October 2, 1914.)

How vaccination protects against smallpox. The germ of smallpox flourishes in man. It grows in cattle also, causing the disease called *cowpox*. After growing in the cow, this germ seems to be weakened and changed so that it grows feebly in man and has only a slight power of producing disease.

In vaccination, germs from a cow are put into the human body. Here they grow and begin to produce the mild inflammation that follows vaccination. The body now works up its destructive substances for these germs, and because the germs are weak, the body is able to kill them before they can multiply to any extent. After this is done, the defensive substances remain in the blood, and if smallpox germs at any time get into the body, the protective substances are there, ready to kill them and keep the disease from getting a start. A person who has been successfully vaccinated is therefore in much the same condition as a person who has had a light attack of smallpox, for he has in his blood substances that will kill any smallpox germs that may get into his body.

How long vaccination protects against smallpox. After vaccination, the protective substances in the blood become weaker and weaker, but seldom disappear entirely. Just when they become so weak that it is necessary to be vaccinated again, it is impossible to say. Sometimes they are fairly strong after seven, eight, nine, or ten years. In a very few persons they disappear so rapidly that in nine months they fail to protect against smallpox. The safest way is to be vaccinated every few years, and when there is danger of being exposed to smallpox, to be vaccinated again if more than nine months have passed since the last vaccination.

Why every one should be vaccinated. *Every one should be vaccinated to protect himself.* We never know when the smallpox germ may come to us from the seats of a car, from a letter, from the clothes of some person, or in any one of many other ways. Since this is true, it is only the part of ordinary prudence to be vaccinated against the disease.

Every one should be vaccinated to protect others. Persons who have smallpox cause expensive quarantine, they interfere with business and with schools, and by scattering abroad smallpox germs they endanger the lives of others. In 1885 *one* man carried smallpox to Montreal and started an epidemic that cost more than three thousand lives.

Little danger in vaccination. Vaccination causes only a small sore, and there is practically no danger from it when it is properly done. How little danger there really is from it is shown by the fact that 3,709,187 persons were vaccinated by government officials in the Philippine Islands, during the years 1907–1908, without a single death. The greatly swollen arms and running sores that sometimes follow vaccination are caused by pus-forming bacteria and are not a true part of vaccination at all. The pus-forming germs usually get into the wound in impure virus, from infected instruments (as from a lancet that has been used in opening a boil), from an unclean skin, or from dirt that gets into the wound. Only pure virus should be used, the skin and instruments should be clean, and the wound (like any other wound) should be protected from pus-forming and tetanus germs.[1]

A fact about germ diseases that should be understood. It is a common idea that if the blood is "pure" we are protected from germ diseases, and if the blood is "impure" we may suffer from these diseases. This idea is not correct. A person's blood may be as pure as any flowing in the veins of man, and yet that person will fall a victim to smallpox germs if he lacks in his blood the substances that kill those germs. His muscles may be like bands of steel and his nerves may be tingling with the joy and vigor of perfect health, and yet if in his blood there are not the particular substances that kill the tubercle bacillus, he had best beware of that germ. He may even, as we have already pointed out (page 22), have substances in his blood that will enable

[1] Virus that has been carefully prepared and sealed in glass tubes is free from all harmful germs. The very few cases of tetanus that have followed the millions of vaccinations for smallpox in the United States have been found to be due to germs that got into the sore from the skin or from dust.

him to kill some kinds of germs and yet may fall an easy victim to germs of another kind. Resistance to germs is not, therefore, a question of pure blood but a question of having in the blood particular substances that will kill particular germs.[1]

In former chapters we have advised you to keep up the health of the body so that it will be able to kill germs, and it is true as a general statement that when the body is in health it is able to manufacture more of the substances that kill germs than it can manufacture when it is weak. You should know, however, that for reasons that are not understood, the body sometimes suddenly loses its power to resist germs even when it seems to be in health. You should also understand that before smallpox germs nearly every one goes down as the wheat goes down before the sickle, and that the only way you can make yourself safe from this disease is to get your body, beforehand, to work up a supply of the defensive substances for the smallpox germ. Therefore, when any one begins to tell you that health consists in keeping the blood pure, and that vaccination is contrary to the principles of health because it introduces into the blood matter from a cow that will cause the blood to be impure — when any one talks to you after this fashion, pay no attention at all to him. For though your blood were as pure as the crystal water

[1] Disease germs are fitted to grow in the body and their natural food is the normal lymph that is found in a healthy body. It is erroneous, therefore, to think that it is a disadvantage to the germs for the lymph to be pure and to contain an abundant food supply. The important factor in resistance to germs is the presence of opsonins and other defensive substances in the blood, and it is possible to be in the best of health and yet lack the substances that will protect us against many diseases.

from a snow-capped mountain peak, it would not kill the smallpox germ unless it contained the particular substances which kill that germ. It is strong blood, and not pure blood, that we need in our battle with the germs.

POINTS TO BE REMEMBERED

1. Until vaccination was discovered, smallpox was the most dreaded of all diseases.
2. The smallpox germ can withstand drying and is easily spread.
3. Vaccination almost surely protects against smallpox.
4. In vaccination a weak race of smallpox germs from cattle is put into the body.
5. The body produces substances to kill these germs.
6. These defensive substances then remain in the blood.
7. Any danger there may be in vaccination comes from bacteria that get into the wound, and not from the vaccination itself.
8. It is best to be revaccinated every few years, and whenever one has been exposed to smallpox.
9. Pure blood does not always protect us from germs.

CHAPTER FIFTEEN

MALARIAL FEVER AND MOSQUITOES

MALARIAL fever does not cause so many deaths as some other diseases, but because it is found over a great part of the world, and because in malarial countries a great number of people are ill from it for long periods of time, malaria must be counted as one of the most important of the diseases that afflict mankind. No community can prosper as it should while its people have malaria, for a person who is suffering from this disease cannot have the energy and ambition he needs to carry on his work.

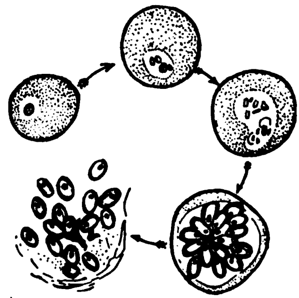


FIG. 59. The growth of the malaria germ in a red blood corpuscle.

The germ of malaria. Malaria is caused by small protozoa that live in or on the red blood corpuscles. A malaria germ grows and becomes larger in a corpuscle and then divides into a number of parts, each of which is a young germ. The corpuscles, then only thin shells, break into pieces, leaving the young germs free in the blood. Each young germ now enters a fresh red corpuscle, grows in it, and divides into a number of germs. These young germs then break forth and attack other corpuscles. A large amount of poison is set free in the blood at the time the corpuscles are broken down, and this causes the chill and the fever that follows it.

How the malaria germ gets into the body. The malaria germ grows in a certain kind of mosquito[1] as well as in

[1] The *Anopheles* mosquito (pronounced a-nŏf′e-lēz). When this mos-

man, and it gets into our bodies from the bites of these mosquitoes. When the mosquito feeds on man, it thrusts its proboscis (bill) down through the skin and sucks out the blood. In drawing blood from a person who has malaria, the mosquito takes malaria germs into its stomach with the blood. These germs pass into the walls of the mosquito's stomach and multiply in little sacs on the outside of the stomach walls. The sacs then burst, and great numbers of the germs pass through the mosquito's body to the salivary glands. The germs appear in the saliva in about ten days from the time when they were first taken into the stomach. When the mosquito bites a person, it injects saliva[1] and germs into the wound, and about a week later the disease appears. It is commonly thought that malaria is caused by drinking impure water or by "miasmas" or poisonous vapors from swamps or damp ground, but many experiments have shown these ideas to be incorrect.

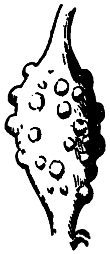


FIG. 60. The stomach of a mosquito that is infected with malaria. The malaria germs grow in the sacs on the mosquito's stomach.

Preventing malaria. Fortunately for us, quinine in an amount that will kill the malaria germ does not kill our cells, and it is, accordingly, one of the most useful medicines yet discovered by man; for not only will it cure malaria, but it is also very useful in preventing it. Other important aids in fighting this disease are the

quito is resting, it stands up on its head, so that its body, head, and bill are in a straight line.

[1] It is the poisonous saliva of the mosquito that causes the itching and swelling that follow a mosquito bite.

careful screening of houses, cutting away grass, weeds, and vines that shelter mosquitoes in the heat of the day, and staying indoors in the morning and evening when mosquitoes are flying. The best way to prevent malaria, however, is to remove the breeding places of the mosquitoes that carry it.

The life history of the mosquito. The mosquito lays its eggs on water. In about a day the egg hatches into a *larva* (commonly called a "wiggler" or "wiggle-tail") that swims about actively in the water. The larva takes in air through a breathing tube, which it thrusts out through the surface of the water to the air, as shown in Figure 62. In from seven to fourteen days the larva changes its form. The head and the fore part of the body become much heavier, and the breathing tubes shift to the back of the body. In this stage it is called a *pupa* (commonly called a "tumbler," because, instead of wiggling as it swims, it tumbles over and over). In from two to five days — ten to twenty days from the time the egg was laid — the pupa splits down the back, and the adult mosquito comes out and flies away.

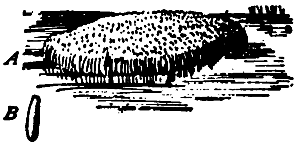


FIG. 61. *A* is a raft of mosquito eggs; *B* is a single egg.

In the larva and pupa stages, mosquitoes feed on small plants and animals that are in the water. In the adult form, they live partially by sucking the juices from plants; but they eagerly attack animals and suck the blood from them when there is an opportunity to do so. How long a mosquito naturally lives in the adult form is not known, but one has been kept for seventy-six days, and considerable numbers of them live through the winter, hidden away in crevices and cracks. The young and the eggs of the mosquito are not killed by being frozen, and mosquitoes often come out in the spring from eggs or larvæ that have lived through the winter.

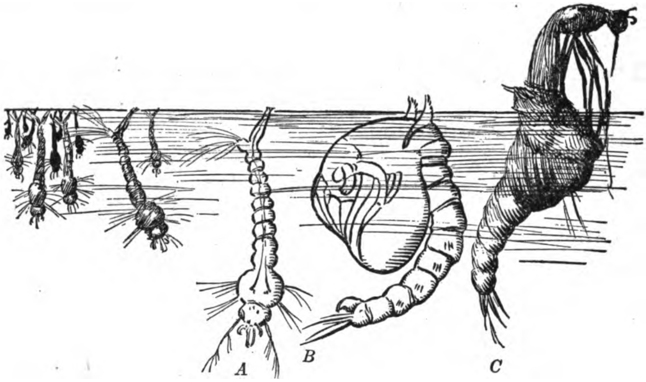


FIG. 62. *A* is a mosquito larva; *B* is a pupa; *C* is an adult mosquito coming out of an old pupa.

Destroying the breeding places of mosquitoes. The first step in the fight with mosquitoes is to deprive them of breeding places near human dwellings. Old cans and pans should be cleared away; water barrels, tanks, and cisterns should be screened so that the mosquitoes cannot get to them to lay their eggs;[1] sagging eave troughs should be braced up so that no water will stand in them, for in an eave trough the larvæ may start in a very small quantity of water and then be washed down into the cistern, where they will complete their development. All pools and ditches near houses should be drained;[2]

[1] Nineteen thousand eggs and young mosquitoes have been found in a rain barrel at one time.

[2] The mosquito that carries malaria is a half-wild kind, and it prefers to breed in ponds, small streams, and ditches. Farmers' families often

and wells should be watched and if necessary covered, for sometimes the larvæ are found in wells. Weeds and shrubbery in which the mosquitoes can find a dark, cool place to hide during the hot part of the day or when the wind blows, should be cut down. The work of destroying mosquitoes in cities and towns must be taken up by public officials who have authority to compel every one to remove the breeding places on his premises.

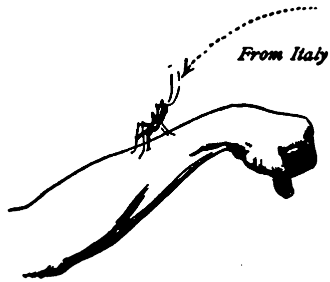


FIG. 63. Germs of malaria were sent from Italy to England *in a mosquito.* An English physician who was bitten by the mosquito developed malaria.

Killing mosquito larvæ with kerosene. When pools of water cannot be drained, all young mosquitoes in them may be killed by pouring a little kerosene on the water. This forms a film over the water, shutting the larvæ off from the air and killing them in a few minutes. If the kerosene is washed away by rains, it must be renewed. It has been reported that ducks are most valuable in destroying the young of mosquitoes.

Screening against mosquitoes. The ordinary screens that are placed on houses are fly screens, not mosquito screens, and the meshes in them are so coarse that the mosquitoes that carry malaria can pass through them. To keep the malaria mosquito out of a house requires a screen with about sixteen strands to the inch. Galvanized screens will in the end prove cheaper than painted

suffer from malaria because country houses are located near breeding places of this kind.

iron wire, and they permit the air to pass through them much more freely. Careful work is needed to make the screening on a house effective; for a feeding of blood is necessary to the female mosquito before she can lay her eggs, and she will search over screens until she finds the smallest crack or opening, or will even come down chimneys, to get into a house. Since mosquitoes are attracted by light, lamps should be kept away from doors in the evening, and on a screened porch the lights should be placed at the other end from the door.

Any one wishing to free his town or house from mosquitoes should write to his State Board of Health for instructions as to the details of the work. In many places local merchants carry only fly screens, but the finer-meshed screens can easily be obtained. Many kinds of fish are of little value for destroying young mosquitoes, but a small minnow that feeds on the top of the water (the "top-feeding minnow") is a great help in keeping ponds free from them.

POINTS TO BE REMEMBERED

1. Malaria is caused by a protozoön that lives in the red blood corpuscles.
2. The germ gets into the blood from the bite of a mosquito.
3. The best way to prevent malaria is to remove the breeding places of mosquitoes.
4. The young of the mosquito may be killed by putting kerosene on the water.
5. Fine screens are necessary to turn mosquitoes.

CHAPTER SIXTEEN

MENINGITIS, INFANTILE PARALYSIS, LETHARGIC ENCEPHALITIS, SORE EYES, PLAGUE, AND RABIES

MENINGITIS

MENINGITIS is responsible for about 18,000 deaths each year in the United States. It is caused by bacteria growing in the membranes about the brain and spinal cord; and the tubercle bacillus, the pus-forming bacteria, and the pneumonia germ are all common causes of the disease. About one third of the deaths are caused by a special germ that is not found in other diseases. When meningitis is caused by this germ it is an infectious disease that often runs in epidemics, and it is called *epidemic cerebro-spinal meningitis*. It is a difficult infection for health officials to control, and next to pneumonia and measles it has given more trouble than any other epidemic disease in the army camps.

How meningitis is spread. The germ of meningitis is in the discharges from the nose of a patient who has the disease, and, it is in the noses and throats of many healthy persons. To control meningitis it is therefore necessary to isolate cases of the disease and to examine those who have been in contact with the sick to see if they are carriers of the germs. Where men are brought together from various places, as in army camps, it is certain that some of them will be carriers, and unless a microscopic examination is made for each man the disease will be introduced. The germs pass from one person to another in all the ways that the germs of respiratory diseases are transferred, and it is difficult to prevent their spread except by isolating the carriers of them. Outside of the body the germs quickly die.

The serum for meningitis. The attack of meningitis is very sudden and usually very severe, and until recently most cases ended in death. Now a serum prepared from the blood of the horse is used in its treatment. This serum is effective only in cases of the disease caused by the special meningitis germ; in the hands of a skilled physician it is of great value in treating these cases of epidemic meningitis.

INFANTILE PARALYSIS (POLIOMYELITIS)

Infantile paralysis seems to become more widespread year by year, especially in the United States. It attacks children under five years of age, especially, but adults also may suffer from it. If recovery takes place, the patient slowly improves until usually only a part of the muscles in one or more of the limbs are left paralyzed. Because the fever is mild, it is often overlooked, and the paralysis is thought to be due to a fall or other injury.

Under a microscope the germ of infantile paralysis appears like a very small coccus, but it is much smaller than any known bacterium, — only about one fourth the diameter of one of the pus-forming cocci. The germs attack especially the spinal cord and brain, but they are found in the secretions from the nose and throat and in the wastes from the alimentary canal. The disease is spread by contact, and cases of it should be quarantined and the wastes from the patients disinfected. Healthy carriers of the germs are found among both the children and the adults who have been in contact with cases of the disease, and these must be quarantined to prevent the spread of the germs. The incubation period varies, but is usually about eight days. The early symptoms are weakness, fever, vomiting, and drowsiness. Other symptoms that may be present in the early stages are diarrhea, cold in the head, pain along the spine, and convulsions. The limbs are loose and flabby, and in many cases the power to move any part of the body is lost. As in a number of other diseases, blood from persons who have recovered from the disease is the most effective remedy. Treatment for the paralyzed muscles, to bring back their power of movement, is very important.

FIG. 64. The roller towel, especially in public places, is a common source of infection and should be avoided.

LETHARGIC ENCEPHALITIS

This is a disease of the brain that has only recently been recognized, but cases of it have been reported from Austria, France, England, and from several places in the United States. Although it has not yet acquired a common name, it is sometimes referred to as the "sleeping sickness," because the patient may lie for long periods as if asleep. It has been mistaken for both infantile paralysis and meningitis. The germ is undiscovered, but since no bacteria have been found in connection with the disease, it is thought to be due to a filterable virus. Probably the germ enters and leaves the body through the mouth and nose, as in meningitis and infantile paralysis. Among the early symptoms are headache, dizziness, nausea, and paralysis of the eye muscles.

SORE EYES

Pink eye. Different germs — the diphtheria germ, the pneumonia germ, or the pus-forming bacteria — may cause sore eyes, but there is a particular bacterium[1] that causes the epidemic form of sore eyes often called *pink eye*. The germs are easily transferred on handkerchiefs, towels, wash basins, and the hands, and by flies. An infected eye should be carefully covered to keep germs from getting into the other eye. Epidemics of pink eye occur in all parts of our country, and children suffering from the disease should not be allowed to attend school.

FIG. 65. Rubbing the eyes and putting the hands to the face are bad habits.

Trachoma. A chronic kind of sore eyes called *trachoma*, or granulated lids, has been found to be very widespread in our country. In the early stages it may appear to be mild, but in the later stages it is a very severe disease and many cases of blindness are caused by it. Although it is a stubborn disease to cure, it can be made to yield to proper medical treatment. The germ is believed to be a filterable virus.

The germs of trachoma doubtless get into the eyes from wash basins and towels, from the hands, and in other ways. The disease spreads through families and through schools, and a trachoma patient should not be allowed to attend school or other public gatherings until he has been treated for the disease.

[1] The *Koch-Weeks bacillus.*

BUBONIC PLAGUE

Bubonic plague is the disease that in the Middle Ages was called the Black Death. The germ attacks rodents (animals like rats, mice, squirrels, rabbits, woodchucks, and muskrats) as well as men, and men usually get the disease from the bites of fleas that have been living on plague-stricken rats. The way to prevent plague is to attack the rats that carry it.

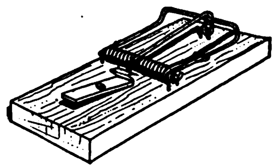


FIG. 66. The cheapest and most effective kind of rat trap.

Something can be done by trapping and poisoning rats, but they multiply so rapidly that the only effective method of dealing with them is to cut off their food supply and break up their homes. To do this in a town or city, it is necessary to keep garbage in covered cans; to rat-proof slaughter houses, mills, warehouses, and stores; to provide metal or other rat-proof bins for grain that is kept in stables and barns; and to elevate outbuildings so that dogs and cats can pass under them.

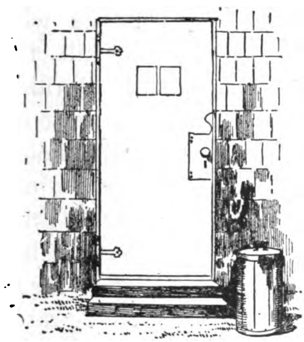


FIG. 67. Keeping garbage in covered cans decreases the food supply of rats. This is a precaution easily taken to prevent plague.

RABIES (HYDROPHOBIA)

Rabies is caused by a very small germ that grows especially in the brain and spinal cord and gets into the body usually from the bites of dogs or cats. In man the incubation period is never shorter than fourteen days, usually it is five or six weeks, and it may be a year. The germs are in the saliva three days (possibly eight days) before the animal shows symptoms of the disease.

Preventing rabies. Practically all the rabies in our country comes from the bites of dogs, and by keeping dogs properly muzzled it is possible to stamp out the disease entirely, as has been done in several European countries.

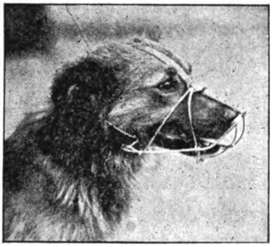


FIG. 68. If all the dogs in our country could be muzzled for a few years, rabies would disappear. The dogs could then be unmuzzled without danger of the disease to man or beast.

Treatment of wounds made by rabid animals. A very great safeguard against rabies is to treat promptly all wounds made by the teeth of animals with something that will kill the germs in the wound. Burning with nitric acid is the most effective remedy, but this should be done by a physician to guard against too great injury to the flesh. The best way is to wash the wound at once with carbolic acid, bichlorid of mercury, or some other strong disinfectant, and then go to a physician. Treatment even after twenty-four hours is useful. A rabid animal scratches at its mouth to remove the tough saliva, and wounds from the claws as well as from the teeth are dangerous.

An animal that has bitten any one should not be killed, but should be shut up until it is known whether or not it has rabies. If the animal remains in health for nine or ten days, there will be no occasion for worry. If it shows symptoms of the disease, it should be killed without injuring the brain, and the head should be packed in ice and sent to the laboratory of the State Board of Health. There the brain can be examined and if the germs are found, the Pasteur treatment should be begun at once.

The Pasteur treatment. There is no cure for rabies after the disease develops, but a preventive treatment by vaccination with dead and weak germs of the disease has been discovered by a great Frenchman named Louis Pasteur. The Pasteur treatment is successful in nearly all cases in which it can be begun in time, but it should start promptly after the bite is received. In many states the State Department of Health gives this treatment free to citizens of the state.

POINTS TO BE REMEMBERED

1. Epidemic meningitis is caused by a particular germ, and the disease is infectious.
2. Sore eyes are infectious, and persons suffering from them should not be in school.
3. The germs that cause infantile paralysis are in the nose and throat. Cases of the disease should be quarantined.
4. The germ of plague is spread by rats.
5. Rats are combated most effectively by cutting off their food supply and by breaking up their homes.
6. Rabies is spread by the bites of dogs..
7. The disease can be eradicated by muzzling dogs.
8. The Pasteur treatment will usually prevent rabies.

CHAPTER SEVENTEEN

SOME GERM DISEASES OF CHILDREN

MEASLES

MEASLES is probably caused by either a filterable virus or a very small coccus that is found in the blood and sputum of those who have the disease. The breaking out is not only on the skin but also in the eyes, throat, and air passages, and the germs are in the secretions from these parts. A patient is dangerous as long as the discharges from the eyes and nose continue, usually for a period of about three weeks from the breaking out of the rash. Where the germs are exposed to light and drying they die in a short time, and the disinfection of houses after cases of measles is not necessary.

Measles a serious disease. Measles is a very serious disease. During an attack the eyes should be rested, shaded from light, and bathed in boric acid or other disinfectant several times a day. The patient should not read or tire his eyes in other ways; he should have careful nursing and be protected from the germs of colds, influenza, pneumonia, and tuberculosis; for more than almost any other disease, measles weakens the resistance of the body to the germs of respiratory diseases, and many cases of ear troubles, bronchitis, pneumonia, and consumption follow an attack of it. Until he has thoroughly recovered, the patient should not expose himself to wet or cold or engage in very hard work. Measles is much more dangerous to children than to older persons, and children should, therefore, be protected from the disease as long as possible. A measles patient should not have visitors, for even though the visitors are not ill they may infect him with bacteria that to him, in his weakened condition, will be dangerous. In the army cantonments, during the recent war, measles was the most common of all infections, and much of the pneumonia followed cases of measles.

Controlling epidemics of measles in schools. Because the first symptoms of measles resemble a cold and the disease is often not recognized in its early stages; because it is highly infectious in these first stages; because many cases of the disease are so mild that they are overlooked; because the germs are so powerful that they can successfully attack almost every one they can reach; and because its victims are chiefly small children, measles is a most difficult disease to control. It can be prevented, however, by isolating both the victims of the disease and also those persons not already protected by a former attack who have been exposed to the germs.[1]

SCARLET FEVER

The germ of scarlet fever has not been found, but it is known that the discharges from the throat, nose, eyes, and ears are infectious, and the patient is dangerous as long as these discharges continue. The germs withstand considerable drying, but the disease is not air-borne,

[1] A plan followed in some schools is as follows: When a pupil is attacked, the school is continued as usual for about eight days. Then the children who were exposed to the infection are kept out of school for a week. After this, all those who have not developed the disease or are not being exposed to it at home are allowed to return. The success of this method is due to the fact that the incubation period of measles is very regularly from about ten to fourteen days.

as was formerly supposed. It is a difficult disease to control, because there are mild cases ("missed cases") of it that are not recognized and quarantined. It attacks children especially, and a person usually has the disease but once.

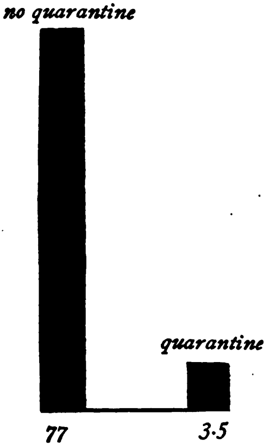


FIG. 69. From 1866 to 1875, when quarantine was not enforced, the average annual death rate from scarlet fever in Massachusetts was 77 for every 100,000 inhabitants. In 1916, the death rate was 3.5 for every 100,000 inhabitants. In the United States as a whole, the death rate dropped about two thirds from 1906 to 1916.

Scarlet fever is a very dangerous disease because there often goes with it a severe attack of pus-forming bacteria (streptococci) that injure the kidneys, ears, eyes, throat, or other parts of the body, and it is not uncommon for it to leave its victims deaf or blind, or in some way injured for life. It should be carefully quarantined, therefore, and a close watch should be kept for the mild cases from which epidemics often spring.

WHOOPING COUGH

Whooping cough is caused by a small bacillus.[1] The germs grow in the bronchial tubes and are in the sputum, especially in the early part of the disease. Whooping cough is highly infectious from the beginning, and a child who is thought to be taking it should not be allowed to remain in school. During quarantine the patient need not be shut up indoors, but he ought to keep away from others who

[1] The *Bordet-Gengou bacillus*, or *Bacillus pertussis*.

might become infected with the germs.[1] Dogs and cats suffer from whooping cough, and during epidemics they may be a means of spreading germs.

Whooping cough dangerous to children. Whooping cough is not usually supposed to be very dangerous, and often cases of it are not carefully quarantined. As a consequence, it is a widespread disease and causes more deaths than scarlet fever and smallpox combined — more than any of the other common infectious diseases of children.[2] Some persons make no effort to protect their children from whooping cough, or even purposely expose them to it. This is a most pernicious practice, for more than four fifths of all deaths from whooping cough are among children under two years of age. The older a child is, the better he resists the disease, and an adult usually escapes it altogether or has a mild attack. A vaccine for whooping cough is now prepared, and it is hoped that this will be useful in preventing the disease and also in shortening and lessening the severity of the attack.

Droplet infection important in measles, scarlet fever, and whooping cough. Measles, scarlet fever, and whooping cough all begin like colds, and in all of them the germs are coughed and sneezed out into the air. One should therefore keep away from a person who has symptoms of these diseases, and to control them those who have been exposed to the germs must be isolated before the symptoms develop.

[1] In some places persons who have whooping cough are required to wear a distinguishing band on the arm when they go out of the house.

[2] The deaths in cases of whooping cough are usually caused by the disease running into pneumonia (broncho-pneumonia).

SOME OTHER INFECTIOUS DISEASES

Chicken pox. Chicken pox is a very infectious disease among children. The germ has not been discovered. It is important mainly because mild cases of smallpox are often mistaken for it, although chicken pox itself in some cases may cause a severe illness. Since older persons almost never have chicken pox, any cases of disease in adults that seem to be chicken pox should be diagnosed as smallpox.

Mumps. It is believed that mumps is caused by a filterable virus that grows in the salivary glands. The patient is dangerous to others for a week after the swelling of the glands is gone.

German measles. This is a different disease from ordinary measles, and one that is less severe. The germ is unknown. The incubation period is from two to three weeks.

POINTS TO BE REMEMBERED

1. Measles is a very serious disease and should be closely quarantined.
2. Bad after-effects often follow cases of measles.
3. The attacks of the pus-forming bacteria that accompany scarlet fever make it an especially dangerous disease.
4. Whooping cough is also a severe disease.
5. All these diseases are especially dangerous to young children.
6. To control them, the mild cases must be found and infected persons must be isolated before the symptoms develop.

CHAPTER EIGHTEEN

OTHER GERM DISEASES

BESIDES the diseases that we have studied, there are other ailments of man that are caused by germs. Many of these are strange tropical illnesses, and we shall not even mention them here. In a considerable number of other diseases that are known to be infectious, the particular germ that is responsible has not been surely determined. In this chapter we shall take up a few very different diseases that it is well to understand.

Acute rheumatism. Some investigators believe that acute rheumatism ("inflammatory rheumatism"), or rheumatic fever, is due to a bacterium of the streptococcus group; others think it more probable that the cause is an undiscovered germ. In this disease there is redness and swelling in one or more joints, the pain is very severe, and there are likely to be several attacks. It seems probable that the same germ which causes this form of rheumatism is also the cause of tonsillitis, inflammation of the lining and valves of the heart, St. Vitus dance, and a rash of the skin; for persons who have acute rheumatism often suffer from these other diseases also. It is thought that the germ enters the body through the tonsils, for a case of tonsillitis often goes before an attack of rheumatism. The joints are not permanently injured by this disease, but in many cases the valves of the heart are left in a damaged condition after the illness is gone.

Chronic rheumatism. Chronic rheumatism, in which the joints are left swollen and stiff, is caused by germs of the streptococcus group. In the greater number of cases, the blood carries the germs to the joints from the tonsils, which may remain infected for years. In other cases, the germs come from abscesses at the roots of the teeth or in the bones of the jaw, from infections of the nasal sinuses (page 229), or from some other part of the body where the germs have a permanent home. That these chronic infections are the cause of many cases of rheumatism is shown by the fact that the trouble in the joints disappears when the tonsils are removed or the other breeding places of the germs are broken up.

Rheumatism causes more suffering and more loss of time than any other disease, and it is the most expensive of all our diseases except tuberculosis. A person who has rheumatism should, therefore, put himself in the care of a skilled physician, and he should not think that he knows as much as a physician about his ailment. For many of the infections of the tonsils that cause rheumatism go on for years without swelling or pain; ulcers in the bones may give no symptoms; an infection of the nasal sinuses may show itself only by causing a tendency to catch cold; and an abscess at the root of a tooth may not show its presence except by a simple inflammation of the gums.

Since these chronic infections are believed to be responsible not only for rheumatism, but also for much kidney disease, heart trouble, and even hardening of the arteries, they should certainly receive prompt medical care.

Pyorrhea. It has been claimed that a chronic infection about the roots of the teeth (*Pyorrhea* or *Rigg's disease*) is in part due to an ameba and in part to pus-forming bacteria. In this disease the germs live about the roots of the teeth and the teeth often become so loose in their sockets that it is necessary to remove them. By carefully scaling and cleaning the teeth and opening abscesses about the roots and treating the diseased gums, a dentist can usually check the growth of the germs if the treatment is begun before the disease reaches an advanced stage.

Infections of the mouth and teeth are more common than any other germ disease, and any one who has either soreness of the gums or cavities in the teeth should visit a dentist as soon as possible. The infections of the teeth that cause them to decay will be discussed in another place.

Foot-and-mouth disease. Foot-and-mouth disease attacks cattle especially, but swine, sheep, goats, and other domestic animals, as well as man, may suffer from it. The disease gets its name from the fact that in cattle infected with it, blisters and sores appear in the mouth and on the delicate skin between and above the hoofs. It is very infectious, and in Europe it has given great trouble. In the United States it has been kept under better control, but in the winter of 1914–1915 a great outbreak occurred. It is caused by a filterable virus, and the germs are in the milk, saliva, and other secretions, as well as in the sores. The germs remain alive for months if kept cool and moist, but die when they are dried. The effective methods of controlling the disease consist of preventing the shipment of cattle from infected areas, killing all cattle in infected herds, and pasteurizing milk to prevent the disease in man.

Leprosy. Leprosy is caused by an exceedingly slow-growing bacillus that is similar in many ways to the bacillus of tuberculosis. The germ probably gets into the body by being inhaled, or through wounds, or possibly by the bite of the mosquito. It is estimated that there are 500 lepers in the United States. Many of them are not in quarantine, and it is probable that the number of cases in our country is increasing. A national hospital that will take care of the lepers from all the states is being built.

Typhus fever. Typhus fever is a very severe disease that was formerly known as ship fever, or jail fever. It has disappeared from the United States, except for occasional cases in our seaports or on the Mexican border, or in the crowded parts of our cities. It is still common in the higher regions of Mexico, in the Balkan countries, and in many other parts of the world, and our health officials must keep a constant watch to prevent its gaining a foothold among us. The germ lives in the blood, and the disease is spread by the bite of the louse, especially the body louse. During the great war typhus fever and other infections spread by the louse caused a million deaths.

Rocky Mountain fever. This is a severe disease found in the northwestern parts of the United States. It is contracted from the bite of a tick, but it is not known where the ticks get the germ. When ticks attach themselves to sheep they are killed by the oil on the wool, and by the pasturing of sheep the number of ticks can be greatly reduced in the regions where this disease is prevalent.

Infectious jaundice. This is a communicable disease in which the patient becomes yellow in color. Occasional cases and sometimes local epidemics of it occur in our country. It is common in Japan, and it proved troublesome in the trenches during the recent war. The germ lives in both man and the rat and leaves the body in the discharges from the kidneys and the bowels. It can be transferred from one person to another as typhoid germs are transferred, or the disease can be contracted from foodstuffs that have been infected by rats. Many wild rats carry the germs, and it is dangerous to allow food stuff to be soiled by them.

Rat-bite fever. Another germ disease that is contracted by man from the rat is rat-bite fever. The incubation period is from 10 to 20 days, and the wound is often healed before symptoms of the fever appear. A wound made by the teeth of a rat should be disinfected to kill any germs that may have been left in it.

Rats are unclean, insanitary, and destructive, and they should not be allowed about human habitations or where human foodstuffs are kept. Directions for rat-proofing buildings may be obtained from the United States Department of Agriculture or from the United States Public Health Service.

Other germ diseases. There are many other diseases that are caused by germs. Among these may be mentioned cholera; dengue ("break-bone fever") and yellow fever, both of which are spread by mosquitoes; trench fever and relapsing fever, that are carried by the louse; and the fatal sleeping sickness of Africa. Germs also cause many diseases of animals, among them cholera and plague in hogs; roup, white diarrhea, and cholera among fowls; distemper in dogs and horses; glanders among horses and men; black-leg in cattle; and anthrax in a number of domestic animals and in man. There are also many other germ diseases of men and animals in the tropics, and bacteria cause a great number of rots and other diseases of plants.

Disease caused by fungi. Many diseases of plants — rusts, smuts, mildews, many of the rots, and various other diseases — are caused by plants (*fungi*) that are similar to molds. These fungi are much larger than bacteria, their bodies being composed of long, threadlike filaments.

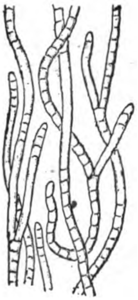


FIG. 70. The fungus that causes ringworm.

A few fungi grow in the human body, especially in the skin and lungs. Among the diseases caused by them may be mentioned ringworm, barber's itch, a white growth in the mouths of babies called thrush, and a considerable number of cases of diseases of the lungs. Lumpy jaw in cattle is also caused by a fungus, and this disease may attack man.

Certain yeasts (similar to the yeast used in bread making) also grow in the human skin and lungs, and in not a few of the patients that are being treated for tuberculosis the cause of the disease is fungi or yeasts and not the tubercle bacillus. This is true especially of millers and of those who have worked with grains. When the sputum of a consumptive does not show the tuberculosis germ, a search for yeasts and fungi should be made.

A very serious tropical disease called "sprue" is believed to be caused by a yeast. In this disease there is a sore mouth, a severe and chronic diarrhea, and great loss of weight and strength. In Porto Rico sprue is one of the most important diseases, and some cases of it are found in the southern part of the United States.

POINTS TO BE REMEMBERED

1. Acute rheumatism is due either to a variety of streptococcus or to an undiscovered germ.
2. Chronic rheumatism is caused by bacteria of the streptococcus groups. In many cases the germs come from chronic infections in the tonsils or other parts of the body, and these breeding places should be broken up.
3. Pyorrhea, a disease of the teeth, is caused by germs, and it should be treated by a dentist.
4. Foot-and-mouth disease attacks animals and man and is very infectious; the germ is unknown.
5. Leprosy is caused by a slow-growing germ that is similar to the tubercle bacillus.
6. Typhus fever is spread by the bite of a louse.
7. Infectious jaundice and rat-bite fever are contracted from rats.
8. Certain diseases of the skin and lungs are due to fungi and to yeasts.

CHAPTER NINETEEN

INTESTINAL WORMS

INTESTINAL worms are not germs, but like germs they prey on the body, and in some regions they are a serious cause of ill health. Since infection with them can be prevented by sanitary measures, we shall discuss briefly some of the kinds of intestinal worms that are found in the United States.

Tapeworms. The tapeworm gets into the body from "measly" beef or pork. To prevent infection with these worms, meat should be inspected by sanitary officers before it is sold and thoroughly cooked before it is eaten.

Roundworms. Roundworms are rather large, yellowish white worms, sometimes thicker than a lead pencil, and over a foot long. Examinations in other countries have proved that from 10 to 40 per cent of the people are infected with roundworms. They are less common than this in the United States, but many persons, especially children, suffer from them. The eggs develop in the soil into small worms, and it is probable that these are usually swallowed in water. The way to check the spread of roundworms is to prevent the pollution of the soil, for the eggs that cause the trouble are spread only by infected human beings.

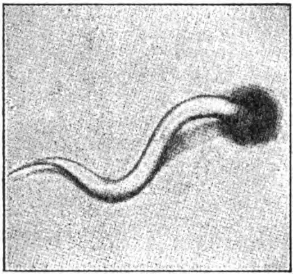
Whipworms. The whipworm is a slender, white worm nearly two inches in length. The eggs get into the body by being swallowed. In some parts of Europe from 10 to 30 per cent of the people are infected, and it is known that whipworm infection is not at all uncommon in the United States.

Pinworms. The pinworm is a small, white worm that grows mainly in the lower part of the large intestine. Pinworms most commonly infect children, and cause severe itching and nervousness. The eggs are often on the hands of infected children; they may get into drinking water; or children, by playing in polluted soil, may get the eggs on the hands and into the mouth. Children that are infected should be treated, so that they may not infect others, and the soil about wells and houses should be kept free from pollution.

Hookworms. The hookworm is white in color, of the thickness of a moderate-sized sewing thread, and about one third of an inch in length. This worm is found in the warmer parts of the whole earth; Africa, India, China, Porto Rico, Guiana, Colombia, the Philippines, and many other places are heavily infected with it. Of more than 700,000 persons examined for hookworms in the southern part of the United States, 35 per cent were found to be infected, and a number of cases of hookworm disease are found as far north as southern Indiana and southern Illinois.

The eggs of the hookworm pass out of the body in wastes from the intestines and hatch in the soil. Sometimes the young worms enter the body by being swallowed in water or in food eaten with unwashed hands. Usually they bore through the skin (causing "ground itch" or "toe itch"), are carried by the blood to the lungs, work their way into the air passages and up the trachea to the throat and reach the intestine by being swallowed. The hookworm feeds on blood which it draws from the intestinal wall, and the most common symptom of hookworm disease is lack of strength and energy for work. Patients suffering from hookworm disease can be cured by the use of very simple medicines.

Away from the air, or in very wet soils, the eggs of the hookworm die, and the disease can be entirely prevented by the use of closets. Great care should therefore be taken to prevent the pollution of soils about houses. To a great extent children may be saved from infection by the wearing of shoes; but keeping the soil free from pollution is the important measure in the prevention of hookworm disease. The methods of preventing hookworm infection and the means of curing it are now well known, and in those states where the disease is prevalent the State Boards of Health issue bulletins that give full information concerning it.



International Health Board

FIG. 71. A young hookworm entering the mouth of a sweat gland. The worm and the pore of the skin are drawn to the same scale.

POINTS TO BE REMEMBERED

1. The tapeworm enters the body in beef or pork that has not been thoroughly cooked.
2. The eggs of other intestinal worms are found in the body wastes.
3. Roundworms, whipworms, and pinworms enter the body by the mouth.
4. Hookworms usually enter the body through the skin.
5. Persons infected with intestinal worms should be treated for them.
6. A safe disposal of body wastes will prevent infection with most kinds of intestinal worms.

CHAPTER TWENTY

OUR DEFENDERS FROM THE GERMS

THE United States is a vast empire which stretches from the Atlantic Ocean on the east to the great Pacific on the west, and from the shores of the warm gulf on the south to the blue lakes and evergreen forests of the distant north. It is a land of great mountain systems and of scores of mighty rivers running from them to the sea; a region of unequaled resources in timber, minerals, coal, and oil, and surpassing all other portions of the earth in the richness of its soil. It is a goodly land, and in it a busy people lives, tilling its fertile and well-watered soil, digging out its stores of coal and iron, tapping its treasures of gas and oil, working in hundreds of factories to turn raw materials into articles for the use of man, and shipping the products of factory and farm to all parts of the earth. Truly it is a fair land, and fortunate are the people who have made it their home.

Disease germs in the United States. Are the people of this rich country able to work in security and peace? Or are there enemies that harass them? They are in the same situation as the inhabitants of all other parts of the earth in that their territory is invaded by small foes that attack many of them each year. Every year more than 500,000 citizens of the United States are slain by germs, and millions of others are laid on beds of sickness and pain by these unseen foes.

Our protectors from the germs. Because health is the greatest of all treasures, it follows that one of the greatest duties of the government is to care for the health of its citizens. To do this there must be public health officials who have authority over all the people, and this is especially necessary in the prevention of infectious diseases, because a private citizen cannot control his neighbors' germs or protect himself from them. On account of these facts, the people of the United States

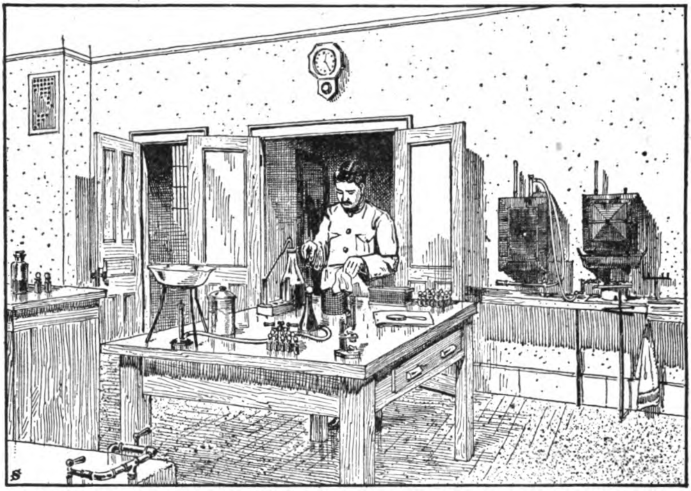


FIG. 72. A bacteriologist at work in the United States Hygienic Laboratory, Washington, D. C.

have public health officials, whose most important duty is to protect the citizens of the country from germs. Some of these officials are employed by the national government, some by the state governments, and some by cities and counties.

National public health officials. The chief of the national health officials is the Surgeon-General of the United States Public Health Service. He lives in Washington, and from his offices directs the work of his assistants. One of the chief duties of these officers is to see that epidemic diseases like plague, cholera, and yellow fever are kept out of the country, but they also make investigations as to the best ways of preventing illness, educate the public in matters of health, assist state and local health officials in times of epidemics, and in general oversee the sanitary work of the country.

State health officials. The principal health officer of a state is usually the Secretary of the State Board of Health, or the State Commissioner of Health. He has his offices at the capital of the state, and, with his helpers, plans the fight that the state makes against the germs. It is the duty of the state health officials to advise the legislature as to what laws are needed to carry out their plans; to go to the help of communities that are threatened with epidemics; to prepare bulletins and in other ways to educate the people concerning hygienic matters; and in every possible way to promote health among the citizens of the state.

The laboratories of the state departments of health. A very important part of the work of the state departments of health is carried on in their laboratories. To these laboratories physicians send from all parts of a state cultures from the throat to be examined for diphtheria germs, sputum to be examined for tubercle bacilli, and blood to be examined for malaria germs. Workers in these laboratories also test the blood from typhoid-fever patients, make anti-typhoid vaccine, examine the brains of dogs supposed to have had rabies, give the Pasteur treatment, examine milk, foods, drugs, and water, and carry on many other lines of work.

City and county health officers. In addition to the national and state health officials, the people employ city and county health officers to assist them in their

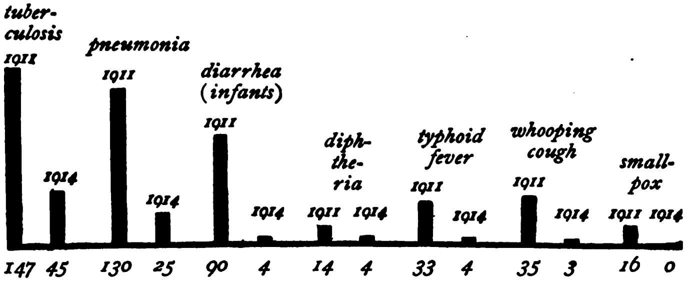


FIG. 73. In March, 1912, Robeson County, North Carolina, appointed a physician to give his whole time to looking after the health of the people. The diagram shows the number of deaths from certain diseases in 1911, the year before the health officer began work, and in 1914, after he had been at work three years. Fifty-five per cent of the people in the county are colored.

fight against the germs. These officials are on the firing line; they are appointed to find the enemy and fight him off from his prey. All these officers in a state are under the State Department of Health, and one great work of the state and national officials is to unite the health workers in a concerted attack on the foe.

The need for full-time county health officers. People in rural districts are not crowded together as they are in cities, and there ought to be few cases of infectious diseases in the country. This is not the fact; germ diseases are as common in the country as they are in the city, and the reason is that the cities have the services of skilled health officials, while in many places the country people are getting little benefit from the great sanitary discoveries that have recently been made. In every county in the United States there should be a high-grade health officer who would give his whole time to saving the people from disease. Figure 73 shows the results secured by one North Carolina health officer who spent his time in this way.

Reënforcements needed for our health workers. "Public health is purchasable." Each community can determine for itself what its death rate from germ diseases will be.[1] Give the health officers a certain amount of money, and with it they will save a certain number of lives. According to careful estimates, easily preventable diseases are, at the present time, costing the United States $3,000,000,000 a year. When the citizens of the United States choose to spend any reasonable part of this sum for health work, the ravages of these diseases will be stopped.

FIG. 74. Louis Pasteur. More than any other one man he made clear to us the nature of germ diseases and pointed out ways by which these diseases can be prevented.

More knowledge of infectious diseases needed. The discovery that illness is due to germs is comparatively recent, and our knowledge of infectious diseases is still far from complete. It is probable that there are many infections that are not yet recognized. In some

[1] In Minnesota the courts have decided that any one who contracts disease from impure city water can collect damages from the municipality that furnished the water. The supreme court of Wisconsin has decided that when a workman contracts typhoid fever from drinking the water furnished in a factory, the employer is liable for damages. The time will probably come soon when any one who suffers from an epidemic disease will be able to collect damages from the public for the attack.

cases we may be calling several diseases that produce similar symptoms by one name, and when from time to time a person is indisposed without any seeming reason, he may be suffering from an infection that has not been recognized and named. Every health officer has in mind a hundred questions that should be investigated to enable him to do his work in the simplest, surest way. It is very important to apply the knowledge that we now have in disease prevention, and it is also most important for us to secure new knowledge that will enable us to attack our health problems in new ways.

We know how this knowledge can be obtained. Cities and states and the nation must appropriate money for research so that investigators can give their time to a study of our health problems. The French people gave Louis Pasteur a laboratory and supported him while he was making his great discoveries, and if they had not done so it is probable that these discoveries would not have been made. It is study and not the passage of time that gives us new knowledge.

POINTS TO BE REMEMBERED

1. Although the United States is a great and fertile country its people do not live in complete security.
2. This rich country has been invaded by disease germs.
3. To protect themselves against germs, the people have appointed health officers.
4. Everywhere the health workers need reënforcements, and there is special need for full-time health officers in the rural regions.
5. There is great need for further study of health problems.

CHAPTER TWENTY-ONE

VITAL STATISTICS

A BUSINESS man who attempts to run a factory or a store needs a set of accounts to give him information about his business. For the same reason a health officer must have for his work a set of records that will give him information about the diseases with which he is dealing. For this reason health authorities keep records of all births, deaths, and marriages, and they require that all cases of certain diseases be reported to them. These statistics that relate to the lives and health of the people are called *vital statistics* and the collection of them is a most important part of a health department's work; for by studying his vital statistics a health officer can tell what diseases are most important, where they are most prevalent, when an infectious disease is in a community, and whether the efforts that he is making to promote health are having any effect.

How death rates are calculated. If you should examine the report of a health officer, you would probably find in it death rates for the month or year for the city or state as a whole, and death rates for different diseases. At first these death rates may seem a little confusing, but when we understand how they are calculated they are in reality very simple. *The death rate of a country means the number of deaths in that country for each* 1000 *inhabitants.* In 1915 the death rate in the United States was 13.5 for that part of the country in which vital statistics are kept. For the same year it was 15.7 in England and Wales, 9.1 in New Zealand, 14.6 in Sweden, 17.6 in Ireland, and 22.3 in Spain.

The death rates that are given for different diseases mean the number of deaths caused by these diseases for each 100,000 population. On page 133 the death rates in certain places from a number of common diseases are given.

How to study vital statistics. The best way for you to begin the study of vital statistics is to examine the figures for your own county or town and then compare them with figures from other places. Make a table showing the number of deaths from some common infectious diseases and compare them with the figures from other places. If typhoid fever is common, the water or milk supply is probably bad or the sewerage system needs attention. If the death rate from diphtheria or scarlet fever is high, the cases are not being isolated and quarantined as they should be. Make a list of the sanitary measures that you think would most improve the health of your county or town.

Reporting cases of infectious diseases. All cases of infectious diseases should be reported to the health officers.[1] Then the officers can know whether children are attending school from a house where there is scarlet fever or measles; they can make sure that cases of whooping cough and diphtheria are quarantined; they can see that the wastes from typhoid fever patients are destroyed: and in general they can keep infectious diseases from spreading from the cases that are in the community.

[1] The laws of most states require that cases of the following diseases be immediately reported to the local health officer: yellow fever, smallpox, diphtheria, membranous croup, scarlet fever, measles, infantile paralysis, meningitis, cholera, typhus fever, plague, leprosy, consumption, typhoid fever, chicken pox, trachoma, pellagra, and certain other diseases. The physician is required to make the report, or the family in case no physician is in attendance.

DEATH RATES IN THE UNITED STATES

	General Death Rate	Typhoid Fever	Malaria	Smallpox	Measles	Scarlet Fever	Whooping Cough	Diphtheria and Croup	Tuberculosis (All Forms)	Tuberculosis of the Lungs	Meningitis	Pneumonia (All Forms)	Diarrhea and Similar Diseases (In Children under 2 years of Age)
United States: Total	13.9	13.3	3.0	0.2	11.1	3.3	10.2	14.5	141.6	123.8	7.1	137.3	65.6
White	13.5	11.9	1.7	0.1	11.2	3.4	9.2	14.8	127.1	110.5	7.0	132.0	64.4
Colored	20.5	33.5	21.8	0.4	9.8	1.1	23.8	9.2	346.9	312.7	8.5	212.0	82.0
Indiana	13.6	21.5	1.4		7.3	3.7	9.3	13.9	136.0	115.5	5.5	114.3	62.6
Kentucky	12.6	31.0	6.4	0.2	7.9	2.4	13.4	17.1	194.4	170.5	12.1	110.7	49.9
White	11.6	29.0	5.4	0.2	8.4	2.5	12.1	17.7	163.2	141.5	12.3	101.9	49.6
Colored	21.3	47.7	14.9		4.0	0.8	24.2	12.5	463.4	420.9	10.5	187.0	52.9
North Carolina	13.1	29.2	14.0	0.5	7.1	2.6	16.7	17.1	148.9	134.9	9.8	104.8	77.9
White	11.4	22.6	9.2	0.3	6.9	3.5	10.7	20.0	103.5	92.0	9.9	84.1	74.5
Colored	16.8	43.8	24.6	1.1	7.6	0.5	29.9	10.6	248.5	228.9	9.4	149.9	85.2
Pennsylvania	14.6	13.6	0.2		18.1	2.8	12.2	19.4	130.1	112.3	8.0	167.7	101.7
Washington	7.7	5.1	0.1	0.1	5.5	0.8	5.0	2.4	81.3	66.5	3.5	53.4	11.1
San Francisco	15.4	3.5	0.9		1.3	1.7	3.9	28.3	193.6	169.4	4.5	129.0	18.1
Chicago	14.5	5.2	0.2		5.4	6.4	4.0	31.5	150.2	132.8	7.5	158.1	141.4
St. Louis	14.9	9.4	1.6		8.8	6.3	9.8	20.9	144.9	129.0	6.6	173.5	49.9
New York City	13.9	3.9	0.3		9.9	2.2	6.9	18.5	173.7	154.9	5.7	179.9	58.1
Your state													
Your city													

The general death rate shows the number of deaths from all causes for each 1000 inhabitants. The death rates for the different diseases show the number of deaths from each of these diseases for each 100,000 inhabitants. Where more than ten per cent of the population is colored, the white and the colored death rates are given separately. The figures given are for 1916.

Advantages to patients of having cases of infectious diseases reported. When cases of certain diseases like measles and whooping cough appear in families, the modern method of quarantine does not shut up those who have already had the disease, provided they keep away from the patient so that there will be no danger of their carrying the infection on their hands and clothes. It is certain that this principle of freeing the members of the family who will not become carriers of the germs will be much more extensively practiced in the future, and to be able to prove that a person has already had a disease may be the means of saving him from an annoying quarantine when he is busy at his work. For the sake of its own interests, therefore, each family should see that the health authorities have a complete record of all the infectious diseases that each member of the family has undergone.

POINTS TO BE REMEMBERED

1. Vital statistics are necessary to the health officer in his work.
2. Much may be learned about the sanitary conditions in different communities by comparing the vital statistics of these communities.
3. In preventing infectious diseases, reports of cases of these diseases are of great value.
4. Reporting cases of certain infectious diseases may later save the patients from troublesome quarantine.

CHAPTER TWENTY-TWO

PREVENTING CONTACT INFECTION

THE home of disease germs is in the human body, and in most cases they leave the body in the wastes from the bowels and in the secretions from the mouth and nose. Chiefly by the hands, and by water, milk, food, and flies, these germs reach the mouths of other persons. Recent investigations indicate that usually the transfer is quite direct; that it is by touching hands, using drinking cups and dishes, and in other similar ways that the germs come to us, and that "contact infection" must be blamed for most cases of diseases like tuberculosis, pneumonia, influenza, diphtheria, measles, and scarlet fever.

The importance of isolating germ carriers. Health officers are becoming more and more convinced that the way to prevent infectious diseases is to destroy the germs at their source; for if these are once allowed to be scattered abroad, it is impossible to block all the paths by which they may reach others. To destroy the germs at their source means that we must find the persons in whose bodies they are growing and prevent these persons from infecting others. Health officers are therefore each year spending more of their time in finding and isolating germ carriers. So important, indeed, do some health officers consider contact infection and so few cases of many diseases do they think come from houses, furniture, and clothes, that some cities have given up the disinfection of houses after diphtheria, measles, and scarlet fever.[1]

[1] The tubercle bacillus lives longer outside of the body than most other germs, and disinfection after cases of consumption is still everywhere advised.

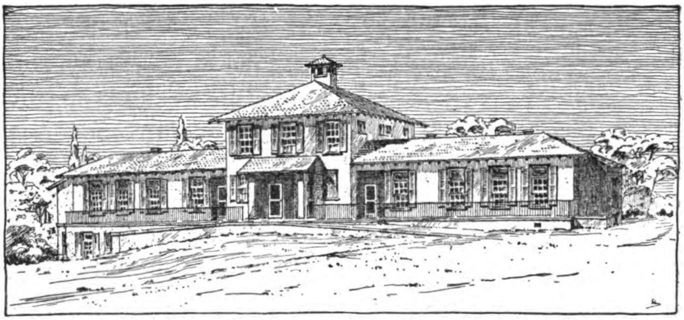


FIG. 75. Isolation hospital for cases of infectious diseases at Jacksonville, Florida. To prevent the spreading of germs within the hospital, the water faucets and doors are arranged so that they may be opened with the elbows. The windows are covered with full-length screens to keep out flies and mosquitoes, but there is no fear that the germs will travel through the air, and visitors are allowed to talk to patients through the windows.

The theory on which this practice is based is that when mucus and other matter containing germs is dried on desks, doorknobs, or other objects, the great majority of the germs quickly die; that the others are weakened by the drying and the light to which they are exposed; and that the small number of feeble germs that one would get from articles of this kind is not dangerous like the great number of fresh germs that one may receive directly from the patient himself or from something he has just handled.

Hospitals needed to prevent contact infection. Every city and every county should have a hospital to which cases of typhoid fever, pneumonia, scarlet fever, diphtheria, and other like diseases can be taken. Then the spread of the germs to other members of the families of the sick persons will be stopped; the interference with the business and work of the other members of the families by quarantine will to an extent be avoided; and the patients will be able to have the care of physicians and trained nurses at all times. This service ought to be paid for by the public; for it is the fault of the public when any one is attacked by a communicable disease. Smooth-running automobile ambulances now make it possible to move patients safely for long distances, and we should no longer attempt to take care of cases of infectious diseases on farms or in private houses.

The problem of mild cases and healthy germ carriers. The greatest difficulties experienced in controlling many infectious diseases have come from the fact that some cases are so mild that they are not recognized and that some persons who are themselves healthy carry the germs. In these diseases, even when every case that is reported is carefully quarantined, only a part of those who are infected with the germs are found, and through the undetected germ carriers the disease spreads on and on indefinitely. At first thought it would seem a hopeless task to try to check such diseases, but in reality this is not the case. These light cases ("missed cases") and healthy germ carriers are not scattered at random among the population, but are usually found among those who have been in contact with the disease.[1] A health officer who has the time and is trained for his work can find the germ carriers, and when these are found and isolated, the disease stops. The difficulty in controlling these diseases at present is that we have not

[1] When a case of diphtheria occurs in a school, the germ carriers will probably be found in the same room with the pupil attacked. Often they will be his special friends or those seated near him.

enough health officers to search out all the carriers of the germs.

Medical inspection in schools. One of the most effective measures for preventing contact infection is medical inspection of schools, because where this is practiced cases of infectious diseases are found in their early stages and are removed from school before the germs spread to others. Each morning the appearance of the pupils should be noted, and if any of them show symptoms of sickness, they should at once be sent home until it is known that they are not suffering from an infectious disease.[1] This is the only safe course; for after an infectious disease develops it is too late to prevent the spread of the germs.

FIG. 76. By medical inspection in schools, early cases of infectious diseases are discovered.

Disinfection. In certain cases of illness it is very necessary that the germs in the excretions of the patient be destroyed. The following are some of the best disinfectants for common use:

Hot water. Boiling water kills the germs of all common diseases, and handkerchiefs, dishes, and clothing that have become infected can be made safe again by boiling them. The surfaces of dishes contain tiny crev-

[1] Any pupil suffering with a severe cough or cold, *or who is obviously sick*, should be sent home without delay and the parents and health authorities notified.

ices in which germs lodge, and in disinfecting dishes with hot water, it is necessary to leave them for a few minutes in water that is boiling, so that the heat will reach the germs in the crevices.

Bichlorid of mercury (corrosive sublimate) dissolved in water, with one part of the bichlorid to a thousand parts of water (1 ounce to 8 gallons of water), kills nearly all kinds of germs in two or three minutes. This disinfectant can be purchased in tablets of the right size to make a pint or half a pint of the solution. For washing floors and furniture, and for disinfecting clothing that can be soaked in it, it is excellent. It destroys metals, and it is not good for disinfecting where there is much organic matter present, as there is in sputum and in the discharges from persons sick with typhoid fever or other intestinal diseases. It is very poisonous.

Biniodid of mercury is more than twice as powerful as bichlorid of mercury, and need be made only half as strong. It is especially useful in disinfecting the hands, since it does not injure the skin. It can also be used on metals.

Carbolic acid, made up in a 2½ per cent solution (3½ ounces of liquid carbolic acid to a gallon of water, or seven teaspoonfuls to a pint), is a good disinfectant. For disinfecting sputum and other discharges from the body, it is well to use a 5 per cent solution.[1]

Lysol is a stronger disinfectant than carbolic acid. It often destroys the colors in clothing. For sputum it is one of the best disinfectants.

[1] This and all other chemical disinfectants must be of full strength and used liberally if they are to do their work. At least as much of the disinfectant as there is of the matter to be sterilized should be used.

Chlorid of lime, used in the proportion of 4 ounces of chlorid of lime to 3 gallons of water, is a cheap and powerful disinfectant. It may be purchased in grocery stores, put up in tin cans under the name of bleaching powder. It cannot be used on colored clothing, and the solution must be freshly made. This is a cheap disinfectant and is often used in cases of intestinal diseases. The wastes should be thoroughly mixed with the disinfectant and allowed to stand for several hours to make sure that all the germs in them are killed.

Sunlight. Bright sunlight kills germs in a few minutes. It is one of the most powerful of all disinfectants, and in some hospitals the mattresses and blankets are now exposed to the sun instead of being sterilized by steam. This natural disinfectant should be used as much as possible. In rooms that require disinfection, the floors, furniture, and other articles in the rooms should be scrubbed with hot water and soap to remove the dirt that protects the germs.

Special points in disinfecting. Any one who gets his hands infected should wash them in a disinfectant before he allows them to touch his clothes, the furniture, or other objects in the room. There is no connection between the odor of a substance and its germ-killing power, and it is of no use to burn strong-smelling substances in a sickroom or to expose carbolic acid in a saucer to scent the air. When a room or building is to be disinfected, the health officers should be asked to do the work.

Unhygienic habits. Certain habits give germs an opportunity to pass easily from one person to another. Among these may be mentioned the habit of putting into the mouth pencils, coins, and other objects that have been in the mouths of others; the habit of using public drinking cups and unsterilized glasses at soda fountains; the habit of allowing the fingers to touch the face, eyes, and lips; the habit of eating without washing the hands; and the habit of spitting on sidewalks and in public places where the germs will be carried by the feet of passers-by into houses, stores, and offices. Most of these habits are unclean and should be given up for reasons of decency; but they are also most objectionable from the standpoint of health, and scores and hundreds of deaths are every year due to them.

FIG. 77. The hands should be thoroughly washed with soap and water before meals.

POINTS TO BE REMEMBERED

1. To prevent contact infection, germ carriers must be isolated.
2. Hospitals should be provided for patients suffering with infectious diseases.
3. More health officers are needed to find mild cases of infectious diseases and healthy germ carriers.
4. Medical inspection in schools is a great help in preventing contact infection.
5. Germs may be killed by heat, sunlight, or other disinfectants.
6. Certain unhygienic habits give germs an opportunity to pass from one person to another.

CHAPTER TWENTY-THREE

MILK AND OTHER FOODS AS CARRIERS OF GERMS

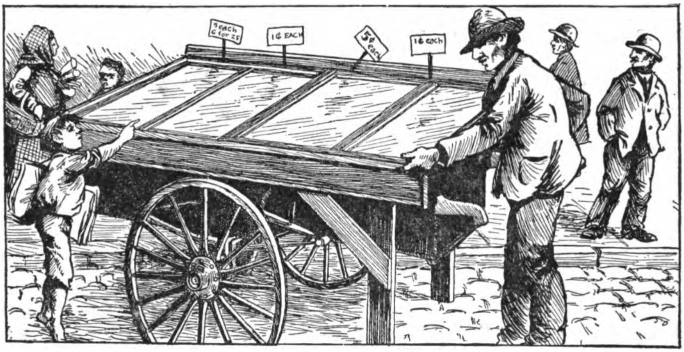


FIG. 78. A pushcart the contents of which are protected from the hands of the public and from flies. (*After a photograph by the New York City Board of Health.*)

ALL over the United States the farmers are producing food to be shipped to the cities. In every town there are milkmen, grocers, butchers, cooks, and waiters who spend all their time in handling foods. We find also that in every home the preparation of food for the family makes up a considerable part of the housework. All this food passes through the hands of many persons and then goes into the mouths of those who eat it.

Suppose some one who is handling food is ill of a germ disease. Will he infect the food with the germs? Are some foods more dangerous than others? What measures can we take to make what we eat safe from germs? These and other similar questions we shall study in this chapter.

Milk the most dangerous of all foods. Milk more nearly than any other food resembles the lymph in which our cells are bathed, and in milk a number of different kinds of germs can grow. As we have already learned, tuberculosis is sometimes contracted from milk, and again and again it has been found that along the route of a certain milkman the people were suffering from typhoid fever, scarlet fever, diphtheria, or tonsillitis and sore throat. When these epidemics are investigated, it is found that a case of the disease exists among those handling the milk or in their families; or that the bottles have been taken back from houses where the disease is present; or, in epidemics of typhoid fever, that the milk vessels have been washed in water containing typhoid germs; or that in some other way the germs are getting into the milk. A bulletin of the United States Public Health Service records 260 epidemics, affecting 11,360 persons, that were traceable to milk. Of these, 179 were typhoid epidemics, 51 were epidemics of scarlet fever, 23 were diphtheria epidemics, and 7 were epidemics of sore throat. There is little doubt that influenza and pneumonia germs also are carried in milk, and now a health officer is often far more concerned about the milk supply than the water supply of his town.

Preventing the spread of disease germs by milk. Formerly health officers tried to prevent milk-borne epidemics of infectious diseases by making regulations that would allow only clean and sweet milk to be sold. These regulations are good; for we do not wish to use dirty milk or milk that is old and full of bacteria. At the same time, all the care possible in these respects has not given us milk that is safe for use; for at any time, on any of the many farms where milk is produced or among any of the many persons who handle it, some sick person or germ carrier may infect it with deadly germs, and all the cleanliness in the world is no protection against a happening of this kind.[1] For this reason, leading health authorities recommend that milk be pasteurized before it is sold, and New York, Boston, and many other cities require by law that this be done.

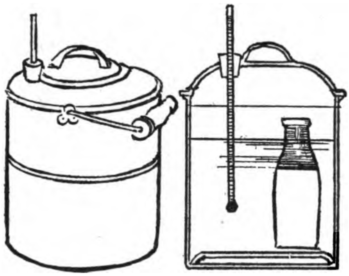


FIG. 79. A vessel arranged for pasteurizing milk. Very convenient pasteurizers for use in the home may be purchased at a low price.

The pasteurizing process. Boiling milk changes some of the substances in it, but if the milk is heated to 150 degrees for fifteen minutes these changes are to an extent avoided and any germs in it are killed.[2] This fact was discovered by the great scientist, Pasteur, and the process is therefore called *pasteurization.* Where raw milk only can be purchased, it may be pasteurized in the home, and it is advisable to do this unless a supply from a very safe source can be secured. After pasteurization milk should be quickly cooled; for the spore-producing bacteria in it are not killed and they will grow and spoil the milk if it is kept warm.

Milk and cholera infantum. Many cases of cholera infantum are caused by bad milk.[3] Often the disease

[1] Many of the harmless bacteria cause milk to sour or give it a bad odor, but disease germs give us no warning of their presence in milk.

[2] The milk itself must be heated throughout to 150 degrees, and not merely the water in which the vessel containing the milk is set.

[3] Of 9111 infants who died in a European city during 1906, only 844 had been fed entirely on their mothers' milk.

does not seem to be due to any one special germ (page 76), but the trouble comes from the enormous number of many different kinds of bacteria that are in the milk in hot weather. Only pure milk is a fit food for babies, and milk that is filled with a multitude of bacteria and the acids and other products that they form in milk is unsafe for a child. *Cleanliness* to keep bacteria out of milk, and *cold* to keep them from growing in it, are the two important points in the care of milk, and the fresher the milk is when it is used, the better. A few infants do not digest pasteurized milk as well as they do raw milk, but in most cases ordinary milk is improved for infant feeding by pasteurization. Other important points in the prevention of cholera infantum are: the thorough washing and scalding of milk vessels and bottles; giving only pure water to the child; keeping from it any indigestible foods that may form a breeding place for bacteria in the intestine; and keeping up the child's resistance to germs by giving it all the fresh air possible and by protecting it from the heat. Flies are especially likely to spread cholera infantum, because napkins from children sick with the disease are often exposed to them.

Germs in other foods. Germs may be carried on vegetables that have been grown in polluted soil; or they may get into food from flies, from animals, from washing the food in impure water, or, most commonly of all, from the hands of those who touch it. Any food that is cooked will have the germs in it killed by the heat, but fruits and other foods that are eaten without cooking may be a cause of disease. The wise person buys from a store where the food is protected from flies, and he does not buy any food that has been fingered over and handled by the public; for with such food there is always danger that disease germs may have been left on it from the hands of some germ-carrying person.

Danger in sick persons handling food. The New York City health authorities examine the cooks and waiters in hotels and restaurants to see that they are free from infectious diseases. This is reasonable; for if a sick person handles dishes and food, he is sure to leave germs where they will go straight into the mouths of others. In public eating houses the dishes and glasses ought to be washed in boiling water to keep the patrons of the place from exchanging germs, and not only in hotels and restaurants, but also in dairies, creameries, bakeries, and stores where food is sold, persons who are carrying the germs of infectious diseases ought not to be employed.

FIG. 80. Persons who handle food should not be carriers of germs.

POINTS TO BE REMEMBERED

1. Many epidemics of infectious diseases are due to germs that are spread in milk.
2. Milk should be pasteurized to kill these germs.
3. Cleanliness and cold are important in the care of milk.
4. Food should be protected from flies and from the hands of the public.
5. Germ carriers should not be permitted to handle food.

CHAPTER TWENTY-FOUR

FLIES AND HUMAN WASTES

THERE is a belief among some persons that flies are useful because they feed on waste. No greater mistake could be made. Flies are hatched in filth, their chief food is the intestinal wastes of animals and men, and where closets are left open they continually pass back and forth between these and our dishes and food. There is nothing more unclean than to live among a swarm of flies, and we now know that they are a most important agency in the spread of disease.

Kinds of germs carried by flies. Flies may get germs on their feet by walking on the skin of a patient who has smallpox, measles, scarlet fever, or erysipelas; they are certain to become infected if they are allowed to feed on the sputum of a consumptive or of a pneumonia, influenza, or diphtheria patient; and the wastes from typhoid, dysentery, and cholera infantum patients must not be exposed to flies or the life of every one in the neighborhood may be endangered. Not only are germs carried on the feet of flies, but when a fly feeds on matter that contains disease germs, the germs are found in the matter that comes from its alimentary canal. There is, therefore, no reason why a fly that walks over or feeds on matter containing the germs of any disease may not spread abroad those germs.[1]

[1] A study of 415 flies showed them to be carrying from 550 to 6,600,000 bacteria. The average was 1,250,000. Living typhoid bacilli have been found to remain in or on the bodies of flies for 23 days and tubercle bacilli for 15 days. Typhoid germs and tubercle bacilli have been found in fly specks, and in one speck left by a fly that had fed on the face of a leper, 1115 leprosy germs were counted.

The life history of the fly. The egg of the housefly is laid in manure (chiefly in horse manure, and almost entirely in fresh manure), and to some extent in dry closets, garbage, and decaying vegetable matter. In a

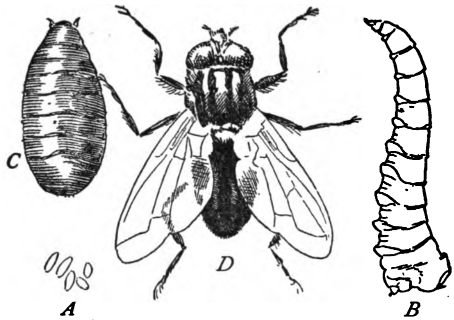


FIG. 81. The life history of the fly. *A* shows the eggs; *B*, the larva or maggot; *C*, the pupa; and *D*, the adult fly.

day or less the egg hatches into a small, white, footless maggot, which usually in from eight to twelve days from the time the egg was laid changes into the adult fly.

Removing the breeding places of flies. It is estimated that three hundred flies may hatch in a cubic inch of manure, and if the breeding places are left undisturbed, flies will hatch faster than it is possible to kill them. It is possible, however, to stop their increase by removing, daily, all matter in which they breed, and burying it or spreading it on the fields where it will dry and the eggs and young of the fly will be killed.[1] They can

[1] Floors of stables must be made of cement or other tight material; otherwise the flies will hatch in the crevices and in the earth that becomes soaked with the liquid manure. Storing manure in covered boxes or barrels to keep the flies from laying their eggs in it has not been successful; for usually the eggs are laid in the manure before it is removed from the stalls, and if it is stored, these eggs will hatch unless they are killed by lime or some other substance.

also be kept from breeding in manure by covering it with lime, or sprinkling it with borax or a solution of hellebore in water.[1] A very effective maggot trap can be made by building for the manure a wooden platform with crevices between the boards, over a shallow concrete tank of water. Practically all the maggots will fall through and be drowned.

Killing adult flies. It is important to destroy flies that are already hatched; for the same flies may remain about a house all summer unless they are trapped or killed. The giant fly traps that are now bought or made, fly paper, poisons, and the fly swatter are all useful in ridding a house of these pests.[2] In the country and in most small towns screens are necessary, and they should be fitted with care so that they will do their work. When any flies at all are in a house, a baby should be screened from them, for not only will it be continually annoyed by flies crawling over it, but it may have dangerous germs left on its face. The milk and bottles of a baby should also be protected from flies (page 76).

The need of more care in the disposal of human wastes. It is the exposure of human wastes that makes flies dangerous, just as it is the pollution of water by these wastes that makes water a carrier of disease. The proper disposal of human wastes is, therefore, one of

[1] A bulletin giving full directions for doing this may be obtained from the United States Department of Agriculture, Washington, D.C.

[2] The following hints may prove useful in the warfare on flies: Hang screen doors to open outward and rub them with a cloth dipped in kerosene or carbolic acid solution; make tops of traps of wire or glass so that the flies will come up to the light; use bananas or bread and milk for bait; take away water and food, so that the flies will come to traps or materials placed for them; mix finely ground black pepper with hard-

the greatest of all sanitary problems. In our own country this problem is far from solved, for we have hundreds of thousands of farms that are still without closets, and in villages, school grounds, church yards, and beside country homes there are thousands of open closets still in use.[1] Any one who understands the habits of the housefly — how day after day it passes back and forth between these places and dining rooms and kitchens — knows that as long as such a condition continues, not even a beginning in sanitation and hardly a beginning in decency has been made. Because of our carelessness and uncleanness in these matters we pay a terrible toll of deaths from intestinal diseases, and it cannot be too strongly insisted upon that one of the first and most important of all sanitary measures is to provide a safe means of disposing of human wastes. On farms and in small towns in particular a reform in this matter is necessary, and it would be for the public welfare if our laws required that a sanitary toilet arrangement

FIG. 82. Diagram showing the death rate from typhoid fever in Jacksonville, Florida, in 1910 and in 1913. In 1910 there were 8500 open closets in the city. By 1913 these closets had been screened against flies.

boiled yolk of egg or add a tablespoonful of formalin to a pint of milk and expose the mixture to flies. Neither the pepper nor the milk with the formalin in it is poisonous to children or animals. The milk placed on porches where flies gather is particularly effective on hot, dry days. When a porch is screened, the door should be at a point where the flies do not gather.

[1] Of 189,586 country homes inspected by the Rockefeller Sanitary Commission, 95,988 had no closets at all and 87,156 others had open closets that allowed the wastes to spread freely over the soil.

should be a part of every human habitation in the land.[1] Figure 82 shows the importance of a safe method of disposing of wastes; there were no changes in the sanitary conditions other than the screening of the closets, that would account for the fall in the typhoid death rate there shown.

Water sewerage. Water sewerage is the only satisfactory method of waste disposal that has been found, and every town should construct a sewer system at the earliest possible date. Every farmer also, as soon as he can afford it, should install one of the small water and sewerage systems that are planned for single houses.[2] This will give his family one of the great comforts of city life and will be the most important step that he as an individual can take to protect the members of his family from disease.

Dry closets. Where water and sewers cannot be had, dry closets must be used to care for human excrement. These may be built over pits or vaults, or a pail system may be used. The health authorities should be consulted as to the best type of closet for the soil and location where it is to be placed, but whatever kind is

[1] The International Health Commission suggests that if nothing better can be provided, an outdoor closet may be made by placing in the forest or among bushes a box turned mouth down over a small pit. The box can be made fly-tight by banking the earth around it and covering the opening, and this is the most important point in the construction of a closet.

[2] The United States Public Health Service, Washington, D.C., issues a bulletin giving plans for the building of a sanitary closet. The United States Department of Agriculture publishes a bulletin entitled "Conveniences in the Home" that will also be found useful to any one planning a water or sewerage system for his home; and nearly every state board of health issues bulletins dealing with these very important subjects.

used must be made fly-proof if it is not to be a source of disease. In towns the pail type of closet has been most successful. Where this is used, the town should provide a wagon or cart to empty the pails at regular times; for it is unsafe to use matter from closets as a fertilizer in gardens; it is dangerous to bury it in back yards where there are wells in the vicinity; and it is a waste of money to require each separate family to pay for the hauling away of this material when the town authorities can have the work done for all the people at a small fraction of the cost.

POINTS TO BE REMEMBERED

1. Flies are very unclean and can carry almost any kind of disease germs.
2. Flies should not be allowed about sick people or about the wastes from the sick, nor should they have access to any human wastes.
3. Flies breed in manure and in other waste matter.
4. These breeding places should be removed.
5. Adult flies may be destroyed by traps, fly paper, poisons, and fly swatters.
6. More care should be taken in disposing of human wastes.
7. Water sewerage is the most satisfactory method of disposing of these wastes.
8. Where sewerage cannot be had, sanitary dry closets should be built.

CHAPTER TWENTY-FIVE

PREVENTING GERM DISEASES

We have now finished our study of disease germs. We have learned where they live and the paths by which they reach us, and we have seen that it is possible to prevent much of the sickness that they cause. Exactly what must we now do to rid ourselves of the communi-

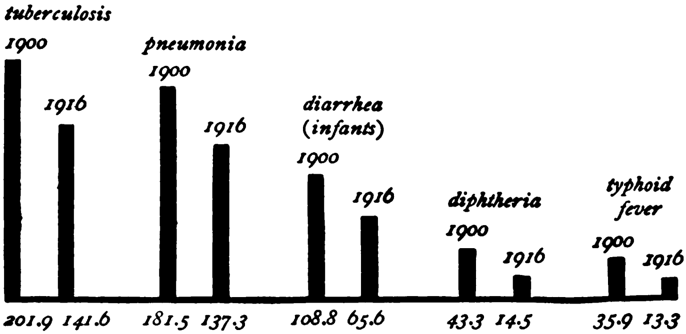


FIG. 83. Diagram showing the death rates (number of deaths per 100,000 inhabitants) from certain infectious diseases in 1900 and in 1916 in the part of the United States where vital statistics are kept. Sanitation is now saving tens of thousands of persons from dying of these diseases each year, and our health officials know how to save tens of thousands more.

cable diseases that are still among us? In order that we may approach this most important question more intelligently let us return to some subjects that we have already discussed.

The nature of disease germs. Suppose that you could put on a pair of spectacles that would magnify ten thousand diameters, and had a pneumonia germ and a diphtheria germ lying on your desk so that you could examine them. The pneumonia germ would appear about the size of a small marble; the diphtheria germ would have about the same thickness, but it would be perhaps an inch and a half in length. Both germs would be made of soft material like the white of an egg inclosed in a thin membrane, or sac. They would have no feet to walk with, no wings to fly with, and as long as you did not touch them there would be no danger of their getting to you.

Suppose now that you should put one of these germs into warm beef broth or into milk. It would take in certain elements from the beef broth or milk for food, would grow longer, and in ten or fifteen minutes it would pinch in two and a new germ would be born. If you should set the liquid in which the germs were growing on ice, they would practically cease their growth, but they would not die. If you should heat the liquid and watch the germs as the temperature ascended, you would see that at about 140 or 150 degrees the material of which they are composed hardened as the white of an egg hardens in hot water, and the germs would be dead. If you should take the living germs out of the liquid and let them dry, they would die as an ordinary plant dies when it is dried; and if you should allow the bright sunshine to strike them, they would be killed at once.

This is the kind of little creatures we must deal with when we engage in sanitary work. Their home is in the body, where it is dark and moist and warm, and to keep the race alive they must pass from person to person in a way that will protect them from the dangers of the outside world. If the passage of germs from one person to another could be prevented for one month, many of our diseases would be no more.

Two public measures necessary to control infectious diseases. We cannot live among other persons and

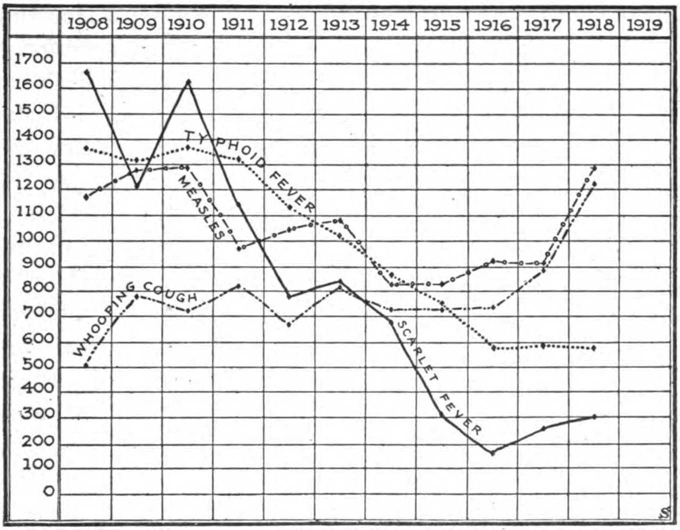


FIG. 84. Diagram showing the number of deaths in New York State from four diseases for a period of ten years. If the rate of decrease here shown for scarlet fever and typhoid fever should continue, how much longer would these diseases exist in New York? Note the upward turn of the measles and whooping cough lines when part of the health officials were called to war work.

touch the things that they have touched without at times getting on our hands and into our mouths the germs that come from them. For this reason, a private citizen cannot protect himself from germs, and we shall have infectious diseases until two great preventive measures are carried through by health officers who have behind them the authority of the government. *The first and most important of these preventive measures* *is to find and isolate the persons who are carrying the germs.* This our health officers can do when we give them helpers enough and funds enough for their work. At present, they can only check epidemic diseases and keep them under partial control. With enough force they could find every case and exterminate these diseases as a good farmer exterminates the last thistle on his farm.

The second great preventive measure is to block the chief paths by which the germs come to us. This we try to do by providing for a safe disposal of human wastes, by guarding the water, milk, and food supplies, and by fighting flies. By this plan the number of cases of germ diseases can be decreased, but less certain results are obtained than by isolating the people who spread the germs. We must use this method, however, for there are yet many germ carriers among us, and until they are removed we must guard ourselves as well as we can from the germs that come from them.

Effective lines of sanitary effort. Many persons still have an entirely wrong idea about where germs live and how they pass from one person to another, and they make many useless efforts to prevent the spread of infectious diseases. For example, when in 1916 there was an epidemic of infantile paralysis in New York City, the following suggestions were made for controlling the disease and protecting the children: flushing the streets; increasing the garbage-removing force; promptly collecting all dead animals; cleaning out the sewers; sweeping floors with moist paper or tea leaves and wiping off all woodwork daily with a damp cloth; bathing children several times a day; giving them no meat to eat; and opening new playgrounds so that children could

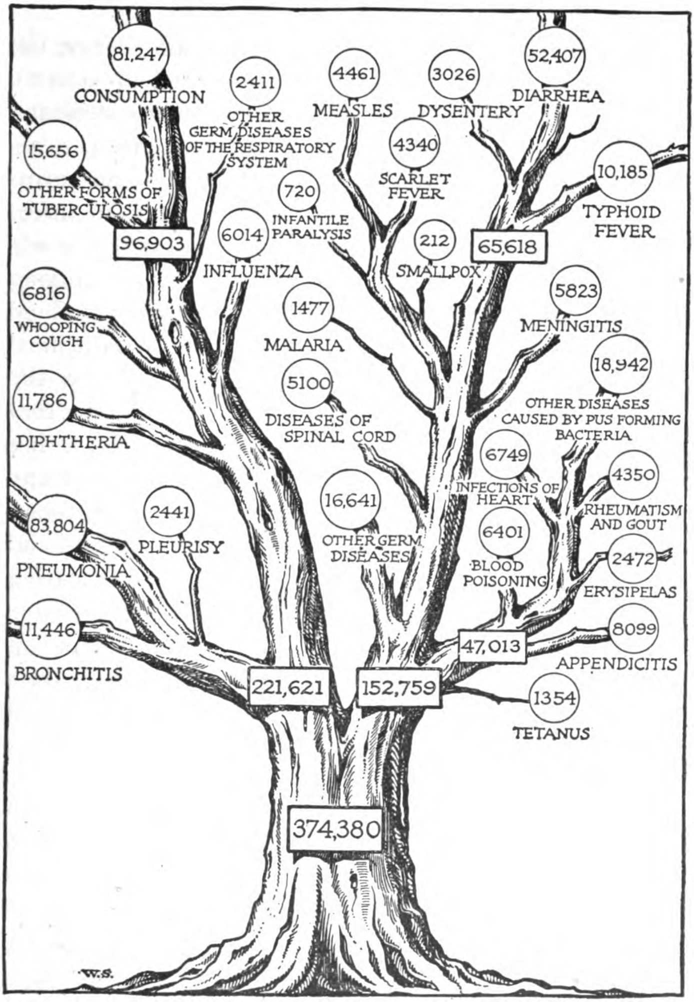


FIG. 85. Deaths from certain germ diseases in 1914 in the part of the United States where vital statistics are kept. With the knowledge that we now have it would be possible to prevent nearly all of these deaths.

spend more time in the open air. Needless to say, the carrying out of these measures would have helped in no way to control the disease, and it is well to understand the two errors that caused the advice to be given.

The first error is the belief that all dirt contains germs and that cleanliness will bring us freedom from infectious diseases. That this is a mistaken notion you will readily understand; you might live in a pigpen or among old shoes and boxes indefinitely without getting typhoid fever, and you might contract this disease from the most cleanly of persons if he happened to be a carrier of the germs. In our sanitary efforts we must remember that disease germs are delicate little beings fitted for life among our cells, and not hardy outdoor plants and animals like weeds and rats. We must not expect, therefore, to find them in ash heaps or piles of rubbish, and we cannot hope to prevent germ diseases by clearing away litter from back yards, gathering up papers from the streets, planting flowers in our parks, or hanging pictures on schoolroom walls. It is in the wastes from human bodies that germs are found, and it is against the spreading of these wastes that we must guard when we try to prevent germ diseases.

The other error that hinders us in the control of germ diseases is the stubborn idea that it is possible by a hygienic life to strengthen the body until it can resist ("throw off") all kinds of germs. We have already discussed this subject (page 94), but an understanding of the defenses of the body is so important that we shall mention it again.

Water cannot be raised above a certain level by pouring it into a vessel, and the defenses of the body, before the body is attacked by germs, cannot be raised beyond a certain point by a hygienic life. We cannot, therefore, depend on our natural resistance to protect us from acute germ disease, — those infections in which germs multiply so rapidly that the body is overrun with them before additional defensive substances can be produced. Diseases like measles, typhoid fever, and pneumonia attack alike the strong and the weak, and as long as we depend upon the resistance of our bodies to protect us from these diseases, so long will the germs of them have the privilege of using us for food. When a hawk is stealing chickens from a poultry yard, the farmer tries to remedy the trouble by killing the hawk and not by strengthening the chicks until they will be able to resist him. So to prevent epidemic diseases we must banish the germs and not attempt something else that has not been accomplished since man has been on the earth.

This does not mean, however, that a hygienic life is of no value in the battle against the germs. After it is infected, the body still has before it the problem of overcoming its enemies, and the better we care for it the more active will its defenders be (page 23). In overcoming chronic diseases like tuberculosis, catarrh, and bronchitis, where there is plenty of time to produce the defensive substances, good food, fresh air, sleep, and proper exercise and rest are of first importance. We must not, however, imagine that these measures will check our quick infections, for all experience proves that this is not the case.

Progress in the prevention of germ diseases. Sanitation is nothing new, for several thousand years ago the Jews kept their lepers under strict quarantine, and their laws called for a careful disposal of human wastes. By sanitary measures plague, smallpox, cholera, yellow fever, and typhus fever, formerly the greatest scourges of mankind, have practically been driven from the civilized world. By sanitation other germ diseases are rapidly being controlled, and hardly an infectious disease can be mentioned that has not been either banished or seriously checked in many communities. For thousands of years sanitation has been tried and proved to be a great success, and its advocates today are only asking that those measures that have freed us from our worst plagues shall be used to free us from the lesser ones that still afflict us. That it is possible to cause nearly all germ diseases to disappear from the earth, all experience in sanitation abundantly proves.

POINTS TO BE REMEMBERED

1. Finding and isolating germ carriers is the first step in preventing germ diseases.
2. Blocking the paths by which the germs reach others is the second step.
3. The idea that dirt causes disease hinders us in our fight against germs.
4. A second hindrance is the mistaken notion that hygienic living will make the body able to resist all kinds of germs.
5. Great progress has been made in preventing infectious diseases, and we have now sufficient knowledge to banish many of them from the earth.

PERSONAL HEALTH

CHAPTER ONE

LIFE AND HEALTH

FIG. 1. The length of time a top will spin depends on the conditions under which the spinning is done.

THREE boys threw their tops into a ring. One top hit a small stone and fell on its side. The second top struck in a sandy place in the earth and in thirty seconds its spinning was over. The third top found itself on smooth ground and it continued to spin for more than a minute.

How long will a top spin? We cannot say. It depends on the conditions under which the spinning is done.

The length of human life. There is a common idea that the body has a certain "natural" lifetime. This idea is not correct. In Europe three hundred years ago the average human life was twenty years. In 1910 it was forty years. At the present time in India it is twenty-four years. In Indiana it is forty-five years, and in Sweden it is fifty-two years. In New York City twelve years have been added to the average life since 1866, and in Indiana from 1900 to 1910 human life lengthened at the rate of six months each year. During this period, therefore, the people of Indiana may be said to have won back one half the time that the passage of the years took from them.

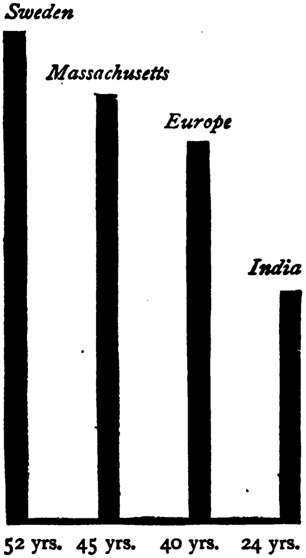


FIG. 2. A diagram showing the average length of life in different parts of the world. The length of time the human body lasts depends on the care that it receives.

The human machine may be destroyed in its first month by lack of proper food; it may suddenly be wrecked by disease germs after it has been running smoothly for twenty-five years; or it may give good service for sixty, seventy, eighty, or even one hundred years. A top spins longer on a smooth than on a rough surface, and the human body lasts longer when it lives and works under good conditions than when it is neglected and abused.

Preventing sickness. In Ceylon for each 1000 people there are each day, on an average, 65 persons sick. In Spain for each 1000 inhabitants the daily average of sick persons in 1912 was 44; in the United States it was 28; in Denmark it was 26; and in New Zealand it was 18. In London, Paris, Berlin, Munich, and Amsterdam in 1880, the daily average number of the sick was 55 for each 1000 inhabitants; by 1909 the number had fallen to 31.

These facts prove that the amount of sickness in different countries depends on the intelligence that the people use in caring for their health. They show that to a great extent a nation can decide for itself how many of its people shall each day be sick and how many of them shall be well.

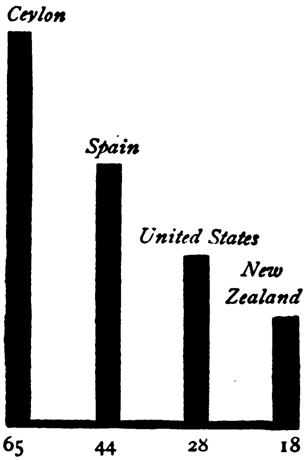


FIG. 3. A diagram showing the average daily number of sick persons per 1000 inhabitants in different countries in 1912. The amount of sickness in any country depends to a great extent on the degree of intelligence its people use in dealing with matters of health.

Disease prevails because of ignorance. If it is possible to escape sickness, why do men suffer from it? It is because most persons do not understand that health can be deserved and earned.[1] Within the last forty years the real causes of many diseases have been discovered, and the way to prevent many of the most important of them is now known. This knowledge has come into the world very suddenly, and people in general do not yet understand it. All over the world, therefore, because of their ignorance people are still suffering from disease. The ancient Greeks taught that knowledge is virtue and that ignorance is sin.

[1] We suffer from disease because of ignorance; we escape it through knowledge. — RICHARDS.

The great sin in the world of health today is ignorance, and we are punished for this ignorance by the preventable sickness that is among us.

FIG. 4. Alexander the Great. He died at the age of 33 because he paid no attention to his health.

Keeping the laws of health. Cut your finger and you will suffer; burn your hand and you will smart for it. Keep the laws under which your body lives and you will enjoy health; break them and you must bear the punishment. You did not make the laws of health; you cannot change them. Nature has laid down her rules, and the wise course for you to follow is to find out what they are and then obey them. In this second part of this book we shall study the human body and the laws of its life.

QUESTIONS

What was the average length of life in Europe 300 years ago? What is the average length of life at the present time in India? in Massachusetts? in Sweden? In New York City how much has been added to the average life since 1866? How rapidly did human life lengthen in Indiana from 1900 to 1910? Is there a "natural" lifetime for the body? Give a reason for your answer.

How many persons are sick each day for each 1000 inhabitants in Ceylon? in Spain? in the United States? in Denmark? in New Zealand? How much has sickness decreased in certain European cities during the last 30 years?

Why do people allow preventable illness among them? What result follows the keeping of Nature's laws? What is the result of breaking these laws? What course should we pursue with regard to them?

CHAPTER TWO

THE HUMAN BODY AND THE CELLS OF WHICH IT IS BUILT

HAVE you ever watched a little plant push its way out of a seed, thrust its roots downward into the earth, and unfold its leaves to the light? And have you seen such a plant grow larger day by day, until finally it blossomed and bore seeds like the one from which it grew? If you have worked in a garden and understand plants, you must often have thought that they are very much like the people about us in the way they grow and go through the cycle of their lives. This is indeed the truth, and, in order that you may better understand your own bodies, we shall begin this chapter by learning something of the structure of a plant and of how a plant grows.

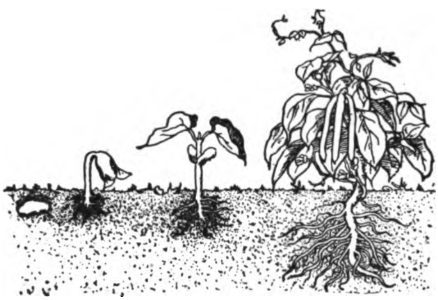


FIG. 5. The life cycle of the bean.

A plant composed of cells. If you could examine a small portion of a leaf or other living part of a plant under a microscope, you would find that, like the human body, it is made up of cells. Each cell is composed of a half-liquid living material, which is inclosed by a cell wall. In the center of the living matter is a denser portion, which is called the *nucleus*. Each cell is alive; each takes in food and does all those things that make a living plant or animal different from sticks and stones and other things that are not alive.

How the young plant starts from a cell called the egg. Break open a seed and you will find in it a young plant. Where did it come from? It grew from a cell called the *egg*. This cell at first is like the other cells of which the seed is built, but at a certain time it increases in size and gathers to itself a rich food supply. It then begins to divide, and from it the new plant comes. Before we begin the story of its growth, however, there are some other facts that it is well for us to understand.

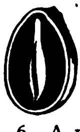


FIG. 6. A pine seed cut open to show the young plant in it.

The parts of a flower. Examine almost any common flower, and you will have no trouble in recognizing the parts shown in Figure 7. First come the little green *sepals*, then the bright-colored *petals*, next the *stamens*, and in the center one or more *pistils*. The lower part of the pistil contains the young seeds and becomes the seed pod. In the heads of the stamens is a fine, powdery substance called *pollen*. When we examine pollen under a microscope, we see that it is composed of a great number of little grains. Each little grain is, in reality, a cell; each contains living matter and a nucleus, as do other cells.

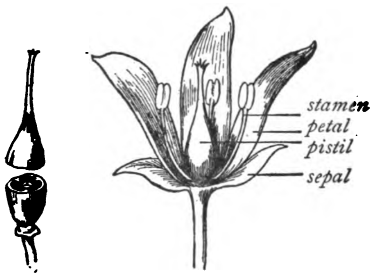


FIG. 7. The parts of a flower. To the left is a pistil cut open to show the location of the young seeds.

The egg fertilized by the pollen. Bees visit flowers for the nectar that is in the blossoms and for the pollen,

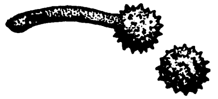


FIG. 8. Pollen grains. On the left a pollen tube is shown growing out from the grain.

which they gather and mix with honey in making "bee bread" for their young. In passing into a flower and out of it, a bee often leaves pollen on the sticky outer end of the pistil. When a pollen grain is thus left on a pistil, a long, threadlike tube grows out from it, makes its way down through the pistil to a young seed, enters the seed, and finds the egg (Fig. 9). Then a nucleus from the pollen grain passes out of the tube and unites with the nucleus of the egg. The uniting of the nucleus of the pollen grain with the nucleus of the egg is called *fertilization*, and the egg is said to be *fertilized*, because in some way it is given the power to grow and make a new plant.[1]

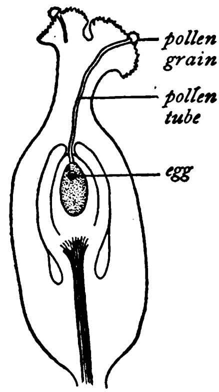


FIG. 9. Diagram showing how the pollen tube passes down through the pistil to the egg.

The growth of the egg into a new plant. After the egg is fertilized, it begins to grow. In a very short time it divides into two cells. Each of these again divides, making four cells, and the process goes on until there is a group of many cells, which have come from the dividing of the egg. From these cells are formed the roots, the stem, the leaves, and the other parts of

[1] When the pollen is washed away by rains, or when the spring is so cold and wet that bees and other insects cannot visit the flowers, the strawberry, plum, peach, and cherry crops fail. Without the pollen the eggs in the young seeds do not grow, the seeds die, and the fruits drop off.

the new plant. The outer ones change into skin or bark to protect the delicate living cells within. Some change into long wooden vessels to carry water from the earth up to the leaves; some form vessels for carrying food throughout the plant; and other cells take up all the different kinds of work that must be done within the plant. Usually the little plant stops at a certain stage of growth and rests within the seed until the warmth of

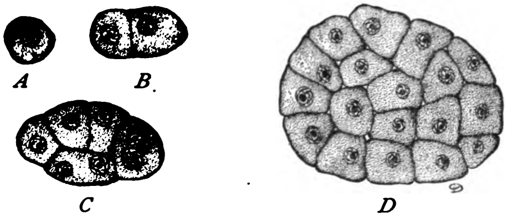
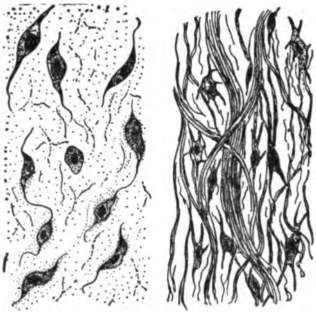


FIG. 10. Four stages in the development of the young plant from the egg. *A* represents the egg, *B* shows the division into two cells, and *C* and *D* are later stages. In two of the cells in *C*, the nuclei have divided, but the new cell walls have not yet been formed.

the next spring stirs the cells into renewed activity and calls the plant forth to a new life.

The growth of the human body from a single cell. The human body, like the body of a plant, starts from one cell. This cell divides and redivides until it forms a great cluster of thousands of cells. Of these cells all the organs and parts of the body are built. Some cells build lime around themselves and form the bones. Some build a great network of tough fibers, called *connective tissue fibers*, which hold all the body together. Other cells make up the muscles; certain cells form organs for digesting the food; the outermost ones make for the body a tough covering which we call the skin; a great group in the head and along the back become the brain and nervous system; and still other cells become fitted for doing all the other kinds of work that must be done in the body. Thus we see that the human body, like the bodies of all living things, whether they be plants or animals, starts with a single cell; and that when the body is grown, all its parts are composed of cells, or of supporting substances, like bone or connective tissue fibers, that the cells have built.



FIGS. 11 and 12. In its first stage connective tissue is a group of cells which build around themselves a mass of jelly-like material, as shown in Figure 11. This material hardens into the fibers that are seen between the cells in Figure 12. All through the body a framework of connective tissue runs, holding the cells, organs, and tissues in place.

The plan of the human body. When the growth of the human body is complete, we find that it is built according to a plan that is much like the plan of the bodies of other animals. Like the bodies of all the higher animals and of birds, frogs, and fishes, it has a head and trunk, and to the trunk are joined two pairs of limbs. In the back we find the jointed spinal column (page 175), which stiffens the trunk and at the same time allows it to bend; through the other parts of the body there are supporting bones with joints that

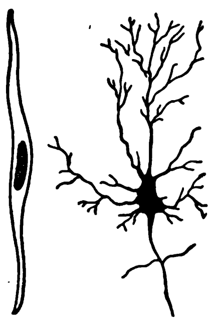


FIG. 13. On the right is shown a nerve cell from the brain; on the left, a muscle cell from the stomach.

permit movement at certain places; and within a large cavity in the front of the trunk are placed a set of great organs, each of which carries on some work that is necessary for our life. Among these organs are the stomach, intestine, and liver, which are concerned with the feeding of the cells; the lungs, which take in oxygen and give off carbon dioxid; the heart, which pumps the blood with its stores of food and oxygen through all the body; and the kidneys, which remove poisonous wastes from the blood. Other important organs in the human body are the brain, which lies securely within the skull, and the eyes, ears, and nose, through which the brain learns about the outside world. In later chapters we shall study in more detail all these organs and their work.

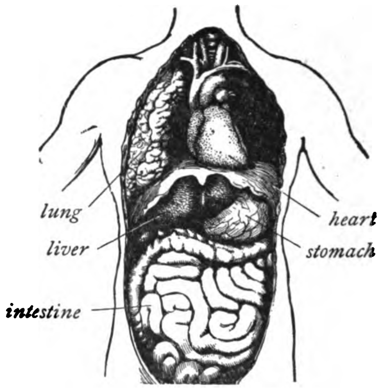


FIG. 14. The principal organs of the body. The left lung has been removed and the edge of the right lung turned back to show the heart and blood vessels more clearly.

Learning to care for the human body. In the first part of this book we studied about disease germs and how to avoid them. This is a most important subject; for when germs get into our bodies they are like weeds in a garden, and we cannot have health while they are growing among our cells. At the same time, we must remember that if there were not a disease germ in all the world, so wonderful a machine as the human body with all its delicate organs and parts would still require intelligent care. A gardener not only fights weeds; he also waters his plants and supplies them with the food materials which they need. So to keep our bodies in health we must not only avoid disease germs but must also keep all our organs at work so that our cells may have the right conditions for their life. In order that we may know how to do this, we must understand the human body and its needs.

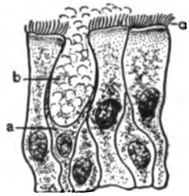


FIG. 15. Cells from the lining of the trachea. *a* is a cell that manufactures sticky mucus (*b*) in which dust and germs from the air are caught. The cilia (*c*) on the other cells are very fine, hair-like processes that beat upward and sweep the mucus, dust, and germs up out of the air passages and lungs.

Anatomy, physiology, hygiene. *Anatomy* is the study of the structure of the body, — of the way its organs and parts are made and how they are all united to form one whole. *Physiology* is the study of the functions of the body, — of how the body lives and of the work that each part does to keep up the life of all the cells of which the body is composed. *Hygiene* is the study of how to care for the body, — of what we must do to keep ourselves in health. It is necessary for you to study anatomy and physiology in order that you may understand your body and its needs, and you should understand hygiene because it teaches you how to keep your body strong for the work that is waiting for you in the world.

QUESTIONS

Of what is a plant composed? Describe a cell. Where does the young plant within a seed come from? Name the parts of a flower. What is pollen? Why do bees visit flowers?

What do they do for flowers? What grows from the pollen grain when it is placed on the pistil? What is fertilization? Describe the growth of the egg.

From what does the human body start? Of what are all the organs of the body built? Name some of the different kinds of cells and tissues in the body. Name the principal organs of the body and explain the work done by each.

What is anatomy? What is physiology? Why do we study anatomy and physiology? What is hygiene? Why do we study hygiene?

SUGGESTIONS TO THE TEACHER

If possible, secure a compound microscope and allow the pupils to examine cells. Cells scraped from the inside of the cheek or lip, or the living skin from an inner layer of an onion, may be used in demonstrating cell structure. Prepared longitudinal sections of a growing root or stem tip show not only the cells, but their differentiation into tissues. Make clear the point that bone, cartilage, and connective tissue are built by the cells depositing dead materials about themselves, and that the living cells constitute only a small part of these supporting tissues.

Identify parts in a simple flower; demonstrate pollen under a microscope. The pollen grains may be made to germinate by placing them in a solution of sugar and water (a 5 per cent to 40 per cent solution, according to the kind of pollen used). Have the pupils plant sunflower seeds in pots. Select two equally vigorous plants; give one plenty of light and water, and set the other in a dark corner of the room and allow the soil to become dry. Note the difference in the appearance of the plants and call attention to the fact that the human body, like plants, is dependent on environment.

CHAPTER THREE

THE FRAMEWORK OF THE BODY

ANY one looking at the solid walls of a tall building would naturally suppose that these walls carried the weight of the great structure above them. As a matter of fact, the building has a steel framework which supports it and braces it in time of storm, and the walls do not bear even their own weight. This is shown by the fact that the workmen often finish a portion of the wall many stories above the ground, before they build in the parts that connect it with the earth. The important thing in supporting the building, therefore, is the hidden framework which outlines the shape of the building and carries its weight; it is not the walls, which are a mere covering hanging on the framework.

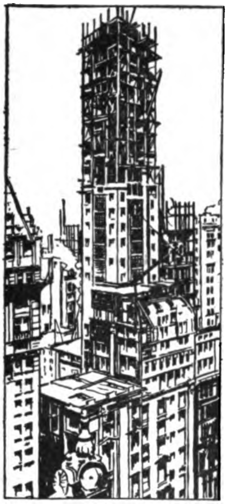


FIG. 16. The weight of the building is carried by the steel framework.

The skeleton. The human body, like a great building, has a framework which gives the body its shape and provides support for it. This framework is composed of 206 bones. All the bones taken together are called the *skeleton.*

In addition to supporting the body, the bones protect delicate organs like the brain and heart, and make it possible for the muscles to move the different body parts. Feel your wrists, your sides, your cheeks, or almost any part of your body, and you will find the bones under the skin and soft flesh. We shall now

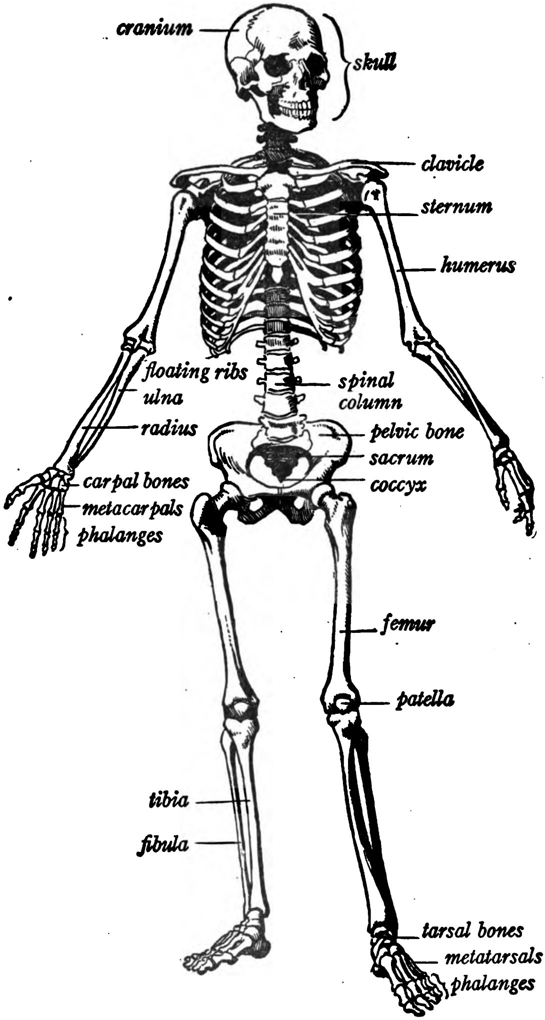


FIG. 17. The skeleton.

study the more important bones of the skeleton and the way in which these bones are joined to make a framework for the body as a whole.

The spinal column the center of the skeleton. The backbone, or *spinal column*, is the center around which the whole skeleton is built. Not only does it run up the back and stiffen and support the trunk, but it also carries the head on its top, and it has the bones of the chest and the bones of the hips attached to it. It is composed of many short bones,— an arrangement which gives it a great number of joints and enables it to bend freely and easily in any direction. Each bone of the spinal column is called a *vertebra* (plural, *vertebræ*). Five of the lower vertebræ are joined to make one large, solid bone which is called the *sacrum*. Below the sacrum there are three or four small vertebræ which form a little tail-like structure, the *coccyx*, on the end of the spinal column.

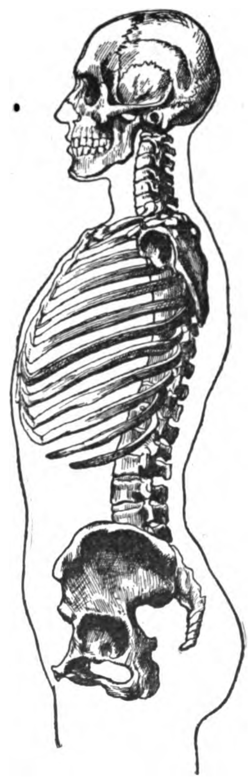


FIG. 18. The skeleton of the head and trunk.

The skull. The skeleton of the head, or *skull*, is composed of the fourteen bones of the face and of eight bones which make a strong box (the *cranium*) to protect the brain. In the skull of a little baby there are places where the bones have not completely covered the brain. A baby's head, therefore, needs to be protected carefully from blows.

The ribs and sternum. The *ribs* are twelve pairs of slender bones that curve around the chest. They are used in breathing and they protect the heart and lungs. At the back they are attached to the spinal column. In front, the seven upper pairs are joined to the breast-bone, or *sternum*, and the next three pairs are hung from the ribs above. The two lower pairs have their front ends free, and are called *floating ribs*.

The bones of the shoulder. The shoulder has two bones, — the collar-bone, or *clavicle*, and the shoulder blade, or *scapula*. The scapula is a flat bone which lies on the back of the shoulder. It is held in place by strong muscles, and at its outer end has a socket for the head of the arm bone. The clavicle has its inner end attached to the sternum and its outer end is propped against the point of the scapula. When the clavicle is broken, as by a fall, the shoulder drops forward and downward.

The pelvis. The *pelvic* or hip bones are two large, widespreading, flat bones that can easily be felt in the sides. They are joined to the sacrum at the back and to each other in front. With the sacrum, these bones form the bowl-shaped *pelvis*, which gives support to the organs that lie in the lower part of the cavity of the abdomen and also furnishes a solid framework to which the legs are attached.

The bones of the limbs. Each limb has in it thirty bones, and the bones of the arm and leg are very similar. The thigh has in it a great bone called the *femur*, and the arm has in it a corresponding bone called the *humerus*. In the leg below the knee there are two long bones, the *tibia* and the *fibula*, and in the forearm there are two similar bones, the *ulna* and the *radius*.

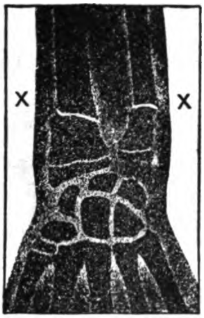


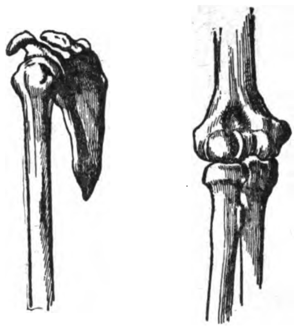
FIG. 19. From an X-ray photograph of a broken forearm and a wrist. The crosses show where the bones are broken.

In the wrist we find a group of small bones (the *carpal* bones), and in the ankle is another group of small bones (the *tarsal* bones). In the hand are five bones (*metacarpals*), each bearing a finger, and in the foot are five bones (*metatarsals*), each bearing a toe. Finally, the fingers of each hand have in them fourteen bones (*phalanges*), and the toes have the same number of bones arranged in the same way. The arms and legs are built on the same general plan, but the wrist has one more bone than the ankle, and the elbow has no bone corresponding to the kneecap (*patella*) on the front of the knee.

Bones composed of animal and mineral matter. A bone is composed of animal matter and mineral matter. The mineral matter is lime. The animal matter consists chiefly of tough fibers buried in the mineral groundwork of the bone. The animal matter gives the bone its toughness and keeps it from breaking. The mineral matter stiffens it and makes it able to bear the weight of the body.

These statements you can prove for yourself by burning one bone in the fire and soaking another in a weak acid. The first bone has the animal matter burned out of it and becomes brittle like chalk. The mineral matter is eaten out of the other bone by the acid, and the bone becomes limber like a piece of rubber tubing. You can easily imagine the difficulties you would be in if your skeleton lacked either the mineral matter which stiffens it or the animal matter which toughens it.

Joints. Close your hand and watch your fingers as they bend. The bending is not in the bones themselves, but at the joints between the bones, and the advantage of having a jointed skeleton is that it makes movement possible. There are two principal kinds of joints in the body, — *ball-and-socket* joints and *hinge* joints. The former allow motion freely in any direction; the latter allow motion only in two opposite directions, as does a hinge. Good examples of ball-and-socket joints are found in the shoulder and the hip; of hinge joints, at the elbow, at the knee, and in the fingers.



FIGS. 20 and 21. On the left is shown the shoulder joint, an example of a ball-and-socket joint. On the right is the elbow joint, an example of a hinge joint.

Cartilage and ligaments. The ends of the bones at the joints are covered with a smooth, white material called *cartilage*, which is kept moist by an oil that is secreted in the joints. This keeps down friction in the joints. Around the joints are many strong bands and cords of connective tissue called *ligaments*. Their chief function is to tie the bones together, but they also inclose the joints so that the oil cannot escape.

FIG. 22. The ligaments of the wrist.

The treatment of sprains. When a joint is bent too far, the ligaments about it are either torn loose from the bones or broken. An injury of this kind is called a *sprain*, and a bad sprain often requires longer to heal than a broken bone. Some athletic trainers who are skilled in treating sprains insist that, if the joint can be properly supported, the injured member should be used as soon as possible. The reason given for this treatment is that exercise helps to keep up a good circulation through the part and also lessens the danger of the new ligaments being formed so short that the joint will be left stiff after the injured tissues have healed. It is difficult, however, to keep the parts from slipping about and breaking up the delicate new ligaments that are forming, and in most cases it is probably better to rest the injured part and exercise it only when this can be done without too great pain.

Dislocations. When a bone is thrown out of place, it is said to be dislocated. A few persons have some joints so loosely tied together that a dislocation is possible with little or no injury to the ligaments, but usually in a case of dislocation the ligaments are badly torn and broken. In such a case, no one but a physician should be allowed to attempt to put the bones back in place; for an unskilled person may cause much pain and do great damage by pulling and twisting at an injured limb.

Broken bones. When an arm or leg is broken, it should be kept stretched out straight so that the sharp, broken ends of the bone will not cut the muscles, nerves, and blood vessels of the limb. If the person must be moved, wrap a pillow, coat, or blanket about the injured member, using sticks or something else stiff enough to keep it from bending, as shown in Figure 23. An injured person may be carried in a blanket, but a door, a cot, or other solid support is better. In lifting the person, the greatest care should be taken to keep the broken limb from bending sharply.

FIG. 23. A broken limb bandaged for moving the patient.

The two parts of a fractured bone are cemented solidly together by a jelly-like white substance which appears on the broken ends and hardens. If the broken ends are not brought together, the fracture cannot heal; and if the injured part is not properly bandaged, there is always great danger that the bone will be crooked or deformed after it has healed. No one but a physician ought to be allowed to set a broken bone.

The skeletons of old persons and of children. The bones of old persons break easily, and a fracture in an old person heals very slowly or refuses to heal at all. Old persons, therefore, should be saved as much as possible from climbing stairs and from doing other things that may cause them to fall. In little children, on the other hand, the bones will bend considerably without breaking, and a fracture in a young person quickly heals.

Caring for the skeleton in youth. Heavy lifting will cause a child to become round-shouldered; tight clothing may bend in the ribs and cramp the organs within the body; and habitually sitting in a stooped position will cause the skeleton to take an incorrect shape. One great cause of a drooping carriage of the head is near-sightedness, and if the eyes need glasses, these should be supplied. It is stated that some children thrust their heads forward because of the discomfort caused by their clothing rubbing on the backs of their necks, and that when their garments are cut low in the back they hold their heads erect.

QUESTIONS

Give three functions of the skeleton. Of how many bones is the skeleton composed? What is the function of the spinal column? What is one of the bones of the spinal column called? What is the sacrum, and of what is it composed? the coccyx? How many bones are in the skull? What is the cranium? Why should a baby's head be protected from blows?

How many ribs are there in the body? What is their use? How are they attached at the back? in front? Name and describe the two bones of the shoulder. Describe the hip bones. To what are they attached at the back? in front? How many bones are there in each limb? Name the bones of the arm. Name the bones of the leg.

Of what is a bone composed? What is the use of the animal matter? of the mineral matter? How can this be proved?

Name the two principal kinds of joints in the skeleton. Explain the kinds of movements they allow and give examples of them. What is cartilage? How is friction in the joints prevented? Give two functions of ligaments.

What is a sprain? What treatment should be given a sprain? What is a dislocation? Why should a broken arm or leg be kept from bending? How can this be done while moving an injured person? How does a broken bone heal? Why should old persons be guarded from falls? Why should the skeleton have especial care in youth? Name some things that may cause the skeleton of a young person to take an incorrect shape.

CHAPTER FOUR

THE MUSCLES AND THE CARRIAGE OF THE BODY

It is a law of physics that a body at rest will remain at rest forever, unless some force sets it in motion by pushing or pulling on it. For example, it is the pulling and pushing of the hand that sends a thrown ball upward into the air. It is the pull of the earth that brings the ball down. It is the push of the gases that come from the explosion of the powder that sends the projectile from a great gun. It is the pressure of the steam in the cylinders of an engine that sets the machinery in motion and gives it the power to do work. Everywhere about us we see objects set in motion, and in every case this is done by a push or a pull from an outside source.

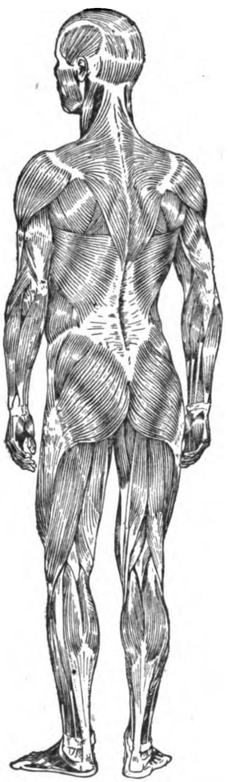


FIG. 24. The muscles.

You can lift your arms; you can extend your legs; you can move your whole body from place to place. Something must be pushing or pulling the different parts of the body to cause these movements. What is it that does this work? It is the muscles that are stretched upon the framework of the body. There are more than five hundred of these muscles, and they make up two fifths of the body weight. You are familiar with the lean meat in the body of an animal, and as this is muscle, you already know something of the appearance and texture of this "master tissue" of the body.

The structure of a muscle. A muscle is composed of long, slender, fiber-like cells, which have the power of contracting, or shortening and thickening themselves. This action of the muscle fibers may be illustrated by allowing a stretched rubber band to come back to its natural condition; or you can get an idea of how the muscle cells change their shape by watching an earthworm shorten and thicken its body as it crawls.

The long, slender cells lie lengthwise in a muscle, and among them is a great network of connective tissue fibers, which ties the whole muscle together and attaches it to the skeleton. When the muscle fibers contract, they cause the whole muscle to shorten and thicken, as you can feel by laying your hand on your upper arm while the muscle draws itself together and lifts the forearm.

How the muscles move the different parts of the body. The muscles stretch across the joints of the skeleton, and when a muscle contracts, it pulls the bones together and causes a bending at the joint. Exactly how this is done you can best understand by a study of Figure 25.

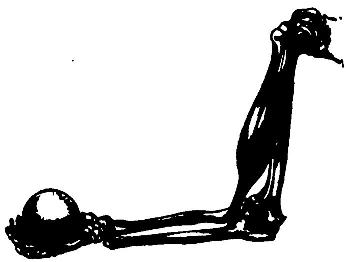


FIG. 25. Showing how the muscles of the arm lift the forearm.

Tendons. In many parts of the body long cords of connective tissue called *tendons* attach the muscles to bones that are at a distance from them. This plan of placing muscles at a distance from the parts that they move, keeps members like the hand from being covered with large muscles, which would be in the way when delicate work is to be done; at the same time it gives these members great strength and enables them to make many different movements.

How the muscles move the body as a whole. You cannot stand on a ladder and pull the ladder up after you.

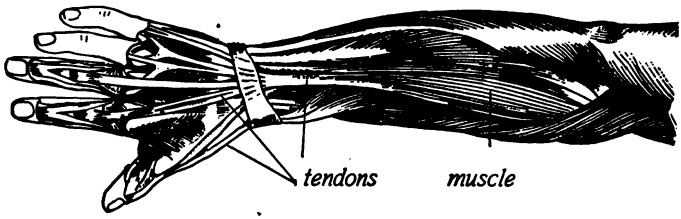


FIG. 26. The muscles of the forearm and the tendons that move the fingers.

You cannot sit on a chair and lift it. Yet you can move your whole body by muscles that are a part of your body. This is possible because you have a jointed skeleton that allows you to thrust out parts of the body and push against outside objects. How this is done you can best understand through an experiment. Stand close to the wall, place your hands against the wall, and straighten out your arms. This pushes you away from the wall and moves your whole body.

It is by this same method of pushing against something that all the different kinds of locomotion in the animal kingdom are brought about. The fish, in swimming, pushes itself forward by striking its tail and fins against the water. The bird, in flying, forces itself onward and upward by beating against the air with its wings. In walking and running, we drive ourselves forward by pushing with the feet against the ground.

The muscles that support the body. Not only do the muscles move the body, but they support it when it is held erect. Muscles on the front and the back of the neck keep the head balanced on top of the spinal column. When we stand upright, other muscles hold the skeleton from bending at the ankles, knees, and hips, and at the joints of the spinal column. The most powerful muscles of the whole body are those of the back, which lie both in front of the spinal column and behind it. They are so important in the carriage of the body, that we shall study them in some detail.

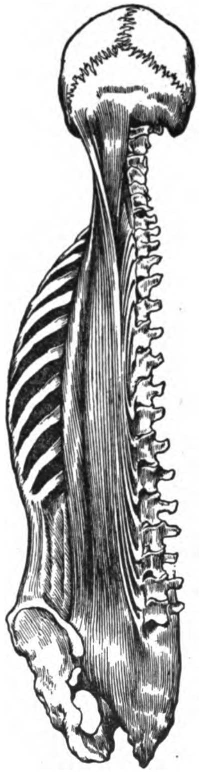


FIG. 27. The muscles that lie along the back of the spinal column.

Muscles that support the head. The head is held from drooping forward by muscles which rise from the vertebræ of the trunk, from the ribs, and from the bones of the shoulder; they are attached to the bones of the neck and to the back of the skull. The action of these muscles can be illustrated by attaching a string to the first joint of the finger, as is shown in Figure 28. Other muscles on the front of the neck keep the head from being drawn too far backward.

The muscles that support the trunk. The trunk is kept erect by muscles along the back of the spinal column, by heavy muscles that brace the spinal column in front in the region of the waist, and by muscles in the walls of the abdomen. The action of these muscles we shall now take up separately.

The muscles along the back of the spinal column rise from the sacrum and pelvic bones and run up the back as high as the base of the neck (Fig. 27). Their function is to keep the trunk from falling forward. Their action may be illustrated by attaching a cord to the finger and drawing it down the back of the hand, as is shown in Figure 28.

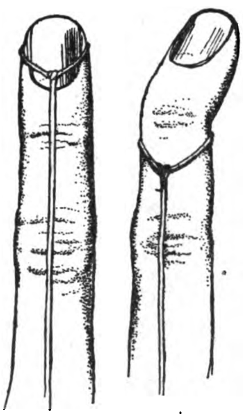


FIG. 28. Illustrating the attachment and action of the muscles that support the head and trunk.

The *abdominal muscles* are stretched between the pelvic bones and the ribs and sternum. When they contract, they draw the trunk forward and cause it to stoop, and they keep the body from being drawn over backward by the muscles of the back. By examining Figures 17 and 18, you can see where these muscles are attached and you will readily understand how they work in opposition to the muscles of the back.

The pull of the muscles along the back causes a forward curve in the spinal column at the waist. The spinal column is therefore supported in front in this region by strong muscles that brace it against the back muscles and keep it from bending too far forward. The lower ends of these muscles are attached to the femurs, which they lift in walking and running (Fig. 29). An examination of Figure 18 will show you how the spinal column bends forward above the sacrum. Study the drawings of the muscles that lie in front of the spinal column and along the back of it, until you understand how they keep it upright by their opposing action.

The body balanced over the feet in standing. The body must be balanced over the feet in standing to keep it from tipping over, and in this position if any part of the body is too far forward or backward, some other part must be thrust out in the opposite direction to keep the balance. For example, if a person bends backward the upper parts of the legs and the lower part of the trunk go forward. If he stoops forward, the head and upper part of the trunk must be balanced by other parts of the body going backward, as is shown by the fact that one cannot bend forward and keep his balance when standing with the back against a wall. If a weight is carried on the back or in the arms, the body bends in the opposite direction to keep the weight balanced over the feet.

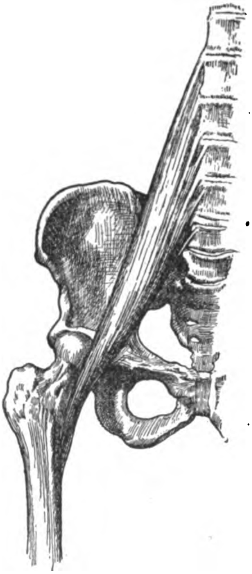


FIG. 29. View from the front of one of the muscles that keep the spinal column from bending too far forward at the waist.

The workings of this principle of balance may easily be observed in the carriage of the head and trunk. The whole upper part of the body is supported by the spinal column, and in standing, the axis of the head, neck, and trunk should form one continuous vertical line. If the head is allowed to fall forward, the spinal column in the upper part of the trunk will sink backward in a balancing curve, bowing the back out behind. The same thing happens if the shoulders fall forward, bringing the arms to the front so that their weight pulls forward instead of downward at the sides. Or, if the spinal column bends too far forward at the waist, thrusting the abdomen out forward, the upper part of the body will be bent backward, throwing the chest up in front. Each part of the body must be held in the correct position; for one part out of position is sure to throw other parts out of position also.

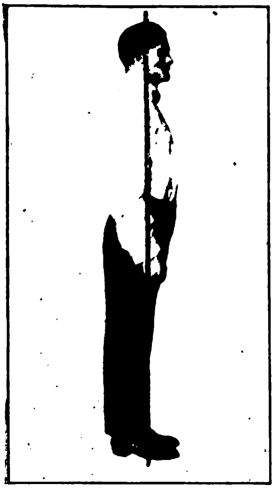


FIG. 30. The vertical line posture test. (*After chart supplied by courtesy of American Posture League.*)

The vertical line test of posture. One test of posture that is in use in many schools is called the vertical line test. If a vertical line is dropped from in front of the ear to the forward part of the foot,[1] the long axis of the head, neck, and trunk will, in correct standing position, be parallel to it (Fig. 30). If the position is incorrect, the line through the axis of the body will be zigzag and not a straight vertical line. The test can be

[1] By forward part of the foot is meant any point from the ball of the foot back to the middle of the arch. The place where the line falls on the foot varies somewhat in different persons.

made by holding a pole in the upright position, as is shown in Figure 30. The vertical line should pass just in front of the knee and in front of the shoulder.

The position of the shoulder. When the trunk, head,

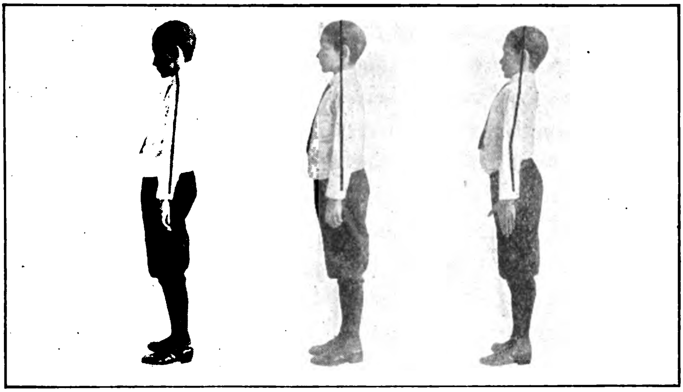


FIG. 31. The figure in the center shows correct posture; the head, neck, and trunk form one continuous vertical line. On the left, the head is too far forward, which causes the spinal column to bend backward between the shoulders and forward at the waist. On the right, the shoulders have been drawn up, the back bent inward at the waist, and the whole upper part of the body thrown too far backward. In the figures on the left and right the head, neck, and trunk form a zigzag line. (*After chart supplied by courtesy of American Posture League.*)

and neck are held upright, a vertical line drawn through the middle of the tip of the shoulder should pass through the ear or behind the ear. If this line passes in front of the ear, the shoulder is too far forward.

To bring the shoulders backward, the scapulas should be pulled flat down against the back. If they stand out like wings under the skin on the back of the shoulders, the arms are hanging too far forward, and unless the position is corrected the spinal column will become bowed out in the back between the shoulders.

In attempting to correct the position of the shoulders, *do not throw back the entire upper part of the trunk.* Practice moving the shoulders about without moving any other part of the body, and learn to draw them back without lifting them and without bending the body forward at the waist and throwing the chest up in front.

Securing an erect carriage. The body is held erect by muscles, and when there is any fault of the carriage of the body, exercises are valuable to strengthen the particular muscles that are weak. The body must be in a correct position when these exercises are taken, or the faults of carriage can easily be made worse. Any one, therefore, who is trying to correct his posture should, if possible, secure the help of a teacher who understands the subject, and he should study his own carriage with great care, to find the proper position for each of the different parts of the body. To teach the muscles to hold the body upright, it is necessary to form the habit of sitting, standing, and walking correctly. The following rules for standing and walking may be helpful in keeping the body erect:

"Stand tall," thrusting up the top of the head as high as possible.

Walk as if you were hung by the top of your head.

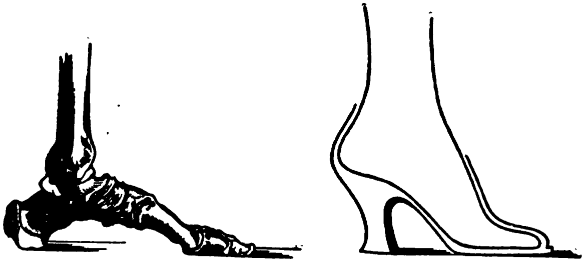
Hold the chin close to the neck.

Press the back of the neck against the collar button.

Keep the abdomen in.

If the upper part of the body leans too far backward so that the heels pound in walking, *sway the body forward at the ankles until the chest is over the toes.*

Mistakes made in trying to secure an erect carriage. When the head droops forward, the mistake is often made of trying to bring it to an upright position by pulling the shoulders back. This is trying to remedy



FIGS. 32 and 33. Showing the arch of the foot, and how a high-heeled shoe props it up on end.

the fault in the wrong way; for nothing that can be done to the shoulders will hold the head erect. The true remedy is to tighten the muscles along the back of the neck and bring to an upright position the upper part of the spinal column, on which the head rests.

Another mistake commonly made is to throw the head and chest back, and at the same time allow the back to be bent in at the waist and the abdomen to be thrust forward. In this case, again, the remedy is to straighten the curves in the spinal column. Persons who have difficulty in keeping the abdomen from being thrown too far forward need to exercise and strengthen the muscles that lie along the front of the spinal column at this point. As you will remember, these muscles are attached by their lower ends to the bones of the thigh, and one of the exercises that is practiced in strengthening them is to lie flat on the back and draw the legs up toward the body. Walking, running, and hill climbing also exercise and strengthen these muscles.

Good health important in securing an erect carriage. Ill health makes the task of carrying the body erect very difficult. Naturally the head droops forward if it is not held up, and if because of sickness the muscles are weak and lie slack on the skeleton, they must all the time be forced to do the work that they ought to do naturally and without effort. Ill health and weak muscles, during the growing years, have an especially bad effect on the carriage; for after the skeleton hardens, it is difficult to change its shape; and after the muscles develop to fit a stooped skeleton, their length is not easily changed.

The foot and the carriage of the body. Of the first million drafted men who appeared at the army cantonments in the Great War, more than 175,000 had flat feet, and in 1917 more men were discharged from the service for flat feet than for any other cause, except pulmonary tuberculosis. Since deformed or painful feet make a good carriage of the body impossible, and since most foot troubles are due to shoes, we shall take up in this chapter the question of how the foot carries the body weight, and of fitting the foot with a correctly shaped shoe.

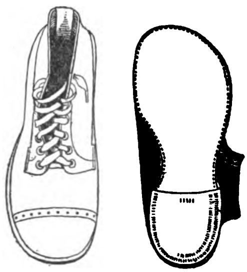
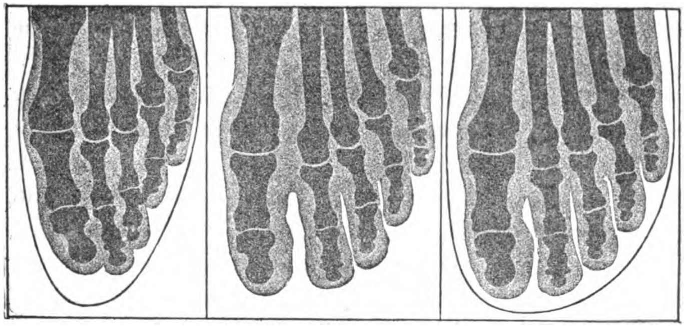


FIG. 34. The United States Army shoe. Improper shoes cause so much foot trouble that one United States Army surgeon has suggested that as a measure of military preparedness all shoes should be manufactured over lasts approved by the government. It is especially important that the feet of children be not deformed.

The structure of the foot. The skeleton of the foot is composed of 26 bones which are held together by muscles and ligaments.

Lengthwise from the heel to the ball of the foot, the bones are built together in the form of an arch. There is also a cross arch in the foot behind the toes, similar to the arch in the knuckles of a closed hand. In walking the foot is moved through tendons that run down along the ankle from the muscles below the knee and are attached to the bones of the foot. The foot is also to a considerable extent supported and held from tipping over sidewise by the pull of these tendons from the muscles of the leg. In walking, running, jumping, and lifting, the foot is subjected to great strain, and in many persons intelligent care is required to keep it from breaking down under the weight that falls on it.

The arch of the foot and high-heeled shoes. The skeleton of the foot is built in the form of an arch, which acts as a spring when the weight of the body falls upon



FIGS. 35, 36, and 37. From X-ray photographs taken during investigations made by the United States Army. Figure 35 shows a foot in a shoe supposed to follow the lines of the foot, and commonly regarded as sensible. Note how the bones of the third and fourth toes are curled under, and how the great toe is bent in toward the other toes. Figure 36 shows the unshod foot of a soldier standing on one leg and bearing his 40-pound marching equipment. Note how the foot expands and lengthens under pressure. Figure 37 shows a foot in the United States Army shoe (Fig. 34). Note the free play of the toes.

it. A high-heeled shoe props this arch up on end, instead of allowing it to stand in its natural position. This interferes with the plan of supporting and carrying the body; for it partially takes away the springiness of the skeleton, and it puts the muscles on both the back and front of the leg on a strain. Some persons have worn high-heeled shoes so long that their muscles have become adapted to the position into which such shoes throw the body, but a position of this kind causes backache and great fatigue in many persons who have spent a barefoot childhood, or who are accustomed to shoes of a different kind.

Shoes that interfere with the support of the foot. The weight of the foot falls on the heel, on the great toe and the ball of the foot behind the great toe, and along the outside of the foot behind the little toe. The foot is, therefore, a tripod, and if anything interferes with any one of its three points of support, it becomes very unsteady.

Shoes with heels that slant forward move the back point of support from the heel toward the middle of the foot and make walking very insecure and difficult. Shoes with pointed toes bend the great toe outward and interfere with the inner front point of support, causing the wearer to turn the toes out and tending to cause the arch of the foot to be turned over on its inner edge.[1]

[1] In the heel, the point of support is toward the outside, and the inner side of the ankle is in a great measure held up by tendons from the muscles in the calf of the leg. If for any reason the muscles of the leg are weak, the inner side of the ankle is not sufficiently supported by them and the arch of the foot is allowed to turn over on the inside. A wide, low heel built forward and out under the inner side of the ankle supports the foot at this weak point.

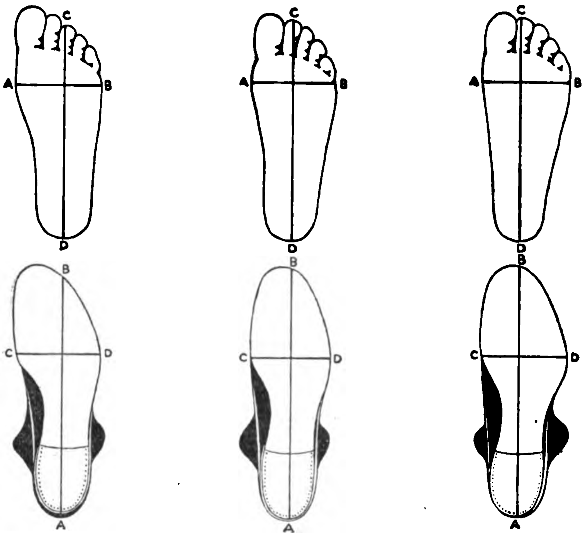


FIG. 38. The American Posture League finds three natural type of feet, straight, inflared, and outflared. The illustration shows these three types and shoes designed to fit each. (*After drawings of Tru-pe-dic shoes.*)

Tight shoes interfere with the outer point of support of the foot by keeping the bones back of the toes from springing down and spreading apart in a natural manner and thus throwing part of the weight on the outside of the foot. All this causes tired and painful feet, and makes walking difficult and fatiguing.

The points of a good shoe. A good shoe should have a wide, low heel, or for a natural foot, no heel at all. It should not bend the great toe around toward the other toes, as many pointed and improperly shaped shoes do, but should allow it to extend in line with the inside of the foot. It should be wide enough to allow the toes and the foot to spread in standing and walking, so that the natural points of support of the foot may be taken advantage of. It should be long enough not to cramp the toes, and it should have a box in it high enough not to press on the toes and cause corns and ingrowing nails. The sole should be flat across, only slightly turned up at the toe, and wide enough that the outer border of the foot will not overhang it.

It is especially important that a shoe be roomy enough to allow the feet to spread and the toes to move in walking; for if these movements are not allowed the muscles of the feet will not develop and will lack the strength necessary to support the arches under the body weight.

The position of the foot in standing and walking. In walking, the feet should be carried pointing straight forward; for when the toes are turned outward, there is a tendency for the arch of the foot to be twisted so that it lies on its inner side. In standing, the toes may be turned outward somewhat, but only to a moderate degree. A person who "toes out" should practice turning his toes inward as he walks. This position of the foot is very important in securing a correct carriage of the body.

QUESTIONS

How many muscles are there in the body? What part of the body weight is muscle?

Describe the cells of a muscle. What is the function of the connective tissue in a muscle? How does a muscle cause the skeleton to bend at a joint? What is a tendon? Of what advantage is it to have tendons in the body? Explain how the muscles move the body in walking and in running.

What function have the muscles in addition to that of moving the body? Where are the most powerful muscles in the body? What muscles support the head? Describe the three sets of muscles that support the trunk.

Why must the body be balanced over the feet in standing? What happens if any part of the body is too far backward or forward? Explain how the principle of balance is exemplified in the carriage of the head and trunk. Explain the vertical line test of posture. Is your own posture correct by this test? What tests show when the shoulders are in correct position? How may they be pulled backward and what mistake should be avoided in attempting to do this?

Give six rules that may help in securing a good carriage of the body. Explain two mistakes that are commonly made in trying to hold the body erect. Explain how exercising the legs keeps the spinal column from bending too far forward at the waist. How does ill health make a good carriage difficult to secure?

How common were foot troubles among the drafted men during the recent war? How many bones are there in the foot? How are the bones held together? Where are the arches in the foot? Where are the muscles that move the feet in walking?

Why are high-heeled shoes objectionable? On what three points of the foot does the body weight fall? What is the objection to narrow heels? to heels that point forward? to shoes with pointed toes? to tight shoes? Describe a good shoe. What is the correct position for the foot in standing? in walking?

REFERENCES

Bancroft's *The Posture of School Children* (Macmillan) will be most helpful to the teacher. The American Posture League, No. 1 Madison Avenue, New York City, issues charts and literature on posture and gives the address of manufacturers of clothing, shoes, furniture, and other articles that have been designed to meet the standards approved by the League.

CHAPTER FIVE

THE HEART AND THE CIRCULATION OF THE BLOOD

In New York City the street cars, automobiles, and wagons fill the streets; the elevated trains roar overhead; and deep in the earth the trains in the subway rush on and on in a procession that never ends. Nor is this all of the transportation system of the city; for water and gas are piped underneath the streets to the homes of the people; most of the wastes of the city are carried away by underground sewer pipes; and the electricity which lights the city and runs much of its machinery passes silently along wires to the places of its use. In these and in many other ways the carrying problem of the city is solved.

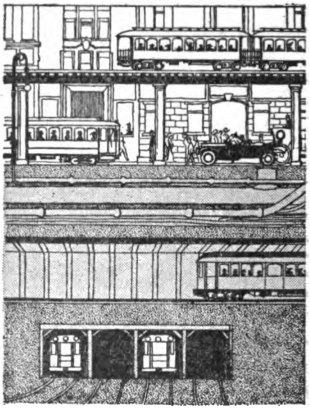


FIG. 39. Transportation in New York City.

The carrying problem in the body. As a city is composed of a multitude of people, so is the body composed of a multitude of cells — 400,000,000,000, according to one estimate. Each of these cells must have food and oxygen, and each must get rid of its wastes. There must, therefore, be a transportation system in the body, and it must be one that is always in working order — not one that breaks down and fails in its work from time to time. Transportation by water is more reliable than any other method that has yet been devised, and this is the method we find used in the body.

The carrying in the body done by the blood. All through the body there is a great system of tubes, or pipes, called *blood vessels.* Night and day the heart pumps the blood through these vessels. Everything that the cells need is dissolved in the blood and carried to them in the blood stream. Into this stream each cell gives off its wastes to be carried away. *Thus all the carrying within the body is done by the blood, and the blood is kept in constant motion through the body by the heart.*

Arteries and veins. The blood in its movement, or *circulation,* through the body flows through the same channels again and again, always returning to the starting point, the heart. We have, therefore, two sets of blood vessels in the body, — the *arteries,* which carry the blood *from* the heart, and the *veins,* which bring the blood *to* the heart. The large arteries send branches to the different parts of the body. These branches divide into finer and finer branches and finally end in very small vessels called *capillaries.* These run in among all the cells and then unite to make small veins. The veins, like the creeks that form a river, keep coming together, until finally all of them are united into the great veins which carry the blood back to the heart.

To understand how the blood passes from an artery into a vein, think of two trees standing with their trunks close together and their tops touching each other. Then imagine that the blood flows up the trunk of one tree, out into its branches and twigs, then on into the twigs and branches of the other tree, and down its trunk. If the blood should make a circuit of this kind through the trees, its journey would be like the one that it makes when it passes out from the heart through an artery and returns to the heart through a vein.

The heart. The heart lies in the chest with its point to the left of the center. Its walls are made of strong muscles, and within the heart are four chambers, or cavities, two on each side. On each side the upper cavity is called an *auricle;* the lower cavity, a *ventricle.*

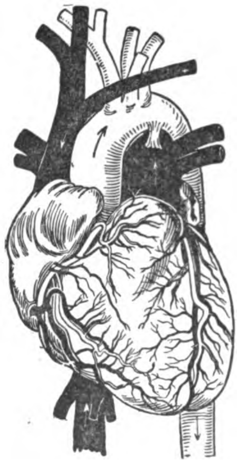


FIG. 40. The heart.

The action of the heart. The veins pour the blood into the auricles. Then the walls of the auricles contract and force the blood down into the ventricles. Next, the strong walls of the ventricles close in on the blood, and drive it out into the arteries and all through the body. After forcing the blood into the arteries, the walls of the ventricles relax, and for a moment the heart rests. Then again the auricles, contracting on the blood that has flowed in from the veins, fill the ventricles, and the ventricles pump the blood on into the arteries. Place your hand on the left side of your chest, and you will feel your heart move as its walls close in on the blood and force it onward through the vessels.

The valves of the heart. In every pump there must be valves to keep the liquid from flowing backward. The heart, like other pumps, is provided with these valves, — two between the auricles and the ventricles, and two at the mouths of the arteries to keep the blood

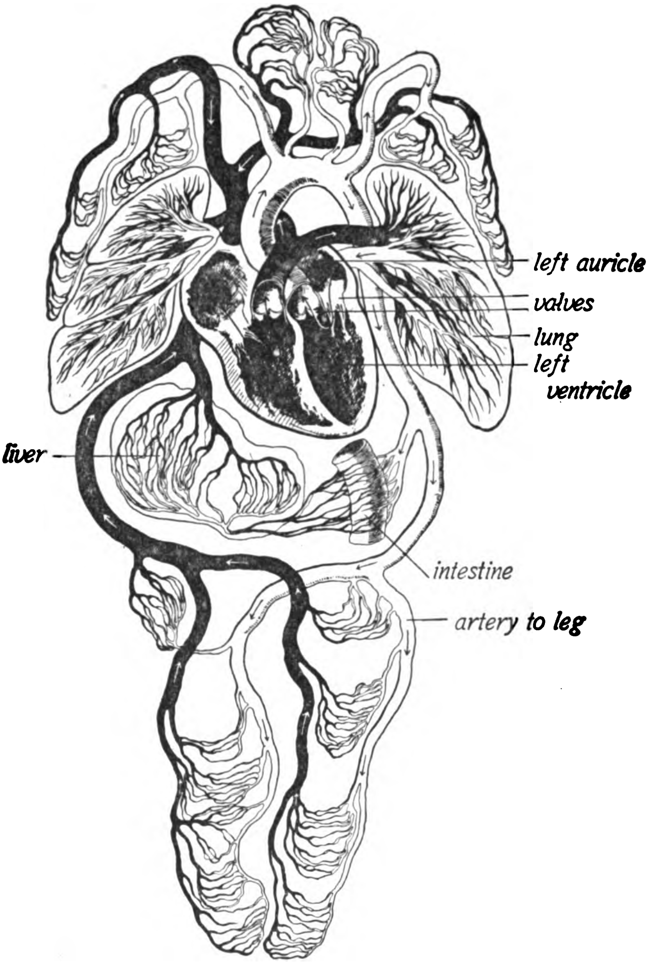


FIG. 41. Diagram showing the circulation of the blood. Note the valves between the auricles and ventricles and at the mouths of the great arteries that open out of the ventricles.

from flowing backward into the ventricles when their walls relax and the chambers open after each beat. In

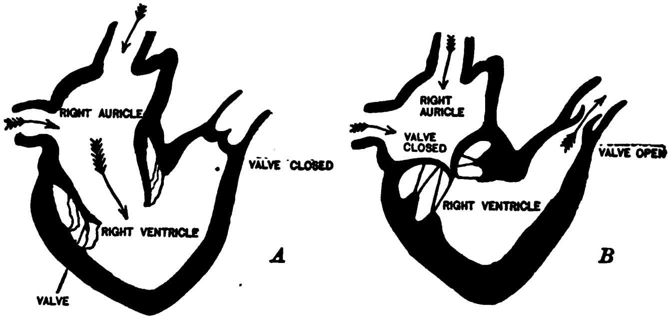


FIG. 42. A diagram of the right side of the heart showing the working of the valves. When the blood flows into the auricles and the ventricles relax, the valves of the heart are as shown in *A*. When the ventricles contract and the blood flows out into the arteries, the valves are as shown in *B*.

Figure 41 you can study out where the valves are placed, and from Figure 42 you can understand how they prevent a backward flow of the blood in the vessels and in the heart.

Tracing the circulation of the blood. Trace the circulation of the blood in Figure 41, and you will see that the heart is a double organ; that the right side sends the blood on a short journey through the lungs and back to the left side; and that the left side drives the blood into the arteries for a long journey through all the body and back again to the right side of the heart. The blood flows through the vessels very swiftly, making the journey through the lungs in about fifteen seconds, and the long journey through the body in less than a minute.

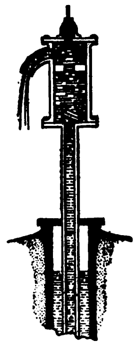


FIG. 43. A diagram of a pump. Locate the valves and explain how they work.

The blood composed of plasma and corpuscles. The blood is composed of a liquid part called *plasma*, and of millions of little cells called *corpuscles*, which float in the plasma. About nine tenths of the plasma is water. The remainder is composed of dissolved food and other materials that are needed by the cells, and of the wastes that come from the cells. The corpuscles are of two kinds, the *red* and the *white*. The red corpuscles are so abundant that there are millions of them in the smallest drop of blood. It is the red corpuscles that give the red color to the blood.

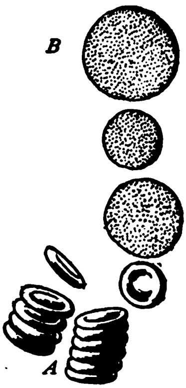


FIG. 44. Red blood corpuscles (*A*) and white blood corpuscles (*B*).

The function of the corpuscles. As the blood passes through the lungs, it takes oxygen from the air that is breathed into the lungs. The oxygen is then carried through all the body and given up to the cells. *This carrying of the oxygen is done by the red corpuscles.* Like little boats floating in the blood stream, they take up their loads of oxygen in the lungs, carry the oxygen out through the body, unload it for the hungry cells, and hasten back to the lungs for more of the oxygen which the cells must have. The importance of this work is shown by the fact that when the heart ceases to beat, or when a person is under water so that the oxygen is cut off from the lungs, the life of the body quickly comes to an end.

The white corpuscles are larger than the red ones and are fewer in number. *Their work is to kill the disease* *germs that get into the body.* This, as you will readily understand, is a most important work.

The lymph. The blood capillaries are so small and so abundant among the cells that you cannot stick a pin into your tissues anywhere without breaking many of them and letting the blood escape. The capillaries have very thin walls, and as the blood flows through them some of the plasma escapes and passes out into the spaces among the cells. This escaped plasma is the lymph, to which we have referred a number of times in earlier chapters of this book.

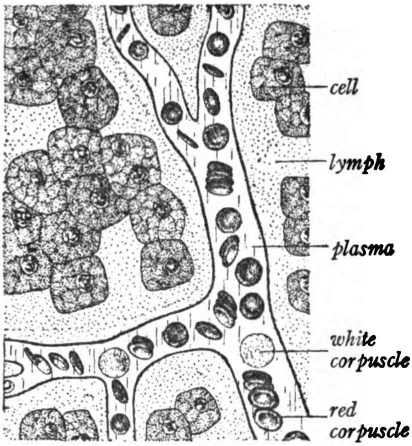


FIG. 45. The cells are bathed in lymph, which is plasma that escapes through the thin walls of the small blood vessels. (Diagrammatic.)

The lymph a middleman between the cells and the blood. In Figure 45 you can see how the cells lie among the capillaries, and how they are bathed in the lymph that escapes through the thin walls of these vessels. The cells, therefore, are not in the blood stream, but this stream, so to speak, merely passes by the house, and the cells must find some way of getting their supplies from the stream into the house. This is done through the lymph. As the red corpuscles pass along in the capillaries, the oxygen breaks loose from the corpuscles, passes out through the walls of the vessels into the lymph, and so reaches the cells. In the same way, the foods that are dissolved in the plasma make their way out into the lymph that surrounds the cells, and the wastes that the cells give off pass through the lymph into the blood and are carried away. *The lymph acts as a middleman between the cells and the blood, passing the oxygen and food from the blood to the cells, and the wastes from the cells to the blood.*

The lymphatic vessels. Among the cells of the body there is, besides the blood capillaries, a system of fine, thin-walled lymphatic capillaries. These unite and form larger vessels, which finally empty into the veins of the shoulders. *The lymphatic vessels act as a drainage system for the body, and their function is to gather up and drain off the stale, impure lymph from among the cells and empty it into the blood.* This allows fresh lymph to escape among the cells, bringing with it supplies of food and oxygen. The lymphatic vessels of the greater part of the body unite in one great vessel called the *thoracic duct.* This runs up the back of the cavities of the abdomen and chest, and empties into the large vein in the left shoulder.

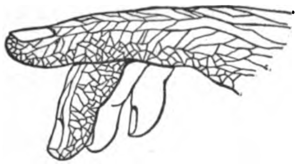


FIG. 46. Lymphatic vessels in the fingers.

The importance of caring for the heart. The responsibility of keeping the whole transportation system of the body in operation falls on the heart, which is usually about the size of the fist of the person to whom it belongs. Night and day, from birth until death, this little organ pumps away, giving a stroke oftener than once a second. We cannot replace an injured valve in it with a new one; it could not stop long enough for that, even if we knew how to do it. If it becomes overworked, or if it is poisoned by disease germs, there is no second pump to take its place while it rests and gets into good condition again. It is such a wonderful organ that usually it gives us little cause for complaint; yet there are certain things that injure the heart, and for our own good we ought to know of these things and avoid them. We shall therefore mention some of the points that are important in the care of the heart.

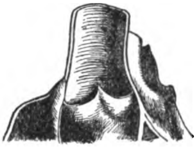


FIG. 47. Valves in an artery where it leaves the heart. There are three valves attached like loose pockets to the wall of the artery. When the blood starts to flow backward into the heart, it catches in the pockets, which then swing out and close the opening into the heart.

The heart injured by disease germs. By far the most common cause of trouble in the heart is disease germs. In diphtheria and scarlet fever the nerves that supply the heart and the muscle cells of the heart walls are so damaged by the poisons produced by the germs, that even in the mildest cases of these diseases, physicians frequently forbid the patient to sit up in bed, because they fear the effect of the strain on the heart. Furthermore, the heart is often so poisoned by an attack of one of these diseases that it does not recover for years, and it may fail under any extra strain that is put upon it during this time. In other diseases, such as pneumonia, rheumatism, and influenza, the germs themselves attack the valves and cause them to shrivel and harden, so that they allow the blood to leak backward, and the heart is damaged for life. As much as possible, therefore, we ought to avoid all these germ diseases, — the catching diseases which are so common, and which people often carelessly give to each other. After an attack of one of these diseases, hard exercise should be avoided until the heart has had time to regain its strength.

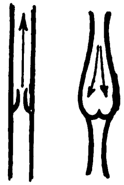


FIG. 48. A valve in a vein. The veins have valves in them to prevent the blood from flowing backward when pressure comes on the veins. Run your finger down a vein on your forearm, and little knots will stand out on the vein at the points where the valves are located.

Too much exercise injurious to the heart. When the muscles are working, they need more food and oxygen and give off more wastes than when they are at rest. The heart must therefore pump the blood more swiftly through the body when we use the muscles. This you can prove for yourself by noting how much harder and faster your heart beats after running or after doing other hard work. Indeed, when we take hard and long-continued exercise, it is usually the heart that becomes tired first of all, although we may not feel it.

There may be danger, therefore, of overworking the heart by long-continued or very severe exercise, especially at that time of life when the boy or girl is entering manhood or womanhood and the body rapidly increases in size. When overworked, the heart, like any other muscle, at first enlarges, and then, if the overworking is kept up, becomes weak and flabby. This condition of the heart is called "athletic heart."

Proper and improper exercise. Do not keep on at any heavy work or hard game until you are exhausted. Do not play tennis all day. Do not spend a whole Saturday afternoon playing football. Remember that a baseball pitcher needs a stout heart as well as a stout arm, and that, for the sake of both your arm and your heart, you should not stay in the pitcher's box a whole half-day at a time. Do not enter long Marathon races that are intended for men and not for boys, and do not get on your bicycle and ride at a fast pace until you are breathless. You should understand, however, that it is only *overwork* that you are being cautioned against, and that both moderate exercise and severe exercise taken for short periods are beneficial to a sound heart, as well as to other parts of the body. Doubtless in time all the pupils in our schools will be examined and each told what forms of exercise are suitable for him. Football and other severe games should be directed only by one who knows how to protect his players as well as how to win games.

Tobacco injurious to the heart. Tobacco sometimes damages the heart until it has a quick, weak, and fluttery beat. Coaches and trainers will not allow athletes to smoke, because smoking weakens both the heart and the other muscles. The question of the effects of tobacco on the body we shall discuss in more detail in a later chapter (page 346).

The heart injured by headache remedies. A number of drugs commonly used (among them phenacetin, acetanilid, and antipyrin) will relieve headaches. The practice of taking these drugs is dangerous; for they all weaken the action of the heart. They should be taken only when prescribed by a physician, and no good physician will prescribe them often for the same person.

The effects of alcohol on the heart and blood vessels. Alcohol is thought to be one of the causes of hardening of the arteries, a disease in which the walls of the arteries become weak and brittle. Certainly it is true that apoplexy, which is caused by the bursting of a blood vessel in the brain, is more common among users of alcohol than among abstainers. Alcohol also in some cases weakens the heart by causing its muscle cells to change to fat, and sometimes in beer drinkers there is the additional trouble that the working cells of the heart are buried in a great mass of fat that must be lifted and moved every time the heart beats.

Irritable heart. In the recent war more men were rejected for military service on account of heart disease than for any other one cause, and among even those who were accepted "irritable heart" proved to be a great hindrance in the military work. In this condition the heart beats too rapidly when exercise is taken, and the person becomes breathless when any hard work is done.

It is probable that several different causes may be responsible for this condition. Sometimes the chief difficulty seems to be that the nervous system is not controlling the heart properly; these cases are much benefited by building up the general health and by carefully graded exercises. With other persons the cause of the heart weakness is a recent illness, such as pneumonia, measles, or influenza, and the trouble disappears if the heart is not overstrained before it has time to recover. In great numbers of other cases there is a chronic infection in some part of the body, such as tuberculosis, or streptococcus infection of the teeth, the tonsils, or the heart itself. For these infections, attention to general hygiene is of the greatest importance, but rest and not exercise is needed. Tobacco seems to be the chief cause of the weakness and irregular action of the heart in some persons; certainly the use of tobacco aggravates the condition in those cases in which it is not the primary cause. Any trouble with the heart calls for immediate examination by a physician.

QUESTIONS

What must be carried to the cells and away from them? How is this carrying done? What is the movement of the blood through the body called? What is an artery? What is a vein? What is a capillary? How does the blood pass from an artery into a vein?

Describe the heart. Explain how the heart forces the blood through the body. Where are the valves in the heart and what is their use? Trace the circulation of the blood from the right auricle back again to the right auricle.

Of what is the blood composed? Of what is the plasma composed? What is the function of the red corpuscles? of the white corpuscles? What is the source of the lymph? Explain how the lymph acts as a middleman between the cells and the blood. Describe the lymphatic vessels. What is their function? What and where is the thoracic duct?

Why is the care of the heart so important? What is the most common cause of injury to the heart? How does overexercise affect the heart? At what age is the heart especially likely to be injured by overexercise? Name some games that put a great strain on the heart.

What effect has tobacco on the heart? Name some drugs that are commonly used as headache remedies. What effect have these drugs on the heart? What effect does alcohol probably have on the blood vessels? What effect has alcohol on the heart? Name some causes of irritable heart. What should a person who has trouble with his heart do?

CHAPTER SIX

RESPIRATION

FILL a bottle with boiled water and one with unboiled water, and arrange growing beans in them, as is shown in Figure 49. The bean with its roots in unboiled water will grow for a considerable time — as long as the mineral matter in the water will provide it with food materials. The roots of the plant in the boiled water will quickly die and the whole plant will then wither, because the roots no longer send the water up to the leaves.

FIG. 49.

Why is it that the roots in the boiled water die? The answer is simple. The boiling of the water drives the oxygen out of it, and without oxygen the cells of neither plants nor animals can remain alive.

The object of respiration. *The first object of respiration is to take oxygen into the body.* Of food, we have enough stored in the body to maintain life for a number of days, or, in some cases, even for several weeks. As to oxygen, however, the body leads a hand-to-mouth existence; for though the air is more than one fifth oxygen, there is not enough of this gas in the body to keep us alive for more than two or three minutes after breathing has stopped. While we sleep, therefore, we must keep on breathing in oxygen; sit as quiet as we may, we must still keep on taking it in; and when we walk or run, we do it taking in oxygen as we go.

The second object of respiration is to give off carbon *dioxid from the body.* Carbon dioxid is a waste gas that is all the time being formed in the cells and carried by the blood to the lungs, to be breathed out into the air. It is formed not only in the body, but where wood, coal, oil, or gas is burned, and it is sometimes found in coal mines, where it is known to the miners as "choke damp."

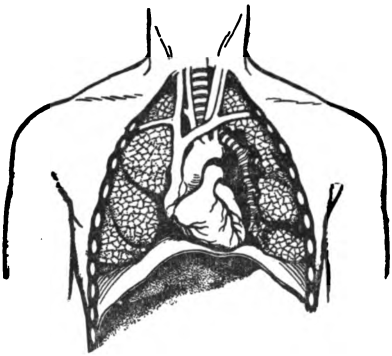


FIG. 50. The chest, showing the position of the heart and lungs.

The cavity of the chest. The cavity of the chest contains the heart and the *lungs.* This cavity is inclosed by the ribs and sternum, and is separated from the abdominal cavity below by a thin cross-partition called the *diaphragm.* In breathing, the chest cavity is enlarged by lifting the ribs upward and outward, and by pulling the diaphragm downward.

The trachea and the lungs. The *trachea* has in its walls stiff rings of cartilage that hold it open so that the air can pass freely through it to and from the lungs. At its base the trachea divides and sends a great branch to each lung. Within the lungs these branches divide again and again, until finally they end in little, thin-walled air sacs. The branches of the trachea are called the *bronchial tubes,* and the lungs have a light, spongy texture because they are composed chiefly of these tubes and of the air sacs in which the tubes end.

The changes in the air in the lungs. The walls of the air sacs are very thin, and great numbers of small blood streams constantly flow through the capillaries in them. The oxygen of the air that we take into the lungs passes into the blood through the walls of the sacs, and

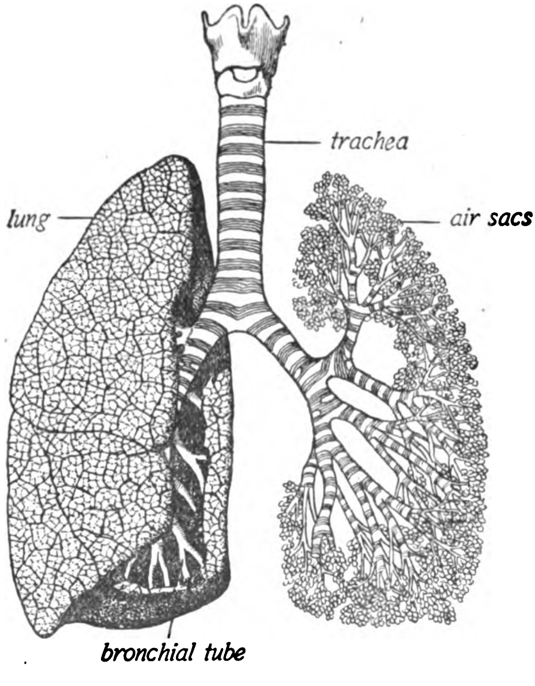


FIG. 51. The lungs.

the carbon dioxid that is in the blood passes out into the air that is in the sacs, and is then breathed out of the lungs. *The air in the lungs, therefore, loses oxygen and gains carbon dioxid, and the blood takes in oxygen and gives up its carbon dioxid.*

These changes take place very rapidly in the lungs, for the capillaries are so numerous that they cover more than one third of the surface of the air sacs, and all the blood in the body goes through them in a little over a minute.

FIG. 52. A small bronchial tube and the air sacs in which it ends.

Injury done to the respiratory organs by dust. Nearly all the diseases of the air passages and lungs are caused by germs. Dust wounds and injures the delicate lining of these parts, and makes it easy for germs to gain an entrance into the tissues. The majority of workmen in certain industries, such as metal grinders, potters, and workers in cotton and woolen mills, die of pneumonia, tuberculosis, and other respiratory diseases. This is due to the multitude of tiny wounds continually being made in the walls of the air passages by the sharp dust and fine fibers with which the air of many factories and mills is laden. Much can be done to make dusty trades more healthful by using water in operations where dust is formed, by hoods and air blasts that suck up the dust from machines, and by the workmen wearing appliances to protect themselves from the dust.

FIG. 53. A workman wearing a mouthpiece to protect himself from dust. (*From a photograph by the Massachusetts State Board of Health.*)

Sweeping without raising a dust. In many states dry sweeping of school buildings and of other public buildings is forbidden by law, because it stirs up great quantities of dust, which then remains floating in the air for hours. The best method of cleaning public buildings, as well as private homes, is the vacuum process. When this cannot be used, wet sawdust, a sweeping compound, or something else effective should be employed to keep down the dust. One device that is sometimes used is a can attached to the handle of a broom and so arranged that it keeps the broom moist with kerosene or water. The floor brush shown in Figure 54 is very satisfactory for sweeping. Paraffin oil is extensively used in making up floor dressings and sweeping compounds. This oil may be purchased at a low price, and gives an excellent polish to floors and furniture. Sawdust moistened with it makes a very satisfactory sweeping compound, and a cloth dampened with it is the best thing for removing dust from furniture and for cleaning doors. A dry cloth should not be used for dusting.

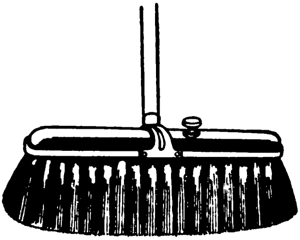


FIG. 54. A dustless brush. The back of the brush is hollow and is filled with kerosene, which slowly trickles down and keeps the bristles moist while the sweeping is being done.

Gaseous impurities in the air. In many houses small quantities of gas are constantly escaping from the pipes, and often this leaking of gas is allowed to run on for weeks and months before the pipes are repaired. Breathing this gas, especially if it is water gas, is most injurious to the health. Another most harmful practice is the use of gas and oil stoves that have no pipes to carry away the fumes; for it is ruinous to the health to breathe the poisonous gases that come from them.

The effect of tobacco on the respiratory organs. Tobacco smoke is hot and irritating and often causes sore tongue and "smoker's sore throat." When the smoke is inhaled into the lungs a sooty deposit which must certainly be injurious is left on the walls of the bronchial tubes. When smoke is exhaled through the nose it has a tendency to cause catarrh and injures the sense of smell. The nicotin that is taken into the blood, either by partially paralyzing the nerve centers that control the breathing muscles, or by its effect on the muscles themselves, causes the shortness of breath with which every smoker who has tried to take part in athletic sports is familiar.

QUESTIONS

Why will a plant die if its roots are in boiled water? What is the first object of respiration? Why can a person live a long time without eating, but only a few minutes without breathing? What is the second object of respiration?

What organs are in the cavity of the chest? By what is the chest inclosed? How is the chest cavity enlarged in breathing? Describe the trachea and its branches. How do the bronchial tubes end? Explain the changes that take place in the air in the lungs.

Why is breathing dust dangerous? What may be done to keep down dust in factories? How may buildings be swept without raising a dust? Why should leaks in gas pipes in houses be carefully looked after? Why is it injurious to use gas or oil stoves that have no pipes to carry away the gases? Discuss the effects of tobacco on the respiratory organs.

CHAPTER SEVEN

VENTILATION

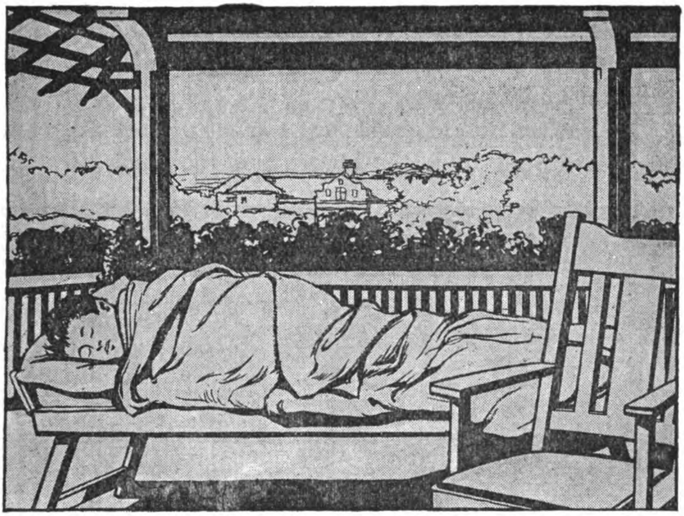


FIG. 55. Move your bed out into the open air if it is possible for you to do so.

THAT fresh air is necessary to the health of the body, we know; but we are not sure that we understand in full why this is so. About one fifth (21 per cent) of the air is oxygen, and the remainder is nearly all nitrogen. The nitrogen is not used in the body, but is simply breathed into the lungs and breathed out again unchanged. The oxygen is taken into the blood and carried through the body to the cells. Air that has been breathed once has lost about one fourth of its oxygen, but we can live on 15 or even on 12 per cent of oxygen, and under any ordinary conditions the trouble with the air we breathe is not with the amount of oxygen in it. It is certain, however, that in many schools and factories bad ventilation is continually undermining people's health and working power. The whole subject of ventilation is of the very greatest importance, and in this chapter we shall take up the study of why we need fresh air and how to get it.

The carbon dioxid problem. Carbon dioxid is given off into the air from the lungs, and too much of it in

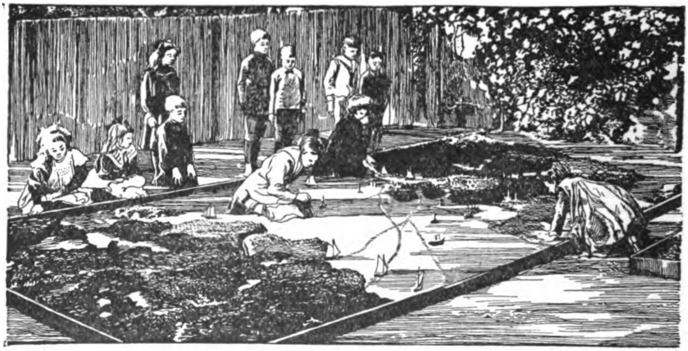


FIG. 56. An outdoor lesson in geography. (*After Ayres.*)

the air is poisonous to us. It was long supposed that this was the chief trouble with indoor air, — that the paleness and lack of strength noticed in those who lived without good ventilation were due to carbon dioxid poisoning. All our rules for ventilating buildings have been laid down with the idea that we must bring in large quantities of fresh air (3000 cubic feet per hour for each person) to keep the carbon dioxid from becoming too abundant in the air that we breathe. This is still a good rule to follow; but the body always contains large amounts of carbon dioxid, and by increasing the rate of breathing, it can be given off more rapidly at any time.

It is probable, therefore, that in ventilation other questions besides the amount of carbon dioxid in the air are of chief importance.

Dry air injurious. In rooms heated by stoves, radiators, or hot-air systems, the atmosphere, therefore, becomes too dry, unless special arrangements are made for moistening it, — drier, in fact, than is the air in the Desert of Sahara. Since dry air quickly evaporates the sweat from the skin and cools the body, people often heat such rooms up to 75 or 80 degrees, because they feel cold at lower temperatures.

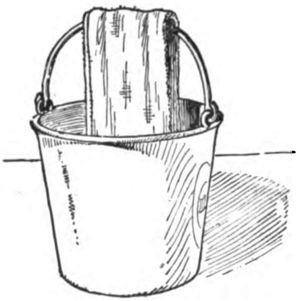


FIG. 57. A home-made humidifier — a pail with a strip of cloth arranged for feeding the water up and letting it evaporate into the air.

Living in a hot, dry atmosphere of this kind is injurious to the eyes; it causes nervousness, also, and a child in a dry, overheated schoolroom is restless and has difficulty in keeping his mind on his work. Vessels of water should therefore be kept in furnaces and on stoves; and in school buildings heated with hot air, arrangements should be made to moisten the air before it is discharged into the rooms. It is economy to give attention to this point; for moist air feels as warm at 65 degrees as dry air at 75 degrees; in some school buildings as much as a 10 per cent saving in fuel has followed the installation of devices for moistening the air.

A moist atmosphere and overheating. When the temperature of moist air rises much above 70 degrees, it gives us a hot, suffocating feeling, similar to that which one has on a warm, sultry summer morning. The explanation of this is that the moisture in the air keeps the sweat from evaporating, and there is a layer of hot, wet air surrounding the body like a shell. In crowded buildings, therefore, where the air is wet from many people breathing it, a proper temperature is very important. It ought not to fall below 65 degrees, for then the people will be chilly; and it ought not to run above 70 degrees, for then the people will become hot and uncomfortable, some of them will develop headaches, and many of them will catch cold when they step out into the cool outside air.

The necessity for motion in the air. In hot weather, and in warm and wet indoor atmospheres, it is most important that there be air currents to break up and blow away the hot, moist air blankets that surround us. How important such air currents are, is shown by an experiment that was carried out in England. In this experiment, a group of students were closed in a small room and watched through a glass in the door. At first they were laughing and joking, but soon they began to show signs of distress. Formerly it would have been concluded that they were suffering from a lack of oxygen or were being poisoned by carbon dioxid. The real trouble, however, was the overheating and the moisture in the air, as was proved by the fact that when an electric fan was started in the room, the students became comfortable again without the introduction of fresh air.

Setting indoor air in motion. In public buildings the air often becomes close and the temperature rises after meetings have been in progress for some time. In such cases a great deal can be done towards keeping the audience comfortable by opening a few windows, so that part of the heated air will escape and currents will be set up through the building. In the Chicago schools, every window in every schoolroom is thrown wide open three times a day to allow the wind to sweep out the stale air in the buildings and to break up and blow away the envelopes of moist air from about the bodies of the pupils. Practices like this should be followed everywhere. A few minutes devoted to flushing out a schoolroom and going through a few resting and stretching exercises are by no means to be counted as lost, for the pupils return to their work with new vigor and zeal.

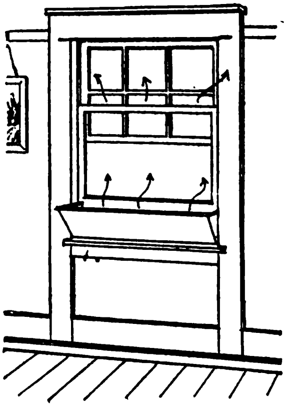


FIG. 58. A window board helps to ventilate a room.

It is well to understand also that the health of many workers could be improved and their working power greatly increased by providing them with electric fans during the hot summer weather. Many factory owners who have put in ventilating systems have found that the increased amount of work accomplished by the laborers in the factory far more than paid the cost of putting in and operating the system. This is what we should expect, for every one knows the difficulty of working in an overheated, stifling atmosphere, and how bracing and invigorating a current of air is on a hot, oppressive day.

Disagreeable odors in crowded rooms. In crowded and heated rooms, odors always arise that cause headache and a feeling of faintness in persons who are sensitive to them. A low temperature makes these odors much less noticeable, and a current of fresh air through the room not only sweeps away the odors themselves, but also refreshes the people and destroys the effects of the odors on them. Persons who are troubled with symptoms of illness when they attend public meetings can sometimes escape the difficulty by arranging for a seat near a ventilator or window, or where a current of air from an open doorway will blow across them. It is probable that "crowd poisoning" is nothing but the effect of the overheating and of the odors that are usual in buildings where many people are assembled.

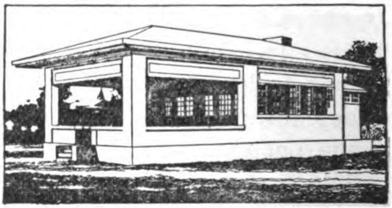


FIG. 59. An open-air schoolroom in Sacramento, California. The inclosed room is used only in bad weather.

Open-air schools. In Oakland, California, during the winter of 1910–1911, an open-air school was in operation. In this school the children did regular work, and they had no special feeding or rest periods. Yet during the first half year no child in the school failed to gain in weight, and the average gain was 3.70 pounds; in the regular school building the average gain was 2.36 pounds. The children in the open-air school were free from colds, while, as usual, the children in the indoor school at times suffered from them. Most noticeable of all, however, was the wide-awake, energetic way in which the open-air pupils kept at their work. Day after day they finished their tasks without becoming tired, and by the end of the year all of them had advanced one grade, several of

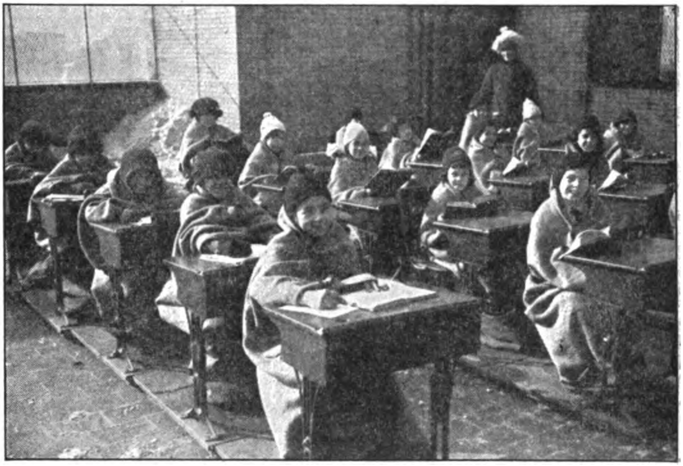


FIG. 60. An open-air class.

them had advanced two grades, and one boy had done two and one half years' work in the one year.

In many places open-air schools have been established for sick children, with the idea of nursing them back to health rather than of advancing them in their school work. In these schools the pupils are fed and have long rest periods, and only light school work is done. Experience has shown, however, that in the open air the children throw themselves into the work so eagerly and their minds are so clear that even in outdoor schools that give only half the usual time to study, the pupils advance as rapidly as they do in an indoor school where they spend the whole day over their books.

Why, then, should not boys and girls who are in good health, as well as those who are sick, be in schools where they can master their work with the greatest ease and at the same time build up their bodies by breathing outdoor air? The time has come when each community must answer this question. In mild climates and in warm weather, there is certainly no reason for going to the great expense of trying to get the right kind of air indoors, when nature has filled all outdoors with exactly the kind of invigorating air that we need.

FIG. 61. Open-air classes held on the roof of the Horace Mann Elementary School, Teachers College, New York.

Outdoor sleeping. In recent years thousands of outdoor sleeping porches have been built in our country. Without a doubt the health is greatly benefited by passing in the open air the many hours that we spend in sleep. The only point that needs to be remembered in moving outdoors is that the warmth of the body must be kept up; that man moved into houses to protect himself from the cold and wet, and when he moves out of them again he must have clothing that will keep him warm and dry. If this point is looked after, the more time we spend outdoors the better. Therefore, move out into the outdoor air to sleep if you can, and if you cannot do this, open wide the windows of your bedroom and let the outdoor air come to you.

QUESTIONS

What two gases make up the greater part of the air ? Which of these gases is used by the body? Under what conditions may the oxygen supply of the air become exhausted?

What is carbon dioxid ? How much fresh air is supposed to be needed by each person in a building ? Why does dry air cause a sensation of chilliness ? What bad effects follow living in a dry atmosphere ? Is there any method of moistening the air used in your school building or in your home? Explain how it works.

Why does one easily become overheated in a moist atmosphere? Describe an experiment that proved the importance of keeping the air in motion. Mention some ways by which air currents may be set up in buildings. In what way have factory owners been repaid for the cost of installing and operating ventilating systems?

What effects have the odors of crowded rooms on certain persons? What may be done to make these odors less noticeable?

Give an account of the open-air school at Oakland, California. For what purpose are open-air schools used in many places? What advancement do the pupils in these schools make in their school work? In outdoor life what point must be kept in mind?

CHAPTER EIGHT

ADENOIDS AND COLDS

FIG. 62. Adenoids sap the strength so that any one who is suffering from them has very little chance of being the best athlete in the school; they dull the mind so that the victim of them rarely stands at the head of his class.

AMONG the most common of all the ailments that afflict the inhabitants of the temperate and frigid regions of the earth, are colds and certain other troubles of the nose and throat. These maladies, of course, are not so severe as many other diseases, but certainly they cause more inconvenience than all our other lesser sicknesses combined. It is true also that they often weaken the body and lay the foundations for other serious difficulties. People lack the general understanding of these diseases that they ought to have, and in this chapter we shall therefore make a study of them. In order that we may do so more intelligently, we shall first consider the structure of the nose and throat.

The chambers of the nose. The air passes through the nostrils into the *nasal chambers*. These long, narrow passages are about three quarters of an inch wide;

they extend up into the head about as high as the level of the eyes, and they run back and open into the throat behind the mouth. They are separated from each other by a very thin, bony partition. On the outer wall of each chamber are three curved and rolled-up bones that stand out in the pathway of the air (Fig. 63). The whole interior of the nasal chambers is lined by the same skin-like *mucous membrane* that is found in the mouth and throat. This is kept moist by a sticky substance called *mucus*.

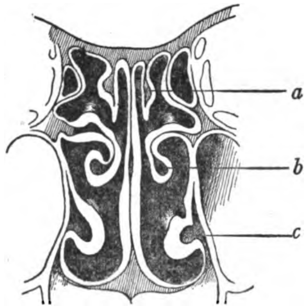


FIG. 63. A cross-section of the nasal chambers, showing the bones (*a*, *b*, and *c*) that stand out in the pathway of the air. The mucous membrane lining the chambers is shown in white.

The air warmed and cleansed in the nose. The air in the nose comes in contact with the lining of the chambers, and is drawn in among the bones that stand out in the nasal passages. In this way the air is warmed, and the dust and germs in it are caught on the moist, sticky mucous membrane that lines the cavities and covers the bones. *The function of the nose in respiration is to protect the throat and lungs from cold and from dust and germs.*

Troubles in the nose. Sometimes the thin partition between the two sides of the nose becomes bent so that it closes one of the nasal chambers; sometimes the bones in the nose enlarge until they interfere with the breathing and prevent the proper drainage of the nose; and in a considerable number of persons, swollen and overgrown portions of the mucous membrane, called *nasal polyps*, block the air passages. In all such cases, the obstruction in the nose ought to be removed by a physician who understands how to do the work. If this is not done, the breathing will be interfered with continually, and colds and chronic catarrh are likely to be the result.

The throat. The throat is a funnel-shaped cavity which curves backward and downward around the base of the tongue. At its bottom are two openings, one leading to the stomach and one leading to the lungs. In front, a little flap-like structure, the *soft palate*, hangs down from above and partly separates the throat from the mouth. Above and behind the soft palate are two openings which lead into the nose, and high up in the walls on either side of the throat are the mouths of the two *Eustachian tubes*, which are small passageways that lead to the middle ears (Fig. 64). In the walls of the throat are four *tonsils*, which we shall describe in some detail.

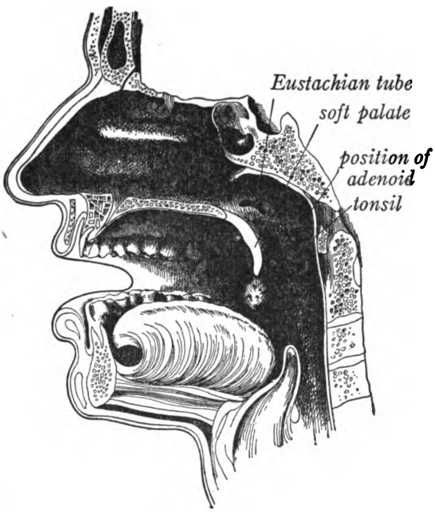


FIG. 64. The nasal passages, mouth, and throat.

The tonsils. One small tonsil lies in the back of the tongue; one is high up in the back wall of the throat; and the other two lie in the side walls of the throat.

These structures are composed of loose, spongy tissue, and leading down into them are small openings, or *crypts*, which are formed by folding the mucous membrane down into deep little pockets (Fig. 65). Germs grow in these pockets and cause disease. In many cases of chronic infection of the tonsil there is no swelling or sensation of pain. In many other cases (cases of tonsillitis), the tonsils are greatly swollen and have pus in them. In some persons, especially children, they are always enlarged, and they may be so swollen that they block the throat and interfere with the breathing. The tonsil which is most commonly enlarged is the one in the back wall of the throat, and the spongy, swollen, whitish mass of soft tissue into which this tonsil changes is called an *adenoid*, or *adenoid growths*.

FIG. 65. A tonsil. A part of the tonsil is cut away to show a crypt.

The symptoms of adenoid growths. In moist climates one fourth of the children may have adenoids. The most easily recognized symptom of them is mouth breathing. If the throat is entirely blocked by them and the tonsils also are enlarged, the mouth will be kept open so wide that any one will notice that the child is a mouth breather. If the throat is only partly filled, the child may keep his mouth open only a little, and the mouth breathing may not be noticed at all except when the child has a cold or is asleep. After an adenoid has been

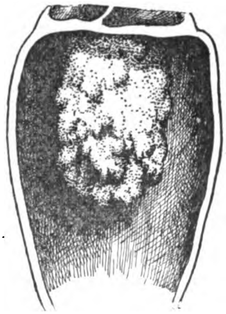


FIG. 66. Adenoid in the throat seen from the front. (*After Wingrave.*)

growing for some time, the upper teeth begin to turn forward; the face is puffed out under the eyes; the eyes have a strained look and are drawn down at the inner corners; the lips thicken; the upper lip shortens and is turned out; there is often a white line running down from the corner of the nose marking off the division between the cheek and lip; and the whole face has a dull, stupid look.

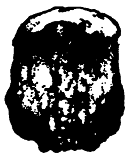


FIG. 67. Adenoid growth that has been removed. One half natural size. (*After Wingrave.*)

In many cases of adenoid growths, the germs work their way up the Eustachian tubes and cause earache, which is an almost certain symptom of them. They also interfere with speech, and any one who "talks through his nose" or has difficulty in pronouncing his words clearly, probably has his nasal passages blocked by them. A child with this trouble usually snores, and in bad cases sometimes gasps and struggles for breath during sleep.

Besides these symptoms of adenoid growths, there are certain other effects that often go with them. Sometimes children who have them are very restless and nervous, and are unable to keep their attention fixed on any one thing. Often they are stupid at their books and fall behind in their school work. Usually the digestion is disordered from swallowing the multitudes of germs that come from the adenoid and tonsils. Often the chest is narrow and the child is undersized,—sometimes two or three years smaller than he should be. Another effect of adenoids, very noticeable in some cases, is a fretful, quarrelsome, and seemingly perverse disposition,—a lack of self-control and a tendency to fly into a rage at the slightest provocation. This causes the victim to make trouble for his parents, for his teacher, and for all who have anything to do with him.

The remedy for adenoid growths and infected tonsils. The only thing to do for adenoids and infected tonsils is to have them out at once. When performed by a skilled

FIG. 68. Typical adenoid faces.

surgeon this operation is not severe, and in thousands of cases it results in an improvement in the condition of the child that is almost miraculous. One sixteen-year-old boy gained fourteen pounds in three weeks after having his adenoids and tonsils removed; and it is a common thing for a child whose adenoid growths have been taken out to make a sudden increase in height and weight and to renew his interest in his school work.

The evil consequences of waiting to outgrow adenoids. Usually, but not always, adenoids disappear by the time a person is grown.[1] It must not be thought, however, that their evil effects disappear with them; for if the nostrils are not used in breathing, the nasal chambers and the upper part of the face do not grow as they should, and the person is left with narrow air passages, protruding upper teeth, a short, thick upper lip, and often with a catarrh and a swollen condition of the nasal mucous membrane that will remain with him for life. Neglected adenoids spoil the beauty of the face for all time, and it is estimated that three fourths of all deafness is due to them. Any one who advises waiting to outgrow adenoids is giving the worst advice possible. They ought to be removed, and this ought to be done before they interfere with the growth of the bones of the nose and face.

Colds. Colds are caused by germs that live on the mucous membrane of the nose and throat. They may be divided into two classes, — *epidemic colds* and *chronic colds*. Epidemic colds are caused by particularly virulent germs that are handed from one person to another until the disease sweeps the community. Most of us must either endure these colds or find a way to escape the germs that cause them — no easy thing to do when people who have colds insist on shaking hands with us and leaving with us a few millions of the germs with which they are so bountifully supplied.

Spraying the nose with something that will kill the germs often helps to check a cold in its early stages.

[1] Trouble with adenoid growths has been reported in a child six weeks old and in a man of seventy years. They are by no means to be thought of as a disease of children only, for many cases are found in persons up to forty years of age.

A hot foot bath cannot kill the germs in the nasal passages, but it helps to draw the blood away from the congested parts and assists in correcting the disturbances of the circulation that accompany a cold. It may also relieve to some extent the headache from which the victim of a violent cold suffers. A hot bath taken before going to bed is even better than a foot bath for drawing the blood away from the congested parts.

In chronic colds, the germs remain with the person all the time, growing only a little when he is in good health and offers a vigorous resistance to them, and springing into greater activity whenever the person gets his feet wet, becomes chilled, loses sleep, or does anything else that weakens his body and lowers its resistance to germs. A person with a cold of this kind is like a country invaded, but not conquered, by an enemy. At one time the inhabitants of the country drive back the foe and give themselves a breathing spell; at another time the advantage is with those who make the attack. The patient's only hope of victory over his germ enemies is to build up his health until his body has sufficient fighting powers to drive them out completely. The following practices have been found important in giving the body strength for this work:

Clearing out the nose and throat. In a great number of cases of chronic colds, the germs have a permanent home in the tonsils, in a mass of adenoid growths, in one of the nasal sinuses,[1] or in some part of the nose.

[1] In the bones that inclose the nasal chambers there are a number of small hollows called *sinuses* (singular, *sinus*). Each one connects by a small opening with the nose, and they sometimes become the seat of chronic infections. Figures 63 and 64 show the locations of some of these

In such cases the first step is to have removed all bent and enlarged bones in the nose, adenoid growths, infected tonsils, and anything else that protects the germs. This step we cannot afford to omit; for the battle against colds is a battle against germs, and we cannot hope to win the fight if the enemy is intrenched behind fortifications. It is important that these seats of infection be removed for other reasons also; for, as we shall see, many of our serious ailments come from them (page 391).

Getting enough fresh air. Experience with both consumptives and well persons shows that no one thing is more important than fresh air in giving the body the power to kill germs. Many persons suffer continually from colds because they live and work in buildings where the air is dry and overheated, and any one who wishes to free himself from a chronic cold must include fresh air in his plans.

Taking cold baths. The practice of taking cold baths helps to give freedom from colds. Probably one way that a cold bath helps is by teaching the blood vessels in the skin to open and close promptly. When cold strikes the body, these vessels ought to close and thus keep the blood in the inner parts where the heat of the body will not be lost. Then, when the cold is removed from the skin, the vessels ought to open and allow the blood to come to the surface of the body. In some persons who are in bad health, the nervous system which governs these vessels does not control them properly, and the vessels in the skin may not close

hollows in the bones, but they do not show the openings into the nasal chambers.

promptly enough to prevent the escape of the heat from the body; or, at the slightest feeling of cold on the skin, the blood vessels may shut up tight and gorge the inner parts of the body with hot blood, while the skin is left cold and shivering.[1] Cold baths help to train the vessels of the skin to open and close properly, and to keep the right amount of heat within the body. In beginning to take baths of this kind, intelligence and care are necessary; otherwise much harm may be done.

Drafts and colds. People are sometimes advised to pay no attention to drafts and to open the windows, no matter how cold the weather may be, because it is germs and not drafts that cause colds. Yet many persons know from their own experience that sitting in a cold draft does cause them to sneeze, to feel chilly, and often to become actually sick. How can the idea that it is beneficial to the health to sleep where the wind will blow over you, be reconciled with the idea that a draft of cold air is dangerous? If motion in the air is desirable, why not have as much of it as possible?

In the first place, it must be understood that drafts of cold air take the heat out of the skin, and that a person who is exposed to them should have sufficient extra clothing to enable him to keep up his body heat. This keeping up of the body temperature is fundamental in the preservation of the health, for the resistance of the

[1] It should be understood that in chills, such as we have in malaria or at the onset of grip or pneumonia, the difficulty is that the blood has been driven to the inner parts of the body, and the skin, where our sense of feeling is, no longer is warmed by the blood flowing through it. There is no lack of heat in the body, for often a person has several degrees of fever at the same time that he is having a chill.

body to germs is weakened at once by the loss of too much heat. Much damage may be done by compelling school children who have been accustomed to hot rooms to sit in their ordinary clothing with the windows wide open on a cold day.

In the second place, it must be recognized that persons who have chronic colds — those who are carrying a host of germs just ready to break through their resistance and put them to bed — are already sick. It must also be recognized that what is safe for a well person or for one accustomed to it, may be neither safe nor wise for a sick person or for one not accustomed to it.

It may be possible, therefore, for a cold draft that would be harmless to a well person to cause a cold in a person who is already infected with the germs; or perhaps it is better to say that a cold draft may make a chronic cold worse in such a person. It is not advisable, therefore, for a person who is weak or half-sick to expose himself suddenly to severe conditions.

Training the body to endure ordinary exposure. A person who suffers from chronic colds needs to build up the strength of the body gradually; to accustom the vessels of the skin to cold baths gradually so that they will act properly instead of throwing him into a chill when a blast of cold air is felt; to clear the nasal passages and the throat of obstructions; and, in general, by degrees to bring the body back to where it will be able to stand ordinary exposure without injury and to kill the germs that are causing the cold. Any one who is always having colds ought, therefore, to begin to build up his health, and if he is wise he will get a good physician to guide him in this task.

Catarrh and bronchitis. Catarrh is a chronic cold in the head. Bronchitis is a chronic cold in the bronchial tubes. In both cases the body is kept poisoned by the germs that are growing in it. Like other chronic ailments, catarrh and bronchitis cannot be cured in a day, and often a climate that is unfavorable to the growth of the germs, or careful work by a skilled physician, is required to cure them at all. In aged persons bronchitis is particularly dangerous, and an old person with this disease should have the best of care.

QUESTIONS

Describe the nasal passages. What effect has the mucous membrane upon the air that passes over it? Name three troubles that may occur in the nose, and the remedy for them. Describe the throat. What is the soft palate? What and where are the Eustachian tubes?

How many tonsils are there? Where are they? Of what kind of tissue are the tonsils composed? What is the cause of tonsillitis? What are adenoid growths?

Give five symptoms of adenoids that show in the face. Give other symptoms and effects of adenoids. What is the remedy for adenoids and infected tonsils? Mention some bad effects of allowing children to wait to outgrow adenoids.

By what are colds caused? Distinguish between epidemic and chronic colds. Give three ways by which the body resistance to the germs of cold may be raised. How does the practice of taking cold baths protect one from colds? Explain how a cold draft may be injurious. What should a person who has a chronic cold do to bring his body back into normal condition?

What is catarrh? What is bronchitis? What bad effects have they upon the body?

CHAPTER NINE

CLOTHING AND THE BODY HEAT

FIGS. 69 and 70. The object of clothing is to keep up the body heat.

A MAN in the cold arctics loses much more heat than does a man in the warm tropics. Yet the temperature of the human body all over the world is the same. A man who is exercising violently produces five or six times as much heat as a resting man produces. Yet the temperature of the human body during exercise and rest is practically the same. Cold-blooded animals become warm or cold according to the temperature of their surroundings, but the warm-blooded animals, including man, keep their heat near a certain point whether the weather is hot or cold. In health the temperature of the human body varies from 98.8 degrees to about one and one half degrees below this point.

The object of clothing. We take our clothing so much as a matter of course, that we often forget that the one great purpose in wearing it is to protect us from cold. It is true that it protects the body from wounds also, and we pay great attention to it because of its effect on our appearance; but yet the fact that the inhabitants of the frigid regions are clad from head to foot in furs, while those who live in the tropics are often very scantily clad, shows that man put on clothing, just as he built houses, to protect himself from the weather. We ought not, therefore, to become so interested in the colors and the appearance of our clothing that we forget the real reason why it is worn.

The necessity for a regulator of the body heat. To a certain extent we can regulate the heat of the body by wearing heavy clothes in winter and lighter clothing when the weather is hot. Yet we cannot regulate the loss of heat from the body by clothing alone; for the temperature of the body must be kept constantly at one point, while the thermometer often runs up and down 20 or 30 degrees in a single day. There must, therefore, be some delicate regulator that will govern the loss of heat from the body according to the changes in the temperature of the air. This work is done by the skin.

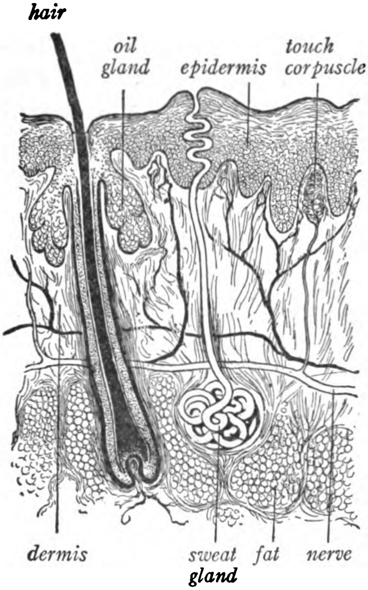


FIG. 71. A section of the skin.

The structure of the skin. The skin is composed of a tough outer layer called the *epidermis*, and of a deeper layer of connective tissue called the *dermis*. The outer cells of the epidermis are dead and are continually scaling off, but the cells in the lower part multiply and grow to take the places of those that are lost. The dermis contains the nerves of touch and great numbers of small blood vessels. Below the dermis is a layer of loose connective tissue in which a considerable quantity of fat is stored. This layer of fat helps to retain the body heat.

Hair follicles and sweat glands. At certain points the epidermis is folded down into deep pockets called *hair follicles*, from the bottom of which the hairs grow. At other points *sweat glands* run down from the outer surface of the epidermis and lie coiled in the dermis. The sweat glands are hollow tubes, the lower ends of which are surrounded by lymph. Water from the lymph soaks through the walls into the tubes and flows out of the mouths of the glands as sweat.

The body heat regulated by the sweat glands and vessels of the skin. The temperature of the body is regulated by the sweat glands and the small arteries of the skin. During hot weather and when we do hard work, the sweat glands assist in cooling the body by pouring out sweat on the surface of the skin. The evaporation of the sweat cools the skin, just as alcohol cools it when allowed to evaporate from it. The arteries do their part of this work by controlling the amount of blood that comes into the skin. When the body is exposed to cold, these small arteries contract and keep the blood in the warm inner organs. When the body is heated, they relax and allow the blood to come to the surface, where it will be cooled.

The danger of chilling the body. Chilling the body disturbs the circulation by driving the blood from the skin and congesting the inner parts of the body. This makes us especially liable to be attacked by the germs of pneumonia, influenza, and colds. Since wet footwear takes the heat out of the feet, the wearing of rubbers when they are needed is a most important precaution in guarding against colds. Pasteur found that fowls were not susceptible to anthrax; but if he put a hen in an icebox for a few hours and then inoculated her with the germs she took the disease. In one of the army camps the records showed that whenever the ground thawed and the men got their feet damp the number of cases of respiratory diseases increased. That chilling the body lowers its resistance to germs is one of the facts of which we are definitely certain.

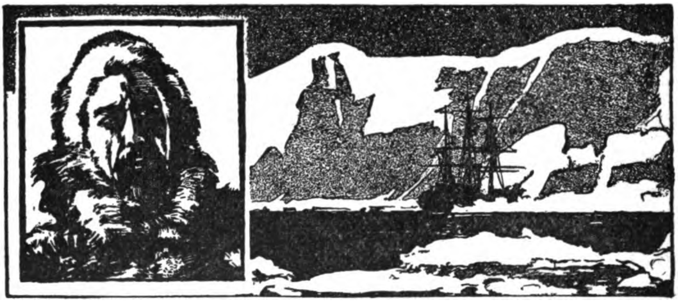
Danger of overheating the body. Working in a hot, moist atmosphere is very exhausting, and it is almost impossible to keep up the health during the summer months unless we can have air currents to blow away the hot air from about the body. Often these can be secured by sleeping and working outdoors, by opening windows, and by the use of ventilators and electric fans. Some persons do not yet realize that from the standpoint of health it is as important to keep cool in summer as to keep warm in winter. Accordingly, they are willing to pay large sums to heat the rooms in which they live and work in winter, but are not willing to spend a small sum for ventilators and electric fans to be used during the heat of the summer. Just as being chilled in winter makes us liable to attacks of influenza and pneumonia, so overheating in summer lowers our resistance to germs and makes us liable to attacks of diarrhea, dysentery, and other summer diseases. In the southern part of our country much attention should be given to the planning and building of houses so that they will be as comfortable as possible during the long summers. Awnings, brick walls, rooms with windows on opposite sides that will permit currents of air to sweep through, basements that can be used on hot days, and sleeping porches that will give comfort on hot nights are all worthy of attention.

Suiting the clothing to the weather. Men who are brought into hospitals suffering from sunstroke are often found to be wearing heavy coats and undershirts, and thick woolen trousers. Little babies in hot summer weather are often covered with "nettle rash" and "heat rash," because they are dressed in such heavy clothing that the skin is kept in an overheated condition. On the other hand, we sometimes see people going without wraps and overcoats when the weather is so cold that they could scarcely keep up their body heat with the heaviest clothing. What we need to remember is that the object of dress is to keep the proper amount of heat in the body, and that each person should wear clothing that will keep the body temperature at the right point. In the spring and fall, especially when the weather is changeable, it is important that the weight of the clothing correspond to the needs of the body. The color of clothing also is important. When a piece of white cloth and a piece of black cloth are spread over snow, the snow will melt much more rapidly under the black cloth. This is because white reflects light, while black absorbs it and turns it into heat. Light-colored clothing, therefore, is best for those who work in the hot sun. A wide-brimmed hat that will shade the neck and upper part of the back as well as the head is a further valuable protection when one is exposed to the hot sun.

Bathing. One object of bathing is to cleanse the body. This we need not discuss. Bathing as it relates to health is mainly a question of the temperature of the water. Cold baths educate the vessels of the skin so that they learn to open and close quickly and thus regulate the body heat properly. The importance of having the blood vessels trained to do this is better appreciated when we remember that animals in the natural state must adapt themselves only to changes in the weather, while man often passes in a few seconds from an artificially heated building into an outdoor atmosphere that is 30 or 40 degrees colder. When these quick changes from warm to cold air are made, the vessels ought to contract promptly and shut the blood off from the skin before too much heat is lost from the body.

The training of the blood vessels through cold baths is of course mainly a work of training the nervous system which controls the vessels, and if a person is weak and out of condition, a cold bath may have about the same effect on his nervous system that a long race would have on the muscles of a person not accustomed to taking exercise. In beginning to take cold baths, therefore, we must use care. They ought to be begun with water that is only cool, the bath should be short, and after the bath the skin should be rubbed briskly with a rough towel. Colder water may be used as the skin becomes accustomed to it, but in no case should the water be so cold or the bath so prolonged that the reaction fails to come promptly.

It is the opinion of some physicians that certain delicate persons are never able to take cold baths without injury; that baths of this kind are injurious to any one who is in poor health or in a nervous condition, and that



FIGS. 72 and 73. Captain Roald Amundsen, who discovered the South Pole. Because alcohol lessens both the endurance of the muscles and the power of the body to resist cold, none of it was used on the Amundsen expedition.

only those who are strong and in robust health can bear the shock of such a bath without injury. Others think that any one can train himself to take them with safety. This question we must leave to the physicians to decide.

Alcohol and the body heat. In cold weather, taking alcohol causes a feeling of warmth, and men often take a drink to enable them better to endure cold. The feeling of warmth that is given by alcohol is deceptive. We feel cold when the blood has been shut off from the skin and warm when the hot blood from the inner parts of the body is flowing through the skin. Alcohol temporarily paralyzes the arteries of the skin and leaves them expanded. This allows the skin to become flushed with blood, and causes a sensation of warmth, but at the same time it allows the blood to be cooled and the body heat to be lost. When we are exposed to cold, the vessels ought to be contracted and we ought to feel cold. Hence to bring the blood into the skin so that the body heat will be lost is an unnatural and unsafe thing to do. Persons who use alcohol cannot endure cold so well as persons who do not use it, as the experience of polar explorers proves.

QUESTIONS

What is the temperature of the body? What is the purpose of clothing? Why must the body have some means of regulating its heat?

Name the two layers of the skin. Describe each. Describe a hair follicle. Describe a sweat gland. What is the source of the sweat?

Explain how the heat of the body is regulated. In what two ways does chilling the body injure it? How may wet feet injure the health?

What is the effect upon the health of overheating the body? Why are air currents especially important in summer? How may they be secured? How may a house be made more comfortable in hot weather? Discuss the subject of suiting the clothing to the weather. At what seasons of the year should we be especially careful to change clothing according to the weather? What color of clothing is best suited to a hot climate?

What do cold baths do for the vessels of the skin? How should one unaccustomed to cold baths begin to take them?

Why does taking alcohol give a sensation of warmth? What has been the experience of polar explorers in regard to the power of drinkers and of abstainers to withstand cold?

CHAPTER TEN

THE NERVOUS SYSTEM

THE work of the nervous system has always been a mystery to mankind. The ancient Greeks thought that the brain distilled some kind of vital spirit, or essence, which flowed out through the body in the form of a gas. If the brain were injured so that the supply of this spirit was cut off, or if the body were deeply wounded so that the vital spirit escaped, life came to an end.

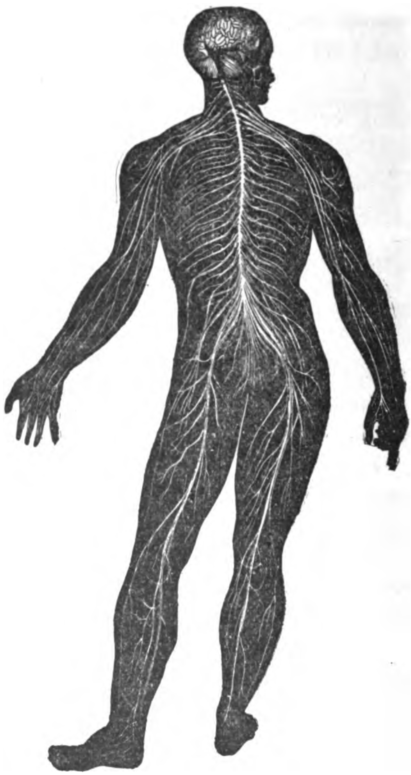


FIG. 74. The nervous system.

Today we know a great deal more than the Greeks knew about the nervous system, but our knowledge of it is yet far from complete. We know enough, however, to help us greatly in the care of the body, and in this chapter we shall take up some of the facts concerning the nervous system that it is most important for us to understand.

The parts of the nervous system. The nervous system is composed mainly of the *brain*, the *spinal cord*, and *forty-three pairs of nerves* that run out from the brain and the spinal cord to all parts of the body. It includes also many little masses of gray tissue, called *ganglia* (singular, *ganglion*), that are found among the inner organs of the body, and a great network of nerve fibers that run among these organs.

The function of the nervous system. *The first function of the nervous system is to control all the organs and parts of the body.* If the heart should beat fast when we lie down to rest and slow when we run; if the sweat glands should pour out water on the skin when we are already freezing and stop work on the hot days of summer; if the muscles moved how and when they pleased, so that they jerked the body aimlessly about; if all the organs worked without system or plan, so that each part of the body carried on its activities without regard to the rest of the body, we should not have a working machine at all, but only a collection of organs and parts. A ruler must, therefore, be set over the whole body to keep all the parts working together properly. This ruler is the nervous system.

The second function of the nervous system is to act as the organ of the mind. This function we shall discuss when we take up the study of the brain.

The nervous system composed of cells and fibers. The nervous system is made up of *nerve cells* and of *nerve fibers.* The nerve cells are larger than most of the body cells, and have a gray color. Most of the nerve cells are found in the brain and spinal cord, but a few of them are found in the ganglia, which are little balls of nerve cells.

The nerve fibers connect the nerve cells with the other parts of the body. They have a glistening white color, but each fiber has a gray central part which carries messages to and from the spinal cord and brain. This gray core of the fiber is a branch of a nerve cell, and we may think of the nerve fibers as long branches of the cells which run out to all parts of the body. The white nerves that we see in the body of an animal are bundles of nerve fibers. The finest nerves contain but a few fibers, and can be seen only with a microscope. The *sciatic nerve*, which runs to the leg, is the largest nerve in the human body. This is a flattened cord three fourths of an inch across.

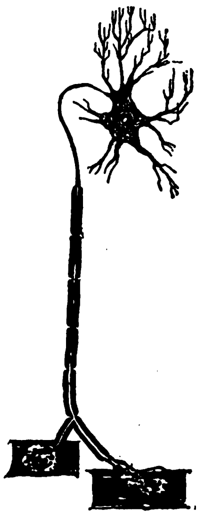


FIG. 75. A nerve cell and nerve fiber. At the lower end the attachment of the fiber to the muscle cells is shown.

Motor and sensory nerve fibers. Some of the nerve fibers carry messages from the brain and spinal cord that cause our muscles to move. These are called *motor* fibers. Other fibers carry messages from the skin, the eye, the ear, and other parts of the body to the brain. These messages cause us to feel, to see, to hear, and to understand the condition of all the parts of the body. They cause sensations in the brain, and the fibers over which they pass to reach the brain are called *sensory* fibers.

The brain. The brain is a mass of very soft tissue weighing about fifty ounces and filling the cavity of the cranium (Fig. 17). It has three principal divisions, the

cerebrum, the ***cerebellum***, and the ***medulla oblongata***. A general idea of the appearance of the different parts of the brain may be gained from Figure 76.

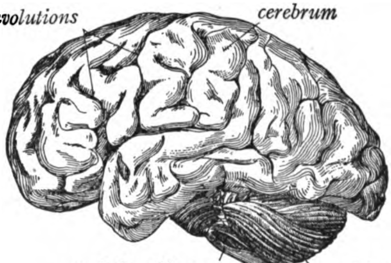


FIG. 76. **The brain seen from the side, showing the three principal divisions.**

The cerebrum. The cerebrum makes up more than three fourths of the entire brain. It is divided by a deep groove into right and left *hemispheres*. The outside layer of the cerebrum is composed of nerve cells, and therefore has a gray color. To make more room for these cells the whole surface of the cerebrum is thrown into folds, or wrinkles, that are called *convolutions*.

From the cells of the cerebrum a great network of fibers runs in all directions through the brain, and connects all its different parts with each other. Other fibers run down through the medulla into the spinal cord and connect the cerebrum with all parts of the body. Most of the motor fibers from the cerebrum are crossed in the medulla, so that the right side of the cerebrum is connected with the muscles of the left side of the body, and the left side of the cerebrum is connected with the muscles of the right side of the body.

The function of the cerebrum. *The gray outer layer of the cerebrum is the seat of all intelligence.* Without it all sensations of light, sound, taste, smell, touch, heat, and hunger are lost. When it is removed, all power of moving the voluntary muscles is gone. The cerebrum, therefore, is the part of the brain that thinks and feels. It is the part that causes us to remember and to know, to love and to hate, to be glad and to be sad. The cerebrum decides what we shall do; it sends out the messages to the muscles when we wish to move; and it governs the whole body. Without its cerebrum an animal can live, but all its intelligence is gone. It still breathes and its heart continues to beat, but it is only a machine, knowing nothing of its own needs and of the world about it.

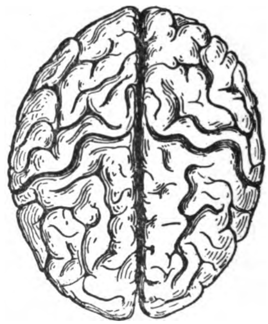


FIG. 77. The cerebrum seen from above, showing the hemispheres.

The cerebellum. The cerebellum lies under the back lobes of the cerebrum. *Its function is to cause all the muscles to keep the proper tension, and to assist in governing the muscles of locomotion.* In walking, more than two hundred muscles are used in holding the body upright and in moving the different parts that are brought into action. Each of these muscles must contract with exactly the right force and at exactly the right time, or they will work against each other and the right movements will not be made. When the cerebellum is injured, all the muscles are weakened and relaxed, and the person loses control of the muscles that support the body and move the legs. This causes him to stagger and reel like a drunken man.

The medulla and the spinal cord. The spinal cord is about half an inch in diameter and eighteen inches long. Without the roots of the nerves that rise from it, it weighs about an ounce. It lies in the canal in the center of the spinal column and is securely protected by the bones about it. The enlarged upper end of the cord is the medulla.

Both the spinal cord and the medulla are composed in large part of fibers that connect the brain with the different body parts. Some of these are sensory fibers, through which messages from the body are passed up to the brain. Others are motor fibers, over which commands from the brain pass down on their way to the different parts of the body. In addition, *the medulla contains the centers which govern the heart and lungs.* When the cerebrum of an animal is removed, the intelligence is lost; when the cerebellum is injured, control of the muscles is lost; but when the medulla is injured, life at once ceases, because the beating of the heart and the breathing stop.

Reflex action. Much of the governing of the body by the nervous system is done without thought. The messages, or nerve impulses, pass through the sensory nerve fibers into the nerve cells, pass on through the branches of these cells into other cells that are touching them, and come out again by way of a motor nerve. An action that is caused in this way is called a *reflex action*, and it can best be explained by an example.

Cross your legs, and strike yourself just below the kneecap with the edge of your hand. If you strike the right place, you will start messages to the spinal cord. These, without any thought whatsoever on your part, will pass into the motor nerves and down into the muscles of the leg. The muscles of the leg will then contract and cause the foot to jerk. *A reflex action is an involuntary action caused by an impulse that starts in a sensory nerve.* It is very different from the voluntary actions that are caused by impulses which start in the cerebrum and pass out to the muscles when we wish to move some part of the body. Practically all the governing of the internal organs of the body is carried on by reflexes.

FIG. 78. The ball starts from the hand and comes back to it again. The impulse that causes a reflex action starts from the *outer end* of a sensory nerve and comes back to the muscle or gland that is thrown into action. *It does not start from the brain.*

Reflexes acquired through practice. The reflexes that we have been discussing are natural reflexes; we are born with them. There is another set of reflexes that comes to us through practice. The skilled swimmer does not think how he shall move his arms and legs; in boxing, the hands move without thought and almost faster than the eye can follow; the telegrapher does not think about the combination of dots and dashes that spell out a word, but reads the message he is sending, and his hand does the rest. In the same way, all of us every day do a great part of our work without thought. We walk without giving attention to the muscles and parts which we must move; we open our mouths to take in food without thinking; we chew our food without noticing that we are chewing; we write without conscious thought as to the shape of the letters. All these things we have repeated so often that we have learned to do them without thought.

Acquired reflexes and education. A very important part of education consists in establishing the right reflexes, so that without thought we shall do the more common things of life properly. A young person who is learning to write ought to learn to hold his pen in the right way and to shape the letters correctly, so that the right reflexes will be formed and the writing question settled for life. He ought to learn to group his words properly and to give the right inflection in reading, so that these matters will attend to themselves thereafter. He ought to take great care to say "please" and "thank you"; to modulate his voice so that it will not become loud and strident when he is talking eagerly; to take off his hat and to rise to his feet when he should do so; and to do all the other things that go to make up pleasant manners; for no one will ever have good manners who has not established reflexes that will make him able to do what he ought to do naturally and without thought of his actions.

When you are learning to do anything, the great thing is to do it right, so that you will form a reflex action of the right kind. Then as long as you live the part of your conduct and work that depends on this reflex will take care of itself and you will be free to expend your energy on the new problems that arise day by day. The object of the training that you are receiving at home and in school is to make for you a set of tools with which to carry on the work of your life. If you wish to be a good workman, you must, first of all, manufacture for yourself a good set of tools.

Habits. Habits are really reflexes that we form by repeating acts, and just as physical habits can be formed, so can moral habits, and habits of the mind, be formed. All kinds of habits are formed most readily in youth, and it is seldom that long-established habits are broken after the age of twenty-five or thirty. Indeed, it is difficult at any time of life to break a habit that has once been thoroughly established. It is because this is true that young people are so constantly urged to form habits of honesty, neatness, accuracy, and cleanliness. An investigation at Harvard University has shown that the students who do high-grade work in the schools of law, medicine, and engineering are students who did their work well before entering these schools; that it makes little difference what subjects they have studied previously, but that it makes a great deal of difference whether they have formed the habit of learning their lessons regularly and thoroughly, or of going through them in a lazy and careless way. The trifler in the lower grades of school is usually a trifler still in the high school, and very few high-school drones ever become capable and industrious college students.

Just what it is that makes the nervous system want to keep on doing things in the same way, we shall not attempt to explain, but it is a well-known fact that what a man does in youth determines very largely what kind of person he will be in later life. If in youth he forms habits of dishonesty and laziness, he is almost certain to develop into an unreliable and unsuccessful man.

If in youth he forms habits of honesty, industry, and promptness, he will probably become a trusted and a successful man. Rip Van Winkle was always intending to stop drinking, but when a glass was offered him, he would say: "We won't count this time"; so the time to begin his new life never came. There are many persons who have good intentions and are meaning to get down to work in the future, but their habits keep them loitering on in the same old ways. The importance, therefore, of forming correct habits in youth can hardly be overestimated.

QUESTIONS

Name the principal parts of the nervous system. Give two functions of the nervous system. Of what is the nervous system composed? Describe a nerve fiber. What are ganglia? What are motor nerve fibers? sensory nerve fibers?

Describe the brain. Describe the cerebrum. How is the cerebrum connected with the other parts of the brain? with all the parts of the body? What is the function of the cerebrum? What part of the cerebrum is the seat of intelligence? Can an animal live if its cerebrum is removed?

Where is the cerebellum? What is its function? What effect upon a person has an injury to the cerebellum?

Describe the spinal cord and the medulla. Why does injury to the medulla cause death?

What is a reflex action? Give an example. Describe the course of the impulse in a reflex action. Describe the course of the impulse in a voluntary action. What is an acquired reflex? How may right reflexes be established? Why is it important to establish this kind of reflexes?

What is a habit? Why is it so important to establish right habits in youth? What did the investigation at Harvard University show in regard to the foundation of good scholarship?

CHAPTER ELEVEN

THE CARE OF THE NERVOUS SYSTEM

FIG. 79. There is no truth in the idea that a person can have too much natural sleep.

SUPPOSE that you decide to raise your hand. The hand comes up. Can you explain exactly what made it rise? It is in reality a very complicated action, and to make sure that you understand it we will go through the different steps in it with you.

First of all, you decided to raise your hand. This was an act of the mind. Then nerve impulses, whatever they may be, were started out from the brain. These impulses traveled down through the medulla and spinal cord, passed out into the nerves of the arm, and finally entered the muscle cells. This caused the muscle cells to contract and lift the arm. The muscles did the work, but the nervous system decided what was to be done and caused the muscles to do it.

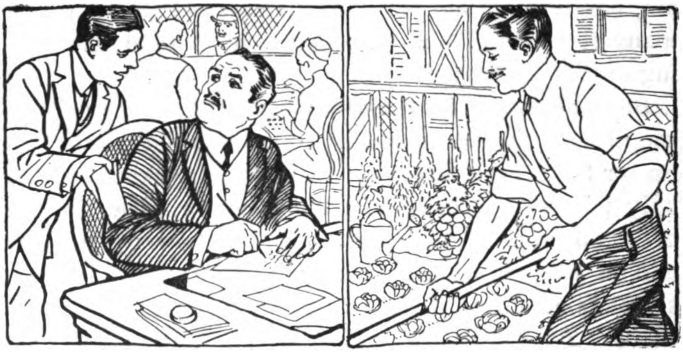
In all our other activities we find that the nervous system plays a guiding and controlling part. The regulation of the body heat; the secretion of the digestive juices; the excretion of the wastes; all these processes, as well as every movement that we make, are under the control of the nervous system. We must, therefore, keep the nervous system in health; for when it goes wrong in its work, the whole body suffers. Fortunately for us, our nervous systems are splendidly built, and on the whole they do their work faithfully and well. There are, however, certain points in the care of them in which many persons fail, and we ought to have an understanding of these points.

Sleep necessary for the nervous system. The cells of the nervous system must have sleep to build themselves up for further work, and so far as we know they are the only part of the body that needs sleep. The amount of sleep needed varies greatly in different persons and in persons of different ages. A little baby may sleep as much as twenty-two out of the twenty-four hours. At six months of age he sleeps about sixteen hours. At seven years of age a child should sleep eleven or twelve hours; at ten or twelve years of age, at least ten hours. Older persons should take the amount of sleep that they find best for them. Occasionally a person is found who keeps in good health on four, five, or six hours of sleep. Other persons must have eleven or twelve hours. Each one should go to bed early enough not to feel sleepy when getting-up time comes; for there is no truth in the idea that one can have too much healthy sleep.[1]

Are you still tired and sleepy when you waken in

[1] Illness and poisons absorbed from the intestines cause drowsiness. When a person is sleepy from one of these causes, the condition is, of course, an unnatural one.

the morning? Are you pale and languid and do you drag yourself through your work? If you are, it may be because you are cutting your sleep short; for there are thousands of people who are starving for sleep as truly as other people are starving for food and fresh air. If you have fallen into a habit of staying up late in the



FIGS. 80 and 81. A change for a time to a different kind of occupation is restful to the nervous system.

evenings, break this habit and go to bed early. A runner or a baseball team that has been losing sleep has not the slightest chance of winning from others of equal ability who have had a sufficient amount of it. This is because the nervous system, when it lacks sleep, is out of condition and cannot control the muscles as it should.

Rest necessary to the health of the nervous system. A great amount of nervous energy is required to drive the more than five hundred muscles of the body, and when we study or do other brain work, it is the nervous system that is called into action. In either physical or mental work, therefore, we tire the nervous system; and we ought not to continue either until our cells are poisoned with the "fatigue toxins" that appear in the body in cases of exhaustion.

Factory workers who are forced to speed themselves up to machines, and little children in schools where the recitation periods and the school days are too long, suffer from fatigue and cannot do their best work. Many earnest, ambitious individuals who are trying to do the very best work of which they are capable, injure themselves and lower their working power by keeping their nervous systems exhausted.[1] In general, it has been found best to work hard during regular working hours, and then to have rest periods when something entirely different is done. In schools there should, therefore, be rest and play periods for young children, and older persons ought to work certain hours every day and then for a time have a different kind of occupation.

Fresh air helpful in resting the nervous system. A nerve fiber from a frog will carry impulses all day without fatigue if it is exposed to the air so that it can take in the oxygen that it needs. If the supply of oxygen be cut off from it, however, it soon becomes exhausted. Undoubtedly children in open-air schools can do more work without becoming tired than can children in indoor schools, and it is the belief of those who sleep

[1] In some factories it has been found that the workmen can accomplish more when they work eight hours than when they work ten hours, because when they work the longer hours they are always tired and never in good condition. The number of hours that is best for a working day must, of course, vary with the kind of work and with the kind of people who are doing the work.

in the open air that they need about an hour's less sleep than they require if they sleep indoors. These facts indicate that fresh air is an aid in preventing exhaustion, and that tired nerve cells are more quickly rested and built up when the body is given plenty of outdoor air.

A peaceful mind necessary for health. In our study of the nervous system we must always keep in mind

FIG. 82. Both the child's pleasure at seeing the toy and the man's pleasure at seeing the child's happiness affect the mind, and through the mind affect the body.

that it has the double function of governing the body and of acting as the organ of the mind. It is perhaps economical to have these two different kinds of work done by the same system, but this plan has its drawbacks as well as its advantages; for the condition of the mind greatly affects and sometimes interferes with the proper regulation of the body.

Good news or bad news may greatly change the beating of the heart. Many soldiers of nervous disposition suffer from serious heart trouble during times of excitement and anxiety. A certain famous ball player found that an attack of stomach trouble always followed a quarrel with the umpire. After a fight a boy ate nothing for more than two days, yet during that time he felt no sensations of hunger. The explanation of such experiences is that the workings of all the internal organs of the body are under the control of the nervous system, and when the nervous system is disturbed, these organs may not carry out their work in an orderly way.

Food that is pleasing to the taste, or even the sight or smell of food, will cause the "mouth to water," which is another way of saying that it causes the digestive juice to flow from the salivary glands. Experiments on a dog have shown that the sight and smell of food, even though the food does not reach the stomach at all, causes an abundant flow of the digestive juices in the stomach; while in a dog that was made angry by having a cat placed near it when it was eating, the flow of the juice in the stomach was interfered with for two whole days.

All these facts show that anger, sorrow, and worry interfere with the proper action of the body; that the mind greatly affects the body; and that a cheerful, quiet, hopeful mind is necessary for health.

At the same time, we must realize that sickness is a real thing, and that when it comes upon us we cannot depend upon the mind alone to restore us to health. When a child has diphtheria, only antitoxin will save its heart from being poisoned, and when tuberculosis attacks the lungs, good food, fresh air, and rest, as well as cheerfulness and hope, are needed if the body is to make a winning fight against the germs. When the kidneys have been poisoned by scarlet fever or by the use of alcoholic drinks, nothing that we can think about them will make them able to throw the wastes out of the body as a pair of sound kidneys are able to do. The mind cannot take poisons out of the body; it cannot kill germs that get into the body. These things the body must do for itself, and all that the mind and the nervous system can do is to help to keep each organ of the body at work at its particular task.

Nevertheless, it is true that the nervous system rules the whole body; that when the nervous system goes wrong, the whole body goes wrong; and that just as food, fresh air, exercise, and rest are necessary to the health of the body, so a peaceful, hopeful mind is necessary in order that the nervous system may remain in health and regulate all the body parts properly.

Conditions necessary for good mental work. A leading psychologist has said that the two conditions essential for effective work with the mind are good health and freedom from worry and annoyance. Our schools, colleges, and universities are mental workshops, and to keep the output of these shops up to what it should be, the teachers and students in them must be kept in as good health as possible and must be given peaceful and pleasant conditions in which to work.

QUESTIONS

What part of the body needs sleep? How much sleep should a baby have? a child seven years old? a child twelve years old? an adult?

Why is rest necessary for the nervous system? Under what conditions of work and rest can a person do the best and most work? Give three facts indicating that open-air life prevents exhaustion of the nerve cells.

What is the effect of joy, hope, and other pleasant emotions on the nervous system? What is the effect of anger, sorrow, or worry? What mental state is necessary to the health of the body? Mention some facts that prove this. Can the mind take poison out of the body? Can it kill germs? How can the mind help the body to do these things? What conditions are necessary for good mental work?

CHAPTER TWELVE

THE EYE

MANY of the messages which travel up the nerves to the brain are started within the body itself, and cause sensations that tell us about the condition of the body. Examples of sensations of this kind are sleepiness, fatigue, weakness, faintness, hunger, thirst, and nausea.

Others of the messages that come to the brain are started in the nerves by things that are outside the body, and these messages bring us information about the outside world. The nerves that carry these messages are the nerves of *sight*, *hearing*, *touch*, *taste*, and *smell*. Seeing, hearing, touching, tasting, and smelling are the five special senses, and the eye, the ear, the nose, the mucous membrane of the mouth, and the skin are the special sense organs.

The brain dependent on the sense organs for information. Through the special sense organs we learn all that we know of the world about us, and when anything interferes with the proper working of these organs, much information that ought to come to the brain fails to reach it. Many children who are thought to be stupid are dull, not because they have slow brains, but because their eyes and their ears are not keen in gathering the information that is necessary to make them intelligent. We must learn to care for our sense organs, especially for our eyes and ears, for without them the brain sits in idleness, and is no more certain of what is the right thing to be done than is the commander of an army whose scouts bring him no news of the enemy's movements.

The nerves in the eye stimulated by light. Light is waves in the ether which fills all space, and the eye is an instrument so constructed that when light enters it the nerves of sight are stimulated and messages are started to the brain. These messages give us a series of pictures of the world about us, from which we learn about the color and the form of objects, about their movements and their nearness to us. From these pictures much of our knowledge comes. Much of the pleasure also that we have in the world comes from them; for just as music starts messages from the ear that give pleasure to the mind, so beautiful objects start messages from the eye that are pleasing to us. Years ago, a great man of science suggested that we should have concerts of beautiful colors for the eyes as well as concerts of music for the ears. Such concerts have already been attempted.

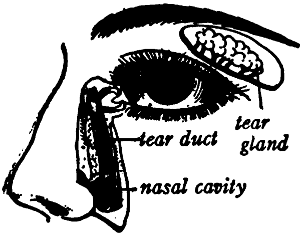


FIG. 83. The tear gland and the duct that carries the tears to the nose.

The protection of the eyes. The eyes are protected from blows by the deep sockets in which they lie, and by cushions of fat on which they rest and turn. They are protected from dust and sweat, and screened from light, by the eyelids, the eyelashes, and the eyebrows. In the outer corner of each of the upper eyelids is a small gland which secretes the tears. These flow across the eyes to the inner corners, and run down a little duct into the nose. In their passage across the eye, the tears wash away dust and germs. In the eyelids are glands, very similar to the glands that oil the hair, which pour out oil along the edges of the eyelids. Sometimes these glands become diseased, and the secretion from them dries and forms scales around the roots of the eyelashes. The trouble in cases of this kind is that germs are growing in the gland. Dropping a solution of boric acid (as much as will dissolve in water) into the eyes will help to prevent the growth of the germs.

The muscles of the eye. The eye is moved about by six muscles. The back ends of these muscles are attached to the eye sockets. The front ends are attached to the ball of the eye. These muscles can turn the eye in, out, up, or down. It is not necessary always to turn the head toward an object which we wish to see; for the eye muscles can turn the eye toward it while the head is at rest.

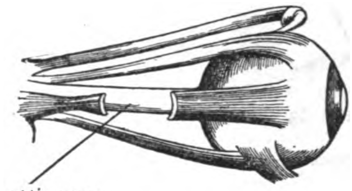


FIG. 84. The muscles that move the eye.

The muscles that move the eye work in pairs against each other, and if one muscle of the pair be too strong for the other, the eye will be turned too far in the direction in which the stronger muscle is pulling. For example, if the outer muscle be stronger than the inner one, the eye will be turned out, instead of looking straight forward; or if the inner muscle be too strong for the outer, the eye will be turned in, instead of looking straight forward. A person whose eyes behave in this way is said to squint, or to be cross-eyed. The trouble, if taken in time, can be remedied by a skilled oculist.

The structure of the eye. The eye has a tough, white outer coat called the *sclerotic* coat; a dark middle coat called the *choroid* coat; and lining the back two thirds of the eye, a delicate inner coat called the *retina*. The front part of the sclerotic coat, which is called the *cornea*, is transparent like glass, and we look out, or rather the light comes in, through a little window that is like a small round watch crystal on the front of the eye.

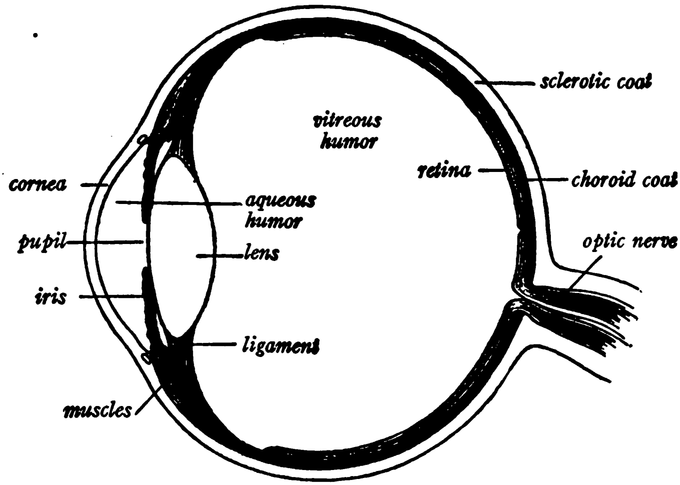


FIG. 85. A diagram showing the structure of the eye.

Inside the eye is found a circular, clear structure called the *lens*, which is fastened by ligaments to the choroid coat. The lens and the ligaments that support it divide the eye into a small front chamber and a large back chamber. The front chamber is filled with a watery liquid, called the *aqueous humor*. The back chamber contains a clear jelly-like substance called the *vitreous humor*. The nerves of sight enter at the back of the eye and spread out in the retina. The light reaches these nerves and starts messages in them by passing in through the cornea, the aqueous humor, the lens, and the vitreous humor, and striking against the retina.

The iris and the pupil. The front part of the choroid coat is called the *iris*. This shows through the clear cornea, and the person is black-eyed, brown-eyed, or blue-eyed according to the color of his iris. In the center of the iris is a circular opening called the *pupil.* Through this the light passes into the eye. Muscles in the iris regulate the size of the pupil according to the brightness of the light, Examine your own eyes after being in a bright light and again after being in a weak light, and you will have no trouble in seeing the difference in the size of the pupils.

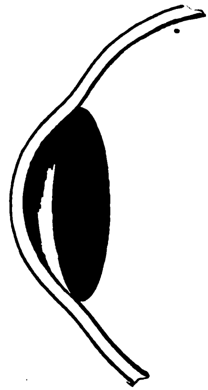


FIG. 86. The iris and the pupil.

The image formed by the lens on the retina. If you were to focus a camera on a group of objects, as for example a house with trees surrounding it, and then look at the ground glass in the back of the camera, you would see an image of the scene that lies before the camera. The image would be upside down, and the right and left sides would be reversed, but the house and the trees would be there, each with its own colors, and each in the right position in the group. The lens in the front of the camera forms this image by gathering up all the light that comes into the camera from each of the objects, and bringing the rays together so as to form a picture of all the objects.

In the same way, the lens of the eye forms on the retina images of the objects that we see. In the eye, as in the camera, the images are upside down, but they are there in their proper colors, and the different objects have the right sizes and the right positions in regard to each other. This picture of whatever we are looking at starts impulses in the nerves of sight to the brain, and when these messages are received by the brain, we form judgments about the size, color, and form of the objects, and say that we see the objects. By means of the images in the eyes we can judge also of the distances of objects from us, of their movements, and of their smoothness or roughness.

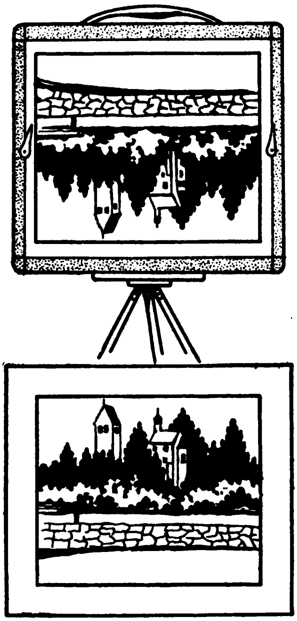


FIG. 87. The lens in the camera forms inverted images on the ground glass in the back of the camera.

The shape of the lens changed in looking at far and near objects. In looking at a near object the lens of the eye must be rounded up, and in looking at a far object it must be flattened. This rounding and flattening of the lens is done by little muscles in the eye which loosen and tighten the ligament that supports the lens. If you should fill a small sack with water and then pull on the ends of the sack, you would flatten it; and if you should then stop pulling on the ends of the sack, the sack would of itself round up. So in the eye, when the ligament is loosened, the lens becomes rounder. This change in the shape of the lens is called the *accommodation* of the eye, because by it the eye is accommodated to the nearness or farness of the object.

Near-sightedness, far-sightedness, and astigmatism. In a camera, if you move the lens too far forward or backward, the image becomes blurred. So in the eye the image will not be clear and the vision will not be distinct, unless the lens is the right distance from the retina.

The eyes of some persons are too long from front to back. In such eyes the lens is too far from the retina and the image is indistinct. These persons see near objects better than far objects, and they are therefore said to be near-sighted. Any one who bends over his book in reading, or who holds his book less than twelve inches from his eyes, is near-sighted.

The far-sighted eye, on the other hand, is too short from front to back, and the lens is too close to the retina.[1] Persons with eyes of this kind see distant objects best, and they are said, therefore, to be far-sighted.

In other eyes, the curvature of the cornea is not the same in all parts; that is, some parts of it are flatter than other parts. Rays of light that pass through this uneven cornea cannot all be brought to a focus at one point, and a clear image is impossible in such an eye. This trouble is called *astigmatism*. It is a very common defect in the eye and may be found alone, or along with either near-sightedness or far-sightedness.

Necessity for a clear image in the eye. If a sharp,

[1] In some cases of near-sightedness and far-sightedness the trouble may be in the shape or the refracting power of the lens.

clear image is not formed on the retina of the eye, serious troubles follow. The muscles in the eye keep pulling and working to try to change the shape of the lens so that the vision will be clear; in reading it is a strain on the attention to tell what letters are in the words, and, in general, it makes all work that requires close attention more difficult. This overworks and deranges the nervous system, and soon the health of the whole

FIGS. 88 and 89. There are 5,000,000 school children in the United States who need glasses.

body is injured. Two of the most common symptoms of eyestrain are headache and trouble with the digestion, often accompanied by dizziness and vomiting.

The importance of spectacles. It is often said that the great amount of close work that people now do injures their eyes, and it is insisted that the eyes of school children in particular are damaged by the work that they are required to do. There is doubtless some truth in this statement, but it is also true that many eyes are naturally defective. Examination of the eyes of the Indians who come direct from the plains to Hampton Normal School, in Virginia, shows that 34.6 per cent of them are in need of glasses to improve their vision or to relieve eyestrain.

It is estimated that there are 5,000,000 school children in the United States who have defective eyes. Nothing can be done for these eyes except to put glasses before

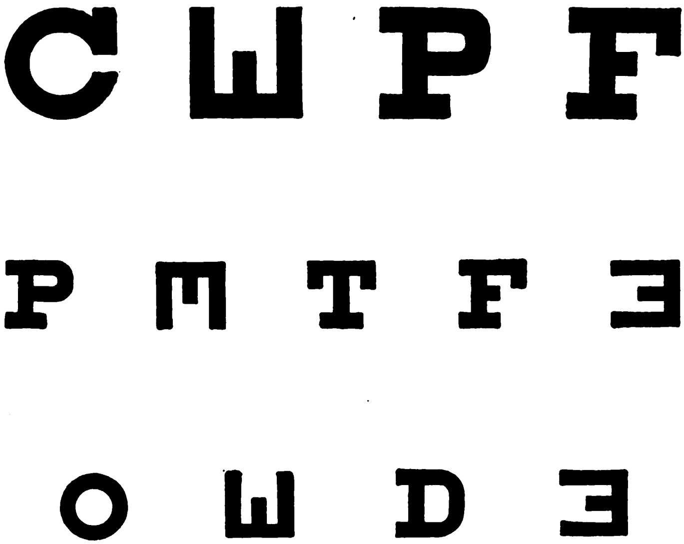


FIG. 90. You should be able to read the upper line at a distance of 30 feet, and the two lower lines at a distance of 20 feet.

them that will cause clear images to fall upon the retinas. We shall not attempt to explain the kinds of glasses that are used to correct the different kinds of eye trouble, but it is an easy matter for a good oculist to select the kind of lens that each eye needs. Test your vision with the letters given on this page, and if you have reason to believe that you need glasses, try to get them; for if glasses are put on in time, many cases of astigmatism and near-sightedness can at least be kept from becoming worse, while if these troubles are neglected, the shape of the eyes may be so spoiled that the person will have trouble with them all his life.

Importance of a good light while working. To read or to work by a dim light is very injurious to the eyes. Too

FIG. 91. A good light while reading is important.

bright a light also is injurious, especially if one faces it, and a flickering light of any kind is bad. In writing one ought to sit so that the light comes over the left shoulder; for then the shadow of the hand will not interfere with the work. Facing a window in the daytime, or a lamp at night, is hard on the eyes. Reading on into the twilight is a great strain on the eyesight, and one ought not to seat himself carelessly too far from the light when doing close work at night.

One difficulty when the light is too dim is that the work is kept so close to the eyes that there is a great strain on the muscles that turn the eyes inward; for the closer an object is to the eyes, the more must the eyes be turned inward to focus both of them on it at the same time. Keeping the work close to the eyes is especially injurious in the case of little children; for their eyes are soft and easily pulled out of shape, and the muscles tugging at the eyes to turn them inward spoil the shape of the globe of the eye and cause astigmatism. To prevent this, schoolbooks for young children ought to be printed in type large enough so that the children will not have to keep the books close to their eyes while studying, and schoolrooms should be well lighted. The rule in erecting modern school buildings is to allow from one sixth to one fourth as much space for windows as there is floor space in the room.[1] Ribbed glass used in the upper sashes assists very greatly in spreading the light evenly over the room.

Resting the eyes helpful and overtaxing them injurious. When we have been reading or doing other close work for some time, it benefits the eyes greatly to stop for a few moments and look at a distant object, or to gaze into the distance without looking at anything in particular. Reading on a moving train or a street car quickly tires the eyes, because the distance between the book and the eye is contantly changing, and the muscles in the eye

[1] Some of the legal requirements of one state in regard to the lighting of schoolrooms are as follows: Schoolrooms shall be lighted from one side only and the glass area shall not be less than one sixth of the floor area, and the windows shall extend from not less than four feet from the floor to at least one foot from the ceiling, all windows to be provided with roller or adjustable shades of neutral color, as blue, gray, slate, buff, or green. Desks shall be so placed that the light will fall over the left shoulders of the pupils, but for left-handed pupils the desks may be so placed that the light will fall over the right shoulder. Blackboards must be dead black in color, and windows must be kept clean.

are kept busy changing the shape of the lens. Reading while lying down is also hard on the eyes, because the book or paper is often held in such a position that the eyes must be strained to see it. If you read while traveling or while lying down, rest your eyes occasionally and stop the reading before the eyes have become fatigued.

QUESTIONS

How are the eyes protected from blows? from light and dirt? Where are the glands which secrete the tears? Of what use are the tears? What is the cause of scales on the edges of the eyelids? Explain how the eye is moved. What causes a person to squint? Name the coats of the eye. Describe the cornea; the lens; the aqueous humor; the vitreous humor; the iris; the pupil. In what part of the eye are the nerves of sight?

Explain how images are formed in a camera and in the eye. In what do the images in the eye start messages? What judgments does the brain form from these messages?

How is the eye accommodated to near and far objects? What causes near-sightedness? far-sightedness? astigmatism? What is the effect on one's health of a blurred image on the retina? How many school children in the United States need glasses? Why is it important, aside from improving the health, that glasses be worn by children who need them?

From what direction should the light come when one is working? Why is it harmful to read or work by a dim light? Why is work that is held close to the eyes especially harmful to little children? How much window space should a schoolroom have? Why is it harmful to read on a moving train? while lying down?

CHAPTER THIRTEEN

THE EAR

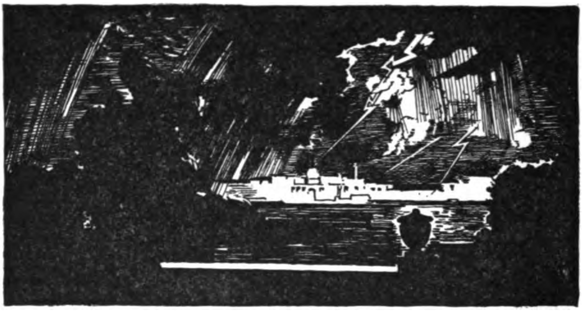


FIG. 92. The light waves start impulses in the nerve of sight, and we see the lightning; the sound waves start impulses in the nerve of hearing, and we hear the thunder.

DOUBTLESS you have seen a flash of lightning fall from the sky, and have stood and waited until the rolling of the thunder came to your ears. What was it that came to your eyes and caused you to see the lightning? It was waves in the ether.[1] What was it that came to your ears and caused you to hear the thunder? It was waves in the air. Why can you not see the thunder? It is because the eye is not affected by waves in the air; only ether waves can stimulate the nerves of sight. Why is it that you do not hear the lightning? It is because ether waves do not affect the ear; only air waves stimulate the nerves of hearing.

[1] Ether is an invisible, elastic fluid that fills all space. Light, the electric waves that are used in wireless telegraphy, and the X-ray are waves in the ether. They run with almost incredible speed, light traveling at the rate of 186,000 miles a second. Air waves are very much slower than ether waves, sound waves traveling only about 1120 feet a second.

Through the ear the confusion of air waves that comes from the instruments of an orchestra is transformed into music; through it we are able to understand the thoughts of a friend when he, by speaking, sends a series of air waves to us across a room. In the whole body there is nothing more wonderful than this instrument that has been given us to catch the waves in the air and carry their motion to the nerves of hearing, which lie deep in the bones of the skull. There are three main divisions of this organ,— the *outer*, the *middle*, and the *inner* ear.

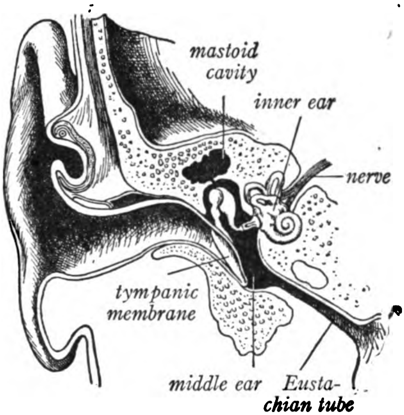


FIG. 93. Diagram of the ear.

The outer ear. The outer ear is composed of cartilage covered with skin. It catches the sound waves and turns them down a winding canal to the middle ear. When a dog, a horse, or a rabbit is listening, it holds up its ears to catch the sound waves, and a man sometimes puts his hand behind his ear to help in catching the sound and turning it into the ear.

The middle ear. The middle ear is a little drum-shaped cavity in the bone of the skull. It is filled with air, and is connected with the throat by the Eustachian tube. At the inner end of the canal that leads inward from the outer ear is a little membrane called the *tympanic membrane.* This stretches like a thin skin across the bottom of the canal and separates the outer ear from the middle ear.

The bone of the skull behind the middle ear is spongy and has a cavity in it which is called the *mastoid cavity.* This opens out, like a little chamber, from the middle ear, and when germs infect the middle ear they often reach the mastoid cavity also. This trouble is called *mastoiditis.* In cases of this disease there is always danger that the germs will find their way to the brain and cause an abscess in the brain.

The bones of the ear. Across the middle ear a chain of three small bones stretches from the tympanic membrane to the inner ear. These bones are called from their shape the *malleus* (hammer), the *incus* (anvil), and the *stapes* (stirrup). The malleus is fastened to the tympanic membrane; the stapes fits into an opening that leads into the inner ear; and the incus is between the malleus and the stapes (Fig. 94). After we have studied the plan of the whole ear, we shall learn how these bones carry the motion of the sound waves from the tympanic membrane to the inner ear.

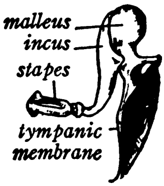


FIG. 94. The chain of bones of the ear connecting with the tympanic membrane.

The inner ear. The inner ear lies deep in the bone of the skull. It is exceedingly complicated in structure and we shall not attempt to explain it further than to say that it has three parts, — a central part called the *vestibule*, a coiled part called the *cochlea*, and three *semicircular canals* at the back that wind through the bone of the skull. The entire inner ear is filled with a fluid, and the fibers of the nerve of hearing end in such a way that when waves are set up in the fluid, the nerve endings are stimulated and messages are started in them to the brain.

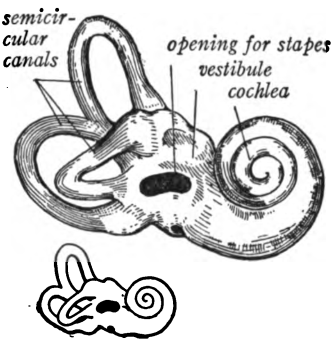


FIG. 95. The inner ear. The lower figure shows the natural size of the inner ear.

How a sound wave starts a message to the brain. When a sound wave strikes the outer ear, it is turned down the canal leading to the inner ear; it then strikes against the tympanic membrane and starts it to swinging out and in. This puts the malleus, the incus, and the stapes in motion, and the stapes is pushed in against the liquid in the inner ear. This sets up waves in the liquid, and the beating of these waves stimulates the nerves of hearing and starts messages to the brain. When these messages reach the brain, we hear the sound.

If the waves in the air are large and strike violently against the tympanic membrane, so that large waves are set up in the fluid in the ear, we say that the sound is loud. If the waves are small, so that the tympanic membrane and the chain of bones swing gently to and fro, the nerves are stimulated only a little, and the sound is soft. Within the inner ear is a wonderful mechanism which is so arranged that a sound having one pitch will start messages in one set of nerves, and a sound having a different pitch will start messages in another set of nerves. By this arrangement the brain is able to tell the pitch of the different sounds that come to it.

Earache and running ear. Practically all ear troubles are in the middle ear and are caused by germs. These germs work their way from the throat into the ear through the Eustachian tube, and they grow in the lining of the middle ear and about the little bones, much as they grow in the nose when we have catarrh. Frequently, in diseases like colds, grip, scarlet fever, measles, and diphtheria, the ears become infected, and in these cases it is most important that a physician give them early and proper care. Often it is adenoids that start ear trouble, and in chronic cases of earache or running ears, adenoids should be looked for.

It is not right to allow children to suffer needless pain from ear troubles, and they ought not to be left to outgrow them; for a running ear already has a hole through the tympanic membrane, and the hearing is in danger of being lost. Nearly all deafness in older persons is due to the fact that when these persons were children, germs were allowed to grow in the ears until they damaged the tympanic membrane or the bones that carry the motion of the sound waves to the inner ear. Sometimes the membrane or the chain of bones is broken down or destroyed. Sometimes the trouble is that the membrane is thickened and stiffened, or the chain of bones is stiffened at the joints until the movement in it is wholly or partly lost. Among grown persons about one third have the hearing affected in one or both ears. This could be prevented by attending to the ears at the proper time.

Other points in the care of the ear. Quinine, if taken for a considerable time, may cause deafness, and this medicine, like other medicines, should be used only when prescribed by a physician. A blow on the side of the head is dangerous to the hearing; for it may send so strong an air wave down the canal of the ear that the

FIG. 96. Testing the hearing.

tympanic membrane may be broken. Live insects in the ear cause great distress by buzzing and moving about. They should be drowned by pouring warm water into the ear.

No one but a physician should attempt to remove objects from the ear, because an unskilled person in attempting to do so may injure the lining of the canal, or break the tympanic membrane. In the canal of the ear there is a bitter wax secreted to protect the ear from insects. Children sometimes form a habit of picking at their ears with the head of a pin or other object. This causes the lining to become inflamed and the wax to be secreted too abundantly. One physician has said, "You should never thrust anything smaller than your elbow into your ear," and another has added, "Before you thrust your elbow into your ear you should wrap your coat around it." If wax accumulates until it becomes troublesome, a physician should be consulted.

QUESTIONS

Describe the outer ear. What is its use? Describe the middle ear. What separates the middle ear from the outer ear? What is the mastoid cavity? What causes mastoiditis? Name and describe the three bones of the middle ear. Where is the inner ear? Name its parts. With what is the inner ear filled?

Where do the nerves of hearing end? Explain how a sound wave stimulates the nerves of hearing. What is the difference between a loud sound and a soft sound? Explain how it is possible for the brain to understand the pitch of a sound.

How do germs enter the ear? In what parts of the ear do they grow? What is the most common cause of earache and running ears? What is the cause of nearly all cases of deafness in grown persons? What per cent of adults have impaired hearing?

What bad effects have excessive doses of quinine? Why is a blow on the side of the head dangerous? What damage may be done when an unskilled person attempts to remove objects from the ear? What is the use of the bitter wax in the ear? What damage may be done by picking at the wax in the ears?

CHAPTER FOURTEEN

THE ORGANS OF TOUCH, TASTE, AND SMELL

THE sight and the hearing are especially important because they give us knowledge not only of near objects, but also of objects that are far away. The sense of smell may also give us information of an object when it is at a distance; but in the main this sense, as well as the sense of taste and the sense of touch, is valuable because it enables us to judge of objects that are near at hand.

FIG. 97. A blind girl reading by sense of touch.

There is not much that we can learn about any of these senses that is important from the standpoint of health. It is interesting, however, to know something of the way in which the messages that cause the sensations of touch, taste, and smell are started in the nerves, and to understand something of what we learn through these senses. In this chapter we shall therefore study the organs of touch, taste, and smell.

Touch. The sense of touch is the most widely distributed of all the senses, for we can feel through the skin on every part of the body. Through the sense of touch, even better than through the eye, we can learn the form of objects; through it we can tell whether objects are smooth or rough, whether they are hot or cold.

Blind persons learn to read by passing the finger tips over raised letters, and persons who are both blind and deaf gain through the touch much of the information that comes to others of us through the eye and ear. The touch, therefore, is a sense that is not only at all times highly useful to us, but one that can be further educated and in time of need called into use to take the place of other senses.

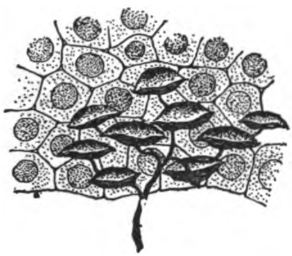


FIG. 98. A nerve fiber ending around the bases of the cells in the epidermis.

The endings of the nerves of touch in the skin. The dermis, or lower layer of the skin, is thrown up into little peaks called *papillæ* (singular, *papilla*) that stand up under the epidermis. Some papillæ contain a great network of little blood vessels. Others contain a *touch corpuscle*, which is a little group of cells with a nerve fiber winding about through it and ending in it (Fig. 71). Other fibers of the nerve of touch divide at the outer end into many little branches which end freely among the lower cells of the epidermis, or spread out into little saucer-like structures around the bases of some of these cells (Fig. 98).

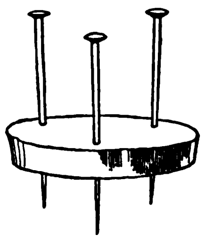


FIG. 99.

The nerves of touch are especially abundant in the fingers, lips, tongue, and tip of the nose, and in these places the sense of feeling is most acute. You can perform some interesting experiments by thrusting two or three pins through a piece of cork or wood

(Fig. 99) and trying how far apart you must place them on different parts of the body to enable you to feel the points of the pins separately.

Messages started by pressure in the nerves of touch. When we touch anything, the epidermis is pressed down on the ends of the nerves of touch. This starts impulses to the brain, and when these impulses arrive in the brain they cause us to feel. If all the nerve endings that are being stimulated have the same amount of pressure on them, we know that we are feeling a smooth surface. If some of them are being pressed harder than others, we know that the surface is rough. When we are touching an object, we know where the object is, because we know from what part of the body the messages are coming. We know whether the object is large or small by the extent of skin surface that is touching it, and by the distance that we must move our hands to pass them over it. If you lay your hand against the wall, messages come in from the whole front of the hand, and you judge that you are touching one large object. If you feel two objects, like the points of two pencils, you know that there are two of them because the messages come from two places in the skin with a space between them in which the nerves are not being stimulated.

Mistaken judgments concerning objects that we touch. The mind can make mistakes in judging of the messages that come in through the nerves of touch as well as in forming judgments from the messages that come in through the eye. Cross your fingers and rub them across the tip of your nose so that the nose is between the two fingers. Can you explain why you seem to feel two noses?

Taste. The nerves of taste are in the mucous membrane of the tongue and of the back part of the mouth. Before anything can be tasted, it must first be dissolved. Then it works its way down among the cells and starts impulses in the nerves of taste. When these impulses reach the brain, we learn whether the object has a sweet, sour, bitter, or salt taste. Many of the supposed tastes of foods are in reality odors, and when because of a cold or for other reasons the sense of smell is dull, many foods are practically tasteless. The continual use of tobacco, alcoholic drinks, and strong condiments like pepper and tabasco sauce, permanently weakens the sense of taste.

The sense of smell. The sense of smell is probably the keenest of all our senses. It is likely that it is of use chiefly to judge whether or not our food is in proper condition to be eaten, and to tell whether air is fit to be breathed. Lower animals, like the dog, have this sense so highly developed that they can follow the track of a man or other animal many hours after the trail has been made. Among men, individuals differ greatly in the sharpness of their sense of smell.

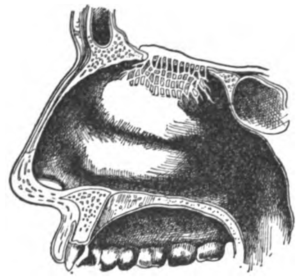


FIG. 100. The nerve of smell ending in the mucous membrane of the nasal chamber.

The nerve of smell stimulated by particles in the air. What we call an odor, or a smell, is in reality little particles of matter floating in the air. These particles come from a rose, from our food, or from anything that we smell, and are drawn up into the nasal chambers with the air. In the mucous membrane that lines the upper part of these chambers are found the *olfactory cells*, from which nerve fibers run to the brain. When odors come in contact with the olfactory cells, impulses are started that cause the sensation of smell.

Care of the organ of smell. When the delicate olfactory cells are destroyed, they are not renewed, and the sense of smell is permanently lost. They may be destroyed by inflammation, which is often brought on by inhaling dust or by working among the fumes of acids or other chemicals. Exhaling cigarette smoke through the nose is also very injurious to the cells, and many cigarette smokers have little or no sense of smell. Another common cause of the loss of the sense of smell is catarrh, which ought always to be treated by a good physician and not allowed to run on from year to year. When the throat is blocked by adenoids, the odors of foods cannot enter the nose as they should, and the pleasure of eating is to a considerable extent lost. The sense of smell is valuable to us both because of the pleasure that we receive from agreeable odors and because of the warnings that come to us in the way of disagreeable odors, and we ought to try to keep it in as good working condition as possible.

QUESTIONS

What do we learn through the touch? What is a papilla? Explain how the nerves of touch end in the skin. Where are the nerves of touch most abundant?

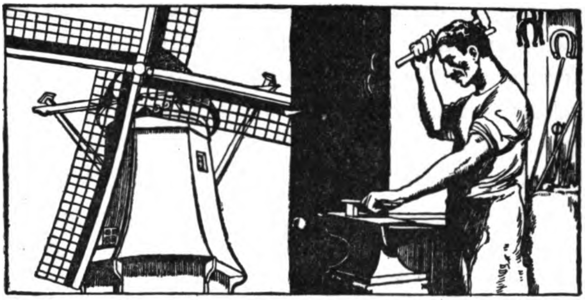
When we touch an object, how are the impulses started in the nerves? How do we judge whether an object is rough or smooth? How do we know where it is? How do we judge of its size?

Where are the nerves of taste? How does the food reach the nerves of taste? Why can we not taste certain foods when we have a cold? How may the sense of taste be injured?

What purpose does the sense of smell serve? What is an odor? Where are the nerves of smell? How are messages started in them? How may the sense of smell be injured?

CHAPTER FIFTEEN

FOODS AND WHY WE NEED THEM

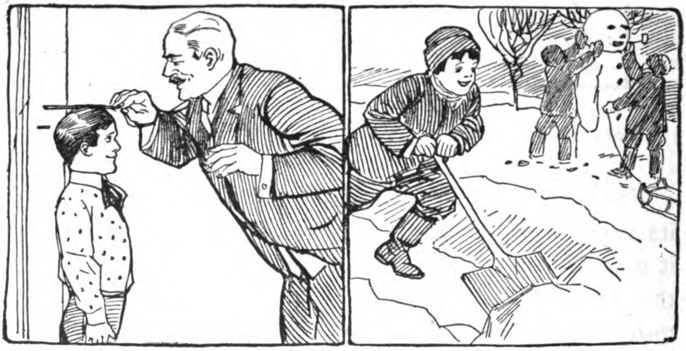


FIGS. 101 and 102. **The windmill gets its power to work from the wind which blows against it; the man gets his strength from the food that he eats.**

FROM my window I can see a windmill standing with its arms outlined against the sky. A little while ago it was whirling rapidly about and pumping water into the tank that it keeps supplied. Now it is standing motionless in the sunshine, as if overcome by the morning heat. Is the windmill broken? Or has anything happened to it that will keep it from any longer pumping water for its owner? Not at all. The only trouble is that the wind which supplied the *power* to run the mill has for the time failed.

Wherever there is motion and whenever work is done, power to cause the motion and to do the work must come from somewhere. We think of a swift and heavy automobile as a powerful machine, but in reality the power comes from the gasoline that is exploded in the cylinders, and when the supply of gasoline gives out, an automobile can no more move itself than can a stone. Every other machine, whether it be run by steam, gasoline, electricity, water, wind, or in any other way, must draw the power that runs it from some source outside itself. The windmill cannot run itself; it must stand and wait until the wind comes to give it motion and make it able to do its work.

Food as a source of power. The human body has strength. It moves and does work. It cannot furnish itself with power, however, so we must have some source



FIGS. 103 and 104. Food is necessary to furnish material for the repair and growth of the cells, and to keep up the body heat.

from which to draw the strength that is in our muscles. This source of power is the food that we eat. *Food is necessary to give strength to the body.* Without it the muscle cells cannot contract and cause the movements of the body parts.

Food as fuel. A locomotive as it thunders past us glows with warmth. It gets its warmth from the fuel that is burned under its boiler. A stove with a fire in it gives off heat to all the room. This heat comes not from the stove itself, but from the fuel that is burned in the stove. Your own body is warm, as you know from feeling it. The heat of the body comes from the food that is burned within the cells. *Food is necessary to keep up the body heat.* Without it the temperature of the body would quickly fall to that of the air about it, and this would be fatal to the cells; for, as you already know, the cells can live and be in health only when the temperature of the body is close to 98 degrees (page 238).

Food as building material. The human body is more wonderful than any machine made by man in that it builds its own parts and keeps them in repair. The body starts as a single cell, which is composed of *protoplasm*, or living material. This cell builds more protoplasm, increases in size, and divides, and this process is kept up until the full-grown body is finally built of living cells which have come from the first cell. Even after the body is grown, new cells must be built; for as long as life continues, the outer cells of the skin, the red blood corpuscles, and some of the other cells are dying and being replaced by new cells.

New protoplasm is also constantly needed to repair the cells; for within all the cells the living protoplasm is constantly breaking down and new protoplasm is being built to take its place. The material that is used in all this building of living matter comes from the food that we eat. *Food is necessary to furnish material for the growth and repair of the cells.*

Elements found in the body. The living matter of the body is composed of at least five different elements, all built together into a material that is very different from any of them. The black solid called carbon makes up over one half of the whole. The two gases of the air, oxygen and nitrogen, together with another very light and highly explosive gas, called hydrogen, make up nearly all the remainder. In addition, some sulfur is built into protoplasm, and in the nucleus of the cell a little phosphorus is found. Among other elements that are present in the body are chlorin and five minerals, — potassium, sodium, calcium, magnesium, and iron. It is not intended that you shall remember the names of all these elements, but it is intended that you shall understand that the body is made of perfectly definite materials, and that if these materials are not supplied in our foods, the body must suffer.

The three classes of foods. Foods are divided into three classes, according to the elements of which they are composed. These classes are the *proteins*, the *carbohydrates*, which include the starches and sugars, and the *fats*. Lean meats, eggs, milk, peas, beans, and all foods made from grains are rich in protein. Potatoes, turnips, cabbage, and other vegetables are valuable mainly for their starch. Grains also contain large amounts of starch. Fruits, sweet potatoes, honey, molasses, and milk contain sugar, and we add great quantities of sugar to our foods to make them more pleasant to the taste. Fats and oils we get in butter, lard, fat meat, eggs, cheese, chocolate, nuts, and olive and cottonseed oil. In general, we get proteins and fats from animals, while from plants we get proteins and carbohydrates. From the table on page 396 you can learn the relative amounts of carbohydrates, fats, and proteins in different foods.

Proteins the building foods. All three classes of foods give heat and strength to the body. The proteins furnish building materials in addition. They contain the same five elements that are found in the living matter of the body, — carbon, hydrogen, oxygen, nitrogen, and sulfur. Since they are used for building up the cells, we should expect them to contain these elements; for we use leather to patch a leather shoe, steel to replace a worn-out part in a machine, and to repair the body, the materials of which the body is built must be used.

Minerals necessary to the body. A man excretes from his body nearly an ounce of mineral salts daily,[1] and it is

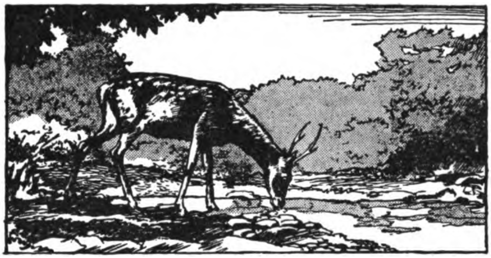


FIG. 105. Wild animals often travel long distances to salt-licks. Man supplies himself with salt, but he often lacks other minerals.

necessary that certain amounts of the different minerals found in the body be supplied to make good this loss. In our food we always get small quantities of these minerals, and little attention has been given to making sure that diets include a sufficient supply of them. Recent experiments show that this trusting to chance for the right amount of minerals is not always satisfactory. Not counting common salt, with which we all supply ourselves, the three minerals that may be lacking in our

[1] The greater part of this mineral matter is common salt, of which the average man uses daily from one third to two thirds of an ounce. This is more than is necessary for the health, for experiments indicate that one tenth of this amount is sufficient to keep the body in good condition.

food are *iron*, *calcium* (lime), and *phosphorus*. We shall discuss the need for each of these separately.

Iron needed to build red blood corpuscles. Iron is used in the body mainly in building *hemoglobin*, the substance in the red blood corpuscles that carries the oxygen. If the supply of iron falls too low, the person becomes pale and weak because of a lack of red corpuscles and because of a lack of hemoglobin in the corpuscles that he has. In cases of this kind the patient is given iron in liquid form as a medicine, and a little of this seems to be used by the body; but all physicians agree that for building hemoglobin the iron in food is far more valuable than iron in other forms.

The green parts of vegetables, especially spinach, are rich in iron; and, in general, eggs, vegetables, and grains, when the outer portion of the grain is used, give a rich supply of this mineral. Milk is low in iron, and in animals that feed their young on milk a large surplus store of iron is laid up in the body before birth. It is estimated that fifteen milligrams of iron are needed daily by a healthy man, and that the average diet contains from twelve to nineteen milligrams.[1] This indicates that it would be very easy to select a diet that would be deficient in this important mineral.

Lime needed by the body. A European investigator has shown that growing animals require about 1.2 per cent as much calcium as they gain in weight. When this amount of calcium is not provided, the bones are frail and the teeth are soft and defective. There must also be a certain amount of calcium dissolved in the

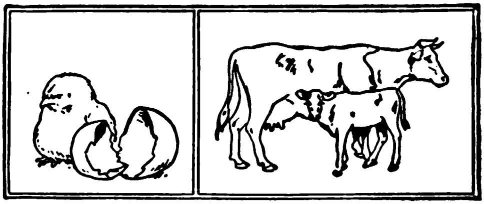
[1] An ounce of iron would furnish the body with 15 milligrams a day for five years.

lymph to keep the cells in health, and if the supply of lime be cut off entirely, life cannot continue. It is claimed that one half the people of the United States are suffering from lime starvation, and it is certainly true that many young children are not supplied with enough of this mineral. Adding a little limewater to artificial foods does not provide enough lime to be of much importance in building the skeleton and the teeth; for a pint of limewater as strong as it can be made contains slightly less lime than is contained in a pint of cow's milk. Milk, eggs, vegetables (especially leaf vegetables), and whole grains hold the first place among the foods that are rich in lime (page 396).

Lack of phosphorus in the body. Experiments indicate that from 65 to 90 milligrams of phosphorus are needed daily in the body, — an amount greater than many diets will supply. The yolk of egg, the outer layer of grains, peas, beans, chocolate, and nuts are especially rich in phosphorus. Meats also supply considerable quantities of this element to the body. Larger amounts of phosphorus are needed during the growing period than in adult life, and if this is not supplied the bones are likely to become soft.

Foods rich in minerals. It is perhaps worth while to call attention at this time to the fact that the foods on which young animals live while starting in the world supply minerals as well as protein and energy-yielding substances to the body. Milk has in it all the elements, except iron, that are necessary to nourish a young animal, and an egg has in it everything necessary to build a chick, including the iron for the blood corpuscles and the lime for the skeleton.

Foods which are rich in minerals ought to form a great part of our diet and be eaten by young people especially. Vegetables, also, because of the large quantities of them that can be eaten, furnish a rich supply of minerals to the body. In the body of an animal the lime is in the skeleton, and when we eat the meat we



FIGS. 106 and 107. Eggs and milk contain the elements necessary to start a young animal on its life.

get little of this mineral.[1] In wheat the mineral matter is mainly near the surface of the grains and is not found in white flour.[2] A diet, therefore, that is composed chiefly of meat and white bread is low in the minerals needed by the body. Whole wheat bread, oatmeal, breakfast foods, and, in general, vegetables and fruits, are rich in minerals. Children who are fed too long on milk suffer because of a lack of iron, and a meat diet supplies less mineral to the body than a vegetable diet. The diet of children in particular needs

[1] When a wolf or a fox eats a bird or a hare, it makes sure of a supply of calcium for itself by eating the bones as well as the flesh. Puppies fed only on lean meat and fat meat showed weakness of the bones, while other puppies of the same litter that were given bones to gnaw, in addition to the meat, developed normally.

[2] The laxative effect of whole wheat bread is now believed to be due to the rich supply of phosphorus in it, and not to the irritating effects of the bran, as was formerly supposed.

care to make sure that the right minerals are contained in it, for there is a special need for mineral matter when the body is growing rapidly. Generally speaking, the mineral income of the body can be increased by cutting down the amounts of meat and white bread eaten and using milk and vegetables more freely.

Vitamins. Within the last few years it has been discovered that certain substances called *vitamins* are necessary for health. We do not know exactly what vitamins are, but small amounts of them are found in our foods, and a good diet must contain them. They are destroyed by cooking with alkalis, and are therefore not found in corn bread or in biscuit made with soda.

We are not sure how many vitamins there are, but two are definitely known to exist. One is present in whole grains, in beans, peas, potatoes, turnips, and other vegetables, and in milk and eggs. In our country almost every one secures enough of this vitamin, but the lack of it causes a disease of the nervous system called beriberi, which is responsible for many deaths among peoples who live chiefly on rice. The second vitamin is found in milk and butter, the yolk of eggs, and the green parts of vegetables. When animals are given a diet that contains none of this vitamin, growth does not take place and there is soreness of the eyes; and when the supply of vitamin is low, growth is slow and the health is poor. Many persons in our country do not get enough of this vitamin, and one of the chief reasons for the use of leaf vegetables and milk is to secure an abundant supply of it.

Scurvy, rickets, and pellagra. Scurvy is a disease in which the joints are swollen and tender and there is bleeding of the gums. It is found in infants that have been improperly fed and among sailors and others who lack fresh food. It can be prevented by fresh meats and fresh vegetables and fruits, and is relieved in a wonderful way by orange juice. Some investigators have thought scurvy to be due to the lack of a vitamin. Others believe it is caused by a bacterium that is able to enter the body when it is not properly nourished. Whatever the cause, the disease can easily be prevented by proper feeding.

Rickets is a disease of children in which the bones are soft. The head grows larger than is natural and becomes somewhat square, and there are knots on the ribs on either side of the breastbone where the bone and cartilage meet. It has been suggested that rickets is due to lack of a vitamin or to a lack of calcium, but neither of these explanations seems to be correct. It is in some way connected with bad feeding and is prevented and benefited by a properly selected diet.

Pellagra is common in Italy, and it is estimated that in the United States there were 165,000 cases in 1917. Most of these cases are found in the Southern states. The disease seems to spread only where the sanitary conditions are bad, and it is probably caused by a germ. At the same time, it has been proved that it is brought on by a faulty diet and that an abundant and varied diet with plenty of fresh foods will prevent it, even when sanitary conditions are bad. It seems most probable, therefore, that pellagra is caused by a germ that can attack the body only when it is in a weakened condition because of improper food.

In our Southern states pellagra is a serious problem.

A great number of the persons attacked by it live, during the winter months especially, chiefly on corn bread, salt pork, and molasses; and it is very necessary that milk, eggs, and fresh vegetables be added to this diet. The garden and poultry club movements, therefore, deserve every encouragement, and the keeping of milk goats might go far toward solving the diet problem of many families. Dried milk, which seems to have all the food value of fresh milk, is now being prepared. It may be that this will prove of great value in warm regions where providing a supply of fresh milk is especially difficult. Meats will not take the place of vegetables, eggs, and milk in providing minerals and vitamins for the body (page 295).

Selecting foods. Of all the hygienic problems that confront mankind, that of selecting a proper diet is one of the most difficult. Since the health of the digestive organs must be kept in mind as well as the needs of the body for certain materials, the whole subject can be entered into more intelligently after the digestive system has been studied. In the next chapter, therefore, we shall discuss the digestive organs and their work, and shall then take up the more difficult subject of selecting a diet that will keep the human body in health.

QUESTIONS

Give three uses of foods in the body. Name the five elements that make up most of the body tissues. Name some other elements which are present in the body. Name the three classes of foods. What foods are rich in protein? in starch? in sugar? in fat?

Which classes of foods give heat and strength to the body? Which class furnishes building material?

For what is iron used in the body? In what foods is iron abundant? Why is lime necessary to the body? What foods are rich in lime? What foods are rich in phosphorus? Why is a diet of meat and white bread deficient in minerals?

What are vitamins? What diseases are due to a lack of them? In what foods is each vitamin found? What other diseases are due to an improper diet? What foods will prevent scurvy? What foods will prevent pellagra?

REFERENCES

Sherman's *Chemistry of Food and Nutrition* (Macmillan) gives a very clear presentation of modern ideas of nutrition, tables of food analyses, and a particularly full treatment of the mineral constituents of the diet. From it have been taken the data concerning the amounts of minerals in different foodstuffs given in the table on pages 392 and 393.

McCollum's *The Newer Knowledge of Nutrition* (Macmillan) is a scientific yet very practical treatment of dietetics from the modern point of view.

CHAPTER SIXTEEN

THE DIGESTIVE ORGANS AND THEIR WORK

ROBINSON CRUSOE on his island had plenty of goats, and from goat hair a fine waterproof cloth is woven that is used as a covering for the tops of automobiles. Yet, because Crusoe had no way of turning the hair of his goats into cloth, he was forced to wear clothes made of stiff, heavy skins and to carry an absurdly heavy and awkward skin umbrella. There were trees in abundance on the island, but it required much labor to convert them into baskets, furniture, and boats. There was clay from which all kinds of dishes and vessels could have been made, but he went for years without tasting soup or boiled food, and he counted it one of the happy hours of his life when he succeeded in making a rude vessel that would stand the fire. There were tons of sand to be had from which glass might easily have been manufactured, but he had no windows in his dwellings. All about Crusoe were materials from which a thousand articles could have been made that would have added to his comfort and enjoyment, but until these materials were worked over and changed, he could not put them to use.

The meats, grains, and vegetables that we eat contain the materials that are needed for the nourishment of our bodies, but the form of these foodstuffs must be changed before we can use them. As ice must be melted before the elements that are in it can be used by the body, so must our foods be *digested* before they can be taken into the blood and used by the cells. *Digestion is the process of breaking up and changing our foods into*

substances that can be dissolved and taken into the blood. Until this is done, our solid food is as useless to us as were most of the materials on his island to Robinson Crusoe.

The digestive system. The digestive system includes the *alimentary canal*, the *teeth*, the *salivary glands*, the *liver*, and the *pancreas*. The alimentary canal is the long passageway through the body into which the food is taken and in which it stays while it is being digested. It is lined with a moist mucous membrane, and in its walls are muscles to force the food onward through the canal. The teeth are a mill set at the mouth of the alimentary canal to crush and grind the food into small pieces so that it will be easier to digest. The other digestive organs are glands that pour juices into the alimentary canal to assist in the digestion of the food. The whole process of preparing the food for the use of the body is a most

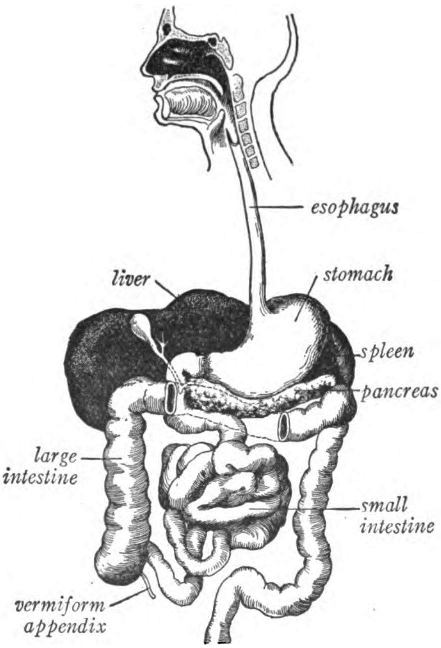


FIG. 108. The digestive system.

important one, and the great set of organs that carry it on fill nearly the whole abdominal cavity.

The digestive glands. The digestive glands are formed by the folding of the mucous membrane that lines the alimentary canal into deep little pockets. The juices that digest the food flow out of the mouths of these glands. The liquid part of the juices is composed of water that passes through the walls of the glands from the lymph, as water passes into a sweat gland (page 240). Some glands are simple, like little wells sunk in the walls of the digestive tract. Others, like the salivary glands and the pancreas, are branched like a tree, and the juices that come from them are secreted by hundreds of little tubules, all of which flow into the main duct of the gland. The glands are said to *secrete* when the liquid flows from them, and the liquid itself is called the *secretion* of the gland.

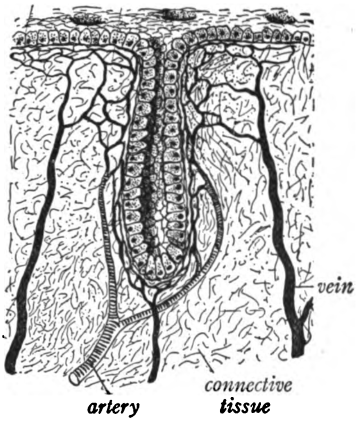


FIG. 109. Diagram of a simple gland.

The work of digestion done by enzymes. Dissolved in the secretions of the digestive glands are certain substances called *enzymes*. These are built up by the cells that compose the walls of the glands and are dissolved by the liquid which passes through the cells when the glands secrete. *The work of digesting the foods is done by the enzymes.* An enzyme digests only one kind of food, so there are different enzymes secreted for breaking up the protein, fat, starch, and each of the different kinds of sugars that we eat. As we study the work of the different digestive juices, we shall speak of them as digesting the foods. You will understand, however, that it is the enzymes in these juices that do the actual work of digestion.

The salivary glands. There are three pairs of salivary glands. One pair lies under the tongue; one pair is found under the corners of the lower jaw; and the other pair is found in front of and below the ears (Fig. 110). These glands secrete the saliva, which is carried to the mouth by ducts leading from the glands. The saliva moistens the food and makes it possible to swallow food like crackers, which in a dry state would become dust in the mouth. Dissolved in the saliva is an enzyme which begins the process of digestion by attacking the starch that is in the food and breaking it up into malt sugar.

FIG. 110. The salivary glands.

The esophagus and stomach. The esophagus is the tube connecting the throat and the stomach. Food and drink do not fall down the esophagus, but are forced down it by the contraction of the muscles in the walls of the esophagus. This you can prove by drinking with your head lower than your body.

The stomach stands almost on its end on the left side of the body close up under the diaphragm. It holds about three pints, and when full is about a foot long. When empty, its walls are drawn together and it occupies little space. It has a double function — to serve as a storehouse for food so that enough can be eaten at one time to supply the body for several hours, and to secrete *gastric juice* for the digestion of the food.

The gastric juice. From two and one half to five quarts of gastric juice are secreted a day. It comes from the many hundreds of little glands which lie in the stomach wall and open into the stomach. The gastric juice contains an enzyme called *pepsin* that digests protein. It contains also an acid which kills many of the bacteria in the foods and so keeps these bacteria from causing trouble in the intestine. The acid in the gastric juice stops the action of the saliva on the starch, but in the upper part of the stomach the food may lie from one to two hours before the gastric juice works its way through it. The saliva, therefore, has a considerable time in which to digest the starch before the acid reaches it. The heat in the stomach melts the fat in the food, which assists in reducing the whole food mass to a liquid condition.

The small intestine. The small intestine is coiled and folded upon itself in the abdominal cavity. It is about twenty-two feet in length and its walls are lined with thousands of little glands. These glands secrete an intestinal juice which contains several enzymes that are important in the digestion of the food. On the intestinal wall are many little finger-like projections called *villi* (singular, *villus*). These contain many blood vessels, and they *absorb* the digested food; that is, they take it into the blood through the intestinal wall. So abundant are the villi that they give the entire inner surface of the intestinal wall the appearance of velvet.

The liver and the pancreas. The liver weighs nearly four pounds and is the largest gland in the body. It lies on the right side of the body under the diaphragm. It secretes a greenish yellow liquid called *bile*, which is poured into the small intestine when food passes into the intestine for digestion. The bile assists in destroying acids that come from the stomach, in making more active the enzyme that digests the fats, and in dissolving the fatty foods. In the next chapter, we shall study other important functions of the liver.

The pancreas is a long, light-colored gland which lies along the lower border of the stomach. It secretes and empties into the small intestine great quantities of thin, watery *pancreatic juice.* This liquid contains enzymes for digesting the three most important foodstuffs, — proteins, starches, and fats. The pancreatic and intestinal juices along with the bile are thoroughly mixed with the food in the small intestine, and they are even more important than the gastric juice in preparing the food to be carried to all parts of the body.

The large intestine. The large intestine begins low down in the right side of the abdominal cavity, passes up the right side of the body, then across under the diaphragm, and down the left side of the body. Just below where the small intestine opens into it, there is a small, worm-like structure called the *vermiform appendix.* The walls of the vermiform appendix contain much loose spongy tissue of the same kind that is found in the tonsils, and just as tonsillitis is caused by germs growing in the tonsils, so appendicitis is caused by germs growing in the walls of the appendix.

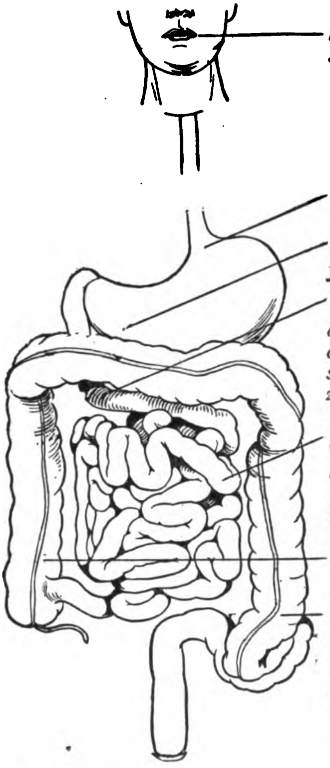


FIG. 111. A diagram illustrating the changes that take place in the food during its journey through the different parts of the alimentary canal.

The story of digestion. Let us now trace the history of a meal by imagining that we can see the food after it has been eaten, and that we can watch it while it is being digested. In the mouth we find that the teeth slide over each other, crush the food into small pieces, and mix it with saliva. The enzyme in the saliva at once begins the process of digestion by attacking the starch that is in bread, potatoes, and many other of our foods, and changing it to sugar.

After the food has been chewed, the tongue draws it back into the opening of the pharynx. The walls of the pharynx then grasp it and press it backward and downward into the esophagus, through which it is carried to the stomach. When the food reaches the stomach, the gastric juice trickles in on it from the glands in the walls all about, and the pepsin attacks the meats and other protein foods. Under the action of the gastric juice the outer layer of the food mass dissolves and slides on into the lower part of the stomach, where the stomach walls contract on it and squeeze it about to mix the gastric juice thoroughly with it.

From time to time the ring of muscle that closes the gateway between the stomach and the intestine opens, and a portion of the food from the lower part of the stomach is forced on into the intestine in the form of a thick liquid.[1] Here a flood of digestive juices is poured in upon it. Greenish yellow bile comes from the liver; great quantities of juice rich in enzymes for digesting proteins, starches, and fats are secreted by the pancreas; and all along the small intestine, juices containing enzymes are poured out by the thousands of little glands that are in

[1] It should be understood that during stomach digestion the food is continuously being worked downward from the upper part of the stomach, and that from time to time it passes on into the intestine in rather small amounts. It takes about six hours for the stomach to be emptied after an ordinary meal.

the wall. The circular muscles in the walls of the intestine keep contracting on the food and cutting it up into little sausage-like segments which are continually being made, combined, remade, and moved about, thus mixing the digestive juices thoroughly with the food.[1] All the time the food is gradually being worked along the intestine and the enzymes are bringing about the following changes in it:

The pancreatic juice attacks the protein and splits that which has escaped the pepsin of the stomach; it breaks up the starch and completes the digestion of this part of the food; and it digests the fat, changing it into glycerin and other substances that will dissolve in the intestine. The enzymes in the intestinal juice assist in digesting the protein and in changing all the different sugars into the one particular sugar (grape sugar) that the body can use.

And now as we follow the food in its course through the intestine, we notice that the liquid becomes less and less in amount; that only the solid wastes remain. As some desert rivers run out over the sand and lose themselves in their own channels, so the stream of liquid food in the intestine disappears. Where is it going? It is soaking into the wall of the intestine and passing into the millions of little capillaries that run in the wall. What will be done with it? It will be carried through all the body to furnish heat and strength, and to be built into bone and muscle and nerve; for as the waterfall, even though it keep the same form,

[1] The segments into which the food is cut are about an inch long, and the contractions of the muscle rings come as often as thirty times a minute.

is made up of rapidly passing water, so our bodies, that seem to us to be the same year by year, are composed of materials that are ever shifting. The skin that we have today will, in a short while, be dead and gone, and the food that we eat today will be built into a new skin. The flesh and heart and brain of an ox are built of grass, and the human body is built of the food that we eat.

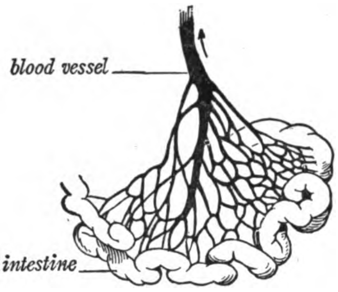


FIG. 112. Showing the vessels which carry the food from the small intestine.

The refuse matter in the large intestine. In all food there is some indigestible material like the woody, fibrous parts of potatoes and cabbages, the skins of fruits, and the tough fibers of meat. This matter passes from the small intestine into the large intestine, where its bulk is very considerably increased by mucus and other wastes that are secreted by the glands in the wall of the large intestine. In this waste material, millions of bacteria grow and cause decay, and in the process of decay, poisonous substances are formed. Nothing is more important to the health than that this refuse material be cleared out of the intestine before the poisons are absorbed into the body. This question we shall discuss in another chapter.

QUESTIONS

What change must be made in foods before the body can use them? What is digestion? Name the parts of the digestive system? Describe the alimentary canal. What is the function of the teeth?

Describe a gland and explain where the secretion of the gland comes from. What is an enzyme? By what is the work of digestion done?

How many salivary glands are there and where are they? What is the function of the saliva? What food is digested by the saliva? Into what is it changed?

What is the esophagus? Describe the stomach. What is the function of the gastric juice? What enzyme does it contain and what is the function of this enzyme? How are bacteria killed in the stomach?

Describe the small intestine. What are villi? What is their function? Describe the liver. What does it secrete? What is the use of the bile? Describe the pancreas. What foodstuffs does the pancreatic juice digest?

Describe the large intestine. What causes appendicitis?

Tell the story of the digestion and absorption of food. Where is the food taken after it is absorbed?

Of what are the wastes in the large intestine composed? Why is it important that these wastes be promptly cleared out of the body?

CHAPTER SEVENTEEN

THE FOODS WITHIN THE BODY

WE have now traced the food through its digestion. We have explained how it is taken into the blood and carried to the cells. What do the cells do with it? What becomes of it after the cells have finished with it? Why, when we keep eating all the time, does not the body become so full of food that we cannot take in more? Perhaps it may start you to thinking about this subject in the right way if we go back for a few minutes to something else that you have seen.

FIG. 113. When the candle burns the elements in it are not destroyed.

Long ago in your Mother Goose book you read:

> "Little Nanny Etticoat,
> In a white petticoat
> And a red nose.
> The longer she stands,
> The shorter she grows."

Why does a lighted candle grow shorter the longer it stands? What becomes of the candle when it is burned? You must study chemistry before you will have a really clear idea of what happens in the process of burning. At present we can only explain to you that the oxygen of the air unites with the elements of which the wax is composed and forms carbon dioxid and water, which pass off into the air. The materials in the candle, therefore, *are not destroyed.* They are merely changed to vapor and gas.

The fate of the carbohydrates and the fats. The cells of the body take in the sugar and fats of the foods. They also take in oxygen. Within the cells the oxygen and the food unite slowly and without smoke or flame, and the food is *oxidized*, or burned as truly as the wax of a lighted candle is burned. This oxidation of the foods furnishes heat to the body and strength to the muscle cells; and, as in the burning of the candle the wax is changed to carbon dioxid and water, so within the cells the fats and carbohydrates are changed to carbon dioxid and water. The carbon dioxid is breathed out of the body through the lungs. The water is excreted by the lungs, the kidneys, and the skin. Thus the fuel foods are burned in the cells and the wastes which are formed from them are cast out of the body. *The profit which the body receives from these foods is the heat and the power to do work which are given to the body when they are burned.*

The fate of the protein foods in the body. The living protoplasm of the body is continually breaking down and being oxidized. The protein food is used to build new protoplasm to take the place of that which is broken down.[1] In time this protoplasm will also be broken down and oxidized, so that the protein materials that are used for building the living tissues are as

[1] Only a part of protein food is built into living tissue. The remainder is oxidized as described on page 316.

truly burned in the body as are the carbohydrates and fats. The difference is that they are built into living material before the oxidation takes place. Carbon dioxid and water are among the waste products that come from the burning of the proteins, but there are other wastes also, — *uric acid* and other similar substances. These wastes are injurious to the cells, and the liver does a very important work in gathering up and converting a great part of them into a harmless substance called *urea*.[1] We shall now describe the organs that excrete the urea and other protein wastes.

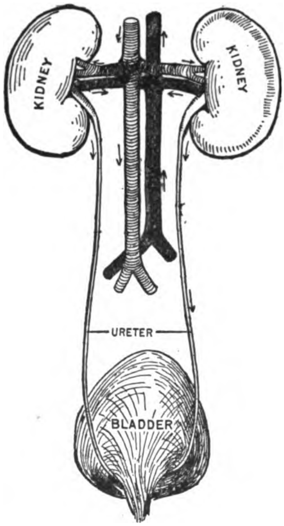


FIG. 114. The kidneys and the bladder seen from behind.

The kidneys. Fastened to the back wall of the abdominal cavity are two bean-shaped organs, called the *kidneys*. Each kidney has in it many thousands of little tubes which all drain into a larger tube, the *ureter* (Fig. 114). The little tubes in the kidneys, like the sweat glands, are surrounded by lymph, and the water of the lymph passes into them and flows out of their mouths, as water passes

[1] About 92.5 per cent of all the protein wastes excreted by the kidneys is in the form of urea. About 2 per cent of the whole is excreted in the form of uric acid, and it is estimated that an equal amount of uric acid is converted into urea by the liver. The uric acid part of the wastes comes from the nuclei of the cells and from the muscle cells when they work.

into a sweat gland and flows out on the skin. The urea and other protein wastes are dissolved in the lymph, and they leave the body by passing with the water through the kidney tubes into the ureter and draining off to the bladder. *The function of the kidneys is to excrete water, salts, and protein wastes.*

Storage of the foods within the body. When more carbohydrate is eaten than is needed for immediate use in the body, it is changed to a starch-like substance called *glycogen*, and is stored within the cells of the liver and to a certain extent in the fibers of the muscles. When the supply of sugar in the blood runs low, this reserve store of glycogen is broken up again into sugar and given off into the blood to feed the cells.

When more fat is eaten than can be used in the body, certain cells take it in and store it within themselves until they become little more than bags of oil. These cells, massed together, form the fat that you see in the body of an animal. When a person is sick and does not eat, the body uses this fat for food.

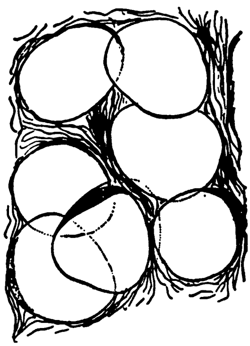


FIG. 115. Fat cells. They are little more than bags of oil.

A small amount of protein is dissolved in the blood, but the great mass of protein in the body is the muscles. It is not necessary for our lives that the muscles be kept at their full size, and when for any reason we are deprived of food, the muscle fibers are broken down and used to nourish the cells of the heart, the brain, and other vital organs. Famine sufferers and persons who have come through long sicknesses are little more than skeletons because their muscles have been used to sustain the organs necessary for life and the fat has been used to give the body heat and strength.

Surplus food in the body. When we eat more carbohydrate than can be stored in the liver and muscles, it is converted into fat and stored in this form. Usually we lose our appetite for carbohydrates and fats when we have had enough to furnish a reasonable supply of fat in the body. We can, therefore, in most cases trust our appetites to tell us when we have had enough bread, potatoes, fat meat, butter, or other starchy or fatty foods (page 325). There are, however, some persons who become too fleshy if they eat freely of such foods.

When more protein is eaten than can be used or stored in the body, it is broken up, and excreted through the kidneys.[1] From this protein the same wastes are formed that are formed from the breaking down of the protein of the body cells. A heavy diet of meat, or of other foods that are high in protein, therefore, gives the liver large amounts of protein wastes to change into urea, and sometimes more of these wastes are thrown into the blood than the kidneys can excrete. Too much protein may also cause putrefaction in the intestine that will seriously interfere with the health.

Alcohol as food. Alcohol in small quantities can be

[1] In the breaking up of the excess protein, the carbon and hydrogen in it are converted into either sugar or fat and used to give the body heat and strength. It is not to be understood, therefore, that surplus proteins are entirely useless to the body. The point is that they yield only energy, and this can be obtained much more cheaply from carbohydrates and fats without filling the body with waste material that throws an additional strain on the liver and kidneys.

used to furnish strength to the muscles. In quantities up to two ounces a day it is oxidized within the cells and gives heat to the body. Because it can be used in these ways, it is often stated that it is a food. The modern idea of a food, however, is that it must not only furnish building material or energy to the body, but that *it must also be harmless when it is broken up within the cells.* This definition of a food is, we think, a correct one; for certainly the toxin of the tetanus or the diphtheria germ is not a food, opium is not a food, and strychnin is not a food.[1] Yet all these poisons are taken into the cells and are broken up in them, and they must furnish a small amount of heat to the cells.

We cannot, therefore, say that alcohol is a food because it is used by the cells, but before making our decision on this point we must know whether in being broken up within the cells it damages them — whether it interferes with those wonderful processes that keep the protoplasm alive. When we view the question in this light, we must decide that alcohol acts as a drug rather than as a food; for, as a drunken man shows, the action of the mind is dulled and made very uncertain by alcohol; under its influence the muscles are weak-

[1] Alcohol is composed of carbon, hydrogen, and oxygen. It is made from sugar, has in it the same elements that are found in sugar, and it would seem reasonable to expect it to act as a food toward the cells. We must, however, recognize that not only what elements are in foods and drugs, but also the way they are built together, is important; for carbolic acid is built of the same materials and is closely related to sugar and alcohol, and strychnin and cocain are composed of carbon, hydrogen, oxygen, and nitrogen, — the same elements that are most abundant in protein foods. Just why substances that are composed of the same elements should affect the cells so differently is hard to explain, but it is one of the facts of chemistry that we must accept.

ened and their control is lost; and its whole effect on the body is that of a drug and not of an ordinary food. Even in small amounts, — amounts far too small to produce signs of intoxication, — there is good reason to believe that alcohol interferes with the enzymes that break up the food within the cells and throws the life processes of the protoplasm out of their natural course.[1]

QUESTIONS

What becomes of the materials in a candle when the candle is burned? What happens to the carbohydrates and fats within the cells of the body? What becomes of the carbon dioxid that is formed in the body? What becomes of the water? What does the body gain by the oxidation of the fuel foods?

What is constantly happening to the protoplasm of the body? What happens to the protein food before it is oxidized? What wastes are formed from the proteins? Describe the structure of a kidney. What is the function of the kidneys?

How is carbohydrate stored in the body? Under what conditions will the glycogen be changed again to sugar? How are excess sugar and fat stored in the body? Of what use is the fat in the body? Where in the body is protein stored? What happens to the muscles and fat of famine sufferers?

What happens if more protein is eaten than can be used or stored in the body? In what way is a heavy protein diet injurious to the body?

Define a food. Why is alcohol sometimes classed as a food? What reason is there for not including it among our foods?

CHAPTER EIGHTEEN

FOODS AND HEALTH

How shall we know what foods we ought to eat and how much of each is best for us? Occasionally the idea is advanced that in selecting a diet the best plan is to follow the appetite,—that the lower animals keep in health by eating the food they like, and that when the body calls for anything it does so because it needs it. It would be fortunate for us if by following this simple rule we could always be sure of keeping our digestive organs in order and of supplying our bodies with the materials that they need. But as a matter of fact this is not the case. Young rats that were allowed to eat freely of 23 different grains and vegetable foods failed to grow to more than half normal size, while other rats, compelled to live entirely on a mixture of rolled oats and dry alfalfa leaves, reached their full size. Certainly many persons crave foods that they know will be injurious to them, and in the selection of foods, rules and principles must be followed as well as the appetite, if the diet is to be adapted to the body's needs.

Requirements of a good diet. A good diet must meet the following requirements:

(1) It must supply the energy needs of the body; that is, it must furnish the body with heat and strength.

(2) It must supply the proteins that are needed for building material.

(3) It must supply the minerals needed by the body.

(4) It must supply the vitamins needed.

(5) It must not be poisonous, and must agree with the digestive organs.

(6) It must supply the bulk needed to insure a prompt removal of the intestinal wastes.

Some important facts that will help us in selecting a diet of this kind we shall now discuss.

The energy needs of the body. *The body must have enough food to provide it with heat and with strength for the work that it does.* A certain amount of food is burned in the body, even when the body is completely at rest after eating, the amount of food burned by the cells is greater. When work is done by the muscles, the amount of food used is increased; — enormously increased if hard work is done.[1] Exposure to cold causes the muscles to have a greater tension, and thus increases the amount of food burned in the body and the amount of heat released. Cold also causes a person to move about more, and to swing the arms and stamp the feet, which increases the heat production of the body; it may cause shivering, which brings still other muscles into

[1] The energy content of food is measured by the heat it yields when burned. The unit of measurement is the calorie, which is the amount of heat required to raise a liter of water one degree Centigrade. Roughly, it is the amount of heat required to raise one quart of water two degrees Fahrenheit. The body gets the equivalent of about 4 calories of heat for each gram of dry carbohydrate or protein eaten, and about 9 calories from each gram of fat. An average sized man needs enough food to yield the following numbers of calories:

Absolute rest in bed without food	1680 calories
Absolute rest in bed with food	1840 calories
Office work or other light work, about	2500 calories
Light muscular work	2700 calories
Moderately active muscular work, as work of farmer, or mechanic	3400 calories
Hard muscular work	4000 calories
Very hard muscular work	6000 calories

In a boys' school where most of the pupils were from 13½ to 16 years of age, the food used had a value of almost 5000 calories for each pupil.

use. In young persons the food is burned very rapidly in the cells, a boy or girl of ten or twelve years requiring as much food as a man or woman, and young persons of 16 and 17 years much more than middle-agĕd persons. Women require somewhat less food than men, and in old persons the food is not used so rapidly by the cells.

Effects of a diet that does not yield enough energy. A group of young men placed on a diet that yielded insufficient energy continued to grow thinner until they had lost a little more than 10 per cent of their weight. After that their bodies burned less food, and they continued to live on this low level without further loss of weight. They did not become ill, but they lacked vigor, and when they attempted severe muscular exercise they found that they lacked strength for it.

During the recent war many millions of persons were forced to live on this low plane, and at all times great numbers of persons in all countries are undernourished. This is especially true of children; among both the rich and the poor great numbers of boys and girls are underfed. Sometimes this is because not enough food is provided. More often it is because the child is not hungry and eats only certain of the articles of food that are placed on the table.[1] Such children are in a low state of vigor, they do not grow fast enough, and it is believed that they have less resistance to infections than they would have if they were well nourished. The best

[1] The sensation of hunger is due to the contraction of the muscles of the stomach, and these muscles do not necessarily contract when the body needs food. It is generally supposed that children overeat, but far more of them do not eat enough. The trouble comes from the fact they eat too much of sweets or other foods that gratify the appetite and refuse many articles of ordinary food.

indication as to whether enough food is being provided is the weight. If this is below what it ought to be, more food or different food should be eaten. If the weight is too great, more food than the body uses is being eaten or not enough exercise is being taken. When a baby fails to grow, it is usually because it is not getting enough food.

Right HEIGHT and WEIGHT for BOYS

Weights and measures should be taken without shoes and in only the usual indoor clothes. Boys should remove their coats.

Height Inches	5 Yrs.	6 Yrs.	7 Yrs.	8 Yrs.	9 Yrs.	10 Yrs.	11 Yrs.	12 Yrs.	13 Yrs.	14 Yrs.	15 Yrs.	16 Yrs.	17 Yrs.	18 Yrs.
39	35													
40	37	38												
41	39	40												
42	41	42												
43	43	44	44											
44	45	45	46											
45	....	47	47	48										
46	....	49	50	50										
47	....	....	51	52	52									
48	....	....	53	54	55									
49	....	....	....	55	56	57								
50	....	....	....	58	59	59								
51	....	....	....	60	61	62	62							
52	....	....	....	....	64	65	65							
53	....	....	....	....	67	68	68	68						
54	....	....	....	....	70	71	71	72						
55	....	....	....	....	....	74	75	76	76					
56	....	....	....	....	....	77	79	79	80					
57	....	....	....	....	....	....	81	82	83	84				
58	....	....	....	....	....	....	84	85	87	88				
59	....	....	....	....	....	....	....	88	89	91	92			
60	....	....	....	....	....	....	....	90	92	94	95			
61	....	....	....	....	....	....	....	....	97	99	100	101		
62	....	....	....	....	....	....	....	....	100	102	104	105		
63	....	....	....	....	....	....	....	....	104	106	108	109	110	
64	....	....	....	....	....	....	....	....	....	112	113	115	117	120
65	....	....	....	....	....	....	....	....	....	118	119	121	122	123
66	....	....	....	....	....	....	....	....	....	....	123	124	125	127
67	....	....	....	....	....	....	....	....	....	....	125	126	127	131
68	....	....	....	....	....	....	....	....	....	....	130	131	133	136
69	....	....	....	....	....	....	....	....	....	....	....	134	136	139
70	....	....	....	....	....	....	....	....	....	....	....	136	140	143
71	....	....	....	....	....	....	....	....	....	....	....	....	142	145

Health in Education
Education in Health

PREPARED BY DR. THOMAS D. WOOD

About What a BOY Should Gain Each Month

AGE	
5 to 8	6 oz.
8 to 12	8 oz.
12 to 16	16 oz.
16 to 18	8 oz.

Courtesy of Child Health Organization, New York City

FIG. 116.

Food for energy. Bread, grains, potatoes, butter, sugar, and fat meats are the foods on which we mainly depend for our energy. The body can use for fuel purposes any protein that is not needed for building material; but proteins are expensive foods, and, as we shall see, it is not wise to eat too heavily of them. The thing to do, therefore, is to eat the proteins that we need for

Right HEIGHT and WEIGHT for GIRLS.

Weights and measures should be taken without shoes and in only the usual indoor clothes.

Height Inches	5 Yrs.	6 Yrs.	7 Yrs.	8 Yrs.	9 Yrs.	10 Yrs.	11 Yrs.	12 Yrs.	13 Yrs.	14 Yrs.	15 Yrs.	16 Yrs.	17 Yrs.	18 Yrs.
39	34													
40	35	37												
41	39	39												
42	41	42	42											
43	43	44	44											
44	45	46	46											
45	....	47	47	47										
46	....	48	49	50										
47	....	....	50	51	53									
48	....	....	52	53	54									
49	....	....	....	55	56	57								
50	....	....	....	57	59	60								
51	....	....	....	....	61	62	63							
52	....	....	....	....	65	66	67							
53	....	....	....	....	....	68	68	69						
54	....	....	....	....	....	70	71	71						
55	....	....	....	....	....	....	72	73	74					
56	....	....	....	....	....	....	76	77	77	79				
57	....	....	....	....	....	....	....	79	82	85				
58	....	....	....	....	....	....	....	85	88	93	96			
59	....	....	....	....	....	....	....	....	92	95	100	105		
60	....	....	....	....	....	....	....	....	97	99	103	107	109	
61	....	....	....	....	....	....	....	....	99	102	105	109	111	
62	....	....	....	....	....	....	....	....	....	105	107	111	113	116
63	....	....	....	....	....	....	....	....	....	107	110	113	115	117
64	....	....	....	....	....	....	....	....	....	....	114	117	119	121
65	....	....	....	....	....	....	....	....	....	....	....	121	123	125

PREPARED BY DR. THOMAS D. WOOD

About What a GIRL Should Gain Each Month

AGE	
5 to 8	6 oz.
8 to 11	8 oz.
11 to 14	12 oz.
14 to 16	8 oz.
16 to 18	4 oz.

Courtesy of Child Health Organization, New York City

FIG. 117.

building material and then take enough fats, starches, and sugars to give us plenty of heat and strength. Usually we can trust our appetites to tell us when we have had enough of these foods. Taking food into the body increases the amount that is burned in the cells, and the amount of body heat produced. Carbohydrates increase the heat production least, fats increase it more, and proteins increase it most of all. A winter diet, therefore, should be higher in fats and protein than a summer diet. Meat helps to keep up the body heat in winter, and a diet consisting largely of fruits and vegetables is advisable on hot summer days.

An adequate protein supply. In digestion the proteins are split into *amino-acids*. These are absorbed into the blood and are used as the building stones with which the body repairs its wastes and grows. Nearly twenty amino-acids are now known, which different proteins yield in different amounts; some proteins lack certain amino-acids altogether, while others they furnish only in small amounts. For its building purposes the body picks out from the blood as much of each of the different amino-acids as it needs, using the remainder for fuel as it uses sugar and fats.

FIG. 118. A Roman and a Japanese soldier. They made their reputations as fighters on a low-protein diet.

Meat, fish, milk, and egg proteins are complete; they supply in large amounts all the amino-acids that the body needs. The proteins of grains, beans, and peas are low in certain amino-acids and must be eaten in large amounts if they are the sole source of protein supply. Potato protein seems to be of good quality, although it is supplied in only small amounts. When a number of different kinds of foods are eaten, the amino-acids lacking in one food may be furnished by another, and thus all the needs of the body will be met. All the protein needs of the body can be met with vegetables, but including meat, milk, or eggs makes it much easier to plan a satisfactory diet. The proteins of soy beans and of peanuts are of better quality than most vegetable proteins. Gelatin is a protein of very low grade.

The mineral supply of the body. This subject has already been discussed (Chapter 16). In general, eating large amounts of meat and sugar causes a lack of minerals, and a diet of vegetables and milk supplies minerals. Of all the minerals, the one most commonly lacking is calcium, which can be supplied by the free use of leaf vegetables and milk.

The vitamin supply. Whole grains, peas, beans, and vegetables contain abundant supplies of the vitamin that prevents beriberi. Milk is moderately rich in this substance. Practically all of our population have enough of this material. The other vitamin is found in the leaves of plants, in the yolk of eggs, and in milk and butter. An animal like the cow or rabbit can eat enough grass or leaves to supply it with this vitamin, but a human being cannot do this. Milk and butter should therefore be used. The livers and kidneys of animals supply this second vitamin (it is found in cod-liver oil), and it is reported to be present in the fat of fish.

The necessity for bulk in the diet. After coarse vegetable foods are digested, there is much refuse remaining. This fills up the intestine and causes the wastes to be moved rapidly along the intestine. It is exceedingly important that this be done, as we shall see later.

General dietary principles. The seeds of plants are our chief source of food; wheat and corn bread, breakfast foods, oatmeal, rice, macaroni, peas, beans, and nuts make up the greater part of the diet of the people in temperate climates. Fruits and vegetables like potatoes, turnips, and carrots furnish about the same elements to the body as grains. A diet composed of these foods is likely to lack certain of the needed amino-acids, calcium, and the vitamin found in leaf vegetables, eggs, and milk. Meat will make good the lack in the protein, but it will not supply the calcium or the vitamin, and to make the diet complete eggs or milk, or leaf vegetables, must be used. As we have already seen, it is difficult for man to eat enough green vegetables to supply the lacking substances, and for this reason eggs and milk, especially milk, should be used. Grains, vegetables like the potato, fruits, and meat do not make a complete diet. Leaf vegetables, milk, or eggs also are necessary.

The importance of milk in the diet. All who understand the food needs of the body are agreed that it is a great misfortune that many families are using less milk than formerly because of an increase in its price. Milk is still one of the cheapest of our foods; a quart of it contains almost as much energy as a pound of steak, and it contains minerals and vitamins that can be supplied in an ordinary diet by nothing else. A certain organization that has long been at work to improve the diets of poor persons says that a quart of milk should be provided each day for a child and a pint for an adult. A noted authority on foods has stated that good milk is worth whatever it costs to produce it, and that no meat should be bought until each member of the family has been provided with a pint of milk. Another authority on foods reports that in his own family from 25 to 30 per cent of all the money expended for food is used in the purchase of milk. The most serious mistake made by our people in the purchase of food is in not buying enough milk. In the southern part of the United States it is especially important that the people in small villages and in the country provide a supply for themselves.

Objections to a heavy meat diet. There is no proof that a moderate amount of meat in the diet is harmful to the average person. But because meats are pleasant to the taste, very large amounts of them are sometimes eaten. This is objectionable for the following reasons:

(1) *Meat does not supply the minerals and the vitamins that the body needs.* If large amounts of meat are eaten, small quantities of other foods will be taken and some of the needs of the body will not be supplied.

(2) *Large amounts of meat in the diet cause poisonous substances to be formed in the intestine.*[1] When more

[1] Individuals differ enormously in the kinds of bacteria that grow in the intestines and in the amount of poison formed by them, and these substances are often abundant in the intestines of animals that live on a vegetable diet as well as in the intestines of meat-eating animals. Nevertheless, it is true that in the average person a diet of vegetables and milk causes small quantities of the poisons to be formed, and a diet of meat and eggs causes an increased quantity of them to be formed.

protein is eaten than the pepsin and trypsin can digest in a reasonable time, part of it passes undigested into the large intestine. Here bacteria cause it to decay, and in the process of decay poisonous substances are formed. These poisons are then absorbed into the body, and they cause headaches and other disturbances by poisoning the cells.

(3) *Meat does not supply the bulk that is needed in the diet.* The lack of bulky material causes the wastes to lie for a long time in the intestine, and this causes more of the poisons to be absorbed from these wastes than would be absorbed if they were promptly removed from the body.

(4) *A heavy meat diet loads the system with protein wastes.* This is probably injurious, in some cases at least. It has long been believed by many physicians that an excess of substances of the uric acid class is the cause of gout and other serious ailments. Part of the trouble, at least, seems to lie somewhere in the protein wastes, and the patients are benefited by cutting the protein to a low point.

Because of these facts it is wise to eat only moderately of meats and to use other articles of food more liberally than they are used when meat is taken in large amounts.

Large quantities of sugar injurious to the digestive organs. In his wild state man secured most of his sugar by eating starchy foods and digesting them to malt sugar. Now he prepares great quantities of sugar and uses it in his food, but the sugar that comes from cane and beets is cane sugar and not malt sugar. This sugar, when taken in large quantities, is very irritating to the stomach, and because in large amounts it is not a natural food for man, we have but a small quantity of the enzyme that digests it. When a large amount of sugar is eaten, therefore, it may remain for a long time undigested in the small intestine, and when this occurs the sugar is likely to be fermented by bacteria and injurious acids formed from it. Sugar should be taken in moderate quantities, and it should be mixed with other foods and not eaten at a time when it will form a thick, sirupy solution in an otherwise empty stomach. A moderate quantity of candy eaten at the close of a meal has a very different effect on the digestive system from that of a large quantity taken before a meal.

Fats. Fats hinder stomach digestion, and except in very cold weather few persons can take a daily ration of more than three and a half ounces of fat without bad results. Persons who suffer from acid stomachs are advised to eat liberally of fatty foods, and about two ounces of fat should be included in the average daily diet. Certain individuals who refuse to eat butter, fat meat, olive oil, or other fatty foods, live on very small quantities of fat, and get their energy almost entirely from carbohydrates. This leaves the lipase without any work to do and throws a heavy task on the starch-digesting enzymes, and it is not so likely to give a well-ordered digestion as a mixed diet. It is also believed that the cells of the body keep in better health when part of their nourishment is supplied in the form of fat; that persons who eat little fat are more subject to germ diseases, especially tuberculosis, than are those who eat reasonable quantities of fatty foods [1]. During the war more

[1] Fat is considered the most important part of the diet in tuberculosis. Outdoor life in this disease is more beneficial in cold climates than in warm

hardship seems to have been caused by a lack of fats than by a shortage of any other class of foods.

Eating vegetables beneficial to the health. Coarse vegetable foods like string beans, cabbage, cauliflower, carrots, turnips, potatoes, beets, radishes, asparagus, lettuce, celery, and spinach are very necessary to the health. They furnish minerals to the body and the bulky refuse that is needed in the intestine. These are the foods that are least palatable to most persons, and they are the ones that are most frequently left out of the diet. One difficulty in getting enough of these vegetables into the diet is that in the country the family garden is often neglected and a sufficient variety of them is not produced. Another difficulty is that in towns and cities these vegetables are often needlessly allowed to wilt in stores and markets, and their tenderness is lost before they are cooked. The chief difficulty, however, is that only a few persons understand how to cook vegetables so that they will come to the table with the attractive flavors and odors that an expert vegetable cook can bring out. Because it is a difficult art to do this, many housewives give their attention to the easier and simpler tasks of cooking meats and of making pies, cakes, and desserts, and serve on their tables vegetables cooked in an unappetizing way. It is very important that the proper attention be given to the raising and preparation of these foods, and every young person

climates and more beneficial in winter than in summer. Some physicians think that this is because in winter the exposure to the cold increases the appetite for fat. Milk and eggs have always been used as a source of much of the fat in the treatment of tuberculosis, and it is possible that a part of the benefits that are supposed to come from the fats in the diet is due to an abundant supply of the vitamin that is found in these foods.

should learn to eat all the different kinds of vegetables that are served in his home.

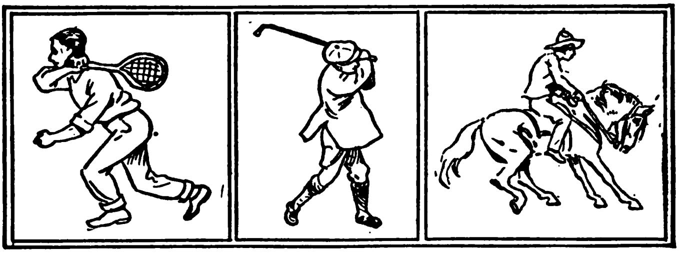
A plan for getting a proper diet. Since the very life of the body centers around the food from which the cells build their living substances and from which they get their energy, it is easy to understand that the question of diet is the most important problem of all hygiene. It is not possible to give any simple rules that will always be a complete guide in eating, but the following suggestions may be helpful:

(1) *Eat enough food.* Only the energy needs of the body are increased by work, and laborers who eat large quantities of food are not nearly so likely to suffer from a lack of protein, minerals, and vitamins as those who take little exercise and eat only small amounts of food. Enough should be eaten to keep up the weight and vigor of the body.

(2) *Eat many different kinds of foods.* As far as it is possible to do so, make it a rule to eat at each meal one food rich in protein, like lean meat, eggs, beans, or cheese; one or more starchy foods like breakfast foods, bread, macaroni, or potatoes; some fatty food like butter, fat meat, or nuts; some coarse vegetable food like cabbage, asparagus, turnips, or beets; a moderate amount of some sweet food like sugar, sirup, preserves, jelly, honey, cake, or a sweet dessert. Follow this plan, and you will probably not be tempted to eat too heavily of any one kind of food and will supply your body with all the different materials that it needs.

(3) *Include milk and butter in the diet.* If this third rule is followed in connection with the two rules previously given, the food needs of the body will be met.

It is very important to follow some plan that will cause enough food to be eaten and all the different materials that are needed to be supplied; for experience has proved that persons who simply follow their appetites or eat the foods that can be most conveniently secured frequently fail to supply their bodies with some of the materials that they need.



FIGS. 119, 120, and 121. Healthful sports and games do much to prevent constipation.

Constipation a deadly enemy to health. No matter what diet is eaten, unless the wastes are rapidly moved along the intestine and promptly cleared out of the body, ill-smelling gases and poisons will be formed in the refuse matter in the large intestine. These will be absorbed into the blood and cause bad breath, headaches, and other evil consequences. In selecting a diet, enough coarse food should be chosen to give large amounts of bulky refuse matter. This will assist in causing the wastes to be moved rapidly along the intestine.

Other important points in the prevention and cure of constipation are vigorous exercise, especially bendings of the body and movements of the legs that will press the digestive organs about and help the circulation of the blood through them; massage the abdomen, which also helps the circulation of the blood through the stomach, liver, and intestines; a daily cool or cold bath; attending to emptying the bowels regularly at a certain hour each day[1]; eating foods like fruits, corn meal, and graham flour, which have a natural laxative effect; drinking large quantities of water, especially at bedtime; and keeping the nervous system in good condition so that the digestive organs will be properly regulated. A few physicians now understand how to treat successfully patients suffering from constipation, and any one who suffers ill health month after month because of poisons produced in his own body should, if possible, put himself in charge of a physician who is especially qualified to treat this trouble.

The cost of food. The object of eating is to supply the body with building material, heat, and strength. To make sure that all the needs of the body are supplied, we must eat foods of different kinds; we cannot live on corn meal and beans, no matter how cheap they may be. It is often possible, however, to supply the needs of the body either with high-priced foods or with other foods that may be purchased at a much lower rate. For example, the same amount of energy that can be purchased in wheat flour for four cents costs ninety-five cents in oysters, and protein costs nine times as much in canned corn as in corn meal.

[1] An X-ray examination of animals shows that before the bowels are emptied the part of the large intestines which runs across the body is raised up partially on end and the part which runs up the right side of the body is dragged across to take the place of the transverse portion. It takes about 20 minutes for these changes in the position of the large intestine to be brought about. It is possible to train the nerves that control the intestine until they will set the muscles of the intestine in action at regular times, and it is exceedingly important to do this.

The average family is not wealthy, and according to the best statistics available it is slightly undernourished. We cannot go into the question of food costs further than to point out that in our country millions of dollars might be saved each year and the health of millions of people greatly improved, if the persons purchasing the food supplies of families understood how to secure the most nourishment for the money that they have to expend. The average American family spends about one third of the money used for the purchase of foods for meats, fish, and poultry and less than one tenth of it for milk. Undoubtedly the diet would be improved by spending more for milk and less for meat.

QUESTIONS

What are the requirements of a good diet? How much food does the body need? At what time of life is most food required? What is the result of living on a diet that does not supply enough energy? What shows whether enough food is being provided? Is your weight what it ought to be?

Name some of the chief energy-yielding foods? What class of foods most increases the heat production of the body? What foods can be used to increase the heat production of the body in winter? What foods will keep the amount of body heat produced lowest in hot weather?

Into what are the proteins split in digestion? For what special purpose are the amino-acids used by the cells? How do proteins differ as to amino-acids they supply? Name some foods that furnish proteins of high grade; some foods that furnish less valuable protein. What foods furnish an abundance of minerals to the body? What foods are rich in each of the vitamins? What foods supply bulky refuse? Why is bulk needed in the diet?

What is the chief source of our food? What other classes of foods supply the same materials as seeds? What needed substances are lacking in these foods? Explain how each of these substances may be supplied. Why is it important that milk be used freely? Give four objections to a heavy meat diet.

Why is sugar injurious to the stomach and intestines when eaten in large quantities? When is the proper time to eat candy? How much fat should be included in the daily ration? Why is it unwise to depend entirely upon carbohydrate foods for energy and to exclude fatty foods from the diet?

Why are coarse vegetable foods necessary for the health? Give some of the reasons why these foods are often omitted from the diet?

Give three rules for eating that will help in giving the body a proper food supply. Why is it important that some plan be followed in supplying the body with food?

Why is it necessary for the wastes to be promptly removed from the intestines? How do coarse, bulky foods assist in this? Give some important points in the prevention and cure of constipation. How does a knowledge of foods help in securing a nourishing diet at a moderate cost?

CHAPTER NINETEEN

THE TEETH

THE teeth are composed of the hardest tissues in the body, but decay of the teeth is the most common bacterial disease of man. Unlike many other infections, this disease runs on and on, and can be checked only by a surgical operation that removes the infected tissues and the germs that are in them. We have therefore a whole class of surgeons (dental surgeons) who give their entire time to the treatment and prevention of infections of the teeth and their surrounding parts. In recent years it has been proved that defective teeth are more injurious to the health than had been suspected, and the importance of keeping the teeth sound can hardly be exaggerated.

How bad teeth injure the health. Bad teeth cause the food to be swallowed in large pieces and thus greatly delay digestion. They also allow germs to gain entrance to the bones of the jaw and establish centers of infection in these parts. These germs are usually slow-growing races of streptococci that live in the bones for years, and often the health is greatly injured by the toxins that are absorbed from them. Frequently the germs are carried from the teeth to other parts of the body and by growing in these parts cause rheumatism, heart disease, kidney disease, and other ailments. This subject will be discussed in a later chapter (pages 385 and 389).

The structure of a tooth. A tooth is composed of a *crown*, a *neck*, and one or more *roots*. The main bulk of the tooth is composed of *dentine*, or ivory, a substance harder than the most compact bone. The crown is covered by a coat of *enamel*. This substance is very hard, but brittle like glass. The enamel can easily be broken by biting on hard objects, and it may be cracked by very hot food or drink taken into the mouth. If it is once broken off it is never replaced, and without the covering of enamel over it the dentine soon decays. The roots of the teeth stand in sockets in the jaw-bones and are covered by a layer of bone-like cement. Lining the socket in which the root stands is a layer of connective tissue that fastens together the root and the bone of the jaw. In the center of the tooth is the *pulp cavity*, a little chamber containing nerves and blood vessels. Break open the tooth of an animal, and you will easily find the enamel, the dentine, the pulp cavity, and the little root canals through which the nerves and blood vessels enter from the jaw-bone.

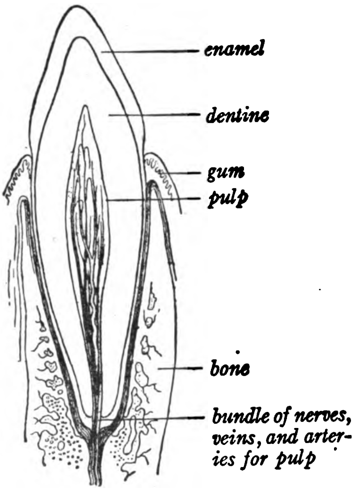


FIG. 122. A section through a tooth showing its structure and how it is fastened into the jaw-bone.

Why a tooth decays. Decay of the teeth is caused by bacteria that grow in the materials that stick to the teeth and lodge between them. It is thought that the bacteria start the decay by forming acids that eat away the enamel. Then other kinds of bacteria enter the cavity and destroy the dentine. If the decay is allowed to go on until the pulp is reached, this is killed and the germs not only grow in the dead pulp but enter the jawbone through the root canal and set up their growth about the end of the root. When the decay is reaching the pulp, but when the nerve endings in the pulp are not yet dead, the tooth may ache. A gum boil is due to infection at the root of a tooth.

The teeth preserved by keeping them clean. The way to preserve the teeth is to keep them clean, so that bacteria cannot find a home around them. The teeth should be brushed both inside and outside after each meal, and food that is lodged between them should be carefully removed. This point is important because decay nearly always begins between the teeth. Some dentists recommend that the food be removed with dental floss, but in the hands of the average person a toothpick is more effective. A quill pick is less likely to injure the gums than a wooden or metal one. Rinsing water about vigorously in the mouth and driving it between the teeth removes many small food particles, and this should always be done after the teeth have been brushed.

A good tooth powder or paste is an aid in cleaning the teeth. Prepared powders or pastes may be used, or a good powder made of precipitated chalk and powdered orris root, which may be purchased from any druggist. Charcoal, pumice stone, or other gritty substances should not be used, as they scratch the teeth and leave

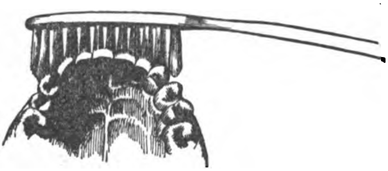


FIG. 123. A curved brush with the bristles longer at the ends cleans the teeth better than a straight brush.

little grooves in the surface where food and bacteria collect. A curved brush with the bristles longer at the

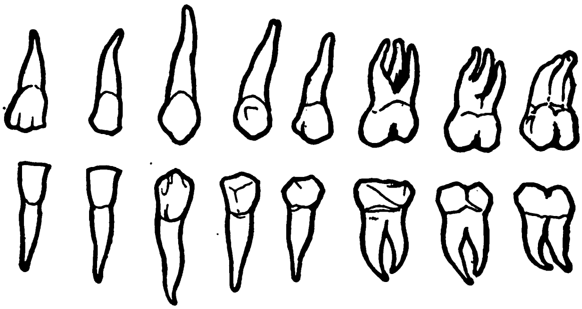


FIG. 124. One half of the permanent set of teeth.

ends cleans the teeth better than a straight brush; a medium-sized brush with moderately stiff bristles should be used.

Deposits on the teeth. The mucus of the saliva forms a film over the teeth, and in many mouths patches of gummy material collect on the teeth where they are not cleaned in chewing the food and by brushing. These deposits are called *dental plaques*, and they are filled with living bacteria that produce acid and start decay beneath the plaques. *Tartar* is a hard mineral deposit that usually forms most abundantly along the edge of the gums. It is often stained brown by the escape of blood into it and may become bluish, green, or almost black from changes in the coloring matter of the blood in it.

Thorough brushing of the teeth helps to keep them free from dental plaques and tartar, but these may appear on places where the brush cannot reach them or even, in spite of the most careful cleansing, where the brush does reach. It is important, therefore, to visit a dentist from time to time to have any deposits on the teeth removed.

The care of the gums. In many persons the gums are slightly inflamed along the margins and bleed easily when they are brushed. To keep them in health it is very important that tartar on the teeth be removed, for the tartar irritates the gums and causes them to shrink, leaving the roots of the teeth bare. This inflammation and receding of the gums may allow germs to work down about the roots of the teeth and form pus about them, thus causing them to become loose in their sockets. When the teeth are cleaned, the gums should also be thoroughly brushed with a light, quick stroke that will stimulate the circulation in them but will not injure them. One dental authority states that inflamed gums can be surely restored to health if the gums and teeth are brushed in the proper manner for two minutes four times a day. Some writers advise that in cleaning the back teeth the brush be given a twisting movement, and that the brushing be always from the gums toward the crowns of the teeth. Others believe that the outer surfaces of the back teeth can be best cleansed by giving the brush a circular or rotatory motion. All authorities are agreed that the brushing should not be crosswise on the teeth. The purpose of brushing is to prevent cavities from forming in the teeth and to keep the gums in health, and the brushing should be frequent enough and thorough enough to accomplish this purpose. It is best to have two tooth brushes, as a brush becomes soft when too frequently used.

The importance of visiting the dentist frequently. It is very important that the teeth be inspected by a dentist at regular intervals and be given any treatment they may need. If the dental plaques are not removed, decay may start beneath them. Tartar that is not removed irritates the gums and causes them to become inflamed and to shrink. A most necessary part of the care of the teeth, therefore, is to have any deposits on them removed promptly, and a dentist should examine the teeth every three months to see if this needs to be done.

It is also important that cavities be filled while they are yet small, both because this plan preserves the teeth and because it is more economical and less painful than waiting until the cavities have enlarged and a great part of the tooth has been eaten away. All over the land people are suffering with toothaches and paying for expensive X-ray work, root fillings, and crown and bridge work when they could have preserved their teeth by spending a mere fraction of the same money at an earlier date for small fillings. If the pulp of the tooth dies and the germs gain entrance into the bones of the jaw, it is exceedingly difficult to eradicate them and sometimes it is impossible to do so. It is not considered safe to fill a dead tooth unless the X-ray is used to make sure that the filling extends to the end of the root canals; even after the roots are filled it is considered advisable to put a temporary filling in the tooth, and after a time to examine it again with the X-ray to make sure that no infection has developed in the bone at the tips of the roots. Dental work of this kind is very expensive, and it is much more satisfactory to have the teeth attended to when only cleaning and small fillings are required. Unless decayed teeth can be so treated that they will be free from germs, it is better to have them extracted, and there are not a few dentists who believe that a dead tooth is better out of the mouth than in it.

The temporary teeth. The jaws are too small in childhood to hold the large teeth that we need in later life. In early life we have, therefore, a set of twenty small *temporary teeth.* This set is composed of four *incisors,* two *canines,* and four *molars* in each jaw (Fig. 126). The incisors are flat and chisel-like for biting off the food. The canines are more round and pointed, and in the dog and other carnivorous animals they are used as weapons and for tearing flesh. The molars are broad, square teeth with square *cusps,* or points, and wide surfaces for crushing and grinding the food. About the sixth year the temporary teeth begin to drop out, and by the twelfth or fourteenth year they have all been replaced by permanent teeth.

The permanent teeth. There are thirty-two permanent teeth. In each jaw there are four incisors and two canines that replace the incisors and canines of the temporary teeth; four *bicuspids* in place of the temporary molars; and six molars that come in behind the space occupied by the temporary teeth. The first permanent molars appear about the sixth year. The third

FIG. 125. The tooth on the right decayed, the roots were not absorbed, and the tooth had to be pulled to make room for the permanent tooth. The tooth in the middle shows the roots partly absorbed. The roots of the tooth on the left have been completely absorbed and the tooth has dropped out.

molars, or wisdom teeth, usually appear from the sixteenth to the twenty-first year, but in some persons these teeth never make their way through the gums.[1]

The importance of caring for the temporary teeth. The first reason for caring for the temporary teeth is that they themselves are necessary for the health; for if they are allowed to decay, the child will form the habit of bolting his food; the digestion will be deranged by the germs that are swallowed; and the nervous system and the disposition will be damaged by the pain from the toothache that the child will be compelled to endure. For the sake of the health during the years of childhood and to prevent the forming of wrong eating habits, the temporary teeth should have the best of care.

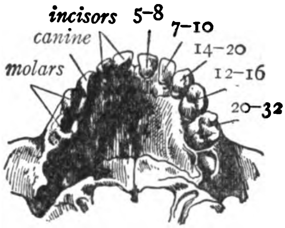


FIG. 126. The upper temporary teeth of a child about three years old with the average time of eruption given in months. The lower teeth usually appear a few weeks earlier than the upper. The first permanent molars, which at this time are being formed in the jaws, are shown behind the temporary teeth.

The second reason for caring for the temporary teeth is to prevent the permanent teeth from coming in irregularly. The permanent teeth begin to form long before

[1] Sometimes when the wisdom teeth or other teeth fail to appear at the normal time it is because they have turned sideways in the jaw or have become tightly wedged among the roots of the other teeth. Teeth that are lodged in the jaw in this way are called *impacted* teeth, and there are many cases on record of persons who suffered greatly from nervous troubles because of the pressure such teeth were exerting. If the teeth do not appear at the proper time and there is any trouble with the health, impacted teeth should be looked for. The X-ray is used in making the examination.

birth at the roots of the temporary teeth, and by the end of the third year even the wisdom teeth are formed in the jaws. These teeth then gradually grow and harden, and the roots of the temporary teeth disappear before them (Fig. 125). Finally, the roots of the temporary teeth are entirely absorbed and the first teeth drop out, leaving the places they occupied to the permanent teeth.

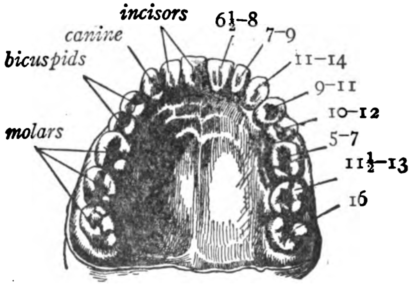


FIG. 127. The upper permanent teeth of a man twenty-six years old, with the average time of eruption given in years. The lower teeth usually appear two or three months earlier than the corresponding upper ones.

If the temporary teeth are allowed to decay, their roots are not absorbed before the permanent teeth. The second teeth, therefore, either remain buried in the jaws or appear in an irregular line, some inside and some outside of the line of the first teeth. Another difficulty caused by decay and loss of the temporary molars is that when the first permanent molars come in they move forward and take positions that belong to the bicuspids and there is then not enough room for the permanent bicuspids. For the sake of the permanent teeth, therefore, the temporary set should have the best dental care, and if for any reason they have been allowed to decay, a dentist should be consulted when it is time for the second teeth to appear. Permanent fillings and not cement fillings should be used in the temporary teeth, for some of these teeth remain in the mouth until the child is 10 or 12 years of age.

The importance of caring for the first permanent molars. The first permanent teeth, which come in about the sixth year, behind the temporary molars, are often mistaken for temporary teeth. These molars have deep grooves in their surfaces in which the food lodges, and they come into the mouths of many children before the habit of washing the teeth has been formed. They are therefore especially liable to decay. They should be filled at once if cavities appear in them, because they are not replaced when lost, and without them the jaws do not grow in length as they should. Count the double teeth in the mouth of a six- or seven-year-old child, and if there are three of them on one side of the jaw, the back one is a permanent molar.

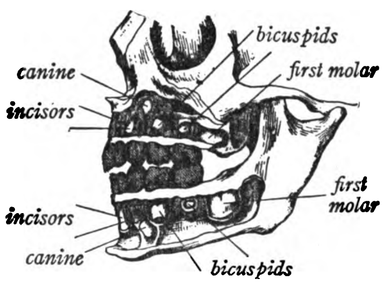


FIG. 128. The jaws of a child four years old. The jaw-bones have been cut away to show the permanent teeth growing at the roots of the temporary set.

Other points in the care of the teeth. Sticky foods like oatmeal and mashed potatoes cling to the teeth and cause them to decay. Hard foods like apples, cornbread, and bacon clean the teeth and give the gums the exercise that is needed to keep up the circulation through them. Every diet, therefore, should contain some tough, solid material into which the eater can set his teeth. Sugar left among the teeth ferments easily and causes decay. For this reason eating candy at all hours of the day, so that the crevices among the teeth are kept filled with it, is almost sure to cause decay.

Straightening irregular teeth. Often the permanent teeth come in irregularly and are turned forward in front because the temporary teeth have been allowed to decay or because adenoids or nasal growths have kept the bones of the jaws and of the roof of the mouth from growing enough to make room for the teeth. When for these or any other reasons the teeth are irregular, a dentist who understands how to straighten them should at once be consulted. By putting pressure on the teeth the bones may be made to grow larger and the arch of the jaw expanded until the teeth have sufficient room.

FIG. 129. This shows how the upper teeth should close on the lower teeth. (*After a photograph from "The Practical Orthodontist."*)

Figure 130 gives an idea of the changes that a good dentist can make in the appearance of a person whose mouth is spoiled by irregular or protruding teeth. The work of straightening the permanent teeth ought to be begun as soon as they appear, and not delayed until all of them are in the mouth, as is often advised. A tooth that has been crowded out of line ought not to be pulled, but the circle of the teeth should be widened until there is room for all.

Defective teeth due to illness and to lack of calcium in the diet. A tooth is first built up by the growth of a "bud," or little group of cells of the mucous membrane which covers the jaw. It is then hardened by having calcium deposited in it. This hardening of the teeth is going on all through childhood, and severe cases of scarlet fever, measles, diphtheria, and other illnesses may interfere with the deposition of lime and cause the teeth to be soft and ill-formed when they come through the gums months or years later.

Defective teeth may also be caused by lack of calcium in the diet, as we have already pointed out (page 294). It is therefore especially important to the teeth

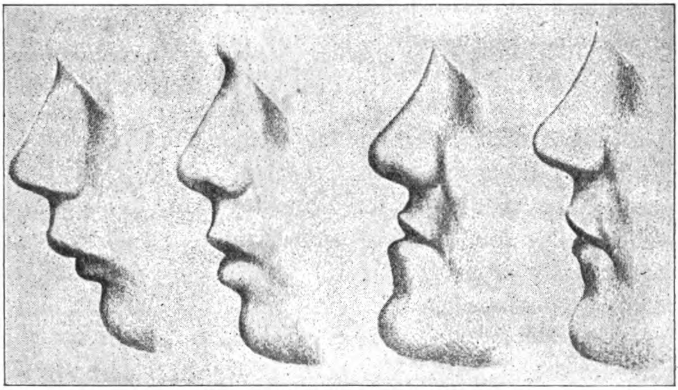


FIG. 130. Two cases in which the teeth needed and received the care of a good dentist. (*After a photograph from "The Practical Orthodontist."*)

that children be guarded from disease and that an abundance of lime be supplied in the food during the early years of life. The question of lime in the diet should be given special care when babies are brought up on any food other than milk.

Care of the mouth of an infant. Little babies often suffer from sore mouth. This disease is caused by germs and is usually brought on by lack of cleanliness. It should be promptly attended to by a physician, because it not only causes suffering and nervousness in the child but also fills the alimentary canal with germs and ruins the digestion. When the teeth are making their way through the gums, the mouth should be examined to see that there are no little ulcers on the gums when the teeth are cutting through. If these are found a physician or a dentist should be consulted; for it is very unwise to allow a child to go on swallowing the many thousands of pus-forming germs that come from the ulcers. One of the best means of preventing trouble in the mouth of a baby is to wipe out the mouth, after feeding, with a clean cloth that has been dipped in a saturated solution of borax or boric acid.

Decayed teeth very common. Among the 846 children examined in a school in Cleveland, Ohio, only three had perfect teeth. Examinations of many thousands of other children show that often as many as 95 per cent of them are in need of dental care. The great majority of young persons lose their first permanent molars before they are twenty years of age, and it is undoubtedly true that no other part of the body is so often defective as the teeth. You should be on guard, therefore, to preserve the precious heritage which nature has given you in the form of your teeth; for your chances of health in later years depend very largely on the care that you give your teeth now. Keep them clean by all means, and if there are small cavities in them, have them filled at once.

QUESTIONS

In what two ways do bad teeth injure the health? Name the parts of a tooth. Of what is the body of a tooth composed? With what is the crown covered? How may the enamel be injured? What results usually follow breaking the enamel? How are the teeth fastened in the sockets? Where is the pulp cavity? What does it contain?

What causes decay of the teeth? What happens if the decay continues until the pulp is reached? How may decay be prevented? Why should particles of food that lodge between the teeth be removed? How may a good tooth powder be made? Why should gritty substances not be used to clean the teeth? What kind of brush is best for cleaning the teeth?

What are dental plaques? What is tartar? Give two important points in keeping the gums in health. How should the brush be used in cleaning the teeth? How often should the teeth be brushed?

Why is it important to visit the dentist regularly? Why should dental plaques be removed? Why should tartar be removed? Explain why it is important to have all cavities filled while they are small.

How many teeth are there in the temporary set? Name and describe the different kinds. How many teeth are there in the permanent set? When does the first permanent molar appear? Give two reasons for caring for the temporary teeth. Why are the first permanent molars especially liable to decay? Why is their loss harmful?

Why are hard foods better for the teeth than sticky foods? Why is constant candy eating injurious? How do adenoids and nasal growths affect the teeth? What should be done when the teeth are crooked? How may illness during childhood injure the teeth? What element needed for building the teeth is sometimes lacking in the diet of children?

When babies have sore mouth, what is usually the cause? What trouble should be guarded against while the teeth are coming through the gums? How can trouble in a baby's mouth be prevented?

Cite some facts to show how common defective teeth are.

CHAPTER TWENTY

TOBACCO

FIG. 131. The peace pipe.

WHEN Columbus returned from the West Indies, he reported that the natives carried with them to kindle fires a brand made by rolling in corn husks the leaves of a certain herb which they cultivated. He also reported that they perfumed themselves with the leaves of this herb, and that no treaty of peace could be ratified among the Indians without smoking the herb in a pipe, because they believed that when the smoke of its burning ascended to heaven the Great Spirit smelled a sweet savor and was pleased.

The use of this Indian herb became popular in England through the influence of Sir Walter Raleigh, and the custom of using it spread rapidly through Europe in the seventeenth century. At first it was thought to have medicinal value, but in a short time men of intelligence and high position came to think of it as a dangerous drug and became alarmed as to the consequences that would follow its widespread use.[1] A great movement against the new custom then sprang up over all the known world. In Turkey the pipes of smokers were thrust through their noses; in Russia the noses of smokers were cut off, and those who repeated the offense were put to death; the church threatened the users of the weed with excommunication; and King James of England issued a protest against its use, in which he declared it to be "a custom loathsome to the eye, hateful to the nose, harmful to the brain, dangerous to the lungs, and in the black, stinking fume thereof nearest resembling the horrible Stygian smoke of the pit that is bottomless."

Why the habit of using tobacco is so widespread. In spite of all the opposition that has been offered to it, tobacco is now used over practically the whole world. In the United States the people spend for it more than four hundred millions of dollars yearly. Of course, if people spend their money in this way, it means that they will be compelled to go without food, clothing, furniture, books, music, and other things that for their health, comfort, and richness of life they ought to have; it means millions of extra years of labor for a people who are already overworked. In India all ages and both sexes are constant smokers, and in China many of the workmen carry with them as their constant compan-

[1] During the seventeenth century the plague, or "Black Death," ravaged Europe, and it was generally believed that smoking was a safeguard against this disease, and even the boys in the schools were made to "smoak." It is possible that there was some foundation for this belief; for the plague is spread by fleas that come from plague-infected rats, and it may be that fleas dislike the odor of tobacco that is present on the clothes and skin of tobacco users.

ions a supply of tobacco and a pipe. Yet in India and in China the great mass of the people toil for a miserable wage that will hardly keep them alive, and in years of crop failure hundreds of thousands of them actually perish for lack of food.

Why do men put this extra burden on themselves? Why did the Indians that Columbus saw perfume themselves with the odor of tobacco? Why do men now engage in the seemingly foolish custom of drawing smoke into the mouth and puffing it out again? Let us search out the answer to this problem.

Nicotin. There are certain drugs that produce such pleasurable effects on the mind that people form the habit of taking them to experience these effects. Among these drugs may be mentioned hasheesh, which comes from Indian hemp and is used by the people of India. It produces a kind of intoxication and fills the mind with brilliant ideas of grandeur and power, causing the most pitiful specimen of humanity to feel himself a very king among men. Alcohol has something of this same effect, for it deadens the judgment and the critical powers of the mind and causes a person to regard his own efforts as brilliant, even when there is no ground for a high opinion of what he has done. Opium deadens the sensibilities to pain and produces sensations of delicious ease and luxury. Cocain, chloral, and a few other drugs produce effects that are pleasant to the mind, and men fall into the habit of taking them. The most widely used of all these drugs, however, is nicotin, which is present in tobacco. The sensations produced by it will be discussed in a later paragraph.

Nicotin a narcotic. Physicians speak of certain drugs as *stimulants* and of certain others as *narcotics*. Stimulants quicken the action of the protoplasm of the cells; they make the muscles contract more strongly and cause the nervous system to conduct impulses better and to control the body with a firmer hand. Narcotics deaden the nervous system and weaken its action; they slacken the muscles and lessen their strength. Strychnin is a good example of a stimulant. It is given by physicians when the heart action flags and when there is general weakness and collapse. Opium is an example of a narcotic. It is given by physicians to dull the senses to pain and to quiet those whose nervous systems have been overwrought. The nicotin that is in tobacco is a narcotic, and it is so strong that a few drops of it introduced into the mouth will paralyze the nervous system and stop the beating of the heart.[1] We shall now discuss some of the more important effects of nicotin on the body.

The influence of tobacco on growth. There are many indications that the processes within the cells that cause growth differ from the processes that go on during the repair of the protoplasm. That is, in cells and in young people that are growing, there are processes going on that are not going on in cells and in persons

[1] Tobacco is from 1 to 4 per cent nicotin. In chewing, only a small part of the nicotin in the tobacco is absorbed into the body, and in smoking, most of the nicotin is broken into other compounds. It is probable that these other compounds produce a large part of the effect that follows smoking. That men smoke to obtain the drug effects of nicotin and of the compounds that come from the nicotin, and not for the physical and mental pleasure of the smoking, is shown by the fact that a smoker is not satisfied with tobacco from which the nicotin has been extracted.

that have reached their full size.[1] Tobacco seems to have an especially evil effect on the processes of growth; for without doubt it is most injurious to the young. Two young guinea pigs that were made to inhale tobacco smoke from the fourth day after birth, on the forty-fourth day weighed 174 and 169 grams respectively instead of 330 grams, which is the normal weight for a guinea pig of this age. One of them died on the forty-fourth day, and the other was not subjected to further inhalations. At the end of the third month this animal weighed only 295 grams. The normal weight at that age is 485 grams, so the animal was still stunted and far below its normal size.

So generally is it known that cigarette smoking interferes with the processes of growth and stunts the young that most of our states have laws forbidding the sale of cigarettes to boys below a certain age. In 1889 the Japanese government became alarmed because of the small size of some of its citizens, and after an investigation of the effects of tobacco passed a law which was worded thus: "Smoking of tobacco by persons under the age of twenty is prohibited." Professor Seaver of Yale University found that of the young men entering Yale during a period of ten years, the smokers averaged 15 months older than the non-smokers, and that notwithstanding their greater age they were one third of an inch shorter and had slightly less lung capacity. The boy who wishes to become large and strong

[1] By experiments on animals it has been found possible to feed them in a way that will keep them alive, but will not cause growth in them. This indicates that the processes of growth and of maintenance are different.

should let cigarettes alone during his growing years, for there is every reason to believe that young smokers fail to reach their full development either of body or of mind.

The effect of tobacco on the muscles. As we should expect, tobacco weakens and relaxes the muscles. Professor Lombard of the University of Michigan tested the strength and endurance of his finger muscles on four days on which he smoked five cigars daily; then on four days on which he abstained from smoking; then again on four days when he smoked as on the first days. He found that on the days he smoked, his muscles had lost on an average 41 per cent of their working power.

The fact that tobacco softens and slackens the muscles was so well known before the days of chloroform that patients were prepared for certain surgical operations by giving them tobacco to bring about a relaxed condition of the muscles. At the present time, it is well known among athletes that smoking lowers the strength, and athletes who are in training are not allowed to indulge in tobacco. Cigarettes will surely kill the baseball pitcher's speed; they shorten the flight of the football player's punt; and the tobacco user's muscles weaken and fail when the crowning effort of the race comes.

The effect of tobacco on the nervous system. The most serious effects of tobacco are on the nervous system. It interferes with the control of the muscles, and it damages the mind, as we should expect a narcotic to do. The trembling that may be seen in the hands of almost any one who smokes cigarettes to excess shows in a very marked way how tobacco interferes with the control of the muscles. Because of this effect, tobacco users are not good marksmen with the rifle, and many of them are unable to do delicate work. The following statement by Luther Burbank, the great plant breeder and nurseryman of California, illustrates this point:

"To assist me in my work of budding — work that is as accurate and exacting as watch making — I have a force of some twenty men. I discharge men from this force at the first show of incompetency. Some time ago my foreman asked me if I took pains to inquire into the habits of my men. On being answered in the negative, he surprised me by saying that the men I found unable to do the delicate work of budding invariably turned out to be smokers and drinkers. These men, while able to do the rough work of farming, call budding and other delicate work 'puttering' and have to give it up, owing to inability to concentrate their nerve force. Even men who smoke one cigar a day I cannot intrust with some of my delicate work."

The effect of tobacco on the mind is even more noticeable than its effect on muscular control. A study of the grades of 500 boys in private schools shows that the grades of smokers were on an average 12 to 15 per cent lower than the grades of non-smokers. Another set of statistics covering sixteen schools in different parts of the country and including 800 boys showed that the smokers had fallen on an average 17 to 28 per cent behind those who did not use the drug. A comparison of 50 smokers and 50 non-smokers chosen at random in Kansas State Agricultural College showed that the smokers had averaged 28 per cent lower in grades and that they had made 74 per cent of all the failures that were made by the 100 students. In every comparison of the scholarship records of tobacco users and non-tobacco users that has been made, the tobacco users stand far below the others in scholarship, and so common is the belief that tobacco interferes with good intellectual work that many large corporations refuse to employ young men who use cigarettes. Judge Stubbs of Indiana gives a list of twenty-two great employers who follow this rule. The list includes Marshall Field & Co., John Wanamaker, and seven great railroads.

How tobacco affects the mind. Tobacco affects the mind, so that the person using it learns less rapidly and thinks less clearly. Those who have used it for some time have a tendency to become nervous, restless, unable to remain still for any length of time, and unable to keep their minds concentrated on any one subject. It is probable, however, that the main reason why tobacco users as a class fall behind other men in intellectual work is that nicotin steals away ambition. Its first effect on the mind is to lull it to rest; to make the smoker contented with himself and his achievements; to make him satisfied to sit and watch the smoke curl upward while other things take care of themselves.[1]

It is true, of course, that many energetic persons use tobacco, and that great numbers of effective brain workers smoke, but nevertheless it is also true that the effects of tobacco on the mind are those given above.

Other effects of tobacco on the body. Dyspepsia is very common among tobacco chewers who swallow

[1] Under the influence of tobacco, thought becomes reverie.

—VICTOR HUGO.

small quantities of the juice and among those who damage their nervous systems by excessive smoking. Another effect of the continued use of tobacco is to raise the blood pressure, which greatly increases the work of the heart.

Smoking also has a bad effect on the air passages; for the hot ammonia and other compounds in the smoke frequently cause "smoker's sore throat," and cancer of the tongue and throat is more common among smokers than among non-smokers. Besides all these effects on separate organs of the body, the nicotin has a depressing and weakening effect on the body as a whole, just as it has an enfeebling and quieting effect on the mind.

The effect of a moderate use of tobacco. In reading this chapter you must bear in mind that not all the evil effects of tobacco that have been described come at once, nor is it possible to observe all of them in every person who is a tobacco user. Small doses of any drug produce proportionately smaller effects than do larger doses, so persons who use tobacco moderately suffer less from it than do persons who use large amounts.

Most of the evil effects of tobacco that we can observe come when it is used to excess, or when it is used by the young, and we all know that there are men all about us who smoke and yet attend to their work. What will be the final result of the use of tobacco on the cells of these men we cannot say, for there are so many things that affect our health that it is not possible without special investigation to know what the effects of any one of these things are. We must have more knowledge before we can state exactly what are the effects of taking small amounts of nicotin into the body year after year, but we do know that if taken into the body in sufficient amounts, nicotin is a violent poison to the cells; that if constantly taken during the growing years, it has a very disastrous effect on development; and that in any amount whatsoever it has a narcotic effect on the muscles and on the delicate cells of the brain.

Why a boy should not use tobacco. "Your first duty in life is toward your *afterself*—the man you *ought* to be. So live that he in his time may be possible and actual.

"Far away in the years he is waiting his turn. His body, his brain, his soul, are in your boyish hands. He cannot help himself.

"What will you leave for him?

"Will it be a brain unspoiled by lust or dissipation, a mind trained to think and act, a nervous system true as a dial in its response to the truth about you? Will you, Boy, let him come as a man among men in his time? Or will you throw away his inheritance before he has had the chance to touch it? Will you turn over to him a brain distorted, a mind diseased, a will untrained to action?

"Will you let him come, taking your place, gaining through your experiences, hallowed through your joys; building on them his own?

"Or will you fling away his hope, decreeing wantonlike that the man you might have been shall never be?

"This is your problem in life; the problem of more importance to you than any or all others. How will you meet it, as a man or as a fool?

"When you answer this, we shall know what use the world can make of you." — DAVID STARR JORDAN.

QUESTIONS

Tell of the discovery of tobacco and its introduction into Europe. What different opinions were at first held about tobacco? Name some drugs that are commonly used for their pleasant effects. What effect has a stimulant? a narcotic? Is nicotin a stimulant or a narcotic?

At what time of life is tobacco especially injurious? Describe the experiment in which young guinea pigs were made to inhale tobacco smoke. Why do most of our states prohibit the sale of cigarettes to young persons? Give the results of Professor Seaver's observations on students in Yale University.

What effect has tobacco on the muscles? Describe the experiment performed by Professor Lombard. For what purpose was tobacco used by physicians before chloroform was known? Why are athletes in training not allowed to use tobacco?

What effect has tobacco on the nervous system? Why are users of tobacco not good marksmen? Repeat what Luther Burbank said about his workmen. Give statistics showing mental progress made in schools by smokers and by non-smokers. What rule have many great employers made regarding cigarette smokers? How does tobacco affect the mind? the digestive system? Discuss the effect upon the body of a moderate use of tobacco.

CHAPTER TWENTY-ONE

ALCOHOL

A STANDARD text on hygiene that was used in many of our medical colleges as late as 1890 taught that malaria was due to miasma from swamps; that typhoid fever was connected with the rise and fall of ground water; that cholera seemed to be related to the temperature of the soil from four to six feet below the surface; that erysipelas was due to impurities in the air; that diphtheria was caused by sewer gas; and that yellow fever was an air-borne disease.

These ideas seem strange to us today, but the fact that they were current so recently even among medical men emphasizes the fact that in the past men have looked upon disease as something that comes upon us from without; that they have thought of the causes of sickness as lying in the world about us. Now we have come to understand that the causes of ill health are to be sought for, not in the swamps and forests and changes of weather, but within the body itself; that it is what goes into the body rather than the distant outside world that is important in hygiene. We have learned that the great secret of health is to keep the lymph in which the cells are bathed free from poisons and impurities and to allow the cells to live their own lives in a natural way.

Along with this new knowledge there has come a truer understanding of the uses of medicines and a greater care about taking into the lymph strong drugs whose effects on the delicate cells are not fully understood. The best physicians now realize that all medicines are foreign and unnatural substances in the lymph, which ought to be given only when there is good reason to believe that the body will be benefited by them; and they are continually amazed at the reckless and ignorant way people pour patent medicines and other strong drugs in upon their cells. In this chapter we shall study the effects on the body of the use of alcohol, a powerful drug that is extensively used by the people of our country.

Where alcohol comes from. *Yeast* is a small plant that lives on the skins of fruits and in very rich earth, and that often blows about in the air. The favorite food of this small plant is sugar, and when it falls into a liquid that contains sugar, it grows and multiplies very rapidly. In doing this it uses the sugar for food and breaks it up into water, carbon dioxid, and alcohol. This process is called *fermentation*. The alcohol in all the different kinds of intoxicating drinks that are used by man comes from the fermentation of sugar by yeast.

Different kinds of alcoholic drinks. The natives of the tropics cut off the flower clusters of palm trees and collect the juice that pours out from the cut ends. This contains much sugar, and after it has been fermented it contains great quantities of alcohol. The Mexicans collect the juice of the *agave*, or century plant, in the same way and manufacture an intoxicating drink from it. Fruit juices are rich in sugar, and in temperate countries the people make wine by allowing them to ferment. Grapes, apples, currants, and blackberries are the fruits that are most commonly used for this purpose. In the manufacture of beer, grain is soaked in water until it sprouts, and the starch in it is digested to sugar and dissolved out in water. Yeast is then allowed to change the sugar in the liquid to alcohol.

Rum is made by fermenting molasses and distilling off the alcohol; whisky is made by distilling the fermented liquid from sprouting grains; and brandy is made by distilling fermented fruit juice.[1] Alcoholic drinks have different tastes, according to the substances from which they are made, and some are stronger than others, but in all of them it is the alcohol itself that is the important thing.

The use of alcohol injurious to the body. Is alcohol injurious to the body? In the past there has been a division of opinion on this point. Today we have come into an age of science, and we are substituting knowledge for guesswork in all fields of human thought. What are the facts in this case? Does taking alcohol among the cells cause the body machine to run a longer or a shorter time, and is it laid up for repairs more days or fewer days in a year when alcohol is used? The following statistics will give us some information on this question.

The effect of alcohol on health. In Australia the workmen have benefit societies that pay wages for time lost on account of sickness. The records of these societies show that the members of societies that admit only abstainers lose but little over half as much time on account of illness as do the members of societies that admit drinkers. This indicates that the use of alcohol increases sickness.

[1] In distilling liquors, the liquid (the fruit juice or the water in which the grain has been soaked) that contains the fermented sugar is heated, and the vapor that comes from it is caught and condensed. The alcohol in the liquid is changed to vapor more easily than water, and the liquors that are manufactured in this way are strong in alcohol.

Alcohol and length of life. In 1909 forty-three of the leading life insurance companies of the United States and Canada decided to investigate collectively the death rates among different classes of their policyholders. The investigation included the histories of over 2,000,000 lives, and was the most extensive study ever undertaken by life insurance companies. Among other figures collected were the following in regard to the mortality rates among users of alcoholic drinks:

	Mortality
Moderate users (2 glasses of beer, one glass of whisky, or their equivalent, a day) .	118 %
Liberal users (steady, free, but not immoderate use)	187 %

These figures indicate that 118 moderate users of alcoholic drinks and 187 liberal users of them die where the number of deaths that would naturally be expected is 100.[1] It should be understood, however, that the information as to the consumption of alcohol was obtained when the policy was applied for, and a portion of those included in the above results probably changed their habits later. Some of them doubtless came to drink more freely and some became total abstainers.

In the above-mentioned investigation, no study of the mortality rate among abstainers was made, but one

[1] Insurance companies from their long experience are able to calculate about how many deaths may be expected to occur among a given number of persons of given ages. This average number is taken as 100 %, and the rate among users of alcohol was compared with the average rate. It should be understood that the above comparisons are not between drinkers and abstainers, but between drinkers and all classes of the insured — drinkers and abstainers taken together. Heavy drinkers are not included, for these are rejected by all companies.

American company that made such a study secured the following data:

	Mortality
Total abstainers	59%
Rarely use	71%
Temperate	84%
Moderate	125%

These figures show a mortality rate among abstainers of less than half that among moderate drinkers.

A number of foreign insurance companies have kept records of the abstainers and drinkers among their policyholders separately and these also always show a higher death-rate among the drinkers. The following examples taken from recent reports of insurance companies will illustrate this point.

In the ten-year period from September 30, 1900, to September 30, 1910, the experience of the Australasian Temperance and General Life Insurance Society showed that where there were 100 deaths among drinkers there were only 62 deaths among abstainers. The Manufacturers' Life Insurance Company during the nine-year period from 1902 to 1910 inclusive had a death rate of 56 among abstainers as against 100 deaths among an equal number of drinkers. For a twenty-eight-year period, ending in 1911, the Sceptre Life Insurance Association had 67 deaths among its non-drinking policyholders, where it had 100 deaths among its non-abstaining members. All other records that have been kept show that there are more deaths among drinkers than among an equal number of abstainers of the same age.[1]

[1] There may be some actuary in the world who believes that total abstainers do not live as long as non-abstainers, but I never heard of one,

We can therefore decide that alcohol used as men ordinarily use it when they drink it for a beverage shortens life.

The effects of the use of alcohol as a beverage on the structure of the cells. The habitual use of alcoholic drinks causes *fatty degeneration* and *fibroid degeneration* of certain of the tissues. In fatty degeneration little droplets of oil begin to collect within the cell, and gradually the living protoplasm of the cell is replaced by fat. When the cells of the gastric glands are changed in this way, they lose their power to secrete; when the muscle cells of the heart are loaded with fat, they lose their strength; when the walls of the arteries are affected, they are, of course, weakened; and when there is fatty degeneration of the liver, kidneys, or nerve fibers, we must expect these organs to fail in their work.

The tissues most commonly affected by fibroid degeneration are those of the liver, kidneys, arteries, heart, and brain. In this kind of degeneration there is an overgrowth of the connective tissue elements, while the working cells degenerate and die. Often in the arteries the elastic muscle coat is not only changed to connective tissue, but lime is deposited in the walls. These changes make "pipe-stem" arteries, which are brittle and often have the opening in them narrowed until it is with great difficulty that the blood makes its way through them. As

and I have never seen any figures showing an advantage in favor of abstainers of less than 21 per cent. Certainly, adding one fifth to a man's life makes it worth while to forego one class of food or drink. — EDWARD A. WOODS, an insurance manager, quoted in Dr. Henry Smith Williams' *Alcohol: How It Affects the Individual, the Community, and the Race.*

we shall later explain, alcohol probably causes these changes in the tissues in an indirect rather than in a direct way.

Some diseases that may be caused by the use of alcohol. In the United States each year there are about 4000 deaths that are directly due to the use of alcohol. Certain diseases, moreover, are more common among drinkers than among abstainers, and it is certain that much sickness and many deaths are due to accidents and diseases that are brought on by the use of alcoholic drinks.

Prominent among the causes of death that are connected with the use of alcohol are: hardening of the liver, in which the liver turns to connective tissue and shrinks into a small, hard organ utterly incapable of doing the work which it is supposed to do; diseases of the kidneys, in which these organs degenerate and fail in their work of excreting the poisonous wastes; heart disease, which may take many forms; hardening of the arteries; apoplexy and paralysis, which are due to the bursting of blood vessels in the brain; insanity and other diseases of the nervous system; tuberculosis, pneumonia, and other germ diseases, to which the user of alcohol falls a victim because he has weakened the defenses of his body; and accidents that would never have occurred had not some one been under the influence of drink.

Alcohol usually an indirect cause of disease. Alcohol itself is a direct cause of certain diseases of the brain, but it is an indirect rather than a direct cause of most of the diseases mentioned above. It has been thought that perhaps one way alcoholic beverages cause these diseases is by damaging the digestive organs and causing poisons to be formed in the intestinal wastes (page 310). A much more probable explanation is that these degenerative diseases are due to chronic infections with germs (page 389), and that alcohol plays its part in causing them by breaking down the resistance of the body to germs. However, it is not a matter of importance how alcohol brings its evil effects to pass. A man may be guilty of a crime, even though he employs others to commit the unlawful deed, and whether alcohol itself destroys the cells or whether it causes germs to do so, we must hold alcoholic drinks responsible for the damage that is done.

The effects of a continued moderate use of alcohol. It should be understood that, except for certain effects on the brain, we are discussing in this chapter the effects of what is called moderate drinking on the body; for when alcohol is used day after day, even though it be used very moderately, there is a piling up of its effects on the tissues. Indeed, the cells of the man who drinks a moderate amount of beer or wine daily are never free from the influence of alcohol. Beer drinkers suffer most of all from fatty degeneration of the tissues, and one need never become intoxicated to experience the evil effects from alcohol that have been described above.[1] The shortening of life given on page 364 is in moderate drinkers and not in drunkards; for the death rate

[1] Alcoholic diseases are certainly not limited to persons recognized as drunkards. Instances have been recorded in increasing numbers in recent years of the occurrences of diseases of the circulatory, renal, and nervous systems, reasonably or positively attributable to the use of alcoholic liquors in persons who never became really intoxicated and were regarded by themselves and others as "moderate drinkers."

— DR. WILLIAM WELCH.

among those who habitually drink to intoxication is so high that no insurance company will accept them.[1]

The effects of alcohol on the mind. Because alcohol causes a person to seem lively and to talk more easily, it is commonly believed that it is a stimulant. This is a mistake. Alcohol is a narcotic, and it produces its seemingly stimulating effect by paralyzing the higher centers of the brain and allowing the person to do and say things that ordinarily his good sense keeps him from doing and saying. In one set of experiments it was found that 20 to 40 grams of alcohol (the amount in from one to two quarts of beer) taken on twelve successive days lessened the capacity to add numbers 40 per cent and the ability to memorize poetry 70 per cent.

Other experiments show that the capacity to think clearly and to judge correctly is greatly influenced by even small quantities of alcohol. Typesetters who were given only a little over an ounce of alcohol a day did 10 per cent less work and made 25 per cent more mistakes than on days when no alcohol was taken, and the effect of these small doses of alcohol continued 48 hours.

After taking a drink, a man feels that his mind is working better and that his ideas come more easily and freely. The truth is that his mind is slower and his ideas are less sensible than usual, but the powers of his mind by which he judges of these things have been deadened by the alcohol, and he is no longer capable of forming a correct opinion of his own acts.

[1] A few of those classed as drinkers may have become heavy drinkers after they were insured, but insurance companies reject not only drunkards, but also those who seem likely to become drunkards. The comparison is, therefore, in the main between abstainers and moderate drinkers.

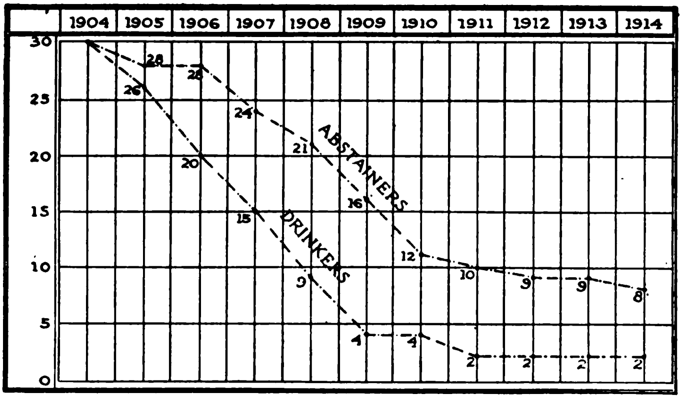


FIG. 132. The records of sixty ball players in the major leagues. Of thirty abstaining players in the major leagues in 1904, eight were still members of big league teams in 1914. Of thirty drinkers, two remained in the major leagües until 1914 and one of these had become an abstainer.

It is probable that the weakening effect of alcohol on the muscles is mainly due to its interference with their control by the nervous system. The movements are made awkwardly, and the muscles work against each other, and so much of their power is lost. This lack of fineness of control in alcohol users is shown at once in a baseball pitcher, a bowler, a rifleman, or any one who does work that requires each muscle to work exactly the right amount and at exactly the right moment.

The drinking habit a handicap. Since the idea of efficiency has penetrated the business world, and since "Safety First" has been adopted as a motto in the industrial world, it is becoming increasingly difficult for a young man who drinks to obtain desirable positions or to secure promotion. Some persons claim that the occasional drinker is being done an injustice in this matter, — that he is being classed with the habitual drinker and is not receiving credit for being as responsible and efficient as he really is. As to the correctness of this view we are not in a position to judge, but certainly under present conditions a young man would do well to remember the question that Connie Mack put to a young ball player when he asked him whether he thought it was worth while, for an occasional drink that would not be missed, to put himself into the drinking group.

Why the effects of alcohol on the body are not more generally understood. The first reason why the real effects of alcohol on the body are not understood by many people is because it makes one feel refreshed when one is still weary; it makes the stomach feel warm and comfortable, while it causes digestive troubles steadily to grow worse; it kills the symptoms of ailments in the body and leaves the person to think that all is well with him, even when serious difficulties are coming on.

The other reason why the effects of alcohol are understood by only a few people is that most of our knowledge on the subject is new. Within the lifetime of persons who are yet of middle age, we have come through a revolution in our hygienic ideas that has left the people, and even some physicians, far behind. We therefore find whole towns drinking polluted water, and many of the people contracting typhoid fever from it; we find at least 75,000 of our countrymen contracting tuberculosis each year by living and working with consumptives; we find teachers who know nothing of adenoids and infected tonsils, although there are 5,000,000 school children in the United States suffering from them; and we find intelligent people still taking alcohol to improve the digestion, build them up when they have become run down, and strengthen them against germ diseases. We are largely governed in our lives by the ideas of the past, and it will require time for the new facts that have been collected concerning the effects of alcohol to drive out the old-fashioned ideas that still prevail among us.

QUESTIONS

How is alcohol produced? How is alcohol made in the tropics? How is wine made? How is beer made? Name some distilled liquors.

What effect has the use of alcohol on the health? Give statistics showing its effect on the death rate.

Explain what is meant by fatty degeneration. What organs may be affected in this way? What changes take place in fibroid degeneration? What organs are commonly affected in this way? Explain the result of fibroid degeneration of the arteries.

In the United States how many deaths each year are directly due to alcohol? Name some diseases that are often indirectly caused by the use of alcohol. What effects has moderate drinking on the body?

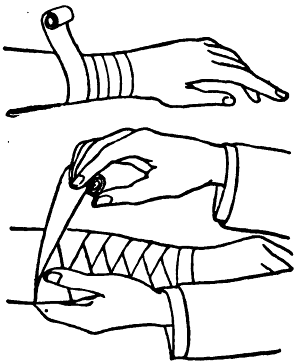
Why is it commonly believed that alcohol stimulates the mind? What effect have small amounts of alcohol on the power to add numbers? to memorize? Describe the experiment in which typesetters were given small amounts of alcohol. Give an account of the speech of Emperor William II before the German naval cadets.

Explain the effects of alcohol on the muscles. Why is the reputation of being a drinker a handicap to a young man? Why are the real effects of alcohol not understood by many persons?

CHAPTER TWENTY-TWO

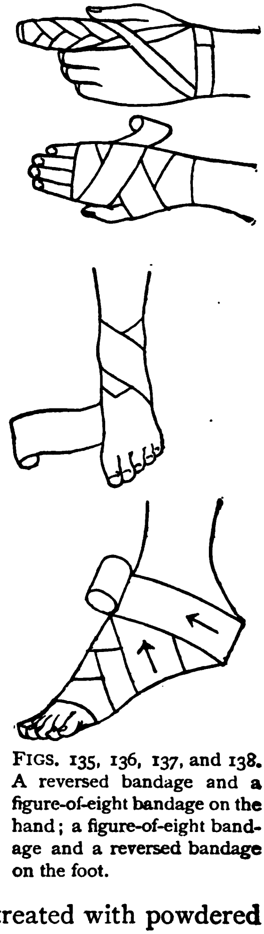
ACCIDENTS

"In time of peace prepare for war." In every house there should be kept in a small box or drawer certain articles for use in case of accident. Among these articles should be soft, worn-out towels; cotton or linen cloths three to six inches square; rolls of bandages varying from one half inch to three inches in width and from one to two yards in length; a bar of green soap; threaded needles, scissors, and safety pins; borated vaselin; bichlorid or biniodid of mercury disks; powdered boric acid; and a bottle of collodion. Accidents come without warning, and having these supplies ready may save suffering or even life.



Figs. 133 and 134. Showing a circular bandage and the method of reversing a bandage.

Bandages. Since many small hurts are treated without the aid of a physician, it is well to understand how to put on a bandage neatly, comfortably, and securely. When the part that is to be bandaged is of nearly the same circumference throughout, the bandage should simply be rolled around the part from below upward, each turn of the cloth covering two thirds of the one below. When the part that is to be bandaged is thicker in one part than in another, as the forearm or leg, the bandage may be made to lie smooth and flat by reversing each turn after the first few turns. To reverse a bandage, hold it at its lower edge and turn it one half over towards you. To give a neat appearance, make each reverse directly above the one preceding it. The figure-of-eight bandage is useful about joints. The best way to get an understanding of the different bandages here described is to study the illustrations in Figures 133 to 138. After two turns have been put on, the bandage should be firmly stitched, and, after the bandage is completed, the end should be securely sewed. A row of stitches from top to bottom, one in each turn of the bandage, is of great advantage in preventing slipping. Always bandage firmly, but never too tightly, and use an equal pressure throughout the bandage.



FIGS. 135, 136, 137, and 138. A reversed bandage and a figure-of-eight bandage on the hand; a figure-of-eight bandage and a reversed bandage on the foot.

Wounds. It is well that a cut should bleed freely, as the blood assists in washing out and killing any germs that may be in the wound. If the cut has been made with a clean instrument, it may be bandaged without any treatment at all, or bandaged after being dusted with powdered boric acid. A wound made by an unclean instrument should be washed with soap and water and treated with powdered boric acid or borated vaselin. If the person must use the injured part in attending to his work, two bandages should be put on. The outer one may be changed when it is soiled, but unless the wound becomes red and painful and has matter in it, the inner bandage should be left undisturbed until the injury has healed.

Deep wounds, such as are made by rusty nails that have become soiled by lying about barnyards, are dangerous, because frequently tetanus germs get into them. A puncture or other wound that is so deep that it cannot be thoroughly cleansed ought to be treated by a physician, who will know whether it is advisable to use tetanus antitoxin as a safeguard against danger from tetanus germs.

Bleeding. When blood flows in jets and has a bright red color, an artery has been cut. If the blood flows in a steady stream, it is a vein that has been severed. In either case, a physician should be called at once. In the meantime, control the bleeding by pressing on the vessel with the thumbs. The pressure should be applied between the wound and the heart if the cut vessel is an artery; beyond the wound, if the bleeding is from a vein. If the physician is long in coming, or if the bleeding cannot be controlled by pressure with the thumbs, twist a handkerchief about the limb, as shown in Figure 139. The blood should not be shut off from the limb for longer than an hour, as much damage may be done by

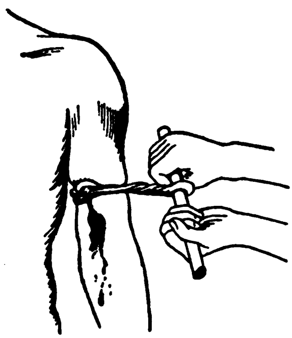


FIG. 139. Checking bleeding from a wound.

depriving the cells of their supply of blood for too long a time.

Blows on the head. A blow on the head sometimes ruptures a blood vessel within the cranium and causes a blood clot to form on the brain. If a person becomes sleepy after such a blow, a physician should be called at once. It is well to wake the person occasionally during the night after such an injury; for otherwise he may sink into unconsciousness without its being discovered.

Burning clothing. If your clothing should take fire, *do not start to run.* If possible, remove the burning garment at once. If this cannot be done, remember that a fire cannot burn without air, and that the quickest way to put out burning clothing is to lie down and wrap yourself in a blanket or rug, or in anything else that you can lay hands on. If nothing is at hand that can be used as a covering to smother the fire, lie down and roll over and over. In any case, *lie down* so that the flames will not come up about your face; for inhaling a flame is often followed by very serious consequences. In passing close to a fire, as in a burning building, the face should be protected if possible by something held before it.

The treatment of burns. A burn in which the skin is only reddened, or in which the blistering is slight, may be treated by simply shutting the air away from it. A paste made of baking soda and water, or of flour or starch mixed with water, is good for this purpose. White of egg, vaselin, olive oil, castor oil, fresh lard, or cream may also be used to cover a burn. Wet cloths wrung out of cold water will help to allay the pain. Burns which cover much surface, or small, deep burns, should be shown to a physician; for it is not always possible to tell at first how much damage has been done, and the injury may be more severe than it appears to be.

A burn made by an acid should be washed and treated with limewater, baking soda, or soapsuds. A burn made by an alkali (such as lime, lye, etc.) may be treated, after thoroughly washing off the alkali, with weak vinegar, lemon juice, sour milk, or buttermilk.

Apparent drowning. Drain the water from the patient's lungs by catching him under the waist and holding him for a few seconds with the head hanging down. Then quickly lay him in the position shown in Figure 140, with a folded coat or blanket under his chest. Place the hands on either side of the back over the lower ribs. Throw the weight of the body steadily downward on the hands and drive the air out of the lungs. Take the pressure off the body without lifting the hands, and allow the air to come into the lungs. Repeat about fifteen times a minute. This method sends more air through the lungs than any of the methods in which the patient is laid on his back, and it has the additional advantage that the tongue does not fall back and block the throat.

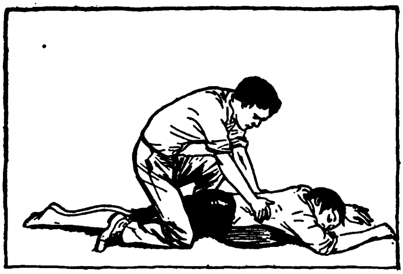


FIG. 140. Carrying on artificial respiration.

Rubbing the limbs along the veins toward the heart causes the blood to circulate and should be kept up if there is a second person to attend to it. Keep the patient as warm as possible by covering him with a blanket and pouring warm water over him, or by laying hot-water bottles about him. A hot-water bottle at the head is especially important, but nothing hotter than can be borne comfortably by the skin of the elbow should be brought into contact with an unconscious person. When the patient begins to revive, give strong hot coffee, or fifteen drops of ammonia in a glass of water. Artificial respiration should be kept up for an hour or longer if the person does not recover sooner.

Suffocation. Suffocation may be produced by hanging, by choking, or by gas or smoke poisoning. Sprinkle cold water on the face; carry on artificial respiration as in cases of apparent drowning; and, when the person is able to swallow, give stimulants as directed above.

Fainting. Lay the patient flat on his back, so that the blood will flow easily to the head. Sprinkle cold water on the face, and give him fresh air. Give strong coffee or ammonia as directed above.

Dangers from electricity. As the use of electricity becomes more common, it is more and more frequently a source of accidents. Even now many people do not seem to know that highly charged electric wires and third rails are deadly affairs, and that those who do not understand their workings ought not to take chances with them. Where a notice is posted warning the public not to cross the track of an electric line, there is a reason for the warning, and you should keep off the track. When a trolley wire or an electric wire breaks and falls to the ground, keep away from it. It is interesting to experiment with electricity, but you cannot afford to begin in this way.

Rescuing a person from an electric wire or a third rail. A live wire lying on a person may be safely flipped off with a dry board or stick. If the person is lying on the wire, the wire may safely be cut with an ax or hatchet that has a dry wooden handle. Cut between the person and the source of the electricity; on both sides, if the source of the electricity is unknown.

In trying to pull a person off a live wire or third rail, great care is necessary or the rescuer will be injured. In attempting to do this, unless the ground is very dry, one should stand on a dry board, a folded coat, or several thicknesses of folded newspapers. A rubber mat is better than the articles just mentioned, but it is not often at hand. If possible, take hold of the person through dry cloth or paper, and catch him by the clothing without allowing the hand to come into contact with his body. Pull him off the rail or wire with one quick, firm motion, and if he is not breathing, carry on artificial respiration as in cases of apparent drowning. A doctor should be sent for as quickly as possible.

Foreign bodies in the eye. If a cinder or other foreign body gets into the eye, do not rub the eye. Keep it closed and the tears will often wash the dirt out into view so that it may easily be removed. Sometimes stretching the upper lid down over the lower lid two or three times, or closing the nostril on the opposite side and blowing the nose hard, will change the position of the object and make it possible to remove it. The inner surface of the lower lid may be examined by pressing the lid down, and some persons are skillful enough to turn the upper lid back over a match or small stick so that the offending particle can be wiped off. Only clean fingers, clean handkerchiefs, or other clean objects should be allowed to touch the eye. After the foreign body has been removed, a few drops of boric acid solution is soothing and is useful in safeguarding against possible infection with germs.

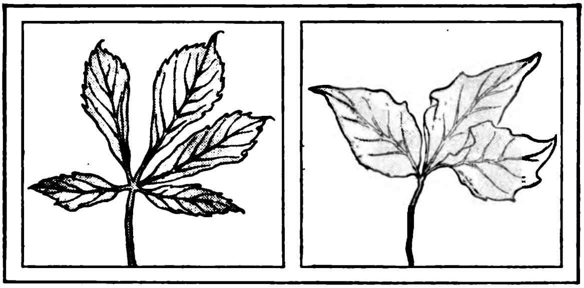
Foreign bodies in the nose and throat. Little children sometimes push beans, peas, beads, or other objects into their noses. Having the child blow the nose will often bring these objects out, but if they cannot be removed in this way a physician should be called. Do not try to remove them with a hairpin or other sharp instrument.

When a button, coin, or other object sticks in the throat, the child should be seized by the feet, suspended head downward, and energetically shaken and slapped on the back. Usually this will cause the object in the throat to drop out.

Treatment for swallowed pins and needles. When a pin or needle has been swallowed, a large meal of bread, potatoes, cabbage, or other coarse foods should be eaten, as they will leave a large amount of undigested matter to coat the foreign object during its passage through the alimentary canal. *Never give a laxative under such conditions.* No anxiety need be felt over swallowed buttons, coins, and other similar objects.

Frostbite. Keep away from the fire and thaw the "bitten" part out very gradually by rubbing it with snow, or by keeping it bathed in ice water until the blood begins to circulate through it again. Suddenly thawing the frozen tissues is far more injurious than the freezing, and every care should be taken to keep in a cool atmosphere until the thawing process is completed.

Ivy poisoning. Dissolve a level teaspoonful of potassium permanganate crystals in a pint of water and bathe the affected parts. Before the skin is broken



FIGS. 141 and 142. The poison ivy is often mistaken for the Virginia creeper. The Virginia creeper has five leaves, while the poison ivy has only three.

the poisonous oil may be partially removed at least by thorough washing with strong soap or with alcohol. In severe cases a physician should be consulted.

Poisoning. *Bottles that contain poisons should not be kept among medicines*, and it is well to paste strips of sandpaper on such bottles, so that they can be recognized even in the dark. When a poison is taken by accident, a physician should be called immediately. If possible, have the messenger tell him what poison has been taken, so that the proper antidote may be brought.

A card with a list of the different poisons and their antidotes should be written out, and placed with the other articles that are kept for use in case of accident. The sooner the antidote is given, the less time will the poison have to damage the body, and when one is thus prepared, a case of poisoning can often be treated before the doctor arrives.

While waiting for the doctor, give an emetic at once to produce profuse vomiting, if the poison is not an acid. Good emetics are: mustard and water; salt and water; lukewarm water alone and in large quantities; and ipecac. Tickling the throat with a feather or thrusting the finger into the throat will help to cause vomiting.

The following list of antidotes for some of the more common poisons may be found useful:

Acids. Give soda, chalk, old mortar, or soap. Oil and milk are useful. For carbolic acid use alcohol (whisky or brandy will do). Oil or milk should be used if no alcohol is at hand.

Arsenic. This is the poison in Fowler's Solution, Paris Green, and Rough on Rats. Give any medicine that contains iron.

Mercuric chlorid. This is also called bichlorid of mercury and corrosive sublimate. Give milk, white of egg, or both. Flour or starch with milk and egg is good.

Phosphorus. Magnesia and chalk in water, and white of egg are good remedies. *Do not give oil or milk.* Phosphorus is the poisonous substance on the end of matches, and is often found in rat poison.

Opium, laudanum, nightshade, and jimson weed. Give strong coffee or ammonia. Keep the patient awake by walking him about, slapping him, or throwing cold water over him, if necessary. Give stimulants as directed under Fainting, on page 378.

Strychnin. Inhaling chloroform or ether will quiet the patient. Give five grains of sodium bromid every half hour. Keep the patient away from cold drafts and noises, and allow nothing to touch him, as any stimulus makes the spasms more violent.

The importance of the problem of accidents. Figure 143 shows the great number of deaths in the United States that were due to accidents in one year. This number takes no account of the thousands of persons in the country who were injured but not killed. The question of accidents, therefore, is a very important one indeed, and especially is this true because the victims are often crippled so that for the remainder of their lives they suffer pain and are hindered in their work. Because nearly all accidents can be prevented by reasonable care, we shall discuss briefly how this may be done.

Preventing accidents. The first step in preventing accidents is so to arrange the conditions under which we live and work that it will be difficult for mishaps to occur. In machine shops and factories and on railroads, this is rapidly being done. The causes of accidents in private homes and on farms should also be removed; for many houses are built with dangerously steep cellar stairs; many barn lofts can be entered only by climbing rickety ladders; stairways and openings in floors that are left unprotected by railings are the cause of many falls; and farm machinery is constantly being operated in a dangerous and careless way. All these and other conditions that cause accidents should be remedied, and when this is done the number of accidents is at once greatly reduced.

The other important factor in the prevention of accidents is the use of intelligence and reasonable care when it is possible for carelessness to cause an accident to happen. In our cities children are continually running directly in the way of automobiles and street cars; drownings occur because of a lack of care in handling boats and because persons who cannot swim venture into water beyond their depth; clothing is set ablaze by standing too near an open fire; and automobile accidents occur because of recklessness in driving these machines. Accidents of this kind can only be prevented by intelligence and watchfulness, and you should constantly educate yourself in those habits that prevent them.

QUESTIONS

Name some articles that should be kept for use in case of accident. Name three kinds of bandages and tell how each is put on. Describe the treatment for cuts. Why is a deep wound made by an unclean instrument dangerous? When blood is flowing from a wound, how can you tell whether it comes from a vein or an artery? How can the bleeding be checked until a physician arrives?

Why should a person not be allowed to sleep uninterruptedly after a blow on the head? If your clothing were to catch fire, what should you do? Describe the treatment of burns. Describe artificial respiration. When should it be used? In addition to carrying on artificial respiration, what else may be done in cases of apparent drowning? What should be done in cases of suffocation? What should be done for a person who has fainted?

Tell how a person may be rescued from a live wire or a third rail. How may foreign bodies be removed from the eye? from the nose? from the throat? What is the treatment for swallowed pins and needles? for frostbite? for ivy poisoning? Give antidotes for the following poisons: carbolic acid; arsenic; mercuric chlorid; phosphorus. Give the treatment for a case of strychnin poisoning. What are some of the more common forms of accidents? What are the two important factors in the prevention of accidents?

CHAPTER TWENTY-THREE

REALIZING HEALTH POSSIBILITIES

WHEN a farmer begins to study how to increase his harvests, one of the first facts he learns is that it is the "limiting factor" that determines what the growth of his crops shall be. An exact definition of what a limiting factor is would mean little either to the average farmer or to you, but an illustration makes it easy to understand the meaning of the phrase.

Suppose that in an acre of land there is enough nitrogen to raise 75 bushels of corn, enough phosphorus to raise 20 bushels, enough potassium and other needed elements to raise 100 bushels, and that the season is favorable and there are rain and sunshine enough to make 100 bushels. What will the crop be? It will be 20 bushels.

The phosphorus is the limiting factor that makes it impossible for the yield to rise above that point. A chain is no stronger than its weakest link, and it is not the half dozen favorable factors, but the one unfavorable one, that determines what the harvest shall be. The important thing for the farmer to do, therefore, is to find the factor that is limiting his crop and strengthen the weak point. Otherwise the abundant supply of water and of nitrogen and other plant foods in the soil is of no value to him.

The limiting factor in health. The health of the human body is dependent on many different things. *All* of these are necessary, and if any one of them is lacking, it will be the limiting factor that will make health impossible no matter how many other conditions may be favorable. One person may have good food, fresh air, and everything else necessary to health except sufficient sleep. In other cases the limiting factor may be the condition of the teeth, adenoid growths, lack of exercise, lack of fresh air, alcohol, overwork, or improper food. With many persons everything necessary for health is present if only disease germs could be kept out of the body.

In some cases more than one difficulty must, of course, be overcome before health can be achieved, but often only one factor makes the difference between illness and health. In our quest for health, it is, therefore, most important that we neglect none of the factors that are necessary for a realization of our health possibilities. To give you some wider ideas that may serve as guiding principles in your search for limiting hygienic factors in your own life, we shall in this final chapter discuss in a more general way the causes of sickness and how they may be avoided.

Health natural to the human body. Plants suffer from many diseases, but practically all these diseases are caused by germs or fungi. When a plant has the food, water, light, and air that it needs, and when the temperature of the soil and air is right, it will be healthy unless outside enemies attack it.

Is the human body built less perfectly than a plant? Does trouble arise within it because of its own weaknesses and defects? The more we know of the body and its workings, the more we are led to believe that it is splendidly built and that, like a plant, it is capable of living at all times in health. In order to understand this point of view more clearly, let us discuss briefly the causes of illness.

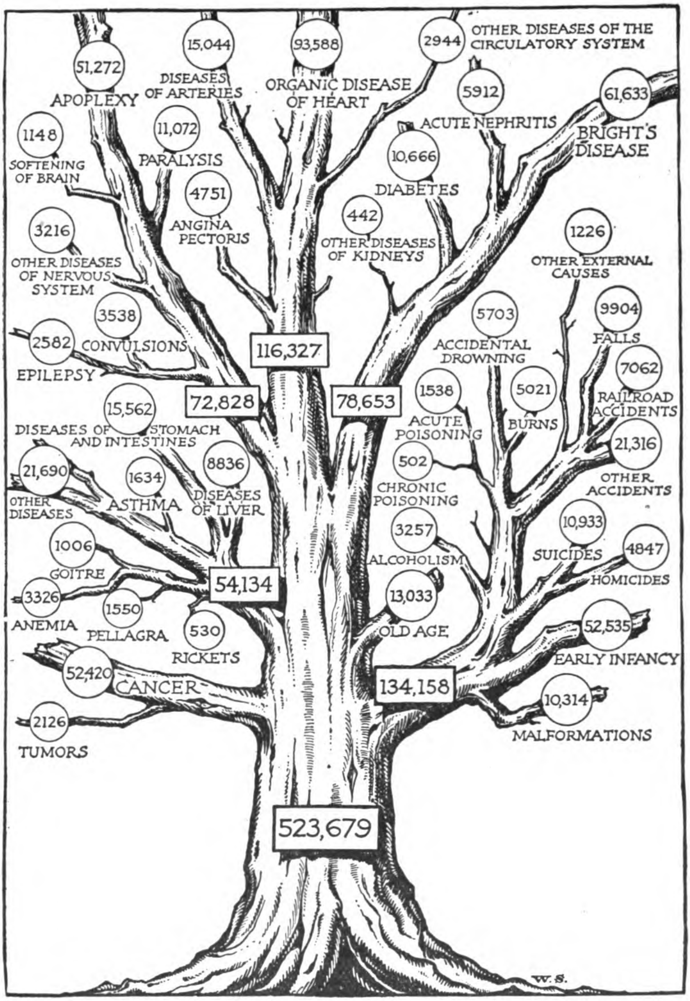


FIG. 143. Deaths from certain causes in 1914 in the part of the United States where vital statistics are kept. Many of these deaths are caused by infections with germs.

Three classes of diseases. For purposes of convenience we may divide diseases into the following three classes:

Germ diseases. Most of the illnesses of early and middle life are caused by germs growing in the body and poisoning the cells. It certainly is no fault of a delicate machine, if something gets into it from the outside and upsets its workings, so we cannot blame the body when it falls ill because of attacks by germs.

Physiological diseases. The causes of a considerable number of these diseases are not well understood. Some of them, like cancer, may yet prove to be germ diseases.[1] Others, like scurvy and pellagra, are caused by the failure of the food to supply the body with materials that it needs. In the case of others, there are probably wrong chemical changes within the cells; and in a number of other diseases, some organ from an unknown cause fails to do its work.

It may be that in some of these diseases the difficulty does lie in the body, — that there are some imperfect human machines. As a matter of fact, however, few persons suffer from diseases of this kind compared with

[1] In cancer a part of the cells multiply and feed on the other cells, but the reason for this has not been found. It is possible, however, to cure the disease in most cases if it is taken in time; for when there is only a small group of cancer cells their growth can often be stopped by radium or the use of the X-ray, or a surgeon can take them out completely and then the disease is gone. Any one who has any growth or chronic sore on his body should have it examined at once by a physician; for in its early stages cancer is often easily dealt with, and most of the trouble comes from cases that have been neglected until the growth has made its way so far among the tissues that it cannot all be removed. The importance of cancer can be seen by a glance at Figure 143.

the number who are ill from other causes, and we are finding that in more and more of our troubles it is not the body that is at fault.

Degenerative diseases. In the diseases represented by the great upper branches of the tree on page 387, there are degenerative changes in the tissues, — the cells die and are replaced by fat or dead materials like those found in tendons and bones. These degenerative changes take place most frequently of all in the walls of the arteries and in the tissues of the kidneys and heart. Because of the great importance of degenerative diseases; because it is probably unnatural for them to come on before old age; and because there is reason to believe that in a great measure they can be prevented, we shall discuss the causes of these diseases and the most practical methods of preventing them.

The causes of degenerative changes in the tissues. The degenerative changes in the tissues are to be looked on as the wear and tear that takes place in the machine. They are the same changes as those found in old age — in fact, they *are* old age. It is probable that anything that injures the health of the body in any way hastens these changes and hurries us into old age faster than we otherwise should go. It is agreed, however, by most medical men that these tissue changes are in many cases due to the following causes:

Overwork, haste, and worry. Persons who do very heavy labor are especially subject to certain degenerative diseases, and there is much reason to think that a hurried, nervous life hastens the breaking down of the body machine. Part of the evil wrought by this kind of life may be due to the fact that it lowers the resistance of the body to chronic germ infections, but there is also much reason to believe that the speeding up of the human machine to the extent that is now often practiced is in itself exceedingly harmful. The importance of a quiet, reasonable life should be understood by all; for he who drives his body beyond its powers of endurance must pay the penalty.

The use of alcohol. The question of the use of alcoholic drinks is a great problem in hygiene, for the cells and tissues of persons who habitually use these drinks break down sooner than do the cells and tissues of those who do not use them. This question we cannot discuss here, but the figures that have been collected by insurance companies conclusively prove that the use of alcohol shortens life. Usually the effects of the alcohol show themselves but little until middle life, and then often the drinker suddenly finds that the organs which must keep up the circulation of his blood and excrete the wastes from his body have already reached old age. Fortunately each one has it in his own power to save his body from injury from this cause.

Intestinal poisons. Phosphorus, chloroform, and the toxins of disease germs can cause degeneration of the cells of the liver and other organs in a few days. Some investigators think that when poisons are absorbed in large amounts from the intestine month after month they also cause these effects. Certainly there is much evidence to prove that heavy eaters suffer more from degenerative diseases than do those who eat moderately, and that most persons who live to a great age are temperate in eating. It is possible, therefore, that the selection of a diet that will prevent constipation and the poisoning of the body by the intestinal wastes is an important means of prolonging life.

Acute infectious diseases. After severe cases of diphtheria, scarlet fever, measles, pneumonia, grip, meningitis, typhoid fever, and other infections, degenerative changes have been found in the arteries of even young children. Undoubtedly disease germs are like sand in the bearings of an engine: they cause the machine to wear more in a week or a month than it ought to wear in years.

Beyond question the deaths that are directly caused by the germ diseases of our early years represent only a part of the damage done by these diseases; for an attack of diphtheria at ten years of age may weaken the heart until it will fail when the person reaches fifty years of age, scarlet fever in childhood may start trouble in the kidneys that will lead to Bright's disease in later life, and it is a common thing for typhoid fever to wreck the health for all time. Insurance companies that have tried issuing policies on the lives of reformed drunkards have found the death rates exceedingly heavy. Even when the drinking is stopped, the effects of the alcohol that has been consumed in years past cannot be removed. So even though a person is not killed outright by an attack of an acute germ disease, it is nevertheless true that his cells are often damaged until they never recover. Communicable diseases, therefore, are of far more importance than is shown by the mere number of deaths that they cause outright, and every one ought to be protected from them.

Chronic germ infections. Persons who are sick for long periods of time with tuberculosis and other chronic diseases very frequently suffer from hardening of the arteries and other degenerative diseases, and it is now believed that chronic infection with slow-growing races of bacteria is the most important cause of Bright's disease, apoplexy, heart disease, and diseases of the arteries, — the great upper branches of the tree shown on page 387. For this reason all decayed and infected teeth should receive attention; diseased tonsils should be removed; cases of chronic appendicitis or gallstone trouble should at once have medical attention; and any other infection with germs should be checked as soon as possible. In combating these chronic infections a hygienic life is of the greatest importance, and in connection with this topic we shall say a final word about the resistance of the body to germs.

We cannot depend on our natural resistance to protect us from acute germ diseases, — those infections in which the germs multiply so rapidly that the body is overrun with them before additional defensive substances can be produced. But in chronic diseases the body has plenty of time to manufacture its protective substances, and the better we care for it the more of these substances will be produced. The most effective method of fighting many chronic diseases, therefore, is to increase the germ-killing power of the body by right habits of living. Unfortunately we as yet have little real knowledge of how the body protects itself against germs and of the exact means by which the defenders of the body can be stirred into action against its minute foes. We do know, in general, however, that when the body is suffering from infection, fresh air, good food, sunlight, and proper exercise and rest are of great importance in raising its defensive powers. In the prevention of chronic diseases, or rather in the curing of them in their early stages, an important factor is the hygienic life.

Practical methods of replacing illness with health. In the United States there are on an average about 3,000,000 persons sick each day. This means that there were 3,000,000 years of sickness in the country in a year. Is it possible to replace this illness with health? It is indeed possible to do this in a large measure, and it can be done in the following ways:

First of all, the citizens of the United States should employ enough health officers to prevent the spread of epidemic diseases. This would prevent the deaths that are due to these diseases and it would decrease the size of some of the great branches on the tree shown on page 387.[1]

Secondly, every citizen of the country ought to be examined thoroughly once a year by a skilled physician. All the important ailments shown on Figure 143 give early symptoms that a physician can recognize, and we ought to have our physicians find these diseases in their early stages, when they can be treated with success. The farmer does not drive his binder through the grain until there is a crash among its parts, but looks it over occasionally to see that all the nuts are tight, and in this way he prevents damage that would otherwise occur. So we should learn to use physicians to keep us well, instead of expecting them to cure ailments that have advanced until hopeless injury has been done. This is

[1] It should be noted that this diagram shows only the deaths in the Registration Area of the United States, — the part of the country where vital statistics are kept. This area includes about 66.8 per cent of the total population of the United States.

the Chinese method; for these shrewd Orientals pay the physician as long as the family remains well, and when any one falls ill they pay no more until the patient is restored to health.

In the third place, if sickness is to give way to health in the United States, our people must live hygienic lives. We do not live in a world of chance but in a world of law, and as we keep or break the laws of our life so shall we enjoy health or suffer illness. All of us should in some way plan to secure fresh air; we ought to exercise, to eat sensibly and moderately, to live without worry and overwork, and to avoid poisoning our cells by the use of tobacco or alcoholic drinks. These habits of life serve as a wonderful protection against the chronic germ infections that cause so much of the illness of later life; they give the cells the conditions that are necessary for their health; and when they are practiced by all the people of the country, the small twig in Figure 143 that is labeled Old Age will grow into a great branch that will become the main trunk of the tree.

POINTS TO BE REMEMBERED

1. Health is the natural condition of the human body.
2. Illness comes because the wants of the body are not supplied or because it is attacked by germs.
3. The people of the United States should employ health officers to prevent communicable diseases.
4. They should employ skilled physicians to treat chronic diseases.
5. They should lead hygienic lives.

APPENDIX

A. SOME IMPORTANT FACTS IN REGARD TO CERTAIN INFECTIOUS DISEASES

Disease	Infectious Material	Incubation Period	Early Symptoms	Time Usually Excluded from School
Scarlet fever	Discharges from mouth and nose	Two to five days	Vomiting, sore throat, headache, or fever. Rash usually appears within 24 hours on neck and chest	About six weeks from beginning of disease
Diphtheria	Discharges from mouth and nose	Few hours to seven days	Sore throat with white patches, swelling of the glands of the neck. In nasal diphtheria, lips are often sore from discharges from nose	Until two negative cultures are obtained
Measles	Discharges from mouth and nose	Ten to fourteen days	Cold in head; inflamed eyes, sneezing and coughing. Rash first appearing on forehead and face about third or fourth day	About three weeks
Chicken pox	Fresh or dried matter from eruption	Fourteen days (eleven to nineteen)	Fever sometimes mild. Rash on second day, developing later into crusts	Until scales and crusts have disappeared
Whooping cough	Discharges from mouth and nose	Fourteen days (may be shorter)	Cold in the head, and cough	Five weeks from beginning of disease, or until the "whoop" has entirely disappeared
Mumps	Discharges from mouth and nose	Fourteen to twenty-one days	Slight fever, pain and swelling of the jaw	Four weeks from enlargement

In some cases discharge from the eyes and ears may also be infectious. Incubation periods are often irregular and may be longer or shorter than the periods given.

B. FOOD VALUES AND COSTS

Name of Food	Refuse	Edible Portion								Money Value of Food as Purchased Compared with an Equal Weight of White Bread
		Water	Protein	Fat	Carbo-hydrate	Calcium (CaO)	Potassium (K_2O)	Phosphorus (P_2O_5)	Iron	
	%	%	%	%	%	%	%	%	%	
Apples	25	84.6	0.4	0.5	14.2	.014	.15	.03	.0003	.07
Bacon	—	18.8	9.9	67.4	—					1.95
Beans (string)	7	89.2	2.3	0.3	7.4	.075	.28	.12	.0016	.20
Beans (lima, dried)	—	10.4	18.1	1.5	65.9	.10	2.10	.77	.0070	1.78
Beef (round, lean)	8.1	70	21.3	7.9	—	.011	.42	.50	.0038	1.72
Beets (fresh)	20	87.5	1.6	0.1	9.7	.03	.45	.09	.0006	.22
Bread (white)	—	35.6	9.3	1.2	52.7	.03	.10	.20	.0009	1.00
Bread (whole wheat)	—	38.4	9.7	0.9	49.7	.04	.27	.40	.0015	1.02
Butter	—	11	1	85	—	.02	.02	.03	—	1.48
Buttermilk	—	91	3	0.5	4.8	.15	.18	.22	—	.27
Celery	20	94.5	1.1	0.1	3.3	.10	.37	.10	.0005	.08
Cheese (cream)	—	34.2	25.9	33.7	2.4					2.69
Chestnuts (fresh)	16	37.8	5.2	4.5	35.4	.04	.50	.20	.0010	.64
Chocolate	—	5.9	12.9	48.7	30.3	.14		.90		1.98
Clams (without shell)	—	80.8	10.6	1.1	5.2			.40		.91
Corn (green)	61	75.4	3.1	1.1	19.0	.008	.131	.22	.0008	.13
Cornmeal (granular)	—	12.5	9.2	1.9	75.4	.015	.17	.30	.0011	1.10
Dates (dried)	10	15.4	2.1	2.8	78.4	.10		.12	.0030	.54
Eggs (uncooked)	11.2	73.7	13.4	10.5	—	.093	.165	.37	.0030	1.23

Figs (dried)	—	18.8	4.3	0.3	74.2	.299	1.478	.332	.0032	1.02
Fish (cod, dressed) . . .	29.9	82.6	16.5	0.4	—	.015	.40	.40	.0004	.91
Fowl (chicken, plucked) .	25.9	63.7	19.3	16.3	—	.015	.56	.58		1.33
Grapes	25	77.4	1.3	1.6	19.2	.024	.25	.12	.0013	.16
Ham (smoked, medium fat)	13.6	40.3	16.3	38.8	—					1.71
Honey	—	18.2	0.4	—	81.2	.005	.50	.04	.0010	.36
Lamb chops	13.5	47.6	21.7	29.9	—					1.95
Lettuce	15	94.7	1.2	.3	2.9	.05	.42	.09	.0010	.10
Milk	—	87	3.3	40	5.0	.168	.171	.215	.0002	.35
Mushrooms	—	88.1	3.5	0.4	6.8	.024	.46	.24		.32
Muskmelon	50	89.5	0.6	—	9.3	.024	.283	.035	.0003	.04
Oatmeal	—	7.3	16.1	7.2	67.5	.13	.458	.872	.0036	1.72
Onions (fresh)	10	87.6	1.6	0.3	9.9	.06	.23	.12	.0005	.15
Oranges	27	86.9	0.8	0.2	11.6	.06	.22	.05	.0003	.01
Peanuts	24.5	9.2	25.8	38.6	24.4	.10	.85	.90	.0020	2.16
Peas (dried)	—	9.5	24.6	1.0	62.0	.14	1.06	.91	.0056	2.30
Pork (loin chops, lean). .	23.5	60.3	20.3	19	—	.012	.34	.45		1.51
Potatoes (white)	20	78.3	2.2	0.1	18.4	.016	.53	.14	.0013	.21
Potatoes (sweet)	20	69	1.8	0.7	27.4	.025	.47	.09	.0005	.27
Prunes (dried)	15	22.3	2.1	—	73.3	.06	1.20	.25	.0029	.40
Raisins	10	14.6	2.6	3.3	76.1	.08	1.00	.29	.0050	.52
Rice	—	12.3	8.0	0.3	79.0	.012	.084	.203	.0009	.98
Spinach	—	92.3	2.1	0.3	3.2	.09	.94	.13	.0032	.19
Squash	50	88.3	1.4	0.5	9.0	.02	.05	.08	.0008	.08
Tomatoes	—	94.3	0.9	0.4	3.9	.20	.35	.059	.0004	.09
Walnuts (soft shelled) . .	58.1	2.5	16.6	63.4	16.1	.108	.44	.77	.0021	1.03

The values appearing in the last column of the table on pages 396–397 have been secured by the use of the formula given in Murray's *Economy of Nutrition* (Appleton). This author finds that on an average a pound of protein costs about 20 times as much as a pound of carbohydrate, and a pound of fat about four times as much. The value of a food may therefore be said to be equal to the protein × 20 + fat × 4 + carbohydrates. The method of making the computations will be understood from the following sample problem in which the relative values of pecans and of an equal weight of dried figs are calculated. Pecans (as purchased) contain 5.1 per cent protein, 37.9 per cent fat, and 8.2 per cent carbohydrates. Dried figs contain 4.3 per cent protein, .3 per cent fat, and 74.2 per cent carbohydrates. The relative values of these two foods may therefore be expressed by the equation

$$\frac{5.1 \times 20 + 37.9 \times 4 + 8.2}{4.3 \times 20 + .3 \times 4 + 74.2} = \frac{261.8}{161.4} = 1.62.$$

That is, a pound of pecans ought, theoretically, to sell in the market for 1.62 times as much as a pound of figs. In the table on pages 396–397 the value of bread is taken as 1, and the other foods are compared with it. The values of any two foods can be compared in this way, and it can then be determined which is the cheaper at current market prices. The teacher will understand, however, that in determining the real value of an article of food there may be many factors not taken into account in the above formula. Bulletin No. 28 of the United States Department of Agriculture contains a very complete list of analyses showing the chemical composition of American foodstuffs. It is sold by the Superintendent of Public Documents, Washington, D.C., for ten cents.

PRONOUNCING GLOSSARY

This glossary is intended chiefly to help the pupil in the pronunciation of the more difficult terms. A few words are defined; the meaning of those not defined is made clear in the places where they occur in the text.

abdomen (ab-dō′men).
abdominal (ab-dŏm′i-nal).
adenoid (ăd′en-oid).
Agave (a-gah′vĕ).
ameba (a-mē′ba), *a rather large protozoön that has no cell wall about it, changes its shape, and takes in its food in the same way as a white blood corpuscle engulfs bacteria* (page 75).
amylopsin (ă-mĭ-lŏp′sin).
anemia (a-nē′mi-a).
Anopheles (a-nŏf′ĕ-lēz).
appendicitis (ap-pen-dĭ-sī′tis).
aqueous (ā′quē-ŭs).
astigmatism (as-tĭg′mat-ism).
auricle (o′ri-cl).
bacillus (ba-sĭl′lŭs).
bacterium (băk-tē′ri-ŭm).
beriberi (bĕr′i-ber′i).
bronchial (brŏng′ki-al).
bronchitis (brŏng-kī′tis).
canine (ka-nīn′).
capillary (căp′il-lā-re).
cerebellum (sĕr-e-bel′lum).
cerebro-spinal (sĕr′e-brō-spī′nal).
cerebrum (sĕr′e-brum).
chloral (klō′ral).
choroid (kō′roid).
cocain (kō′ka-ĭn).
coccus (kŏk′kŭs).
coccyx (kŏk′six).
cochlea (kŏk′le-a).
communicable (com-mu′ni-ca-ble) disease, *a disease that one person can contract from another.*
cornea (cor′ne-a).
corpuscle (kor′pŭsl).
Culex (kū′lex).
dengue (dĕn′gā).
dentine (dĕn′tĭn).
diaphragm (dī′a-frăm).
diphtheria (dĭf-thē′ri-a).
disinfectant (dis-in-fĕct′ant).
dysentery (dĭs′en-tĕr-y̆), *an intestinal disease in which there is a bloody discharge from the bowels.*
emetin (ĕm′e-tĭn).
enzyme (en′zīm).
epidemic (ĕp-ĭ-dĕm′ik) disease, *a disease that people catch from one another easily and which many people have at once. An outbreak of a communicable disease.*
esophagus (e-sof′a-gus).
Eustachian (yu-stāk′ke-an).
femur (fē′mur).
fertilization (fer-til-īz-ā′shun).
gangrene (găng′grēn), *inflammation that goes on until part of the tissue is dead.*
germ (jerm), *a bacterium or a protozoön that can cause disease.*
germicidal (jer-mĭ-sī′dal), *germ-killing.*
glycogen (glī′kō-jen).
hasheesh (hash-ēsh′).
hemoglobin (hĕm-ō-glō′bĭn).
humerus (hyu′me-rus).
humidifier (hyu-mĭd′i-fī-ĕr).
hygiene (hī′ji-ēn or hī′jēn).
hygienic (hī-je-ĕn′ik).

incisor (in-sī'sor).
infected (in-fĕkt'ed), *containing germs, as an infected wound.*
infectious (in-fĕk'shŭs) disease, *a disease, the germs of which can be passed from one person to another.*
larynx (lăr'ĭnks).
lipase (lĭp'ās).
lymphatic (lim-făt'ik).
lysol (lī'sōl).
magnesium (mag-ne'zhe-um).
medulla oblongata (med-ŭl'la ŏb-lon-gah'ta).
meningitis (mĕn-ĭn-jī'tis).
miasma (mī-ăz'ma).
microbe (mī'krōb), *a living thing so small that it can be seen only through a microscope.*
molar (mō'lar).
narcotic (nar-kŏt'ic).
nicotin (nĭk'o-tĭn).
nocardia (nō-card'ē-a).
opsonin (ŏp'sō-nĭn).
pancreas (păn'kre-as).
papilla (pap-il'ah).
patella (pa-tĕl'la).
pellagra (pĕl-ăg'ra or pĕ-lah'gra).
pepsin (pĕp'sin).
permanganate (per-măn'gan-āt).
phalanges (fȧ-lăn'jēz).
pharynx (făr'ĭnks).
phosphorescent (fŏs-fo-rĕs'ent).
poliomyelitis (pŏl-ĭ-ō-mī-ĕ-lī'tĭs).
pollen (pŏl'len).
polyp (pŏl'ip).
proboscis (pro-bŏs'is).
protein (prō'te-in).
protoplasm (prō'to-plasm).
protozoön (prō-tō-zō'ŏn).
ptomaine (tō'ma-ĭn).
ptyalin (tī'a-lin).
pupa (pū'pa).
pus (pŭs).
pyorrhea (pī-ō-rē'a).
rabies (rā'bĭ-ēz).
respiratory (rĕs'pĭ-rā-tō-re).
retina (rĕt'i-na).
saliva (sal-ī'vah).
salivary (săl'i-vā-re).
sanatorium (săn-a-tō'ri-um), *a place where people go to regain health; a hospital for the treatment of patients who can be cured.*
sciatic (sī-ăt'ik).
sclerotic (skle-rŏt'ik).
sepal (sĕp'l).
serum (sē'rum).
spirillum (spī-rĭl'lum).
sputum (spū'tum), *matter coughed up from the lungs and air passages.*
stamen (stā'men).
stegomyia (stĕg-ō-mī'ya).
strychnin (strĭk'nĭn).
tetanus (tĕt'a-nŭs).
tonsillitis (tŏn-sĭl-lī'tis), *inflammation of the tonsils.*
trachea (trā'ke-a).
trachoma (trā-kō'ma).
trypsin (trĭp'sin).
tuberculosis (tū-ber-kū-lō'sis).
tuberculous (tū-ber'kū-lus), *infected with the germs of tuberculosis.*
tympanic (tĭm-păn'ik).
tympanum (tĭm'pan-um).
ureter (yu-rē'ter).
virulent (vĭr'u-lent), *powerful in producing disease.*
virus (vī'rŭs).
vitamin (vī'ta-mĭn).
vitreous (vĭt're-us).

INDEX

A star (*) indicates an illustration.