SANITATION AND HYGIENE FOR THE TROPICS

BOOK ONE, PRIMER OF SANITATION FOR THE TROPICS — BOOK TWO, PHYSIOLOGY AND HYGIENE FOR THE TROPICS

BY

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MARGARET ANNA PURCELL

WITH AN INTRODUCTION BY DR. DAVID P. BARROWS FORMERLY DIRECTOR OF EDUCATION FOR THE PHILIPPINE ISLANDS, AND A CHAPTER ON OPIUM BY THE RIGHT REVEREND CHARLES H. BRENT, PRESIDENT OF THE INTERNATIONAL OPIUM COMMISSION OF 1909

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WORKS OF JOHN W. RITCHIE

"Our national health is physically our greatest asset. To prevent any possible deterioration of the American stock should be a national ambition." — THEODORE ROOSEVELT.

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This book is divided into two main parts, the first of which, Primer of Sanitation for the Tropics, presents to children, from the standpoint of the tropics, the importance of disease germs and how to fight them. The second of these main divisions, Physiology and Hygiene for the Tropics, teaches the anatomy and physiology necessary for the intelligent application of the laws of hygiene. The two parts together form a complete course in sanitation, physiology, and hygiene for elementary schools in the tropics (In collaboration with M. A. Purcell.) Illustrated. Cloth. List price $1.00.

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PREFACE

THE purpose of this book is to conserve health and decrease illness in the Philippine Islands. In the revision of it, the authors have therefore included the results of recent discoveries in the field of health in so far as they are applicable to Philippine conditions. As much concrete practical information as possible has been provided, but the importance of building proper health ideals also has been kept in mind and the effort has been made to organize the material presented in a way that will make it suitable for school use. The facts and ideas have been presented in as simple language as possible, and it is hoped that Philippine teachers will find the book useful in teaching one of the most important subjects in the schools.

For assistance during the preparation of the original manuscript the authors are under obligations to many persons of Philippine experience, especially to members of the Bureau of Education and the Bureau of Health. During the revision, the reports of the many splendid investigations into Philippine health problems by members of the Bureau of Science have been used as source material, and thanks are due to Dr. Victor G. Heiser, Director for the Orient of the International Health Commission, for valuable suggestions on certain chapters of the book.

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BOOK ONE — PRIMER OF SANITATION FOR THE TROPICS

BOOK TWO — PHYSIOLOGY AND HYGIENE FOR THE TROPICS

INTRODUCTION

THE course of study in Philippine schools was planned with the object of increasing the well-being of the people; each subject in the course is found there because it was believed that it would help to this end. Every subject in the course is important; each is in some way practically beneficial; but no other is of so much importance or of so great benefit as the study of hygiene and sanitation which begins with this little book. I believe that this is the most valuable subject studied during the entire course.

It is much harder for the inhabitants of tropical countries to keep strong and well than for people in other parts of the world; and the Philippine Islands are wholly a tropical country. Communicable diseases are more common here than in colder places. Most germs are low forms of plants, and, like other plants everywhere, they grow best in places that are warm and moist. So while the people of colder regions can perhaps live with less attention to sanitation, in tropical countries like the Philippines, a constant battle must be kept up if people are to be healthy or even live at all. This battle against the small germ enemies that attack health and life we call Sanitation; it is the subject of this Primer.

Because they live in a tropical country; because their villages and towns lack pure water and wholesome surroundings; because from time to time many deadly diseases have come into the islands and have not been stamped out; and because of ignorance and neglect of sanitation for many centuries, the Filipinos of every class are afflicted with many dreadful diseases. Some act very quickly and kill large numbers, like cholera; some act slowly but kill even more people than the cholera, like tuberculosis; some may not kill their victims outright, but may weaken and enfeeble them till they can neither work nor enjoy life. These diseases are the worst handicap that the Filipinos have; until they are freed from them, real progress is impossible.

Physically the Filipinos are well endowed by nature. They are comely, graceful, and of much endurance. They are exceptionally good walkers; many are fine swimmers; nearly all possess a natural strength and agility that make up for their rather small size. But the unhappy fact is that these bodies, naturally intended to be strong and healthy, usually are diseased in one way or another. At the Philippine Medical School the bodies of people who die in Manila are carefully examined, that doctors and students may learn if possible the real cause of their death and how others may be cured. Of one hundred people so examined, nearly all were found to have been suffering from one or more diseases besides that of which they died. Nearly all had, or had had, tuberculosis in some part of the body. More than nine tenths had worms or other harmful animals in their intestines, which sapped their strength and prevented them from being well and strong. These poor people were examples of the widely spread diseased state of the Filipinos.

Disease not only takes the strength from the body, but it weakens the mind as well; it prevents mental and moral progress. By nature, Filipinos have good minds as well as good bodies. Dr. Herzog, a scientist at one time in the employ of the Philippine Government, examined and weighed the brains of 113 Filipinos who had died. He compared the weight of these brains with those of Europeans and decided that the brain weight of Filipinos "is high, and compares quite favorably with European nations." Experiments conducted in the Bureau of Education to test the strength of memory in Filipino children showed their memories to be as good as in the children of any other people. Filipino students have always won high praise for zeal and diligence, but if we examine the student body all over the islands, the fact becomes evident that they have insufficient strength and are beset by chronic diseases. Of the graduates of Intermediate Schools a large number have died or become invalids shortly after finishing their studies. All this makes us believe that the Filipinos can never do as much brain work and achieve as good results as the students of other peoples, unless they are freed from disease.

Health and sanitation have another side of great importance to the Filipinos as a people. Filipinos are a virile and prolific race, and, under proper conditions, would increase rapidly in numbers. Of all races this is not true; nearly all the people living on islands of the Pacific to the eastward are rapidly becoming fewer, and it seems certain that they must sometime entirely disappear. But this is not true of the Malay. If the Malay people would learn to live healthful lives and to destroy the diseases that now have a hold on them, they would in another century become very numerous and powerful. The Malay people of Java have increased from about 3,500,000 in 1800, to nearly 30,000,000 at the present time. They live in clean country villages. They have plenty of good food and they have been protected from disease. Their increase in numbers has been one of the most notable ever known.

In 1800 the Christian Filipinos numbered about 1,500,000. As the islands developed in prosperity, the Filipinos increased rapidly. By 1850 they were estimated to number over 3,800,000. In 1879 a church census showed the population to be about 5,800,000. It seemed that the Filipinos would soon be a very populous nation. But since then the rate of increase has become much less, and population has gained but slowly. In 1887 it had not reached 6,000,000. In 1893 the official census was taken, and the Christian Filipino people were found to number 6,987,686, a gain of only 1,000,000 in sixteen years. The Director of Health has stated that he believes that at the present time population is stationary in many parts of the Archipelago. Why is it that the rapid rate of increase of the first half of the last century has not been kept up? It is due principally to the bad state of public health, and this in turn is due to the absence of sanitation.

In 1863–1865 and again in 1882 and for years afterwards, cholera was ravaging all parts of the islands and killing thousands of persons. In 1902 it broke out again and by the middle of 1904 had killed more than 160,000 people. It has since reappeared and caused many deaths, though not nearly so many as formerly, because the people and the Government have known better how to fight it. Other dreadful diseases that one person communicates to another are present all the time, and the great number of lives thus destroyed keeps the population from advancing.

There is another cause for this failure to advance, and a very important one. Many villages and towns have become overcrowded, and the growth of population for a century has made these towns insanitary, nothing having been done to provide public improvements and conveniences. When a few families live by themselves in a little barrio there is not the need of water and sewerage systems that there is when the barrio grows to be a great community of hundreds of families. What are the conditions of the people in Filipino towns? Houses are crowded too closely together, and tuberculosis, especially a disease of city life, is active everywhere. Harmful worms and germs that cause disease constantly enter the bodies of people from the unclean ground. Only a small part of the babies born can live, and the children that do survive do not have the right kind of food, or wholesome places in which to work or play. Under such conditions as these no people can hope to become a strong, healthy, and powerful nation. The first patriotic duty of the educated young people of the Philippines is to take up the fight for clean, well-equipped towns and villages and for a sanitary life. The study of this little book is the first step in such effort.

DAVID P. BARROWS

UNIVERSITY OF CALIFORNIA

BOOK ONE

PRIMER OF SANITATION FOR THE TROPICS

It is within the power of man to cause all parasitic diseases to disappear from the world.

PASTEUR

CHAPTER I

THE CAUSES OF SICKNESS

We all want to be well and strong. Yet we are often weak and sick. Why is it that we are not always well? Why do our bodies often become sick and cause us much suffering and pain? In this book we shall learn about some of the things that make us sick. We shall learn, too, how to avoid the diseases that these things cause.

The needs of the body. Our bodies have many needs. They must have food and water. They must have fresh air. They must have exercise to keep them strong, and they need sleep to give them rest. *Sometimes we become sick because our bodies do not have the things that they need.*

Things that injure the body. All of you know some things that you would not dare to eat. There are some poisons so strong that a very little of them will make a man sick or will even kill him. There are poisonous plants that no one eats. There are some fish that are not good to eat. Nobody will buy meat after it is old and spoiled. All of you know that these things poison our bodies and make us sick. *Sometimes we become sick because we take into our bodies things that injure them.*

Disease germs. Disease germs are very small plants and animals. They are so small that we cannot see them without a microscope. A microscope makes things look much larger. You know how small an ant's foot is. Look at Figure 2, and you will see how large it looks through a microscope. With the microscope wise men have seen disease germs and have studied them. They have learned that when these germs grow in our bodies they poison us and make us sick. *Often we are sick because disease germs are growing in our bodies and poisoning us.* There are many different kinds of disease germs, and they cause many different diseases.

FIG. 1. Disease germs are so small that they can be seen only through a powerful microscope.

Infectious diseases. We catch some diseases from people who are sick with them. This seems very strange to us, but everybody knows that it is true. Suppose that a man is sick with cholera. A friend visits him for ten minutes. Then in a few days the friend has cholera, too. A boy who has sore eyes comes to school. Soon the boy who sits beside him also has sore eyes. A girl comes to school from a house where there is smallpox. The girl is not sick, but soon two or three children in her class have smallpox. These diseases — cholera, the disease of the eyes, and smallpox — went from one person to another. Diseases that one person gives to another person are called *infectious* diseases. All infectious diseases are caused by germs.

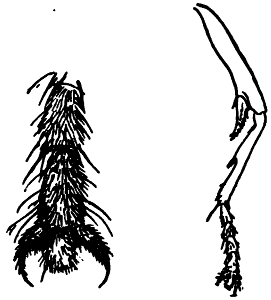


FIG. 2. The foot and leg of an ant, seen through a microscope.

How one person catches a disease from another. What is it that is passed to us when we catch an infectious disease? *It is disease germs.* The girl who comes from the house where there is smallpox brings germs on her clothes or her hands. She gives the germs to the other children. In some way the man who catches cholera from his sick friend gets cholera germs into his mouth and swallows them. The boy who catches sore eyes gets germs into his eyes. When we catch a disease, we do so by getting the germs of that disease into our bodies.

Some diseases that are caused by germs. Smallpox, cholera, plague, leprosy, malaria, dysentery, measles, tuberculosis, typhoid fever, dengue fever, — these are some of the diseases caused by germs. Think how much sorrow these diseases cause. Think how much time and money they cost. Think how many people die of them. Then you will understand why it is important to know how to prevent infectious diseases.

Four important facts about infectious diseases. Here are four facts about infectious diseases to learn and remember:

1. *All infectious diseases are caused by germs.* The germs grow in our bodies and poison us.

2. *Infectious diseases are spread by disease germs from the sick.* When a person has an infectious disease, the germs of that disease may be in the wastes from his body; they may be in the matter that he coughs up; they may be in scales that come from his skin. If the germs from his body find their way into another person's body, that person also will have the disease.

3. *Disease germs cannot harm us unless they get into our bodies.* You will never have any infectious disease if you do not let the germs of that disease get into your body.

4. *Infectious diseases can be prevented.* If all the germs that come from the bodies of the sick were destroyed, soon nobody would have an infectious disease. There would be no germs to get into people's bodies, and infectious diseases would be stamped out.

What sanitation is. The word *sanitation* comes from a Latin word that means *health*. It is the study of how to keep healthy by avoiding disease germs. We may call sanitation the battle against disease germs. In this book we shall study sanitation; we shall learn how to fight disease germs; and we shall learn how to keep ourselves and other people free from infectious diseases.

The first great rule of sanitation. From this chapter you will understand that the first thing to do in the fight against disease germs is this: *Destroy all germs that come from the bodies of the sick.* If a man has cholera, smallpox, or leprosy, do not let the germs that come from him be scattered about where they will cause the disease in other persons. It is easy to destroy a handful of weed seeds while you are holding them in your hand; but it is very hard to destroy them after they have been scattered over a field. It is easy to destroy the germs as they come from the sick, but it is hard to destroy them after they have been scattered abroad.

QUESTIONS

Name some of the needs of the body. Name some things that injure the body. Give three causes of sickness. What are disease germs? How can we see them? How do they make us sick?

What is an infectious disease? Name five infectious diseases.

Explain how one person gets a disease from another. Name all the germ diseases that you know.

Tell four important facts about infectious diseases. What is sanitation? Give the first rule of sanitation. What should be done with the germs that come from the body of a person sick with an infectious disease?

SUGGESTIONS TO THE TEACHER

It would be well if the teacher at this time would study the last chapter of Part Two of this volume and work out the problems on pages 425 and 426. This will help in giving an understanding of the health problems of the Philippines that will be valuable in guiding the class through the study of the different chapters in this book. It would be very profitable if the teacher and class would prepare a large wall chart, similar to the drawing on page 417, but showing on it the number of deaths in the Philippine Islands as a whole instead of in Manila, from each important disease.

Dr. Fernando Calderon estimates that in the Philippines malaria causes each year 25,000 deaths, beriberi 25,000 deaths, leprosy 1000, and tuberculosis 40,000. Since the population of the Philippines is about 30 times as great as that of Manila, and generally speaking the same diseases that are found in Manila are found throughout the archipelago, an estimate of the total number of deaths may be made by multiplying the numbers shown on page 417 by 30. For example, if meningitis causes 205 deaths in Manila, the total number of deaths due to this disease in the Philippines will probably be 30×205, or 6150 deaths.

Certain diseases, like cholera or plague, may not be prevalent throughout the islands, and the teacher should modify the size of the branches as seems reasonable to him and to the class. In discussing the diagram, the teacher should always judge whether or not it correctly illustrates the relative importance of the different diseases in his own locality. For example, some regions are free from malaria, and in other regions it is the most important of all diseases. In fishing villages there may be many deaths from drowning, and in inland towns there may be almost no deaths due to this cause. Direct the attention of the class to their own hygienic problems and the best methods of solving them.

CHAPTER II

DISEASE GERMS

When a horse is far away from you, you cannot see the hairs on it. Yet the whole body of the horse is covered with hairs. Often there are germs on our hands. Yet without a microscope we cannot see the germs even when our hands are covered with them. There are millions of germs in the soft matter that comes from a boil, but we cannot see them. Flies carry hundreds of germs on their legs, but we cannot see these germs. We cannot see the thousands of germs that come from the body of a person sick with consumption or cholera. Germs are too small for us to see, so we must learn where they live, and how to guard against them without seeing them.

Fig. 3. Most small things we can see when we get near them. Germs are so small that we cannot see them, no matter how near we are to them; only a microscope can make them large enough for us to see.

Disease germs killed by drying and sunlight. Many kinds of germs can live in water, but most germs are killed by drying, and all of them are killed almost at once by bright sunlight. Fresh air helps to dry and kill germs. Therefore windows should be kept open, and air and light should be allowed to come into houses.

FIG. 4. A place where disease germs can live.

Why unclean matter is dangerous. Unclean matter often contains germs. Since it is usually warm and moist, it protects germs from light and drying, and they can remain alive in it for a long time. It is dangerous to have filth about houses and towns, for if there is filth about us, many germs also will be about us, and some of them will get into our bodies and cause sickness. Houses and yards should be kept dry and clean, so that germs can find no place to live about them.

How fast disease germs can multiply. When a germ is full-grown, it divides in the middle. Then there are two germs. When these two germs are full-grown, they divide. Then there are four germs. Soon each of the four germs divides into two germs. As long as the germs have a good place to live in, they will keep on dividing. Most germs can become full-grown and divide in an hour. You can see why it is so dangerous to get disease germs into your body. One or two germs alone might not do you any harm, but in a few hours they can increase to an army of germs. Take pencil and paper, and find out how many germs can come from one germ in twenty-four hours, if the germs divide once an hour.

FIG. 5. A diagram showing how a germ multiplies by pinching in two.

How disease germs get into the body. Some germs get into the body through cuts or wounds in the skin. Mosquitoes and fleas sometimes leave germs in our bodies when they bite us. Other germs are breathed in through the nose. But most often germs get into the body through the mouth. Sometimes we swallow them in food, sometimes in water; they may get into our mouths from dirty hands, from drinking cups, or from anything that touches our mouths.

The second great rule in sanitation. Our first rule in sanitation tells us to kill the germs that come from sick people, so that other people will not get the diseases. But people do not kill all the germs from the sick. Some germs are sure to be scattered about, and we must try to keep these germs from getting into our bodies. The second great rule of sanitation is this: *Do not let disease germs get into the body.* To follow this

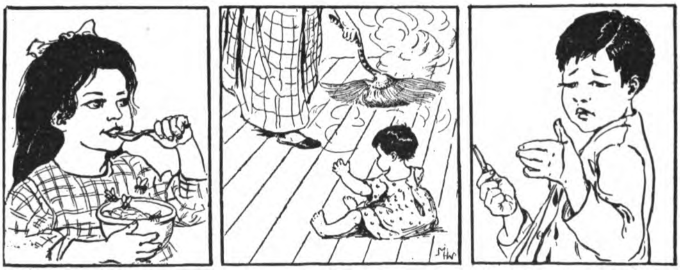


FIG. 6. Germs can enter the body through the mouth, through the nose, or through a break in the skin.

rule we must take care of wounds; we must not let mosquitoes and fleas bite us; we must guard the nose; and we must guard the mouth. If we follow this rule and do not let disease germs get into our bodies, we shall not suffer from infectious diseases.

What happens when germs get into the body. When germs get into the body, they try to grow in it and to use the body for food. The body then tries to kill the germs. If it is strong, and if only a few germs get into it, the body can kill the germs. Then we do not become sick. But if the body is weak, or if too many germs get into it, it cannot kill them. Then the germs will grow and multiply until the body is very sick, or perhaps dies. The germs cause the body to become sick by making a poison in it.

How germs are killed by the blood. It is by means of the blood that the body kills the germs.

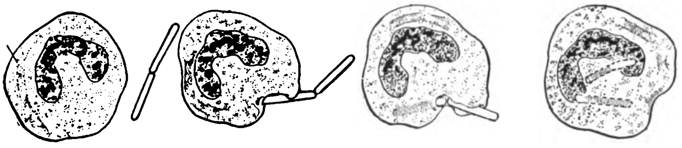


FIG. 7. A white corpuscle taking in and destroying a disease germ.

When we look at a drop of blood through a microscope, we see in it thousands of little bodies that are called *blood corpuscles*. Some of the corpuscles are white in color. These white corpuscles swallow disease germs and destroy them. They are the soldiers of the body, and their work is to kill the germs that get into the body. This is the first way in which the body fights germs.

The second way in which the body fights germs is by a *germ-killing* substance in the blood. This substance poisons and kills germs. When germs get into the body, more of this substance appears in the blood to kill them. After some diseases, as for example smallpox or measles (sarampión), a great deal of the germ-killing substance may remain in the blood for years or even through life. Then when any of the germs of that disease get into the body, the germ-killing substance at once kills them. Most people therefore have these diseases only once.

How we can help the body to fight germs. We ought to take great care to keep disease germs out of the body. But even if we are careful, some germs are certain to get into our bodies when we do not know it. Then if the body is well and the blood is rich and strong, we can fight the germs. But if the body is sick and the blood is weak, we cannot kill the germs.

We ought to give our bodies good food. We ought to give them exercise and sleep. We ought to care for them in every way, and keep them well and strong. The blood works hard to kill our germ enemies, and we ought to help it all we can. Here is the third great rule of sanitation: *Keep the body in health, so that it will always be ready to kill the disease germs that get into it.*

QUESTIONS

Name some different kinds of matter in which germs are found. Why do we not see germs? Where do germs grow best?

Name two things that kill germs. What will help to kill the germs in a house?

Why is it dangerous to have unclean matter about a house?

How do germs multiply? If germs divide once an hour, how many will come from one germ in twenty-four hours?

Name four ways by which germs get into the body. Give the second rule of sanitation. What must we do to follow this rule?

What do germs try to do when they get into the body? What does the body try to do to the germs? How do the germs make the body sick? What is it in the body that kills the germs?

Give the third rule of sanitation. What helps to keep the body in health?

SUGGESTIONS TO THE TEACHER

The teacher should make sure that the class clearly understands that we must fight germ diseases either by keeping the germs out of our bodies or by strengthening the body until it can resist the germs. In diseases that run a quick course, like cholera, plague, typhoid fever, and diphtheria, the germs multiply so rapidly that even the strongest person cannot resist them. In diseases that run a long course, on the other hand, like bronchitis and tuberculosis, the body has plenty of time to build up its defenses, and a great part of the fight against these diseases must be made by proper care of the body. As each disease is studied, the methods of preventing it should always be kept before the class.

The teachers of the Philippines should steadily work toward the time when there will be a trained health officer in each municipality, and from the beginning of the course they should impress on their pupils that it is only through the work of health officers that epidemic diseases can be controlled. To prevent certain of the slower germ diseases, skilled physicians are needed, and good food and proper care of the body are most important.

CHAPTER III

THE SKIN AND THE PUS-FORMING GERMS

We shall first study the germs that get into the body through the skin, and the diseases that they cause.

The two layers of the skin. Look at Figure 8. This shows how a small piece of skin looks under the microscope. You can see that the skin has two layers. The outer layer is called the *epidermis.* It is tough and hard, and you can stick a pin into it without causing it to bleed and without causing pain. The inner layer of the skin is the *dermis.*

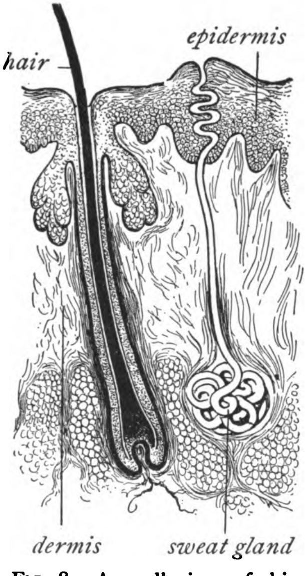


FIG. 8. A small piece of skin, very much magnified.

The hair follicles and the sweat glands. In Figure 8 you can see that the hairs grow in deep little pockets in the skin. These pockets are called the *hair follicles.* Look also at the *sweat glands.* These are little hollow tubes through which the sweat flows out to the surface of the skin.

How germs get into the body through the skin. One great use of the skin is to form a coat over the body. This coat protects the body from germs. But when the skin is cut or broken, germs can get into the body through the wound. Sometimes germs get through the skin when it is not wounded. They get into the hair follicles or the sweat glands, which are the weak places in the skin.

The pus-forming germs. Most of the germs that get into the body through the skin are *pus-forming* germs. There are different kinds of pus-forming germs, but all of them cause inflammation (redness and swelling) and all of them form pus.[1] These germs are always in the dirt about places where men and animals live. Some of the less dangerous kinds are always on the skin. Pus from boils, wounds, and sores contains millions of strong and dangerous germs.

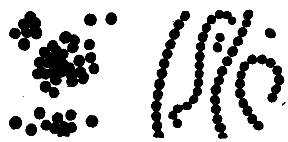


FIG. 9. The two most common pus-forming germs, as seen through a powerful microscope.

Diseases caused by the pus-forming germs. When a few pus-forming germs work down into the skin and begin to grow, they form a *pimple*. When they make a larger and deeper growth, they form

[1] Pus is the thick, yellowish matter that comes from a boil or a sore.

a *boil.* A growth larger than a boil, with several openings through the skin, is called a *carbuncle.* A very wide-spreading growth is called *erysipelas.* When pus-forming germs get into a wound, they may cause only a little pus to form, but sometimes they cause the most terrible inflammation. Sometimes they cause old sores, or *ulcers*, that will not heal. Sometimes they spread through all the body and cause the person to die of *blood poisoning.* Some kinds of pus-forming germs are very dangerous, and other kinds do only a little harm. But it is bad to have any of them get into a cut or a wound.

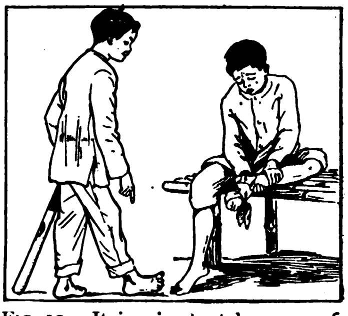


FIG. 10. It is wise to take care of even a small cut.

The care of clean wounds. All wounds should be cared for, so that germs will not get into them. When the wound has been made with something clean, and the blood flows freely, you need not put anything on the cut. Even if a few germs get into the cut, the blood will probably either wash them out or kill them. Tie a thin, clean cloth about the cut. *Be sure that the cloth is clean.* If you cannot get a cloth that you know is clean, cover the wound with a piece of clean paper, taken from the inside of a school tablet, and tie a cloth over the paper. Do not take off this cloth until the cut has healed. Then you will be sure that no germs can get into the cut. Put another piece of cloth around the thin cloth. This second cloth can be changed when it is soiled. It is best to tie up even a small cut on the hands or feet, because wounds on the hands and feet are likely to get dust and dirt into them. If this is done promptly, it will often prevent a painful sore.

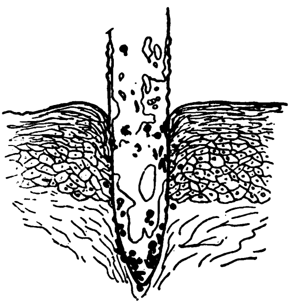


FIG. 11. When a nail or a splinter is driven through the skin, it may carry germs down and leave them in the wound.

The care of wounds that have dirt in them. Sometimes a wound is made with something not clean, or pieces of dirt and earth get into it. Then the wound must be washed clean before it is bandaged (tied up). Only clean water should be used to wash a wound. Warm, salt water is good for this purpose. It is best to use boiled water for washing a wound, because the germs in boiled water are all killed when the water is heated. Where there is much dirt in a wound, a soft, clean cloth and clean soap are great helps in cleansing it. After the wound is cleansed it is good to bathe it with a mild disinfectant[1] before tying a cloth around it.

Caring for wounds that have pus in them. When there is pus in a wound, we know that germs are growing in it. Then the bandage must be taken off, and the wound must be cleansed. The pus in the wound must not be allowed to get into any part of the wound that has no germs in it, and it should not be allowed to spread about on the skin, for there are millions of germs in it. Wash the wound with hot salt water, or with either boracic acid or weak carbolic acid solution. After the wound has been cleansed, it must be bandaged again, and the bandages must be kept moist with boracic acid or weak carbolic acid solution. A salve or ointment that contains boracic acid or a little carbolic acid is useful in treating small wounds and sores.

FIG. 12. Disease germs may be clinging to dust that gets into a wound; therefore all dirt should be washed out of wounds.

Treating boils and abscesses. Cloths that have been dipped in hot water, or a hot poultice, will help to lessen the pain from a boil. They will

[1] A disinfectant is something that kills germs. Boracic acid and a 5 per cent alcoholic solution of iodin are good disinfectants for use on wounds.

cause the boil to "come to a head" more quickly, so that it can be opened. A poultice must not be kept on long enough to make the skin around the boil soft. If this is done, the germs will get into the soft skin and will start new boils. When a boil or an abscess is soft and full of pus, it should be opened and cleansed. If this is not done, the inflammation may spread to other parts of the body.

Taking care not to spread pus-forming germs. The germs in pus are often of a strong and dangerous kind, and we must take great care to keep them from being scattered. Do not let flies walk over a boil, a sore, or a wound that has pus in it, for a fly can carry thousands of germs on its legs. Burn bandages from a sore or an abscess, for they are covered with germs. Pus should be caught on paper or cloth, and should be burned at once. A knife that has been used to open a boil should be put into boiling water to kill the germs on it. A person who dresses a wound or a sore must wash his hands carefully, with soap and hot water, as soon as he has finished. If he can get a disinfectant, he should hold his hands in it for a few minutes, for he may get a boil on

FIG. 13. How a fly would look if we could see the germs it carries on its feet.

his own body if the germs that are in the pus get on his skin. Sometimes a person who has a boil causes other boils on his own body. He gets

FIGS. 14, 15, and 16. What a person should do after dressing a sore or a wound: (1) burn the old bandages; (2) wash his hands carefully; (3) boil the knife used on the sore or for cutting the bandages.

germs under his finger nails; then he scratches them into his skin, and the germs cause other boils.

Sore eyes. Sometimes sore eyes are caused by pus-forming germs. These diseases of the eyes are very catching. The germs are on things used by people who have sore eyes, especially on such things as towels. Flies can carry the germs from one person to another. Keep your hands away from your eyes, for you may get the germs on your hands; do not use books or pencils that belong to a child whose eyes are red and sore.

Boracic acid dissolved in water makes a good wash for the eyes. Drop it into the eyes once or twice a day when they are sore, and it will help to kill the germs in them. You need not be afraid that the boracic acid solution is too strong if all the acid is dissolved.

Protecting mothers from pus-forming germs. When a little baby is born, the hands of the doctor and of everybody who comes about the mother should be free from germs. The sheets that are spread over the bed must be clean sheets that have been washed in boiling water and have been dried without touching the ground. Only boiled water should be used, and everything possible should be done to protect the mother from pus-forming germs, for many mothers die of the inflammation that is caused by these germs.

QUESTIONS

Name the two layers of the skin. Describe the outer layer. What is a hair follicle? What is a sweat gland?

What is one great use of the skin? How do germs get through the skin? Which germs most often do this? Where are these germs found? Name some of the diseases caused by the pus-forming germs. Describe these diseases.

How should you care for a clean wound? For a wound that has dirt in it? What kind of water is best for cleansing a wound? Why? Tell how to care for a wound that has pus in it. For a boil. Of what use are hot cloths or poultices on a boil?

What should be done to keep pus-forming germs from spreading? What should a person do after cleansing a wound or a boil? Explain how a person who has a boil may cause new boils in other parts of his body.

CHAPTER IV

TETANUS

THERE is another germ besides the pus-forming germs that sometimes grows in wounds. This is the germ that causes tetanus. Tetanus is a very severe disease, and most people who have it die of it. The germ is very hard to kill.

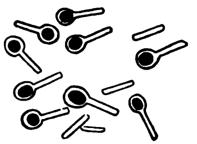


FIG. 17. Germs of tetanus, highly magnified.

Where the tetanus germ is found. The tetanus germ lives in the soil. Grass-eating animals, such as the horse and the cow, often swallow it. It does not make the animal sick when it is swallowed, but it grows and multiplies in the intestine, and tetanus germs are often found in the wastes from animals' bodies. Therefore there are often many tetanus germs in the earth about places where animals are kept.

How the tetanus germ enters the body. The tetanus germ enters the body through any break in the skin. It may enter through a very small cut as well as through a large wound. Wounds made by an unclean knife, or by a nail lying in the dirt, or by a dirty piece of wood, are especially dangerous, for tetanus germs are often on such things. Usually the germ does not grow in an open wound, but only in deep wounds where it is buried from the air. The most dangerous wounds are small, deep ones, like those made by a dirty nail or splinter. Such wounds do not bleed much, and the germs are not washed out by the blood.

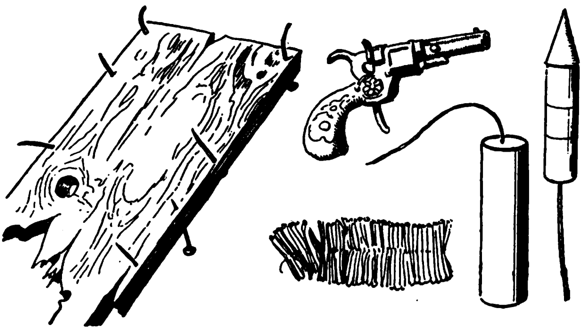


FIG. 18. The narrow, deep wounds made by such things as these often are infected with tetanus germs.

A wound of this kind closes over soon, and the germs are left buried deep in the wound. Away from the air the germs begin to grow and to divide into young germs. They begin to make a poison which is very strong. Soon the body is poisoned, and the person who is attacked cannot move his jaw. Can you tell why tetanus is sometimes called *lockjaw?* After a while all the muscles in the body become stiff, and the person cannot control any of them. The poison of the tetanus germs is so strong that a very few germs in a little wound can make enough of it to poison the whole body.

How to guard against tetanus germs. Any wound that has dirt in it must be cleansed as well as possible (page 17) and must be treated with a disinfectant. A deep wound that has dirt in it must be cleansed very carefully. This cleansing protects against both tetanus germs and pus-forming germs. When a person has a wound on the foot, he should keep it carefully tied up, and if possible should wear a shoe until the wound has healed. Tetanus germs live in the earth and there is great danger that they will get into wounds on the feet.

Why babies sometimes die of tetanus. Have you ever heard that many babies die when they are eight days old? You will hear people say that the babies die of "eighth day sickness." People give that name to the disease, but they do not know what the disease is, or what causes it. The disease is tetanus, and it is caused by tetanus germs that get into the baby's body. There is a cord on a baby's body that must be cut off when the baby is born. When this cord is cut, tetanus germs may get into it. A salve is put on the cut to help it to heal, and a piece of cloth is put over the salve. Sometimes the person who is taking care of the baby puts on salve that is not clean, or uses a cloth that is not clean. Then tetanus germs get into the cut. In eight days the germs make so much poison in the baby's body that the baby is sick, and soon dies. It is wrong to cut the cord with anything that is not clean, or to put on a baby's body a cloth that is not perfectly clean. Salve that has dirt or ashes in it is very dangerous, but a salve that has boracic acid or carbolic acid in it will help to keep the germs from growing in the cut end of the cord. It is sad to think of the many, many babies who die because people do not know how to guard them from tetanus germs.

QUESTIONS

Where is the home of the tetanus germ? Why are many tetanus germs often found about places where animals are kept?

What kinds of wounds are most dangerous? Why? Why is tetanus sometimes called lockjaw? Why are wounds on the feet especially dangerous?

SUGGESTIONS TO THE TEACHER

Additional directions for caring for wounds are given on pages 407–409, and it would be well for the teacher and class to dress and bandage some of the infected sores or wounds on the hands or feet of the smaller children. A remedy called *tetanus antitoxin*, which is prepared from the blood of the horse, is of great value in curing tetanus. It will also prevent tetanus, and in many countries, when a person has received a wound that is likely to cause tetanus, he goes to a physician and is given a dose of antitoxin. In localities where this remedy may be obtained, the teacher should explain its use to the pupils.

CHAPTER V

DISEASES THAT ARE SPREAD BY MOSQUITOES

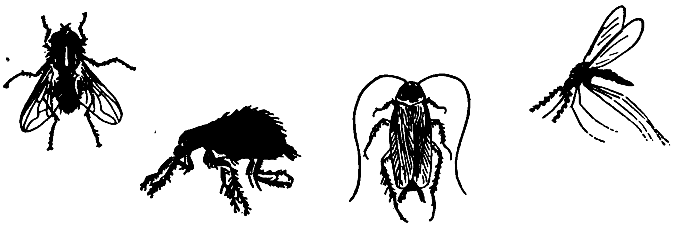


FIG. 19. Some of our insect enemies. The mosquito and the flea leave disease germs in the wounds that they make; the fly and the cockroach leave disease germs on food and dishes that they walk over.

WE have already learned that the germs of some diseases get into our bodies from the bites of insects. When an insect bites a person, it makes a little wound. If there are germs in the insect's body, they pass from its body into this little wound, grow there, and cause the disease in the person. Not all insects carry disease germs. The insects that do us the most harm in this way are mosquitoes and fleas. Mosquitoes carry malarial fever, dengue fever, and yellow fever. Fleas help to spread plague. Lice also carry disease, and many persons believe that bedbugs spread certain germs. All these insects are very troublesome as well as dangerous, and every family should do its best to keep them from getting into the house.

Malarial Fever

The germ of malaria. Malaria is caused by a germ that lives in the blood. When a malaria germ gets into the blood, it grows larger and larger. At last it separates into a number of young germs. Each young germ grows, and divides into many germs. They keep on growing and dividing. When the old germs separate into young germs, a great deal of poison is set free in the blood. This poison causes the chills and fever that always go with malaria.

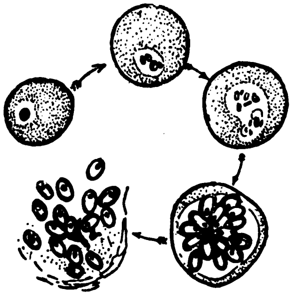


Fig. 20. Showing how a malaria germ will separate in the blood into many germs.

How malaria germs are spread. You cannot get malaria directly from a person who has it. You may live in the same room with a malaria patient and not have the disease. *You get malaria germs into your body only when a mosquito carries them to you from some one sick with malaria.*

The mosquito that carries malaria germs. Do not think that all mosquitoes carry malaria germs. There are only two kinds of mosquitoes that can do this, and only one of these kinds is common.

This mosquito is called the *Anopheles* mosquito. Look at Figure 21, and you will see that the Anopheles mosquito is a little different from the common mosquito. The Anopheles is not

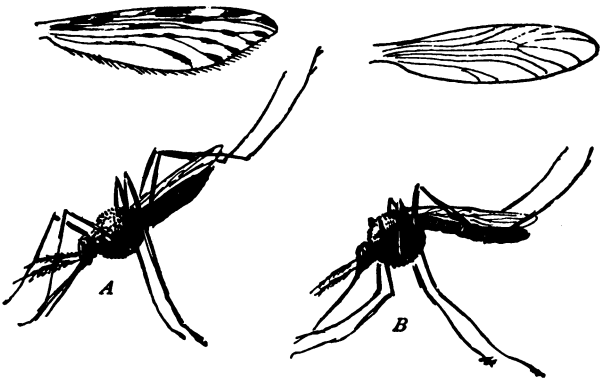


FIG. 21. *A* is the Anopheles mosquito (the mosquito that carries malaria), showing its position while resting, and the spots on its wings. *B* shows the common mosquito (Culex).

found everywhere. In places where there are no Anopheles mosquitoes people do not have malaria.

How the Anopheles mosquito carries malaria germs. When a mosquito bites a person, it sticks its long bill through the skin and sucks the blood. If malaria germs are in the blood, they go with the blood into the mosquito's stomach. The germs grow in the mosquito's body and divide into many little germs. Some of them find their way into the mosquito's saliva, and when the mosquito bites another person, the germs get into that person's blood from the mosquito's saliva. About a week after the

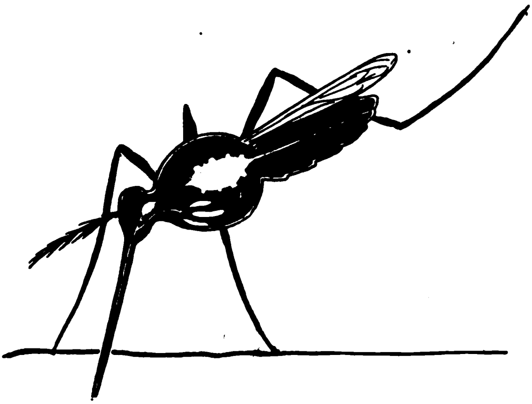


FIG. 22. Diagram of a mosquito's body. The malaria germs pass from the stomach to the salivary glands. Then they go through the mosquito's bill into the persons whom the mosquito bites.

person is bitten he has a chill. Then he knows that he has malaria.

How to fight malaria. The malaria germ is one of the few disease germs that can be killed by medicine. When we get cholera germs into our bodies, or tuberculosis germs, the doctors can sometimes give us medicines to make our bodies stronger, and in this way help the body to kill the germs. But the medicine cannot kill the germs themselves. Only the blood can do that. For malaria there is a medicine that will kill the germs. This is quinine. If malaria germs are in your body, you can take quinine to help the blood in the work of killing them. Quinine is made from the bark of a tree that grows in South America. A medicine like quinine can be made from the bark of the dita tree, which grows in the Philippine Islands.

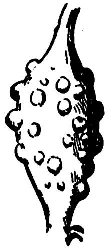


FIG. 23. The stomach of a mosquito that is infected with malaria. The malaria germs grow in the sacs on the mosquito's stomach.

For many years the people of Albay and Ambos Camarines have had a great deal of malaria. Many people get the disease after every rainy season. That is the time when there are many Anopheles mosquitoes flying around in those provinces. In the rainy season of 1905, the health officers gave quinine to everybody who would take it. Many of the people took small doses of quinine, and when the mosquitoes left malaria germs in the blood of those people, the quinine was there in the blood to kill the germs. Very few of the people who took the quinine had malaria that year. If you live in a place where people have malaria, and if you cannot protect yourself from mosquitoes, you had better take a little quinine during the season when many mosquitoes are flying about.

Preventing malaria by the use of mosquito nets. The great danger from Anopheles mosquitoes comes at night, for night is the time when they fly about. Remember that you cannot get mala-

FIG. 24. Sleeping without a mosquito net: unrestful sleep and the danger of getting malaria.

ria unless an Anopheles mosquito bites you. It is very foolish, then, to sleep without a mosquito net.[1]

Keeping mosquitoes from biting persons who have malaria. A mosquito cannot give a person malaria until it bites some one who has the germs in his blood. A malaria patient should therefore sleep under a mosquito net, and should take quinine to kill the germs in his blood. This is very important, for where one person in a house has malaria, all the mosquitoes in the house get the

[1] Dr. L. O. Howard of the United States Department of Agriculture recommends this mixture to keep mosquitoes away: 1 part of cedar oil, 2 parts of oil of citronella, 2 parts of spirits of camphor. Pour a few drops on a handkerchief laid on the pillow, or on some part of the pillow that the skin will not touch.

germs into their bodies, and soon other persons in the house have malaria. In houses where no one has malaria, the mosquitoes are usually free from the germs, and cannot give any one the dis-

FIG. 25. Sleeping with a mosquito net: restful sleep and protection from malaria.

ease. If any one in your family, or any of your near neighbors, has malaria, try to persuade him to sleep under a mosquito net, and to take quinine. Then mosquitoes will not get the germs of malaria from him and will not carry the disease to other persons in the neighborhood.

The best way to prevent malaria. Quinine and mosquito nets will help to keep malaria from spreading. But the best and surest way to prevent the disease is to kill the mosquitoes. In the next chapter we shall learn how to get rid of mosquitoes.

Dengue Fever

Dengue is not so severe a disease as malaria and does not cause many deaths; but it is a very common disease in the Philippine Islands. People have it again and again, and often it leaves them very weak, or crippled with rheumatism. Until the present time the disease could not be prevented, because nobody knew the cause of it. The doctors knew that it must be an infectious disease, because many people in a town have it at the same time. But they did not know how the germ was passed from one person to another. Now they are almost certain that mosquitoes carry the germ. The mosquito that carries dengue is not the Anopheles. It is the common mosquito. By sleeping under a net and by destroying mosquitoes, you can protect yourself against both dengue and malaria.

Yellow Fever

Yellow fever is a very severe disease. It has never been known in the Philippine Islands; but in Mexico, in Cuba, and in the southern part of the United States, there have been dreadful epidemics of yellow fever. People in Cuba are more afraid of yellow fever than of smallpox.

How yellow fever has been driven out of Cuba. Until the year 1898 nobody knew how people got yellow fever. In that year some doctors of the United States Army found out that the yellow fever germ is carried by a mosquito. The mosquito that carries yellow fever is called *Stegomyia*. The health officers in Cuba began to fight mosquitoes, and now there is very little yellow fever in the country.

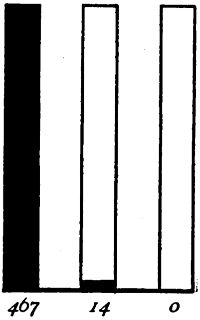


FIG. 26. Showing how the number of deaths from yellow fever in Havana was lessened by the fight against mosquitoes. From 1890 to 1900, there were 467 deaths from yellow fever each year; in 1901, when the fight began, 14 deaths; the next year, 1902, no deaths.

What we can learn from Cuba. What happened in Cuba shows us that a disease carried by mosquitoes can be stamped out. It encourages us to try to drive out malaria and dengue from the Philippine Islands, just as yellow fever has been driven out of Cuba.

QUESTIONS

What diseases are carried by mosquitoes? What disease is spread by the flea?

Where does the malaria germ live? What causes the chills and fever in malaria? How do malaria germs get into the body? What is the name of the mosquito that carries malaria? How does it differ from other mosquitoes?

How do malaria germs get into the body of the mosquito?

How does the mosquito put these germs into a person's body?

What medicine will kill the germ of malaria? Explain how taking small doses of quinine will protect a person from malaria. Where in the Philippines has this been tried?

In what other way can a person protect himself from malaria? When a person has malaria, what must he do to protect other people? What is the best way to prevent malaria?

Why is dengue a serious disease? How is it spread? How can it be prevented?

Where has yellow fever been a much-dreaded disease? How is it spread? What has been done in Cuba to stamp it out?

What can we learn from Cuba about preventing diseases that are carried by mosquitoes?

SUGGESTIONS TO THE TEACHER

There are several kinds of Anopheles mosquitoes in the Philippines. Investigations made by the Bureau of Science indicate that only two of them carry malaria. Both kinds breed in streams and in ditches where there is running water, and they do not breed in salt water or in rice fields. The larvæ (page 37) live especially among grass and other vegetation along the edges of the streams and ditches, and their number can be greatly lessened by clearing away all vegetation along the banks. Many "ditch towns" (towns that have water flowing through ditches in the streets) have been found to be badly infected with malaria, and in other towns located near natural breeding places the people suffer greatly from this disease.

Since finding that only stream-breeding mosquitoes carry malaria, the Bureau of Science is very hopeful about the malaria problem in the Philippines; for by looking after one small breeding place, some towns that now suffer from malaria can be entirely freed from malaria-carrying mosquitoes.

CHAPTER VI

HOW TO DESTROY MOSQUITOES

SINCE mosquitoes carry the germs of some diseases, the best way to stamp out those diseases is to destroy the mosquitoes. Have you ever tried to kill a mosquito that was singing around your head? If you have, you can understand how hard it would be to kill all the full-grown mosquitoes. We must learn where mosquitoes lay their eggs, and where the young ones grow. We must destroy them before they can fly.

Where mosquitoes lay their eggs. Mosquitoes lay their eggs on the surface of water. Pools and puddles of standing water are the places that mosquitoes like best. But they will lay their eggs in anything that has water standing in it. An old broken can or dish that holds rain water is a good place for mosquito eggs. In one old can 266 young mosquitoes were found. Water often stands in the hollow at the top of bamboo poles, and mosquitoes breed there. Wells that are left uncovered, and ditches that are not drained, are good places for young mosquitoes.

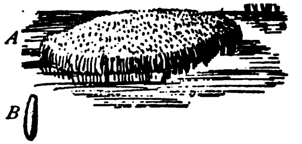


FIG. 27. *A* is a raft of mosquito eggs; *B* is a single egg.

Young mosquitoes. A mosquito egg hatches in a day. Figure 28 shows you how the young mosquito looks when it comes out of the egg. It is called a *larva.* The larva can swim about

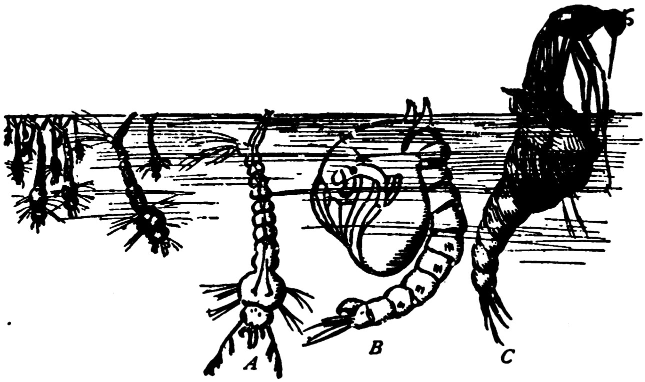


FIG. 28. *A* is a mosquito larva; *B* is a pupa; *C* is an adult mosquito coming out of an old pupa.

in the water, but it must come to the surface of the water to breathe. When it breathes, it pushes a breathing tube out of the water. In from seven to fourteen days, the larva changes to a *pupa.* In a few days more (ten to twenty days from the time the egg is laid), the pupa splits down the back, and the mosquito comes out. Figure 28 shows you a pupa changing into a full-grown mosquito.

The larva and the pupa feed on small plants and animals in the water. The full-grown mosquitoes get most of their food by sucking juices from plants, but they suck also the blood from animals.

Destroying the breeding places of mosquitoes. Mosquitoes seldom fly far. Sometimes a strong wind blows them a long distance, but usually they

FIG. 29. A good breeding place for mosquitoes. Pools left by a river in the dry season should be drained or filled in.

stay near the place where they are hatched. The Anopheles mosquito, especially, flies only a short distance. You need not go far to find the breeding places of mosquitoes that are around your house.

The first thing to do in fighting mosquitoes is to *take away their breeding places.* Drain the larger pools and puddles. Fill up the smaller ones with earth. Clean out and drain ditches where water is standing. Cover or screen all wells and rain-water tanks so that mosquitoes cannot lay their eggs on the water. Pick up all old cans or jars that may catch rain water. Fill up or take away everything in which water may

FIGS. 30, 31, and 32. Stagnant pools, ditches that are not kept cleared, and uncovered rain-water tanks are places where mosquitoes lay their eggs.

stand. Do not leave any place where mosquito eggs can hatch. If a town is not on dry ground, or if the rice fields are very near, it is hard to keep the town free from mosquitoes.

FIG. 33. Spreading kerosene on a pool to kill the young mosquitoes.

Using kerosene on pools and ditches. Sometimes a pool or a ditch cannot be drained. Then kerosene should be put on it. A very little kerosene will spread over the surface of a large pool. The kerosene makes a cover on the water, and the young mosquitoes cannot breathe. They cannot push their breathing tubes through the kerosene to get air, and without air they die. A little kerosene put on the pools along the edges of a river will keep mosquitoes from breeding there.

Difficulties in fighting mosquitoes. In the United States, many towns have driven away all mosquitoes. But this is not so easy to do in the Philip-

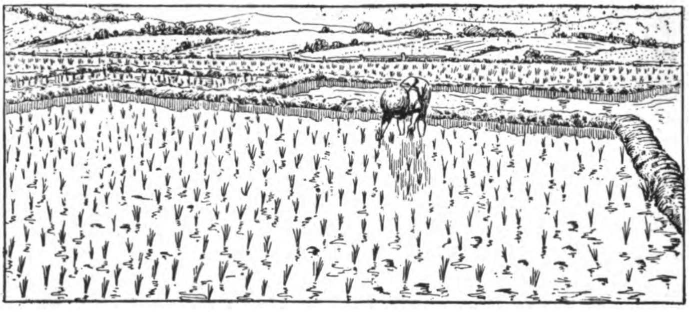


FIG. 34. It is not wise to build a house very near the rice fields, where mosquitoes are sure to breed in the standing water.

pine Islands. Here the weather is always warm, the rainy season is long, and rice fields where water must be standing are often near the towns. But even in small towns and barrios, people ought to do what they can to fight mosquitoes, for a few mosquitoes are not so bad as a great many mosquitoes. A man may not take malaria from the bite of one mosquito, when he would surely take it if many mosquitoes bit him. Everybody should sleep under a mosquito net, and if malaria is about, should take a little quinine to kill any malaria germs that may get into his blood.

Everybody who has malaria or dengue should be screened from mosquitoes, and should be given quinine to drive the germs from the blood. If the mosquitoes do not get germs from malaria and dengue patients, they cannot harm us.

QUESTIONS

Where do mosquitoes lay their eggs? How many times does the mosquito change in becoming a full-grown mosquito? How long does it take the mosquito to pass through all these changes? What do young mosquitoes eat? What do old mosquitoes feed on?

In fighting mosquitoes, what is the first thing to do? How can mosquitoes be kept from breeding in pools, puddles, and ditches? In wells and water tanks? How may young mosquitoes in water be killed? Why does this kill them?

Why is it difficult to fight mosquitoes in the Philippine Islands? Why should we do what we can to fight mosquitoes, even if we cannot get rid of them? Why should people who are well sleep under mosquito nets? Why should people who have malaria and dengue sleep under nets?

SUGGESTIONS TO THE TEACHER

Besides the germs of malaria, dengue, and yellow fever, the mosquito carries also a small worm that lives in the blood of man and causes a disease called *filariasis*. How common this disease is in the Philippines is not known, but of 2629 prisoners examined in Bilibid Prison, the worms were found in the blood of 402.

In killing the young of malaria-carrying mosquitoes, it was found best by the Bureau of Science to work petroleum into the bank of the stream or ditch, with a broom, instead of pouring it on the water. Petroleum may always be used in place of kerosene, in localities where it can be obtained.

CHAPTER VII

PLAGUE

An old name for plague was "the Black Death." For many hundreds of years the people of Europe and Asia have dreaded this disease. Great epidemics would begin in Asia; then the disease would be carried to Europe by ships. Soon the disease would spread all over Europe.

The present epidemic of plague. At the present time there is a great epidemic of plague in the world. It started in China in 1891. From other cities it spread to Hongkong. From Hongkong it was carried to many other countries. Plague is a disease that does not last long in cold countries, for the winter weather kills the germs. But in a warm country, the disease lasts all the year. The epidemic in India has been very severe. From 1896 to 1907 there were over 6,000,000 deaths from the plague in India.

Plague was brought to Manila from Hongkong in December, 1899. From that time to June, 1906, 938 persons in Manila died of the plague. It was then stamped out, but it entered Manila again in 1912, and only a very vigorous fight against it by the health officers prevented its spread.

How the germ of plague gets into the body. The germ of plague has two ways of entering the body.

Sometimes it is breathed in, and sometimes it gets into the body through wounds in the skin that are made by the bites of fleas. The second way is the more common way.

Plague carried by rats and fleas. Rats suffer from plague, and fleas bite the rats. When a rat has plague, there may be as many as a mil-

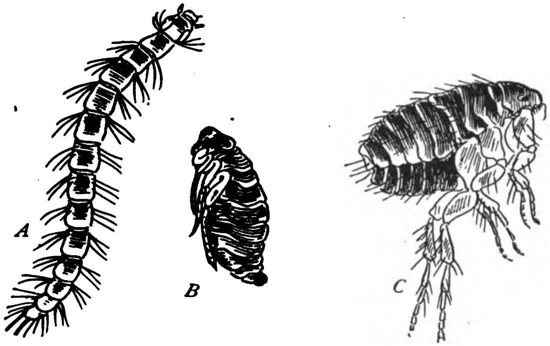


FIG. 35. The life history of the plague flea. *A* is the larva, *B* the pupa, and *C* the full-grown flea.

lion germs in one drop of its blood. A flea that bites a rat takes in germs with the blood that it sucks. Then if the flea bites a person, some of the germs get into the wound. The germs grow in number, and soon the person has the disease.

Fighting plague by preventing the spread of germs. Persons who have plague must not be allowed to spread the germs. To prevent this, health officers go on board every ship that comes from a foreign country. If any person on the ship is sick with plague, he is taken to a hospital at once. When people on land get the disease, they are kept away from other people until they are well. Everything that comes from their bodies is burned.

Fighting plague by destroying rats. When a rat dies of plague in a house, or near a house, the fleas on the rat will leave it. They will go to the people in the house, and will bite them. When there was plague in Manila, the health officers hired men to catch and kill the rats, so that they would not spread the plague. They always watch all ships, for there are many rats on ships, and it is hard to keep the rats from getting ashore. Whenever the health officers have found on a ship a person sick with plague, they have fumigated the ship.[1] Every week ships come from ports where many people are dying of plague, but the health officers have been so careful that they have been able to control this disease. The health officers in Cebu and Iloilo also carefully watch all ships for rats and for cases of plague.

The lesson taught by the fight against plague in Manila. We can learn something from what has happened since the health officers began to fight

[1] To fumigate means to fill a place with smoke or vapor that will kill rats, insects, or germs.

the plague in Manila. We see that an infectious disease can be prevented. We see that this can be done by preventing the spread of the germs. We see also that when we are trying to keep down an infectious disease, we must be careful all the time. It is not wise to wait for an epidemic before we begin to be careful. If the health officers in Manila should begin to be careless in examining ships and fighting rats, plague would soon spread to all parts of Manila. From Manila it would spread to the provinces, and soon thousands of people all through the Philippine Islands would be dying of plague, as they are dying in India and China.

QUESTIONS

What name was formerly given to plague? Where is plague most severe now? How long is it since there has been an epidemic of plague in the Philippine Islands?

How does the germ of plague get into the body? What animal suffers from plague? Explain how the germ of plague gets to man. In what two ways do health officers fight plague?

What can we learn from the war against plague in the Philippine Islands? Why must we guard against epidemic diseases all the time? What would happen in the Philippines if health officers should become careless about examining ships?

CHAPTER VIII

THE AIR PASSAGES AND THE LUNGS

In Chapter II of this book, you learned that sometimes disease germs are breathed in. Before we study the germs that usually get into the body in this way, we shall learn something about the parts of the body that are used in breathing.

The air passages. When you breathe, the air enters your nose through the two *nostrils*. It goes down into your throat through the back nostrils. Then it goes down the *trachea*, which is sometimes called the *windpipe*. The trachea divides into two branches, and the air goes through these branches to the *lungs*.

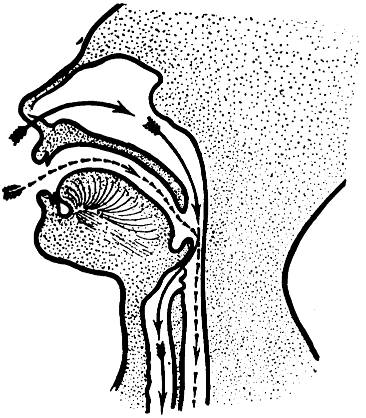


FIG. 36. The solid arrows show the path of the air to the lungs; the dotted arrows show the path of the food to the stomach.

The lungs. The large branches of the trachea divide into smaller branches. These branches divide into other branches, and the small branches keep on dividing. Look at a mango tree, and see how the big trunk divides into big branches, and how the big branches divide into

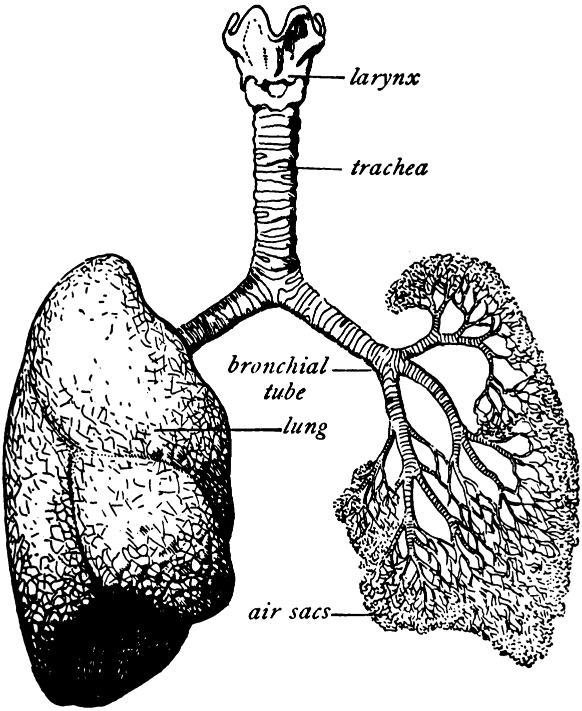


FIG. 37. The lungs. The outside of the lung on the right has been taken off to show how the bronchial tubes branch.

smaller and smaller branches. That is the way the branches of the trachea divide. All the branches of the trachea are called the *bronchial tubes*. Each little bronchial tube ends in a little *air sac.* The lungs are composed chiefly of these little sacs.

What the blood gets in the air sacs. Through the walls of the air sacs the blood runs. When you breathe air into your lungs, the blood in the air sacs gets oxygen from the air. Oxygen is something in the air that the body must have; without oxygen the body will die. The blood gets oxygen from the air in the lungs, and carries it all over the body. Why does a man die when he stays under water too long?

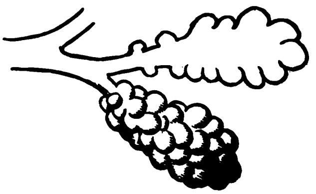


FIG. 38. Air sacs that lie at the ends of the small bronchial tubes in the lungs.

What the blood gives off in the air sacs. As the blood goes all over the body, it takes up something that the body does not need. This is called carbon dioxid. Carbon dioxid is poison, and the body must get rid of it. Therefore the blood carries it to the lungs, and while the blood is going through the air sacs of the lungs, it gives off the carbon dioxid to the air. So when you breathe out, carbon dioxid comes out of your lungs with the air. When you breathe in, the oxygen from the air gets into your blood.

Why diseases of the lungs are dangerous. When a part of the lungs is diseased, the air sacs in that part of the lungs are stopped up. Then the blood that goes to that part does not get rid of its carbon dioxid, and it does not get oxygen for the body. If a large part of the lungs is diseased, the body will die. You will understand now that it is very important to keep the lungs in health, and that diseases of the lungs are very dangerous.

Diseases of the air passages and lungs. The air passages have a warm, moist lining. This lining is a good place for germs to grow. If germs enter the mouth or the nose, they can go down into the trachea and the lungs. Some of the diseases that germs cause when they grow in the air passages and lungs are *colds*, *catarrh*, *influenza*, *pneumonia*, *whooping cough*, and *consumption*. The worst disease of them all is consumption, which is very common among Filipinos.

QUESTIONS

Draw the air passages and lungs and name the parts. Explain how the trachea divides in the lungs. What are the branches of the trachea called? How do the small branches end?

What does the blood gain in the air sacs of the lungs? What does it lose? Why does a man die when a large part of his lungs is diseased?

Name some of the diseases of the air passages and lungs. Which is the worst of these diseases?

CHAPTER IX

TUBERCULOSIS

Tuberculosis a great enemy of man. Tuberculosis has always been one of the worst enemies of man. In the Philippine Islands, more people die of it than die of any other disease. One sixth of all the deaths in the Philippines are caused by tuberculosis. This disease alone kills more people than cholera and smallpox together. In the United States, about 150,000 die of it every year. In Europe, also, tuberculosis is the most deadly of the infectious diseases. All over the world, great numbers of men, women, and children are dying of this disease every day.

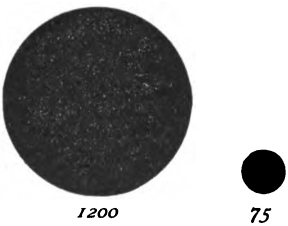


FIG. 39. The large circle represents the number of people in Manila who died of tuberculosis in 1906–1907, and the small circle the number of persons who died of smallpox.

The cost of tuberculosis. Tuberculosis costs more in money than any other disease. This is because most of the people who have it are between fifteen and forty-five years old, the age which is the best working time of life. People get the disease who might be supporting themselves, and working for their parents and families. They are sick for a long, long time, and sometimes their relatives must take care of them for months or even years. This one disease costs the people of the United States at least $1,000,000,000 a year.

The germ of tuberculosis. The germ of tuberculosis grows very slowly. A long time before a person knows that he has the disease, the germs are growing in his body. The tuberculosis germ is very hardy. After it has begun its growth in the body, it is not easy to kill it. It can grow in almost any part of the body, but it grows best in the lungs. Tuberculosis of the lungs is called *consumption.*

FIG. 40. Tuberculosis germs, very much magnified.

Where tuberculosis germs are found. The germ of tuberculosis does not grow in the ground as the tetanus germ does. It grows only in the bodies of men and animals. It can live for a long time, however, in a damp, dark place. It is found in dirt and dust about places where animals are kept and about houses where consumptives[1] have lived. In a dark house tuberculosis germs can remain alive for several months or even for one or two years.

How tuberculosis germs are scattered in sputum. There are millions of germs in the sputum of a consumptive. When a consumptive spits on the

[1] A consumptive is a person who has consumption.

street or on the floor, he sets free an army of germs. These germs may then get on the hands, the feet, or the clothing of other persons, and in food, in water, or from the hands they may

FIG. 41. Streets should be sprinkled and grass planted about houses; for people who breathe dust are likely to get tuberculosis.

be taken into the mouths of these persons. When they are swallowed, they are carried by the blood to the lungs, where they may grow and cause the disease.

Insects help to scatter the germs of tuberculosis. A fly that feeds on the sputum of a consumptive carries germs from the sputum on its feet. If it walks over food or dishes, or over the face and hands of a person, it leaves the germs where they may easily get into the mouth.

Destroying sputum. The sputum of a consumptive should be destroyed. If this is not done, the germs will be scattered about, and other people will get the disease. A consumptive should spit on old pieces of cloth, or on paper, or even on a large leaf, and should burn this before the sputum dries. When the sputum dries, the germs cannot be kept from scattering. It is very bad for a consumptive to swallow the sputum, for if he does this, the germs may get to other parts of the body, and may start the disease there.

Tuberculosis germs scattered in droplets. When a person coughs or sneezes, tiny drops of saliva fly from the mouth or nose, sometimes to a distance of two or three meters. These droplets float in the air, and they can carry germs of any disease of the air passages and lungs. It is rude for anybody to cough or sneeze in another person's face. It is very wrong for a consumptive to do this, for the germs of consumption may be carried to other people in this way. Always cover your mouth with your handkerchief and turn away your face when you cough or sneeze.

Fig. 42. In droplets that are coughed out into the air the germs of influenza, colds, and other respiratory diseases are found.

Other ways in which tuberculosis germs are scattered. Since the germs of consumption are sure to get on the hands of a consumptive, they may be left on anything that he touches. Since the germs are always in his mouth, they will be found on anything that a consumptive puts into his mouth, and on the dishes that he uses. Since the germs are in the mucus of the nose, they will be found on a consumptive's handkerchiefs. The mucus dries on the handkerchief, and the germs blow about when the handkerchief is taken out of the pocket. The habit of blowing the nose with the fingers is always disgusting, but it is worse than disgusting when the person has any disease of the air passages, for it covers the hands with germs that will be left on whatever the person touches.

Why a consumptive should not touch food that other persons eat. A consumptive is likely to have germs on his hands, and may leave them on anything that he touches. But the danger is greatest with food, for the germs that are left on food are certain to find their way into another person's body. A consumptive should never cook the food for other persons, and should never eat with his fingers from the same dish with others.

What a consumptive must do to protect others. Nobody who has consumption wants to give it to other people. Certainly nobody wants to give it to his own family. But a consumptive will surely give the disease to some one else if he is not careful to avoid scattering germs. He must remember that fire, hot water, and sunlight are the best disinfectants he can use.

FIG. 43. A consumptive's bedding should be aired in the sunlight every day.

A consumptive should always use pieces of cloth or paper for sputum and mucus, and he should burn them at once. He must hold something before his face when he coughs. He ought to keep his hands away from his face and mouth as much as he can, so that germs will not get on his hands. He should have his own dishes, and these dishes should be boiled in hot water, and should not be washed with other dishes. He must wash his hands often in soap and water, and he must have a wash basin and a towel for himself. His sheets and pillow cases must be put into boiling water when they are washed, and his sleeping mat and pillow must often be put out in the sun. The strong sunlight will kill the germs that may be on these things. A consumptive should not drink from the cup that other people use. He ought never to touch the food or dishes of others, and he should not touch other persons' hands, or things that others must handle. The wastes from the body of a consumptive should be destroyed, for the germs are found in these as well as in the sputum.

A separate house best for a consumptive. It is much safer for his family to have a consumptive live in a little house by himself. At least he ought to sleep in a room by himself. A consumptive cannot live and sleep in the same room with other persons without great danger to them. A consumptive's room should be open to the sunlight as much as possible, for light and drying are the great enemies of the tuberculosis germ.

QUESTIONS

What proportion of the Filipinos die of tuberculosis? How many people die of it each year in the United States? Why is tuberculosis a very expensive disease? What does it cost the people of the United States each year?

Does the germ of tuberculosis grow rapidly or slowly? Is it easy to kill or hard to kill? In what parts of the body can it grow? What is tuberculosis of the lungs called?

Where is the tuberculosis germ most often found outside the human body? How long can it live in a house?

Why should the sputum of a consumptive be destroyed? Tell of two ways by which the germs in sputum may be scattered about. When tuberculosis germs are swallowed, how do they get to the lungs? How can sputum be destroyed?

How far may droplets of saliva be thrown in coughing or sneezing? What should a person do when he coughs or sneezes? Tell some other ways in which a consumptive may scatter germs. Why should a consumptive have nothing to do with preparing food?

What can a consumptive do to guard others from the disease? Why should a consumptive live in a house by himself? Why should a great deal of light be let into the room of a consumptive?

SUGGESTIONS TO THE TEACHER

A glance at the diagram on page 417 will show that diseases of the air passages and lungs, especially tuberculosis, are the most important of all the diseases in the Philippines. Practically all diseases of these parts are caused by germs. It has long been known that diphtheria and influenza are very infectious, and recently it has been found that almost all cases of tuberculosis and pneumonia are contracted by living with those who are suffering from these ailments. A consumptive should not live and eat with his family, and persons who do not need to be about a pneumonia patient should keep away from him.

In combating bronchitis and tuberculosis, the two most important respiratory diseases, the importance of nourishing diet and proper care of the body must always be kept in mind. Any one who has a cough should have special care until he has recovered from it.

CHAPTER X

THE TREATMENT OF CONSUMPTION

For thousands of years doctors have tried to find a medicine to cure consumption. But no medicine that will cure this disease has ever been found. No medicine has been discovered that will kill the germs of consumption as quinine kills the germs of malaria. But the doctors have discovered that consumption can be cured if the cure is begun when the disease is starting. Many consumptives in America and in Europe have been cured, and now the disease is not called incurable.

What cures consumption. The blood tries to kill consumption germs when they get into the body, just as it tries to kill other germs that get in. If the blood succeeds, the person gets well. If the blood fails, the person dies. Only the body itself can cure consumption. Only the blood can kill the germs in the body.

What helps the body to kill the germs of consumption. The tuberculosis germ is very hardy, and the blood must be strong and rich to kill it. When the body is healthy, the blood is rich. Therefore a healthy body can kill the germs of tuberculosis and can cure itself of consumption when an unhealthy body cannot do so. Anything that makes the body stronger helps it to fight the germs of tuberculosis.

The symptoms of consumption. The most common symptoms[1] of consumption are loss of appetite, loss of weight, coughing (especially coughing after going to bed and early in the morning), weakness and tiredness, night sweats, and spitting of blood. A person who has these symptoms should give himself good care. If he can go to a good doctor, he should go at once, for the doctor can tell him whether or not he has consumption.

Why treatment for consumption must begin early in the disease. When a person has had consumption for a long time, a large part of his lungs has been destroyed. Then his disease cannot be cured. But if he can give himself the right care soon after the disease begins, he may be cured.

What is most important in treating consumption. The doctors have learned that some things are very important in the cure of consumption. These are the things that will strengthen the body in its fight against the germs.

Rest. A consumptive must rest because exercise makes his fever rise. If he has much fever, he should not even walk about the room or try to talk. He should be quiet all day long. If a consumptive has no fever, he can take some

[1] Symptoms are the signs that tell us what disease the body has.

exercise, but he must not exercise so much that his fever will rise. A consumptive who tries to do hard work is making his disease worse.

Good food. A consumptive needs a great deal of good food to give him strength to fight

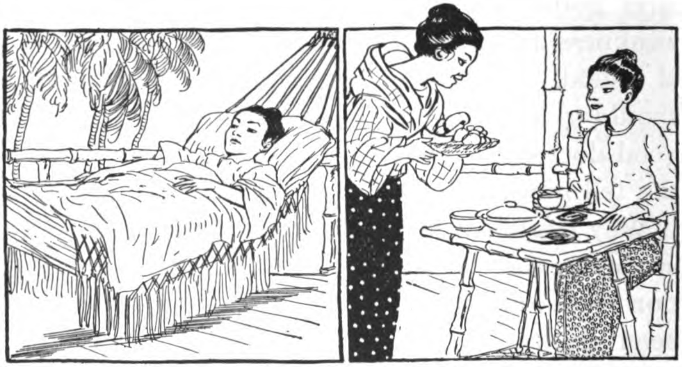


FIG. 44. A consumptive needs rest, fresh air, and good food.

his disease. Milk and eggs are the best of all foods. A consumptive needs also some meat and other good foods. He should eat early in the morning, and he ought to have a lunch between meals and one before he goes to sleep, if he can eat at these times. His food must be well cooked, so that he will like to eat it and will not become tired of it.

Fresh air. Nothing builds up the body and helps it to kill germs so much as plenty of fresh air. It is very important for a consumptive to rest and sleep in the open air. The American and European doctors who have cured consumption tell their patients to live outdoors. The patients stay outdoors even when the weather is very cold. Sometimes a veranda is built where the patient can live and yet be sheltered from the sun and rain.

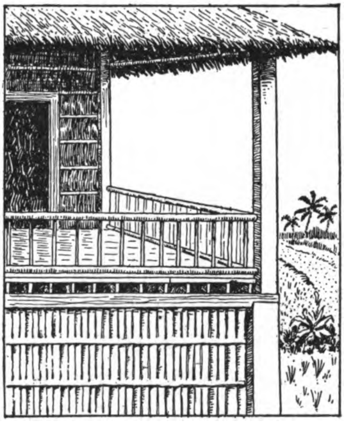


FIG. 45. A simple veranda that can be added to any house for a consumptive to sleep on.

There are few places in the Philippine Islands where a bamboo veranda with a nipa roof, or a small house with windows on all sides, cannot be built for very little money. A consumptive needs such a place to live and sleep in. No person can be cured of consumption if he is shut away from the fresh air. Whether he sleep outdoors or not, he should never cover his face while sleeping.

A consumptive must sleep under a mosquito net to get restful sleep and to keep malaria germs from getting into his blood. It is very hard for the body to fight two diseases at the same time.

Other things important for consumptives. Damp houses and houses on wet soil are places where tuberculosis germs can live for a long time. Therefore a consumptive should live in a dry house built on dry soil. The nights are sometimes chilly, and a consumptive needs a woolen blanket for cool nights. It is bad for anybody to sleep in the clothes that he has worn all day, but it is especially bad for a consumptive, for his clothes may be damp with perspiration.

A consumptive must remember this: anything that helps his body to be stronger, helps it to fight the germs. A good doctor can give him some medicines that will help him to build up his body. But no doctor can give him medicine that will kill the germs. A consumptive ought not to spend money for medicines that promise to cure consumption, for they will not help him. He had better spend his money for good food and other things that a consumptive needs.

QUESTIONS

Has any medicine been discovered that will kill the germs of consumption? Has consumption ever been cured? What is it that kills the germs of consumption in persons who are cured? How does keeping the body healthy protect us from the germs of tuberculosis?

What are the symptoms of consumption? What should a person do who has these symptoms? Why is it important to begin the treatment of consumption early in the disease? Name the four most important points in the treatment of the disease. Mention some other important points.

CHAPTER XI

OTHER DISEASES OF THE AIR PASSAGES AND LUNGS

THERE are several diseases of the air passages and lungs that are more common in cold countries than in warm countries. Some of these diseases, however, are found in the Philippine Islands, and in this chapter we shall study them.

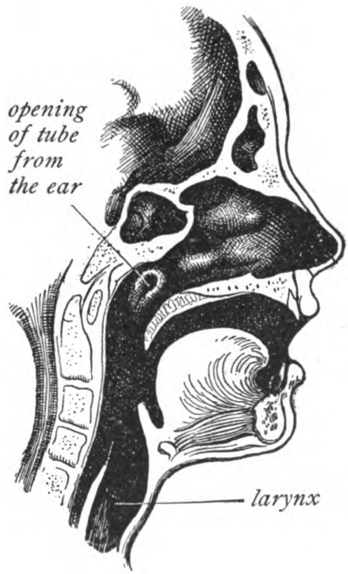


FIG. 46. The air passages of the head and throat.

Colds and catarrh. Some kinds of germs can grow in the lining of the nose and throat. When these germs grow and cause inflammation, we say that a person has a cold. When they keep on growing, and the person has a cold all the time, we say that he has catarrh. The germs are spread like the germs of consumption, in sputum and mucus.

Colds and catarrh should be avoided, for they weaken the body so that it cannot fight against other germs that may get into it.

Pneumonia, influenza, and diphtheria. In cold countries pneumonia, influenza, and diphtheria cause many deaths. In the Philippines they are not so important, but there are many cases, and it is well to try to avoid the germs. The germs are spread like the germs of consumption, colds, and catarrh. They are more dangerous than the germs that cause colds.

FIG. 47. One way in which the germs of colds may be spread.

How to avoid the germs of diseases of the air passages and lungs. When a person has any disease of the nose, throat, or lungs, the germs are always in the mucus and the sputum. All these germs are scattered in the same ways by which the germs of consumption are scattered. A person who has one of these diseases should be careful not to give the disease to others. If you wish to avoid the germs of these diseases, you must follow three rules. The first rule is: *Keep your hands clean.* Remember that you cannot do this by dipping them in water once a day. You must wash them well with soap at least twice a day, and you ought to wash them whenever you have been playing and working in the dust and dirt, and always before you eat.

Another rule to follow is this: *Never put into your mouth anything that has been in another person's mouth.* A pencil that has been in the mouth of a person who has a cold is covered with germs; if you put it into your mouth, you will get germs that may cause you to have a cold. You can get germs from the drinking cup of a person who has a cold.

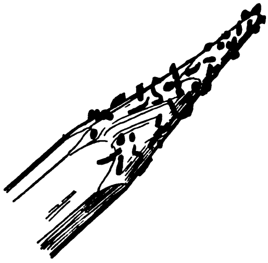


FIG. 48. If germs were as large as small insects, a pencil would look like this after it had been in the mouth of a person who has some disease of the air passages.

This is the third rule to follow: *Do not eat food that other people have handled.* This means that you must not eat from a dish into which other people put their fingers.

You can do much to avoid these and other diseases, by keeping your body strong and healthy.

QUESTIONS

Name four diseases of the air passages and lungs, besides consumption. In what parts of the world are these diseases most severe? In what part of the body do the germs of colds grow? How does catarrh differ from a cold?

How do the germs of these diseases leave the body? Give three rules to follow in trying to avoid these diseases.

CHAPTER XII

LEPROSY

LEPROSY is one of the most dreadful diseases known to man. It is more common in warm countries than in cold countries, and there has been a great deal of it in the Philippine Islands.

How the germ of leprosy gets into the body. We know that leprosy is an infectious disease, but we are not sure how the germ gets into the body. It may get in through wounds, or it may be breathed in. The germ looks like the tuberculosis germ, and some doctors who have studied the disease think that the leprosy germ and the tuberculosis germ are spread in the same ways. Other people think that the germ of leprosy, like the germ of malaria, is left in the body by a mosquito.

How the germ of leprosy grows. The germ of leprosy grows very slowly. It may be growing in the body for two or three years, or even longer, before the person knows that he has the disease. It makes a very small amount of poison, so the body is poisoned little by little, and a person who has leprosy may live for many years.

A possible cure for leprosy. Doctors have studied leprosy for many years, but until recently no cure for the disease has been known. Now a medicine has been found that helps lepers, and a number of them have apparently been cured. It is hoped that this new remedy will be useful in fighting this dreadful disease.

The importance of preventing leprosy. Our first great rule in sanitation is to destroy the germs that come from the bodies of the sick. It is hard to follow this rule with lepers, for the germs are on the skin, in the sores on the body, and in the mucus from the nose. It would be almost impossible to live in the house with a leper and not get germs on one's hands.

Our second great rule in sanitation is to keep disease germs from getting into our bodies. It is hard to do this, too, with leprosy, for we do not know how the germs get into the body, and so we do not know how to guard against them.

There is only one way to prevent the spread of leprosy, and that way is to segregate[1] the lepers. If lepers live in the same houses with other people, the disease will never die out. If all lepers live away from other people, the disease cannot spread.

The Culion leper colony. There were almost 4000 lepers in the Philippine Islands in 1905. Every year there were about 700 new cases of leprosy. There was no way of taking care of

[1] To segregate people means to make them live apart from other people.

most of them. Some of them worked a little; some were supported by their relatives; some went about begging; and a few were cared for in

FIG. 49. Part of the Culion leper colony, showing some of the houses in which the lepers live.

leper hospitals in Manila and Cebu. There was no way of stopping the spread of the disease. So in 1905 the government of the Philippine Islands bought Culion Island, with the town of Culion, for a leper colony. All the people of Culion sold their houses to the government and moved away to other islands. A hospital was built on Culion, the houses were repaired, and new houses were built. Then a government ship went about from place to place, collecting the lepers. They were taken to Culion, where they now live in their own town. There are doctors and nurses to take care of them, and they are much more comfortable than they were before. In the provinces from which the lepers were collected in 1906, there had been about 300 new cases a year. The year after the lepers were collected there were only 50 new cases. It will take some years to isolate all the lepers in the islands, for some persons who now seem to be well may have the leprosy germ in their bodies, and the disease will not show itself for some time. But there will be fewer cases each year, and by and by, we hope, there will be no lepers in the Philippine Islands.

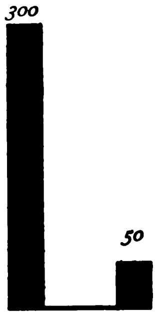


FIG. 50. The long line represents the number of new cases in some provinces before the collection of the lepers; the short line represents the number of new cases the next year.

The duty of persons who have leprosy. A person who has leprosy should not try to hide it. He should tell the health officers about it, and should consent to go to Culion. It is very hard for a person to leave his family and his friends and go away from home, when he knows that he may never return.[1] But he must remember that he is more dangerous to his family and friends than a murderer would

[1] The relatives of lepers may visit them at Culion, but they cannot live there. All visitors must leave the island at night. The families of some lepers have moved to an island near Culion, so that they can visit the colony often.

be. He would not like to have anybody, even a stranger, get leprosy from him, and the only way he can keep his disease from attacking other people is by going away from other people. If he goes to Culion, he will have good care as long as he lives, and will be happier than he would be at home, for at home he would be a burden and a danger to all about him.

QUESTIONS

How does the germ of leprosy get into the body? Can leprosy be cured? From what parts of a leper's body are the germs spread? How can the spread of leprosy be stopped?

How many lepers were there in the Philippine Islands in 1905? How many new cases had there been each year? How many new cases were there in 1906 in the provinces from which the lepers had been collected? How many persons in these provinces had been saved from leprosy? Where is the leper colony? How do the lepers live in this colony?

What should a person do when he finds that he has leprosy? Why is it his duty to do this? Explain why it is for the good of the Filipino people to have all the lepers live in one place.

CHAPTER XIII

DISEASES OF THE ALIMENTARY CANAL

WE have learned something about the disease germs that enter the body through the skin, and about those that attack the air passages and lungs. Now we shall learn something about disease germs that grow in the *alimentary canal.* These germs enter the body through the mouth, usually in food or water. Before we study them, we must know something about the parts of the body into which the food is taken.

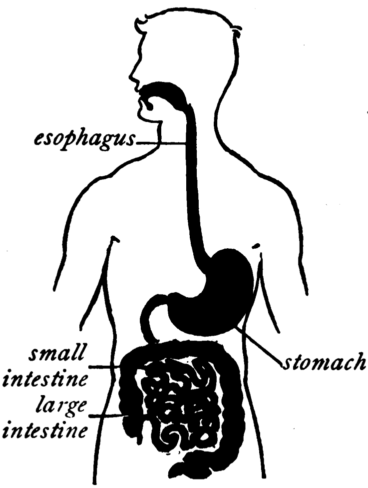


FIG. 51. The alimentary canal.

The alimentary canal. Figure 51 shows you the alimentary canal. You can see that it is like a long path through the body. It begins at the mouth, goes through the stomach and the small intestine, and goes to the end of the large intestine. When the food is eaten, it is taken into the stomach. From the stomach it goes into the intestine, and passes slowly along the intestine while the blood takes up the good parts of the food. The blood carries the good parts of the food all over the body to feed the different parts of the body. The large intestine sends out of the body the parts of the food that the blood cannot use.

It is always warm, dark, and moist inside the intestine, and food for germs is always there. Do you understand now why the intestine is a place where a few germs soon grow to millions?

Intestinal diseases. The diseases caused by germs that grow in the intestines are called intestinal diseases. Some of the important intestinal diseases are cholera, dysentery, typhoid fever, and diarrhea. These diseases are much to be feared in hot countries, where germs can multiply very rapidly in water and in food. *All intestinal diseases can be prevented, for we cannot get the diseases unless we take the germs into our mouths.*

QUESTIONS

Draw the alimentary canal and write the names of the different parts. What does the blood take up as the food passes along the intestine? Where does the blood carry it?

Why do germs multiply in the intestine? Name the important intestinal diseases. How do the germs of intestinal diseases get into the body? How can these diseases be prevented?

CHAPTER XIV

CHOLERA

The germs of all the intestinal diseases are spread in about the same ways. When a person has one of these diseases, the germs are always in the wastes from his body. From the wastes they find their way to food or water, and are swallowed by some one else. They may get on the hands and in this way may be carried to the mouth. Then the germs grow in the intestine of the person who swallowed them, and are in the wastes from that person's body. These germs may give other persons the disease. This is how an epidemic of any intestinal disease is spread — by germs in the wastes from one person's body getting into the intestines of other persons.

Why cholera is a dangerous disease. Cholera is the most severe of the intestinal diseases. Almost three fourths of the people who have the disease die of it. It is a disease that works quickly. The germ makes a very strong poison, and in forty-eight hours after the germ enters the body, the disease shows itself. In cholera, the patient either gets well or dies in a very short time. Compare cholera with leprosy, in which the germ sometimes takes two years to make poison enough for the disease to appear, and where the patient may live for years. Cholera spreads very rapidly. This shows that the germ is strong, for a large number of those who get the germs into their bodies have the disease.

The germ of cholera. The germ of cholera can live for a long time in damp soil and in water. It can swim about in water. It cannot grow in the bodies of animals. On food that is kept in a moist place it can live for several days. In some kinds of food, such as cooked rice, it can grow and divide into young germs. Sunlight and drying quickly kill it.

How the cholera germ enters the body. Cholera germs get into the body only through the mouth. They are swallowed with food and water.

How cholera germs get into the body in food. Since the germs are found in the wastes from the body of a cholera patient, they are sure to be on the hands of anybody who takes care of a cholera patient. They may be on the sheets or the clothes of the patient. They are sure to be on his hands, and they may get from his hands to anything that he has touched. Remember how fast germs increase in number, and you will understand that there must be billions and billions of germs in the body of a person who has cholera.

Germs may be carried to food on the hands of persons who have been around the patient. Flies and cockroaches may carry them to food. If the wastes from the patient's body are left uncovered in any place that flies and cockroaches can reach, the germs are sure to get on the feet of these

FIG. 52. Eating with the fingers from a common dish; one of the ways in which disease germs are spread.

insects. Then the flies and cockroaches swarm into the kitchen and walk over food. Germs are left on the food and are swallowed with it.

The danger of unclean hands. A person who does not keep his hands clean is a great danger to everybody else. This is especially true in the Philippine Islands, because in many Filipino families everybody eats from the same dish. All the food is put into one big dish, and everybody puts his hands into this dish. If one person in the family has cholera germs on his hands, the whole family is in danger of getting them from the food that he has touched. Usually the food left over is put away for another meal. If a few germs from somebody's hands are left in this food, they will divide into thousands of germs before the next meal.

FIG. 53. Food sold in the market may be infected by a person coming from a house where there is cholera.

The danger of handling foods in the market. People whose hands are not clean are a danger in the markets, for often they handle the fruits and vegetables, and even the meats, that are for sale. A hundred persons may put their hands into a pail of buyo leaves, to pick over the leaves. If any of these persons have cholera germs on their hands, the germs may get into the water and on the leaves. Then the people who buy the leaves will swallow the germs.

How cholera germs get into water. People used to think that cholera germs flew through the air and fell into water from the air. Now we know that this is not true. We know that the germs must be carried to the water from the body of a cholera patient. Water may be infected[1] in several ways.

River water becomes infected when people who have cholera germs about them bathe in the river. The river is infected when clothes are washed in it, if there are cholera germs on the clothes. Sometimes the wastes from the bodies of cholera patients are thrown into the river, or the wastes are thrown into a ditch that drains into the river. Then the river water is sure to be very much infected.

FIG. 54. The river water may become infected with cholera germs from the clothes washed in the river.

A well may be infected from the hands of the persons who take water from it. Water thrown out on the ground near the well may soak into the ground and run into the well. Water used in washing the clothes of cholera patients may run into the well.

The greatest danger comes from outhouses and

[1] To infect anything is to put disease germs into it. Infected water or infected food is water or food that has disease germs in it.

closets that are not kept clean, and from the filthy custom of throwing waste matter out on the open ground and leaving it there uncovered. When it rains, germs from this matter are sure to be carried into rivers and wells.

Germ carriers. For several years cholera broke out among the prisoners in Bilibid prison in Manila. The prison officers could not understand how the cholera got into the prison, for no sick prisoner had entered, and all the prisoners had pure food and pure water. At last the doctors examined the 263 men who cooked the food for all the prisoners. None of them were sick, but cholera germs were growing in the bodies of 17 of them. The other prisoners were getting the germs from the food that these 17 men cooked. The officers appointed other men to do the cooking, and ordered all the cooks to wash their hands carefully before they touched the food. Then there was no more cholera in the prison.

FIG. 55. A cook who has cholera germs on her hands may infect the food.

In cholera times, a few persons carry cholera germs in their bodies who are not very sick, or are not even a little sick. These persons do not know that they have the germs in their bodies. But the germs can be spread from them and can cause cholera in others. Healthy persons who are carrying germs in their bodies are called "germ carriers." Probably there are many germ carriers now in the Philippine Islands, and for some years people must take great care to keep cholera from breaking out again. You can understand that it may be unsafe to throw the wastes from the body of even a healthy person into a river, or to leave them on the ground. In a later chapter we shall study the different ways of taking care of body wastes so that they will not be a danger to every one.

FIG. 56. Drinking water taken from a river is never safe until it has been boiled.

The need of constant care to avoid cholera germs. When there is an epidemic of cholera, it must be stamped out. In the next chapter, we shall learn something about what to do in time of epidemic. You must understand, however, that there is always danger of cholera in the Philippines. There is cholera almost all the time in China, India, or Japan. Ships from these countries often come to Philippine ports. Sick people from the ships are always taken to the hospital, so the disease does not spread from them. But germ carriers may come into the country, and fruit and vegetables that have germs on them may be brought in. An epidemic can begin with one case of cholera, or can start from a few vegetables. We need not always take all the care that we must take in time of epidemic, but there are some things that we should always do. We shall save ourselves from other intestinal diseases, as well as from cholera, if we follow these rules:

1. *Drink only pure water.* This means that we must either get drinking water that we know is pure, or boil all the water that we drink. There are very few places in the Philippine Islands where we can get drinking water that we know is pure. In Chapter XXIV we shall learn more about how to get a pure water supply. In most towns in these islands, there is at present only one way to be sure that you are not drinking infected water, and that is to drink only boiled water. Cholera germs, as well as the germs of other intestinal diseases, are killed by heat. When you boil water, you kill the germs. Do not think

that you must drink the water while it is hot. Let the water cool, but do not leave the jars uncovered, and do not put the water into jars or bottles that have been rinsed in unboiled water. Do not let anybody put his hands into the water when he dips it out. Use a long-handled dipper for taking out the water.

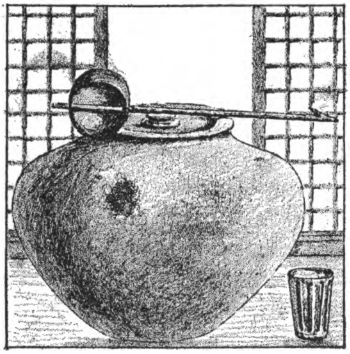


FIG. 57. A covered water jar, with a dipper for pouring the water into the drinking glass.

2. *Keep food covered.* Do not leave food of any kind where insects or dust can get into it. Do not eat food that has been handled by others.

3. *Always wash your hands before eating.* Keep your hands clean. Then germs will not get on your food from your hands, and you will not put germs on the food that other people eat. Remember that you must protect other people as well as yourself. Germs that do not make you sick may give disease to another person whose body is not able to kill the germs.

4. *Keep your house clean.* This means more than polishing the floors or dusting the furniture. It means keeping clean the ground under the

house. It means keeping the kitchen clean as well as the sala. It means keeping outhouses and closets clean. It means keeping the house clear of rats and insects. It means taking care of all waste matter so that it will not help disease germs to live and spread.

QUESTIONS

How do the germs of intestinal diseases get into our bodies? How long after cholera germs get into the body does the disease appear? Is the disease quick or slow? Is the germ strong or weak? Where can the cholera germ live? Where can it grow? What kills it?

How do cholera germs get into the body? Explain how cholera germs may get into food. Why should the hands be kept especially clean in cholera times? Why should people not be allowed to handle food in the markets? In what ways may cholera germs get into water?

What is a germ carrier? Why will it be difficult to keep cholera from breaking out in the Philippine Islands for some years to come?

In what countries is cholera almost always present? How can the disease be brought from these countries to the Philippines? Give four rules for preventing cholera. What kind of water is safe to drink? What is meant by keeping a house clean?

SUGGESTIONS TO THE TEACHER

Boiled water tastes flat, and therefore many persons dislike drinking it. The cause of this taste is that the air is driven out of the water by the boiling. The change in the water can be avoided by heating the water until it just begins to boil and then taking it from the fire. This will kill any dangerous germs, and it does not change the taste of the water.

CHAPTER XV

WHAT TO DO IN CHOLERA EPIDEMICS

The two things to be done in an epidemic of cholera. Cholera spreads from one person to another more quickly than any other disease. Therefore an epidemic of cholera is especially dangerous, and every one ought to do his best to help stamp out the disease. In a cholera epidemic, there are always two things to do: first, to take proper care of persons who get the disease; second, to prevent the disease from spreading.

Taking proper care of cholera patients. You have already learned that cholera is a severe disease and one that runs its course quickly. A cholera patient needs constant care, and he needs a good doctor. If there is a hospital near enough, the patient should be taken to it. In a hospital there are doctors and nurses who know how to treat cholera. They have the medicines that are needed, and they can give the patient constant care. In Manila, during the epidemic of 1905, many cholera patients were taken to the hospital. Of those patients, one fourth recovered. Some patients did not want to go to the hospital, and were allowed to stay in their own homes. All of them died. People in Manila used to be afraid of hospitals, but now they know better; they have learned that the best thing a cholera patient can do is to go at once to the hospital. The sooner he goes, the more likely he is to recover.

In most provincial towns and barrios there is no hospital. When cholera breaks out, the municipal government must take a house for a hospital. The district health officer must get the medicines and disinfectants that will be needed. Then cholera patients should be taken to this hospital. There are very few doctors or nurses in most Philippine towns, and if there are many cases of cholera, all the patients cannot be taken care of unless they are in a hospital.

Preventing the spread of cholera. The rules that you learned in the last chapter must be followed by everybody. Remember that food and drinking water must be guarded against infection. Remember also that *it is the duty of every citizen to report a case of cholera in his house.* If every case of cholera is reported to the health officer, the germs can be kept from spreading. But if a case is not reported, the germs will be scattered through the whole neighborhood, and many people will suffer.

What to do in a house where there is a case of cholera. All wastes from the body of the patient must be disinfected. Carbolic acid or lime may be used for disinfecting wastes. All matter that is vomited, as well as matter from the intestines, must be disinfected. If you cannot get either carbolic acid or lime, bury waste matter at once, and be sure to cover it well with earth. Be very careful not to bury it near wells or springs, for germs from it may get into a well or spring and infect the water.

Carbolic acid or lime must be put into the closet every day. Some person in the house may get germs from the sick person, and the germs will be in the wastes from his body, although he may not be sick with the disease.

Everything that is used for the patient, whether dishes or clothes, must be boiled to kill the germs. Mats and things that are not of much value should be burned. Everything in and about the house should be put in the sunlight and should be dried as much as possible, for light and drying will kill cholera germs. Every one in the house should disinfect his hands often. All drinking water must be boiled, and all food must be carefully covered. Only cooked food should be eaten. If the people in the house take great care to avoid swallowing the germs of cholera, they will escape the disease.

As soon as there is no more sickness in the house, the house should be carefully disinfected. The floors and all the woodwork or bamboo that can be reached must be scoured with washing soda. Then the health officers will spray a disinfecting solution on the floors and walls, using a small spray pump.[1]

Keeping out visitors. When there is a case of cholera in a house, nobody except a doctor or a

FIG. 58. Visitors may spread germs from the sick-room through the whole neighborhood.

nurse should be allowed to enter the house. Do not let anybody go into the patient's room except the persons who are taking care of him. Friends and neighbors can do no good by seeing him, and they may get the disease or carry the germs home to their own families. Nothing should be carried

[1] The disinfecting solutions ordinarily used in spray pumps are carbolic acid 5 per cent, or Jeyes Fluid 2 per cent.

out of the house, for in this way the germs may be spread to other houses. When cholera patients are taken to a hospital, there is not this danger of germs spreading through the neighborhood.

Isolating cholera suspects and contacts. Wherever it can be done, all cholera suspects and cholera contacts must be isolated.[1] Since the disease takes forty-eight hours to develop, such persons will seem to be well for two or three days after they have been infected. Cholera contacts must be isolated for at least two days.

Why doctors and nurses do not take cholera. Should you not think that the doctors and nurses who take care of cholera patients would get the disease? There have been cholera epidemics in the Philippine Islands, as in 1902, 1905, and 1908, when many doctors and nurses worked hard, doing the disagreeable and dangerous things that must be done for cholera patients. But none of these doctors or nurses died of cholera.

During the epidemic of 1908, some young men and women offered to help in the hospital in Manila. These volunteers were eighteen students from the Philippine Medical School, twelve

[1] A cholera suspect is a person who has a disease that looks like cholera. Sometimes the doctors cannot tell for a day or two whether the sickness is cholera or some other intestinal disease. A cholera contact is a person who has lived in the same house with a cholera patient or has been in a place where he might get cholera germs.

students from the Medical School of the University of Santo Tomás, and six students from the training course for nurses in the Philippine Normal School. They all worked in the cholera hospital, and helped to care for the worst cases of cholera. Yet not one of these volunteer nurses took the disease. They did not get cholera because *they were careful not to let the germs get into their bodies*. They washed their hands in disinfectants many times a day. They *always* disinfected their hands before eating. They did not eat or drink anything that cholera germs could get into. They followed all the rules for protecting themselves.

Two lessons to be learned from the experience of the doctors and nurses. We can learn two lessons from the experience of the doctors and the nurses. We learn, first, that if we follow the rules given us by the health officers, we can escape cholera. We learn also that nobody need be afraid to take care of cholera patients, *if he will guard himself properly* against the germs. In some places, people have been so afraid of the disease that nobody dared to nurse the cholera patients, and they were left without care. This is both foolish and cruel, and there is no need for it. People in the small towns and barrios cannot always get such disinfectants as carbolic acid and bichlorid of mercury. But everywhere people can use boiling water and fire, and these two are the great enemies of all disease germs. Boil or burn everything that comes in contact with the patient; wash your hands carefully in very hot water and soap several times a day, and always before eating; bury all matter from the patient's body. These things can be done in the poorest and most distant barrio in the islands. If they are done thoroughly, there is little danger of the disease spreading.

Obeying the rules of the health officers. In time of epidemic, everybody should obey the orders of the health officers, and should follow the rules that they give. These orders and rules are made for the good of everybody. They are made by doctors who have spent years in studying diseases, and who know what must be done to check an epidemic. A person who hinders the health officers in their work is not a good citizen. If the health officer tells you to stay in your own house, do not steal out at night and go to some other town. You may carry the cholera to that town and may cause the death of many people there. The epidemic of 1902 began in Manila, in a small district of the city. The health officers told all the people in that district to stay in their houses and not go to other districts, for fear that they would carry the disease with them. In the night some people who even then were sick with cholera stole out to other parts of Manila; some went to towns near Manila. Wherever these people went, cholera broke out. In a short time there was an epidemic that spread to all but three provinces in the islands, and killed over 110,000 people. If the people in that district of Manila had obeyed orders, this great loss of life might have been avoided.

The Bureau of Health cholera circular. On page 177 you will find a copy of a circular sent out by the Bureau of Health. This circular tells you what to do in time of cholera. Read it carefully. What you have learned in this book will help you to understand the reasons for the rules given in the circular.

QUESTIONS

Why is a cholera epidemic especially dangerous? What are the two things to be done in an epidemic? Where can cholera patients be best cared for? Why?

Why is it the duty of a citizen to report a case of cholera? What should be done with all matter from the body of a cholera patient? Why should disinfectants be put into the closet? What disinfectants can be used? What should be done with the patient's dishes and clothes? Why should sunlight be admitted to the house? What should be done with the drinking water? What kind of food should be eaten? Why is it especially important during a cholera epidemic to wash the hands before eating?

Why should visitors not be allowed in a house where there is cholera? Why should cholera suspects and cholera contacts be isolated? Why is it that doctors and nurses do not take cholera? What two lessons can we learn from the experience of doctors and nurses? How can people in any town or barrio always kill the germs of cholera as well as of other diseases?

Explain why it is for the good of all for every one to obey the orders of the health officers. What happened in 1902 because some people in Manila refused to obey the orders of the health officers? Was it right for these persons to cause their countrymen to die?

SUGGESTIONS TO THE TEACHER

All the recent studies of cholera show that healthy germ carriers are very important agencies in the spread of the disease. Some of these persons have been found to carry germs for six months. Germ carriers can be found only by examination for the germs with a microscope, and we must have health officers to make these examinations.

The teacher should keep before the class the importance of towns' and of families' providing themselves with pure water supplies and with safe methods of disposing of human wastes. We never know when germ carriers are among us, and the only safe way is to arrange our conditions of living so that it will be difficult for the germs to reach the mouths of healthy persons.

CHAPTER XVI

TYPHOID FEVER, DYSENTERY, AND DIARRHEA

THERE are several intestinal diseases besides cholera that cause a great deal of sickness in the Philippine Islands. Like cholera, they are infectious diseases, and the germs are swallowed in water or in food.

TYPHOID FEVER

Typhoid fever is a very severe disease. Many of the people who have this disease die of it, and even if they recover, it is many months before they are well again. Typhoid fever sometimes spreads very rapidly, and it is hard to stop an epidemic of it. In the United States many people die of it, and it is much feared. Typhoid fever is widespread in the Philippine Islands, and sometimes there are many cases of it. The symptoms appear in from seven to twenty-one days after the germ gets into the body, usually in about two weeks.

How typhoid germs are spread. The germ of typhoid fever is carried in water and in food. It is found in all matter from the intestines of a typhoid patient, and in the matter vomited. It may get on the hands of anybody who takes care of a patient, and may be left on anything handled by such a person. Germs are carried on the feet of flies and cockroaches. Rivers and wells may be infected by germs from wastes that are not disinfected or buried. Washing the clothes of a typhoid patient in a river will infect the water.

Dysentery

There are two kinds of dysentery. One kind, *bacillary dysentery*, is caused by a germ that is much like the typhoid germ. This kind of dysentery attacks persons suddenly, and the disease is very infectious. The germs are spread in all the ways that typhoid germs are scattered, and where bad water is used or sanitary conditions are bad in other ways, many persons die of this disease.

The other kind of dysentery is caused by a large germ called an *ameba* (plural, *amebæ*) and is called *amebic dysentery*. The amebæ of dysentery, like typhoid germs, may be found wherever people are careless about body wastes. Usually they get into the body from the hands of infected persons or from surface water.[1] There are many carriers of the germs, and it is especially dangerous for persons of this kind to handle foods.

[1] Surface water is water that flows over the surface of the ground, or near the surface. Water in shallow streams and springs is surface water. The water in most wells drains into them from the upper part of the soil. Therefore the water in most wells also is surface water.

Diarrhea

Several different germs may cause diarrhea. Like the dysentery germs, they are carried in water or in food. This disease is seldom dangerous, except for little children. But it weakens the person who has it, and if other germs get into his body, the body may not be able to fight them.

Germ carriers in intestinal diseases. Some persons who are not sick may carry in their bodies the germs of typhoid fever, dysentery, or diarrhea. These germs pass out of the body in the wastes from the alimentary canal, and if they get into another person's body, they will cause the disease there. For this reason matter from human bodies should not be left where flies and cockroaches can get to it; it should not be left where germs from it can get into drinking water. It should be placed where the germs in it will die.

How to avoid the germs of intestinal diseases. In preventing intestinal diseases, it is most important to have a pure water supply and to dispose in a safe way of human wastes. As long as people drink surface water without boiling it, these diseases will be very common. As long as they allow human wastes to lie on the ground under houses, germs will be carried to food by flies and cockroaches, and will be washed into rivers and wells. Then many people will swallow the germs when they drink the water, and will die of intestinal diseases.

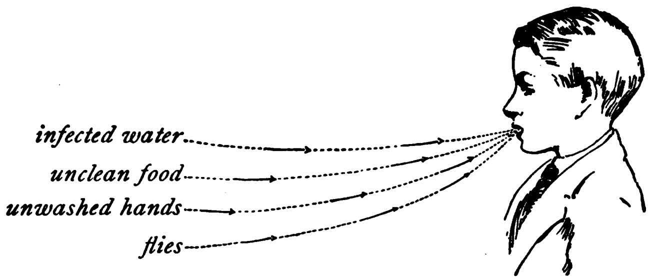


FIG. 59. Showing in what ways the germs of intestinal diseases get into the mouth.

To escape intestinal diseases we must drink pure water or boiled water. We must keep our food and dishes covered from insects. We must not eat food that other people have handled unless it is first cooked or dipped in boiling water. We must wash our hands before we eat. We must not eat out of a dish into which other people put their hands. Finally, we must dispose of human wastes in a safe way, so that the germs in them will not be scattered about under our houses and will not get into food and water.

QUESTIONS

Name four intestinal diseases. How do the germs of these diseases get into the body? Where are the germs found? Why is it not safe to drink surface water or river water?

How may the water of a river be infected? How may germs of intestinal diseases get into wells? Why is it safer to cook low-growing vegetables before eating them?

What is a germ carrier? What is the danger in leaving human wastes under the house? What is it most important to do if we wish to avoid intestinal diseases? Why must we keep food and dishes covered? Why must we wash our hands before we eat? Why is it dangerous to eat from a dish into which other people put their hands?

SUGGESTIONS TO THE TEACHER

In 1914 Dr. Fernando Calderon wrote to physicians in all parts of the Philippine Islands, asking for information in regard to the diseases most common in the different provinces. The replies he received indicate that dysentery is found throughout the whole archipelago, and that it affects alike the mountain dwellers and the fishermen by the sea. Many cases of what is called diarrhea in infants are caused by the germ of bacillary dysentery. A medicine called *emetin* is very successfully used in treating amebic dysentery, and where physicians are prepared to administer it the pupils should be told of its value. It is important that it be used as early as possible in the disease.

One very insanitary habit that is practised in some Filipino families is that of washing the body with the hand when the toilet is visited. Many persons who are not ill from intestinal diseases are carriers of the germs of these diseases, and it has been found that many cases of dysentery and cholera in the Philippines are caused by germs that come from the hands of healthy carriers. Especially should any one who prepares or handles food take the greatest care to keep his hands from becoming soiled with matter that may have germs in it, and no vessel that is used in the kitchen or for drinking purposes should ever be taken to the toilet room. A surgeon cannot free his hands from germs by even an hour of washing in hot water and soap, and a very important means of checking intestinal diseases in the Philippines is for the people to use toilet paper and keep their hands free from germs.

CHAPTER XVII

INTESTINAL DISEASES OF CHILDREN

More than one half of the children born in the Philippine Islands die before they are two years old. Almost all these children die of intestinal diseases. Great care is needed to guard a little baby from diseases of this kind.

Why so many children die of intestinal diseases. Babies cannot resist disease germs as well as older people can. Their little bodies cannot kill the germs. Because people do not understand the danger from disease germs, they do not protect the babies from germs. A baby's stomach is not fitted for any food but milk. Yet people often give a baby such solid food as banana. Solid foods lie in the baby's stomach and intestine and make a place for germs to grow. People often give babies polluted water; they allow flies to crawl over the babies and leave germs on their hands and faces; and in many other ways they let dangerous germs get to a baby's mouth. Another reason why so many babies die is that they are not properly covered at night. They suffer from the cold, and this weakens them so that they cannot resist the germs of disease.

Guarding a baby from germs. Never give a baby unboiled water to drink. This is the safest rule to follow in almost every town in the Philippines. A few germs that would not trouble a grown person will make a baby very sick. Water that comes from a good water system (as in Manila) or from an artesian well, and clean rain water — such water is safe. All other water is unsafe for babies until it has been boiled. When a baby's milk is mixed with water, only pure water should be used. A baby's face and hands should be washed only in water that is free from germs. A baby should be kept away from children who are sick with intestinal diseases, for the intestinal disease of which so many children die is infectious, and children can catch it from one another. It is very important, also, to keep a baby screened from flies.

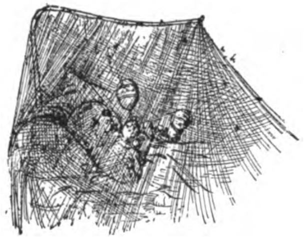


FIG. 60. A baby should be screened from flies.

The right kind of food for babies. Until a baby is eight or nine months old it should have nothing but milk. This means that *nobody must ever give it any solid food.* Do not give a baby a little piece of banana, or a bit of fish, or a spoonful of rice. A baby's stomach and intestine cannot digest such food, so the food does the baby no good. It is likely to do the baby great harm, for it may stay so long in the alimentary canal that the germs of some intestinal disease will have a chance to grow in it.

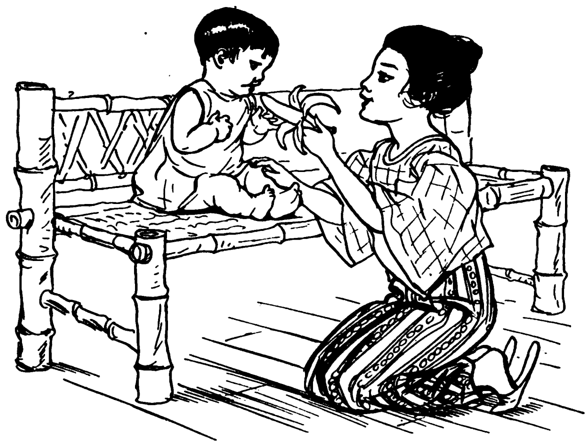


FIG. 61. One reason why so many Filipino children die is that the wrong kind of food is given to them.

When a baby is eight or nine months old, it may have a little solid food. It can eat a little rice, if the rice is very well cooked. The yolk of a hard-boiled egg is good for a baby to eat. Broths will not hurt it. But meat and fish, raw fruits and vegetables, candy, cake — all these things are bad for children under a year and a half old. Especially bad for babies or small children is food that has been fried. Many boys and girls take care of their little brothers and sisters most of the day. Whenever they have anything to eat, they give the baby a bite. This is bad for the baby in two ways, for usually the food is not the kind that a baby should have, and usually the older child bites off a piece for the baby. It is not safe for any one to put into his mouth what has been in another person's mouth, and it is very unsafe for a baby, since babies cannot resist germs so well as older children or grown persons.

Keeping the baby warm. Often in cool weather and at night babies are not kept warm enough. It weakens them to be cold or to sleep in damp clothes, and makes them more likely to be sick. Spread over a baby enough covering to keep it warm and see that its clothes are dry. This will do much to save it from sickness.

QUESTIONS

How many of the children born in the Philippines die before they are two years old? Of what kind of diseases do most of these children die? Why is it that so many children die of intestinal diseases?

What kind of water is safe for babies? Why should a baby be kept away from other children who are sick with intestinal diseases?

How old should a baby be before it is given solid food? How does solid food injure a baby? When a baby is old enough to begin to eat, what foods may be given it? What foods will injure it? Why is it important to keep a baby warm?

CHAPTER XVIII

SKIN DISEASES

In the Philippine Islands some infectious diseases of the skin are very common. They are not dangerous diseases, but they cause much suffering, especially among children. The most common of these diseases is the itch. There are two kinds of itch.

FIG. 62. An itch mite, magnified.

Itch (sarna). The kind of itch that is called *sarna* is caused by a very tiny animal called the *itch mite.* This little animal lives in the epidermis (Fig. 8) and crawls along in it like a little turtle. It lays its eggs in the skin, and the eggs soon hatch into little itch mites. The little mites crawl farther out into the skin and spread the disease. A person who has the itch may leave these little mites on clothing, on books, or on anything that he touches. The mites may then get on the skin of another person and bury themselves in it.

How to cure sarna. Anybody who has sarna should go to a good doctor and get medicine to rub on his skin. The medicine will kill the itch mites. If a person cannot go to a doctor, he may be able to cure himself in this way:

Take a hot bath; wash the diseased places in the skin thoroughly with soap, and keep them wet for some time to soften the skin. Then to kill the itch mites rub sulfur ointment on the diseased places.[1] Rub on the ointment every day for three days. Then put on clean clothes that have been boiled and wait a few days. If the disease does not go away, take another hot bath and again rub on the ointment for three days. Keep on doing this until all the itch mites are killed.

FIG. 63. Itch mites cling to the fingers and may be left on anything handled by a person who has the disease.

Do not scratch the itchy places in the skin and then scratch other parts of the body, for the itch mites cling to the fingers when the diseased places are scratched, and you may spread the disease all over your body. Little babies have a tender skin, in which the itch mites like to live, and babies suffer very much from this disease. It is not right to allow them to suffer for weeks and months when they can so easily be cured.[2]

[1] An ointment can be made by mixing together equal parts of sulfur and lard, or equal parts of sulfur and coconut oil.

[2] The sulfur makes the skin red, and it must not be used too long at a time, or the disease will seem to be getting worse. The skin of a baby is especially delicate, and the sulfur ointment must be used on it with care.

Dhobie itch. The second kind of itch, called *dhobie itch*, is caused by a little threadlike plant that grows in the skin. At the ends of these threads are little round bodies called *spores*. These spores are like little seeds, and new plants can grow from them. Like the itch mites, the spores are spread from the hands of a person who has the disease, or from his clothing, or from things that he touches.

How to cure dhobie itch. Dhobie itch is not easily cured. When a person has this disease, it is best for him to go to a good doctor. One doctor gives the following treatment for dhobie itch:

Wear thin, white underclothes to protect the diseased parts of the body from being rubbed. Change the underclothes every day, and have them boiled. Cover the diseased places every day with a powder made of equal parts of starch, oxid of zinc, and boracic acid. If the parts are raw and very sore, cover them with thin cotton cloth on which has been spread carbolized zinc ointment.

Ringworm. There are many other diseases of the skin that are caused by little plants like the plant that causes dhobie itch. Ringworm is the most common of them. Sometimes these diseases come on the skin of the hands or arms;

sometimes they are found on other parts of the body. Often they attack the skin of the head and cause patches of the hair to fall out. Children especially suffer from these diseases. They catch them from each other, and sometimes from cats and dogs. Any child who has one of these diseases ought to be treated by a doctor who knows how to cure the disease.

Lice. Lice in the hair injure the health by keeping the person from getting the quiet rest that he needs. They may be killed by oiling the hair thoroughly with a mixture of equal parts of kerosene and coconut oil. This should be put on in the evening and washed off with soap and warm water in the morning. Sulfur ointment (see page 102 for directions for making it) also is good to kill lice in the hair.

QUESTIONS

Name the two kinds of itch that are common in the Philippine Islands. What causes sarna? How does the disease spread in the skin? How does it spread to other parts of the body? How does it spread to other persons? How may the itch mites be killed?

What causes dhobie itch? How does it spread? How may it be cured? How may lice be killed?

CHAPTER XIX

INTESTINAL WORMS

THERE is a great prison in Manila called Bilibid where more than 4000 prisoners are kept. In Spanish times the water and the food for the prisoners were bad, and of each 1000 prisoners, at least 250 died each year. When the Americans took charge of the prison, they began to try to make it a more healthful place, and by 1907 the number of deaths had fallen to 70 a year for each 1000 prisoners. But the number of deaths was still too large. Then the doctors of the prison found that nearly all the prisoners had intestinal worms. The men were given medicines to kill the worms, and the number of deaths each year fell to 13 for each 1000 prisoners. The worms had not made the men feel sick, but they had weakened them. When the germs of tuberculosis, dysentery, or some other disease got into their bodies, the men died. Their bodies were not strong enough to resist even a few germs.

Intestinal worms in the Philippine Islands. The prisoners in Manila come from all parts of the Philippine Islands, and most of them are infected with intestinal worms before they come to the prison. Examinations made in other places show that all through the islands the worms are very common. The doctors who have studied the subject tell us that probably 5,000,000 persons in these islands are infected with intestinal worms. This means that in a town of 10,000 people, at least 8000 have the worms; that in a school of 100 pupils, about 76 pupils are infected; that in a family of 7 persons, 5 are infected. Many of these persons have two or three kinds of intestinal worms.

Eelworms and whipworms. Two common kinds of intestinal worms are eelworms and whipworms. Eelworms are sometimes over 30 centimeters long and are thicker than a lead pencil. Whipworms are very slender, and are only about 5 centimeters long. The eggs of both eelworms and whipworms pass out of the body in wastes from the alimentary canal. The eggs hatch into very small worms, which are usually swallowed in water.

Hookworms. The hookworm is the worst of all intestinal worms. It is between one and two centimeters long, and is about as thick as a fine hairpin. It fastens itself to the wall of the intestine by little hooks on its head. It weakens the body by sucking blood from the wall of the intestine and makes a poison that injures the body.

The symptoms of hookworm disease. The symptoms of hookworm disease are paleness, thinness, weakness, dull eyes, dry hair, and a large abdomen. If a person has only a few worms in his body, his

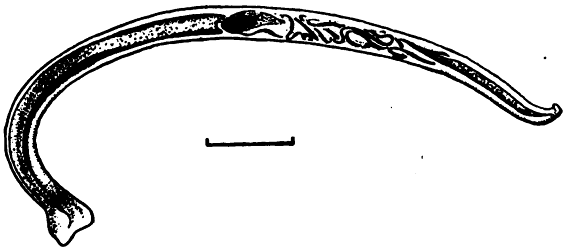


FIG. 64. A hookworm magnified. The short line shows the real length of a full-grown hookworm.

health will not be much injured. If he has many worms in his body, he may have so great a weakness and so severe an anemia (lack of blood) that he will die.

How hookworms get into the body. The eggs of the hookworm pass out of the body in the wastes from the alimentary canal. In the soil the eggs hatch in a few hours into a worm so small that it can hardly be seen without a microscope. If this little worm can get on the skin, it will bore through the skin into the blood, and will make its way from the blood into the intestine. When the worms go through the skin, they cause the sores called *ground itch* in the United States, and *mazamorra* in countries where Spanish is spoken.

The importance of getting rid of intestinal worms. Except consumption and malaria, no diseases are so important in the Philippine Islands as those that are caused by intestinal worms. The examinations made in Bilibid and other places show that nearly all the people have these worms. One of the most important things for the Filipino people is to have the diseases cured and the spread of the worms stopped. A pupil or a teacher who is poisoned and robbed of his strength by intestinal worms cannot do his work well in school. The laborer who is weak and sick from them is of little use in the fields or in a factory. The Filipino people cannot hope to become rich and great as long as their energy and strength are sapped by these small robbers. A few doses of very simple medicines will cure those who have the worms in their bodies, and if every one in the Philippines who is suffering from intestinal worms could have medical treatment, many lives would be saved.

What has been done in Porto Rico. In 1900, 90 per cent of the country people in Porto Rico were infected with intestinal worms, and 12,000 out of 36,000 deaths in the island were caused by them. By 1914, more than 500,000 people had been treated for intestinal worms, and the number of deaths from this cause was only 527.

How the spread of intestinal worms can be prevented. It is easy to prevent the spread of intestinal worms. The eggs are found only in the wastes from the alimentary canal. These eggs die if they are shut away from the air, and if good closets are built to receive the wastes, the eggs of the worms will die. Do not allow the soil about the house to become polluted with wastes. Then the spread of intestinal worms will be prevented.

QUESTIONS

About how many persons in the Philippine Islands are probably infected with intestinal worms? How large are eelworms? How large are whipworms? How do these worms get into the intestine?

How large is the hookworm? How does it injure the body? What are the symptoms of hookworm disease? Where does the hookworm hatch? How does it get into the body? What disease of the skin does it cause?

Why is it important for the Filipino people to get rid of intestinal worms? How many of the people of Porto Rico were infected with intestinal worms? How many deaths did these worms cause? How many people in Porto Rico did the government treat for hookworm disease in 1908?

How can the spread of intestinal worms be stopped? Would it be easy or difficult for the Filipino people to free themselves from hookworms? Why may hookworms be called robbers?

CHAPTER XX

SMALLPOX

SMALLPOX is one of the most severe diseases known. For hundreds of years great numbers of people have died of it. From 1700 to 1800 it killed over 60,000,000 people. There was no way of preventing the disease, and almost everybody expected to have it some time. There were 12,000,000 people in Mexico when the Spaniards discovered that country. Smallpox was taken in by the Spaniards, and it killed one half of the Mexicans.

FIG. 65. Edward Jenner, who in 1797 discovered vaccination, the greatest medical discovery the world has ever known.

About one hundred years ago, a doctor named Jenner found out how to prevent smallpox by vaccination. Now there is very little smallpox in civilized countries, for most of the people are vaccinated. In uncivilized and backward countries, smallpox is still common, for the people in those countries do not understand that vaccination will protect them from this disease.

The germ of smallpox. The smallpox germ is found on the skin of a smallpox patient, and in the lining of his mouth, throat, and nose. The germs cause sores in the skin, and the matter from these sores dries on the skin in scabs.

How smallpox germs are spread. Germs from the nose or throat of a patient may be scattered by coughing or sneezing. Germs are left on anything that the patient touches. The light, dry scales that come from the skin have many germs in them, and these scales can be blown through the air. The germs may be dried for months without being killed. They are easily carried about on clothes, books, letters, rags, and many other things. Great epidemics in Europe have been caused by germs that were carried in cloth and furs from Asia.

Why smallpox is a very dangerous disease. Very few persons have blood that can resist the smallpox germ. Neither healthy people nor sick people can fight it. Your grandmothers and grandfathers can remember how many people died of smallpox in the days before vaccination was common in the Philippine Islands. If 100 unvaccinated people are exposed[1] to smallpox, 95 or 96 of them will have the disease.

[1] To be exposed to a disease is to be where the germs may get into your body.

Quarantine and disinfection in smallpox. When there is smallpox in a house, the house and all the people who live in it must be quarantined. This means that nobody except a doctor or a nurse may enter the house, and that the people who live in the house must not go to other houses, to market, or to church. All the clothes and bedding used by the patient must be burned or boiled. Everything that the patient touches must be wiped with a cloth wet in a disinfectant. Every one who goes into the patient's room, or helps to take care of him, must wash his hands in a disinfectant after touching the patient. A person who is nursing a smallpox patient must change his outside clothes before he goes from the sickroom to any place where he will meet other people. Many germs are in the scales from the patient's skin. A salve with a disinfectant in it can be spread on the skin, and this will keep the scales from flying all about the room.

Vaccination a protection against smallpox. The best way to prevent smallpox is to have everybody vaccinated. That this protects against smallpox no one can doubt. In Germany all children must be vaccinated before they are a year old, and again when they are between thirteen and fourteen years old. In five years there were in Germany only 289 deaths from smallpox in the whole country.

In the city of Philadelphia, during a smallpox epidemic, over 700 medical students were taken to visit the smallpox hospital. All but one of these students had been vaccinated, and that student was the only one to take the disease.

If every man, woman, and child in the Philippine Islands were vaccinated, there would be no more smallpox in the islands. There would not be anybody who could take the disease. But it will be some years before every one is vaccinated, and there will be some cases of smallpox every year. So we must try to keep smallpox germs from spreading.

How long vaccination protects against smallpox. We cannot tell how long vaccination will protect a person against smallpox. Sometimes it protects him for seven, eight, nine, or even ten years. Usually two vaccinations will protect for a lifetime. In a few persons, however, vaccination does not protect after nine or ten months. Whenever you are exposed to smallpox, you had better be vaccinated again, especially if you have not been vaccinated for more than nine months.

How vaccination protects us from smallpox. In vaccination a very weak race of smallpox germs from a cow is put into the body. The germ-killing substance then appears in the blood and kills these germs. Then the germ-killing substance remains in the blood for years afterward and kills any smallpox germs that may get into the body. In this way persons who have been vaccinated are protected from smallpox.

What to do to a vaccinated arm. In vaccination the skin is scratched with a sharp knife, called a lancet. But before the scratch is made, the skin must be washed clean with soap and water. Then it must be bathed with alcohol, and must be allowed to dry. This is to kill any pus-forming germs that may be on the skin, for they might get into the scratch, grow there, and make a bad sore. The lancet also is cleaned with disinfectants before it is used. If there were any germs on the lancet, they would get into the scratch and would make a sore.

After you are vaccinated, do not put down your sleeve and do not let anything touch your arm until the scratch is dry. Then tie a clean cloth around it, and do not touch it. If the vaccination takes, your arm will swell a little, and a small sore will form. Sometimes a poultice is put on a vaccinated arm. This is a very bad thing to do. Never put anything on a vaccination sore but clean, boiled water and clean, wet cloths. When the arm is sore, change the cloth twice a day, and burn the cloth that you take off.

Vaccination in the Philippine Islands. Before the year 1901, only a few of the people in these

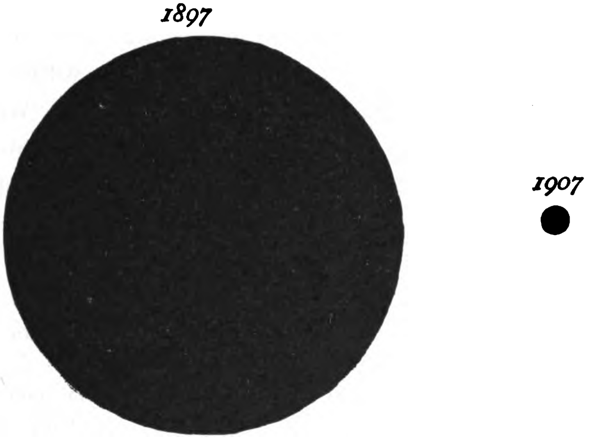


FIG. 66. In the Philippine Islands, before the American occupation, only a small part of the inhabitants were vaccinated. In 1897, about 40,000 people died from smallpox. In 1907, there were only 304 deaths from this disease in all the islands. It was vaccination that caused this decrease, for in most parts of the Philippines there was no quarantine or disinfection of a kind that would have any effect in controlling smallpox.

islands were vaccinated. Many people died of smallpox. In 1896, at least 40,000 people in the Philippines died of it. In 1902, the Bureau of Health began to send vaccinators into the provinces to vaccinate people. Every year since 1902, large numbers of person have been vaccinated. From June, 1906 to June, 1908, the health officers vaccinated 3,709,187 persons. In 1907, there were only 304 deaths from smallpox in the islands. In a few years there may be no deaths from it. But you must remember that vaccination protects less and less each year. If people do not take care to be vaccinated again in a few years, we may have a great epidemic some day, for there are many places in the islands where smallpox germs are still alive. We must remember, too, that somebody coming from another country may bring smallpox germs with him.

QUESTIONS

How many people did smallpox kill between the years 1700 and 1800? How many of the people of Mexico died of smallpox when the disease was taken into that country? Why is there little smallpox in civilized countries at the present time?

Where is the germ found in a smallpox patient? How may the germs be scattered? How can they be carried from one country to another? Why is smallpox a very dangerous disease?

Tell how you would disinfect a house where some one had been sick with smallpox. Give some facts that show that vaccination is a protection against smallpox. How long does vaccination protect against smallpox?

How should the arm be prepared for vaccination? Why? How should it be cared for after vaccination?

How many persons died of smallpox in the Philippine Islands in 1896? In 1907? What has caused the decrease in the number of deaths?

CHAPTER XXI

SANITATION AND INFECTIOUS DISEASES

In this book we have been studying the infectious diseases that are most common in this country. Now we shall study the ways of preventing infectious diseases; that is, we shall study *sanitation*. Keeping everything clean and free from disease germs is sanitation. A house or a town that is free from disease germs is *sanitary*, and one that is not free from germs is *insanitary*. Everybody would like to live in a sanitary house and a sanitary town. There are some things that every person can do to help sanitation in his town; there are some things that every family can do; and there are some things that must be done by the whole town. Before we learn what the person, the family, and the town must do, let us review what we have learned about all infectious diseases.

Review of what has been learned about all infectious diseases. Infectious diseases are those that are carried from one person to another. Some of the most severe diseases are infectious. One half of the people in the world die of these diseases.

Infectious diseases are caused by very small plants and animals, called disease germs. When a person has an infectious disease there are millions of germs in his body. Some of the germs are always in matter that comes from his body. In some diseases the germs are in matter that is coughed up from the lungs. In other diseases they are in the mucus from the nose and throat. Sometimes they are in scales that fall from the skin. But most often they are in the wastes from the alimentary canal.

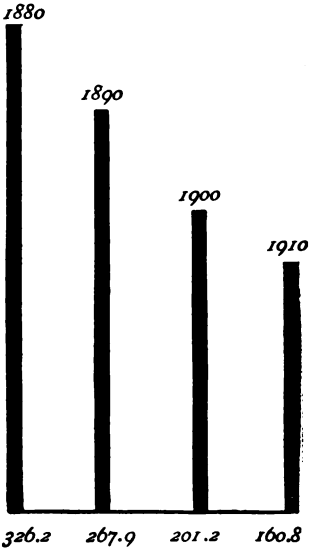


FIG. 67. This diagram shows the gradual decrease in the number of deaths from tuberculosis in the United States. The numbers given are the deaths per 100,000 in the part of the United States where statistics have been carefully kept.

The germs that come from a sick person cannot do any harm until they get into another person's body. They may be carried to other persons by insects or animals, on objects handled, in food, or in water.

What has been done in preventing infectious diseases. In countries where people know something about disease germs, much has been done to prevent the spread of infectious diseases. In England and in America only about one half as many people now die of consumption as died of that disease forty years ago. Plague was so bad in London at one time that the grass grew in the streets. Yet plague was driven out of England many years ago. Within the last fifty years there have been epidemics of yellow fever in some cities of the United States when people died faster than they could be buried. But yellow fever has been driven out, and now it is almost unknown in the United States. Smallpox and leprosy have almost disappeared from the greater part of the world, and some of the other diseases that formerly killed many people are now seldom seen. This is because people have learned how to escape the germs of these diseases.

What can be done in the Philippine Islands. Already much has been done to check the spread of infectious diseases in the Philippine Islands. Plague has been driven out; smallpox is almost conquered; and it is hoped that sometime there will be not a leper in the islands. Cholera has been checked, and if a hard fight is made against this disease, soon the Philippines will be free from it. People have learned how to prevent malaria, dengue, consumption, dysentery, and other diseases that are killing thousands of Filipinos all over the islands. Will the Filipino people drive out these diseases so that they may live in happiness and strength? Or will they live in weakness and sickness and allow these diseases to continue destroying the people as they are now doing? We hope that the Filipino people will soon free themselves from this burden of disease.

How infectious diseases can be prevented. If the people of these islands wish to fight successfully the infectious diseases that are now so common among them, they must do the following things:

1. They must rid their houses of the insects and animals that carry disease germs.
2. They must guard their food from germs.
3. They must guard their drinking water from germs.
4. They must take proper care of all human and animal wastes.
5. They must quarantine epidemic diseases.
6. They must learn the value of isolation and disinfection in all infectious diseases.
7. They must avoid habits that give germs a chance to get into the body.
8. They must avoid habits that weaken the body and make it unable to fight disease germs.

In the following chapters we shall learn how people can follow these rules.

QUESTIONS

What is sanitation? When is a house or a town sanitary? When is it insanitary? What is an infectious disease? How many people die of infectious diseases? How are these diseases caused? How do the germs leave the bodies of sick persons? How are they carried to other persons?

Name some diseases that have been checked or almost conquered by sanitation. What has been done in the Philippine Islands by sanitation? Name some other diseases common in this country that can be checked or driven out.

Give eight rules that must be followed by any people who make a successful fight against infectious diseases.

SUGGESTIONS TO THE TEACHER

It would be well at this time if the teacher would read the first and last chapters of the second part of this volume and try to transfer to the class the spirit of these chapters. The pupils need to be taught that sickness and health are not dispensed by fate, but that in this field, as in other fields, man must work out his own destiny. Individuals and nations that work energetically for health secure it, and those who do not put forth efforts towards the prevention of disease always suffer much illness.

In particular should the pupils be made to understand the nature of parasites and of parasitic diseases. It is not "natural" for the body to be ill because of germs that prey upon it, any more than it is "natural" for a person to be injured when he is attacked by a tiger or bitten by a poisonous snake. In all these cases the body is attacked and injured by something outside of itself, and with proper care these injuries can be prevented. Sometime we shall have a world that is free from disease germs, and every teacher should attempt to train his pupils to do their part in hastening that time. If the Philippine Islands could be free from infectious diseases, they would become one of the richest parts of the world, and the Filipino people would become a great nation of seventy-five or a hundred million souls.

CHAPTER XXII

DISEASE-CARRYING INSECTS AND ANIMALS

In Chapter V you learned what diseases mosquitoes carry, and you learned something about the best ways of fighting mosquitoes. In this chapter we shall study other insects and animals that spread disease.

The housefly. Flies walk over all kinds of unclean matter, from which they get germs on their feet. Then they fly to the house and walk over food and dishes. They leave the germs on whatever their feet touch. Germs may also be found in flyspecks. A fly feeds on matter that contains disease germs; then the germs are found in the matter from the fly's alimentary canal. In one speck left by a fly that was caught on the face of a leper, 1115 germs were found; 10,000 germs have been found on the legs of a fly. It is very dangerous and unclean to have swarms of flies about the house.

Fig. 68. The foot and leg of a fly, as seen through a microscope.

The kinds of germs carried by flies. Almost any kind of disease germ may be carried by flies.

A fly may get smallpox germs on its feet by walking on the skin of a smallpox patient. It may get germs from a sore or an ulcer and may carry them to some one's face or hands. A fly may go from a person who has sore eyes to a baby's face; the helpless baby cannot defend itself. If the fly feeds on the sputum of a consumptive, it will have tuberculosis germs in its body. Then the germs will be left in the flyspecks on food or dishes. It is especially dangerous to let flies walk over the wastes from the human body. They may scatter the germs of cholera, typhoid fever, and dysentery. In 1908 there were many cases of cholera in Pangasinan Province. At the same time there was a plague of flies. It is supposed that the flies did a great deal to spread the germs of cholera. There was cholera in Bilibid Prison in 1906, with many new cases every day. The prison doctor saw that flies were going from the closets to the kitchen. He had all the closets screened so that flies could not get to the wastes. Then the number of cases each day became much

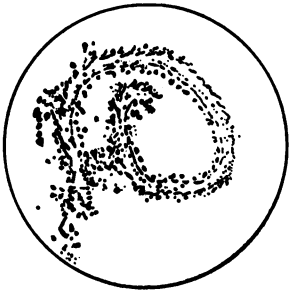


FIG. 69. Tracks left by a fly on a plate of jelly. When looked at through a microscope, the black specks are found to be germs.

less. This shows how necessary it is to keep flies away from human wastes.

FIG. 70. This child is healthy and well, but flies may leave disease germs in his food.

Keeping flies out of the house. Do not let the flies have anything to eat in your house and they will not trouble you. Put away all food as soon as a meal is over. Do not leave dishes of food uncovered. Do not throw garbage under the house. Keep all waste matter where flies cannot feed on it.

Getting rid of flies. The best way to get rid of flies is to take away the places where they lay

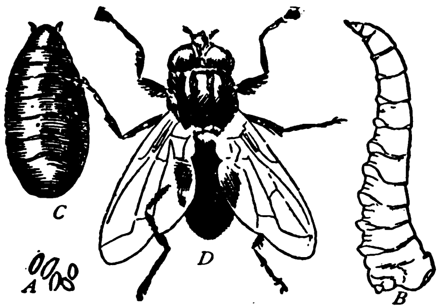


FIG. 71. The life history of the fly. *A* shows the eggs; *B*, the larva or maggot; *C*, the pupa; and *D*, the adult fly.

their eggs. The fly lays its eggs in manure (especially horse manure), in the wastes in closets, and in decaying garbage. In a day or less, the egg hatches into a small, white, footless maggot. In about ten days more, the maggot changes into the adult fly. Once a week take away all matter in which flies lay their eggs and on which maggots can live. Bury the matter, or spread it out on the fields. The hot sun will kill the eggs and the maggots.

Cockroaches. Cockroaches, like flies, get germs on their feet when they walk over human wastes.

Then they may walk over dishes and food, and leave the germs there. You can get rid of them in the same ways that you get rid of flies. Keep food covered, and do not leave garbage or other waste matter about the house. Cockroaches will not stay in a house where they must starve.

Rats. Rats cause a great deal of trouble. They destroy many things, and they may carry the germs of intestinal diseases to food. But we are afraid of them especially because they carry the germs of plague. In Chapter VII you learned how fleas get the germs from rats and carry the germs to persons. Rats are most dangerous in cities like Manila, Cebu, and Iloilo. Ships come to these cities from countries where many people have plague. Rats from these ships may bring the plague into the city. In a city there are many houses close together, and in some of the houses too many people are crowded. In such houses the rats like to live, and it is hard to get them out. In India, where there is a great epidemic of plague, people have tried many ways of fighting rats. They have caught some rats in traps; but rats are very wise, and they will seldom go into a trap. Poison may be used; but most rats will not touch food that has poison in it. The people in India have learned that the best thing to do is to keep cats. With rats, as with flies and cockroaches, it is easier to get rid of them if you do not let them have food. Keep your house clean; do not leave dark corners where they can make their nests; and keep all food where they cannot get it.

How larger animals sometimes carry disease. The larger animals cannot carry diseases unless people are very careless. When people throw waste matter out on the ground, pigs and dogs walk over it, and may get germs on their feet. When they walk through a ditch or a brook, or wade in a river, the germs will be washed from their feet into the water. People who use the water, either to drink or to wash dishes, may get the germs into their bodies. It is uncleanly to leave wastes where pigs can get to them. It is uncleanly and unsafe to drink water that animals walk in or to wash dishes in it, without boiling it.

QUESTIONS

How many germs has a fly been known to carry? What kinds of germs can flies carry? How may flies be kept from coming into a house?

Where do flies lay their eggs? Into what does the egg hatch? How long does it take a fly to become full grown?

What is the best way to get rid of cockroaches? What danger is there from rats? How have the people of India succeeded best in freeing themselves from rats?

When may larger animals carry disease germs? How can this be prevented?

CHAPTER XXIII

GUARDING FOOD FROM DISEASE GERMS

Most people buy the greater part of their food in a market or a store. Then they take it home to cook it. Thus disease germs have two chances to get into the food we eat; they may get into it in the market or store, and they may get into it after we have taken it home. It is very important to guard food from germs, because many foods are a good place for germs to grow. In them a few germs from a fly or from the fingers of a germ-carrying person can increase to a multitude.

Guarding Food in the Market

It is difficult for one person to do anything to keep disease germs out of food while it is in a market. The municipal government must keep the market so clean and sanitary that germs will not find it a good home. The people who sell in the market must not be allowed to offer food that is spoiled, and they must protect the food from dirt and dust. All food that is offered for sale should be inspected before it is allowed to enter the market. The market must be so arranged that sellers can easily keep their goods clean. To have the market sanitary is very important to a town, for disease can spread more easily from a market than from any other place.

An insanitary market. In many towns in these islands, the market is the bare ground with a few sheds built on it. There is no floor, and

FIG. 72. An insanitary market.

there is no way of draining the ground. In dry weather the surface is covered with a deep layer of fine dust. The feet of people walking about the market raise clouds of dust, and the dust settles on everything. In wet weather, the dust becomes mud. Since there is no drainage, the water does not run off, but stands for a long time in every little hollow in the ground.

Some people come to the market early in the morning and stay all day. There is no public closet, and in a short time the ground around the market is polluted by the people. Often goods are brought to a market in a cart, and the horse or the carabao is left standing all day near the

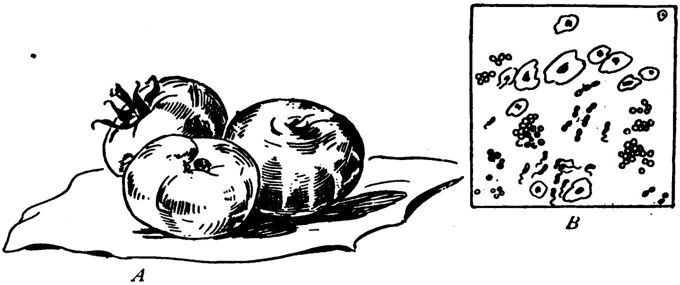


FIG. 73. *A* shows tomatoes that have been handled by many people in the market, but that look clean. *B* shows the germs that might be seen if a piece of the skin were examined through a microscope.

market. Animals stand in the same place day after day, and the ground becomes very unclean. Often animals soil the ground in the market when they are drawing the carts into place.

On this ground, which is always muddy or dusty, and is often polluted with animal wastes, people spread out their goods for sale. They do not cover the food, and dust and flies soon settle on it. Those who want to buy handle the food, often with very dirty hands. The germs of intestinal diseases may be carried to the food by the flies; tuberculosis germs are very likely to be carried by the dust; pus-forming germs, cholera, tuberculosis, smallpox, dysentery, and many other kinds of germs may be left on the food by dirty hands. Almost any kind of disease germ has a chance to get on the food in such a market. There is not so much danger in foods that will be cooked, because the cooking will kill the germs; but many of the foods sold in the market are fruits and vegetables that are eaten raw, or foods that are already cooked. These cooked foods are the most dangerous of all, and in times of cholera epidemics should not be sold.

The location of a sanitary market. To be sanitary, a market must be in a good place. Moist places are good homes for germs, so a market must not be on damp, swampy ground. The best place for a market is on high ground. The ground need not be a hill, but it should rise a little, so that water will not stand in the market during wet weather. If the market must be on low ground, there should be ditches around it to drain it.

The floor of a sanitary market. The floor or ground of a sanitary market is made of hard material. It is not easily worn by the feet of people walking over it, and very little dust rises from it. The floor is smooth, and has no cracks into which dust may settle. It slopes a little, so that it may be washed at the end of each day. There are canals, made of the same material as the floor, which carry the water to the ditches around the market. The best material for the floor of a market is cement. Cement is smooth and hard; it has no cracks to catch dirt; it can easily be swept and washed.

In a sanitary market, two public closets are built, one for men and one for women. If many animals are brought to the market, it is best to build a corral for them.

Keeping the market clean. A sanitary market is kept clean. Somebody must wash the floor, and somebody must keep the sheds, tables, and closets clean. After the municipality has built a sanitary market it must hire a janitor to take care of the market. The janitor must clean the market every day after the people have gone; he must sweep out the public closets and must wash the seats every day: he must clean out the manure in the corral.

If there is an artesian well in the town, or if the town has any other public water supply, pipes carry the water to the market. Then there is water enough to cleanse the market properly and the people in the market will have pure water in which to wash their hands. If there is no public water supply, a well must be dug near the market. Water for drinking must not be taken from this well. It is not safe to drink water from a well so near a market.

Tables in the market. Things for sale are not placed on the floor in a sanitary market. There are tables, not less than seventy-five centimeters high, for all the sellers. In some markets, the municipality builds the tables as part of the market. In other markets, the sellers build the tables.

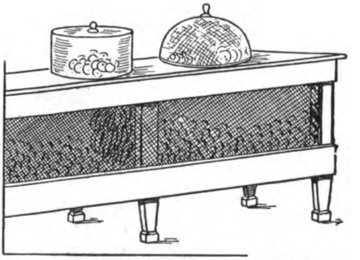


FIG. 74. A sanitary market table and screens used in the Manila markets.

It is better for the municipality to furnish the tables, for then all will be alike.

Covering food from flies. Cooked foods, sweetened foods, and all foods that draw flies must be covered. Buyers must not be allowed to handle cooked foods, or foods that are eaten raw. People will learn that it is dangerous to eat foods that other persons have handled. When they have learned this, they will not buy from anybody who lets buyers handle everything in his baskets or on his table.

Sanitary stores. Foods in stores also must be protected from dust, from flies, and from handling. Where cooked food is sold and is eaten in the store, a clean dish must be given to each buyer.

Guarding Food in the House

It is not enough to buy clean food in a sanitary market. The buyer must take care that it is not

Fig. 75. An insanitary way of preparing food.

infected after it is taken home. Food must be kept where flies, cockroaches, and rats cannot get to it, and it must be covered so that dust and germs cannot fall into it.

The importance of cleanliness in preparing food. The person who does the cooking must be very careful to have clean hands. She must wash her hands well before she begins to cook a meal. A person who is sick, or a person who has just recovered from an infectious disease, must never have anything to do with the cooking.

Many families have no table in the kitchen. All the work of preparing the food is done on the floor, where people may walk with dirty, germ-covered feet. Food may be left on the floor for half an hour or more, while the cook is preparing something else. Dust may fall into it from the feet and clothes of those who walk through the room. It is not easy to keep food clean when it is prepared on the floor.

FIG. 76. The right way to prepare food.

Cleanliness in eating. In many houses we see the food placed in large dishes on the floor. There is one dish for the rice, and one dish for the fish or meat. The family squats in a circle around the dishes, and each person takes the food with his fingers. Germs from the hands of one person may infect the whole family. A person who eats with his fingers may infect himself. It is hard for the body to fight against a disease if new germs get into it every day.

The habit of eating with the fingers and the custom of eating from a common dish are especially dangerous in time of epidemic. They are especially dangerous, also, when anybody in the family has diarrhea, dysentery, or consumption.

Each person in the family should wash his hands carefully before a meal. The dishes should

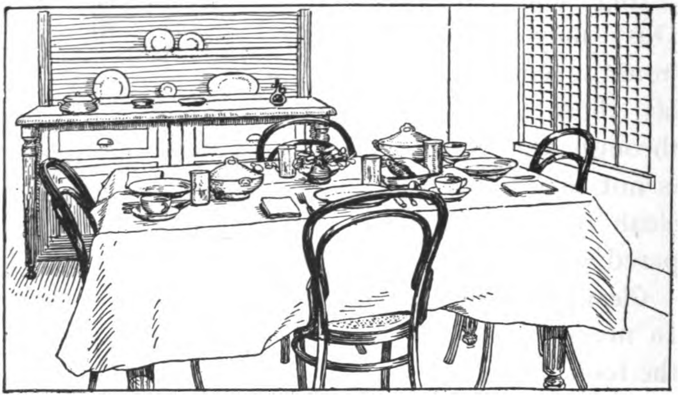


FIG. 77. It is more pleasant, as well as more sanitary, to eat at a table than to eat on the floor.

be put on a clean table, and not on the floor. Each person should have his own plate, cup, knife, fork, and spoon. Each one should take what food he wants with a spoon or fork, should put it on his own plate, and should use a spoon or a fork to carry it to his mouth.

Clean dishes. After the meal, the dishes must be washed with hot water and soap. Dishes that are washed with cold water are sure to be greasy and unclean. Clean dish towels must be used to dry the dishes. Some careless cooks use the same towel for their hands, for the dishes, and for wiping the table or the floor. This is a very insanitary thing to do. Dishes that animals have eaten from should be washed very carefully. It is better to keep one dish for dogs or cats, and not to give them food on the dishes that people use.

The dishes must not be left on the floor, or where they will get dirty and dusty. They must be put away as soon as they are washed; then they will be clean for the next meal.

A consumptive or a person who may have disease germs of any kind on his hands is almost certain to leave these germs on the dishes that he uses. The dishes of a sick person should therefore be placed in boiling water.

QUESTIONS

Why is it very important to guard food from germs? Why must the municipal government keep the market sanitary?

Describe an insanitary market. In what ways may germs get into foods in a market of this kind? Describe a sanitary market. What is the best material for the floor? Who should keep the market clean? Why is it necessary to have a supply of water near a market?

Why should there be tables in a market? In what other ways must care be taken to keep germs out of foods?

How may germs get into foods in the house? Why should foods be prepared on tables and not on the floor? Why is it insanitary to eat with the fingers? To eat from a common dish? How should dishes be washed?

CHAPTER XXIV

A PURE WATER SUPPLY

THE germs of all the intestinal diseases are carried in water. It is therefore very necessary to have a good supply of safe drinking water. Safe water is water that has no disease germs in it. Many persons think that clear, cool water must be pure water, but this is not so. Germs are so small that millions of them may be in a drop of water, and yet the water will look clear.

FIG. 78. How unclean surface water often gets into a well.

Water that is not safe to drink. Water from the surface of the ground is never safe to drink. It always contains matter that has been washed into it by the rains, or has been carried to it by underground streams.

Water from a surface well is usually very dangerous. The well is near a house, where the surface of the ground often is soaked with wastes. Sometimes six or seven families bathe and wash their clothes near the well, to save the trouble of carrying water. The dirt washed from the bodies and from the clothes runs down into the well through the ground, especially if the ground about the well slopes toward it.

River water is not safe to drink. It is very unsafe when there are many houses on the banks of the river, for people throw wastes into the stream.

FIG. 79. Showing why the water of a river is unsafe to drink.

Many of the houses hang over the river, and all the dirt, sweepings, and garbage are thrown into the river. People wash their clothes in the river, and both persons and animals bathe there. Even a short river may have six or seven towns and barrios on its banks. It is not pleasant to think of drinking the water that has flowed by all these houses. By the time the water reaches the sixth or seventh town, it must be very dirty and unsafe.

Even a mountain stream that has only one house on its banks may be dangerous. If anybody in the house has cholera, dysentery, or diarrhea, and the wastes are thrown into the river, the water will be polluted, and people in towns far down the river may get the disease if they drink the river water.

FIG. 80. A river carries with it dirt and filth from all the towns on its banks.

In some towns that have irrigation ditches, canals are made along the streets, and people use the water from the canals. This is an insanitary thing to do, for water in the street cannot be clean. People wash clothes in these canals, animals walk through them, and dust and dirt from the street blow into them.

A water system. The best way to supply a town with water is by a water system. Pipes are laid from some stream to the town. A large pipe is put into each street, and a small pipe goes from the large pipe to each house. The water flows along these pipes, and the people in the house can always have water without the trouble of carrying it from a well or river. It is easy for them to keep clean their bodies, their clothes, and their houses, for they can always have all the water they need. There are many towns in the Philippines that could get water from mountain streams and at small cost could carry it to the town through pipes.

How a water system must be guarded. The water from the pipes will not be safe to drink if the supply is not properly guarded. The pipes must be laid to a part of the stream that is above all the houses. The municipality must not allow anybody to live on the river above the intake.[1] Nobody should be allowed to wash clothes, to bathe, or to swim in the river above the intake. If the water is carefully guarded in this way, it will be safe to drink.

Artesian wells. A water system sometimes costs a great deal of money, and it will be many years before most of the towns in the islands can have a water system. There is a cheaper way of getting good water. This way is not so convenient as the water system, but it is one that most towns can afford. This is by sinking artesian wells. An artesian well is made with a machine that digs a very deep hole. It digs down to the water that is buried deep in the earth. Water that is

[1] The intake is the place where the pipes take the water from the river or stream.

so far below the surface is pure, because germs from the surface cannot go so far through the ground. In 1907 and 1908, a few artesian wells were sunk in towns in Pampanga and Bulacan.

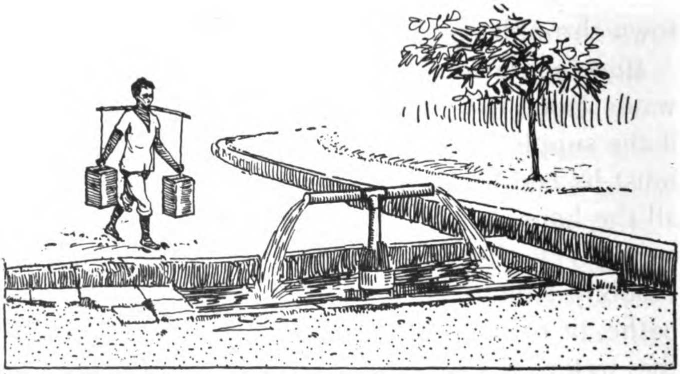


FIG. 81. Water from an artesian well is safe to drink.

In the next year there were only one half as many deaths as usual in these towns. Artesian wells always have water, even in the dry season. Many towns in the Philippines now have artesian wells. Every town and barrio should have them.

How to make wells safer. Water systems and artesian wells are the best ways of getting good drinking water, but at present most of the people cannot get water in either of these ways. How can they get water that is safe to drink, while they are waiting for the town to sink artesian wells or to build a water system? A great deal can be done to make surface wells and streams more safe than they are now. If you must drink water from a surface well, *take care that no impure water gets into the well.* Dig the well on a

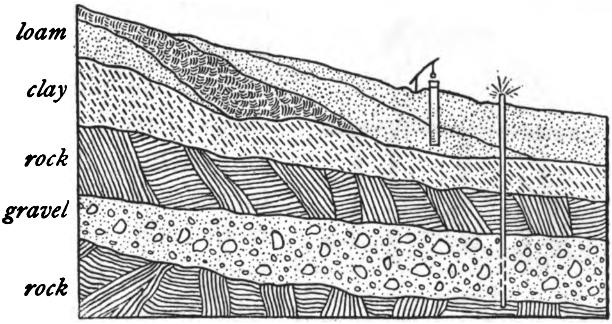


FIG. 82. A surface well goes only a little way into the earth, and gets water from surface streams. An artesian well goes through layers of clay and rock, and gets pure water from the deep underground streams.

high place and as far from the house, pig-pen, and stables as you can. Put tough clay or cement around the mouth of the well. This will carry surface water away and will keep it from running down behind the wall. Build a tight platform over the well, so that nothing can fall into the water. It is a good plan to build a roof over a well. The roof keeps dry the ground around the well and the rain drains away from the well, instead of draining into it. If the owner of the well can afford it, he should buy a pump, for pails that are handled by many persons may get dirty, and may get germs on them from the hands.

Do not let people bathe or wash near the well. It is a good plan to have a long bamboo tube running to a jar or pail at some distance from the well. When water is drawn, it can be poured into the tube; the water will run into the jar or pail. This saves carrying water, and bathing and washing may be done away from the well. Nobody who is sick, or who is taking care of sick persons, should go near the well. A well from which many people get water is usually unsafe, for there is always danger that some germ carriers are among them.

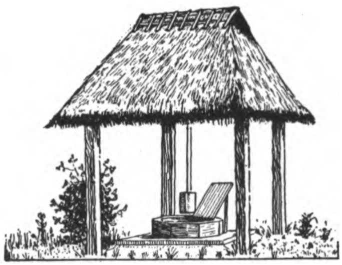


FIG. 83. A properly built well. It would be much safer if the water were drawn with a pump.

Why drinking water should be boiled. Even if a good well is built, and even if everybody in the house is very careful about the well, the water is not quite safe to drink. *You never can be sure that water from a well or a river is safe to drink unless you boil the water.*

In the first part of this book you learned that great heat kills disease germs. When water is boiled, the heat is so great that all the germs are killed. As soon as the germs are killed, the water is safe to drink. It is like raising a crop of rice. To raise rice, the farmer must plant seed in a field. To have disease, the seeds of disease must be planted in the body. Disease germs are

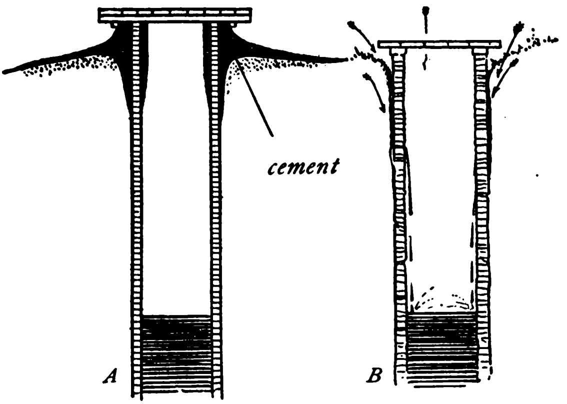


FIG. 84. *A* shows a well so arranged that surface water and germs are kept out of it. *B* shows how surface water and germs get into a well.

the seeds of disease. When a man drinks water that has disease germs in it, he is planting the seeds of disease in his body, and when they grow, they will produce disease. But any farmer knows that it is foolish to plant cooked rice for seed. The cooking has destroyed the life in the seed, and the seed will not grow. In the same way boiling destroys the life in disease germs, and even if they get into the body, they cannot grow.

Remember that to boil water is not the same as to heat it. The water must bubble as well as give off steam before it is boiled. Water for drinking should be boiled over a clear fire and should be covered so that it will not taste of smoke. After it has boiled, it should be poured

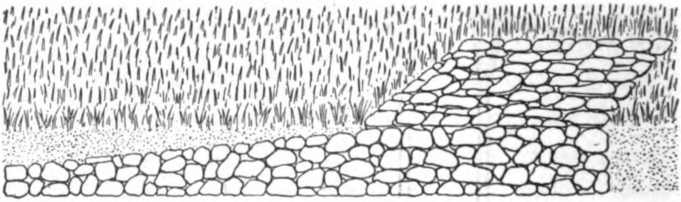


FIG. 85. A stone drain. Water poured here quickly seeps into the ground.

into a clean jar to cool. The jar must be covered, so that no dirt will get into the water. Sometimes people dip out the water with a cup or a bowl. When this is done, germs from the hands may get into the water. A long-handled dipper should be used for taking out the water. But the dipper must not be used to drink from. If several persons drink from the same dipper, germs from their mouths will have a chance to get into the water.

Tanks for drinking water. Large tanks are sometimes used to catch rain water and keep it for drinking. This water is much safer than water from a surface well, but it is not always pure. To have the water safe, the tank must be kept clean and covered. Water from a roof must not be allowed to run into the tank until after enough rain has fallen to wash the roof clean.

Disposing of waste water. It is always insanitary to have waste water standing under a house. It makes the ground damp, and therefore a good home for germs. Often garbage or other solid matter is in the water, especially in water used for washing dishes. If there is a well near the house, the water will drain into the well, and may carry disease germs with it. In a town that has a sewer system, such water is thrown into a sink, from which it goes into the sewer pipes. Figure 86 shows you a drain that has been found useful in the Scouts' camps.

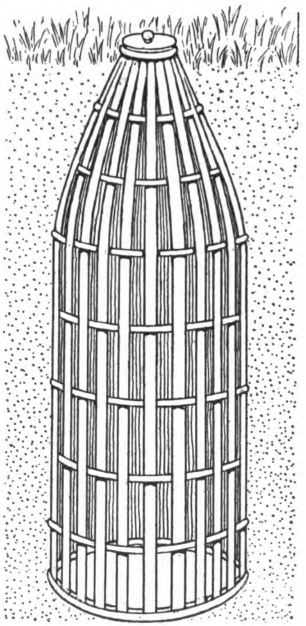


FIG. 86. A bamboo drain used in the Scouts' camps.

QUESTIONS

What kind of water is safe to drink? Is clear water always pure? What kind of water is unsafe? How do germs get into a well? Into a river? Why is the water in irrigation ditches in a town sure to be impure?

What is the best way to supply a town with water? How must the water supply be guarded? What is an artesian well? Is the water from an artesian well safe? How did the opening of artesian wells change the death rate in Pampanga and Bulacan?

What must be kept out of a well if the water is to be safe? Where should the well be located? What should be put around the mouth of the well? Why should there be a platform over the well? Why is a pump safer than well buckets? What may be done to prevent bathing and washing too near the well? Which is safer, a well from which many people get water, or a well to which only a few people go? Why?

When should drinking water be boiled? Explain how boiling water makes it safe to drink. How should water be kept after it is boiled? How may a safe supply of rain water be secured?

Explain why waste water should not be allowed to run under a house. How may waste water be safely disposed of?

SUGGESTIONS TO THE TEACHER

Recent studies have shown more and more the importance of the hands in spreading disease germs, and the dangers of a well so arranged that germs from the hands can get into it. Just as it is not safe for a great group of people to eat together and use the same dishes, so it is unsafe for many persons to handle the same well buckets and unsafe to use water which has in it the germs from the hands of these persons. If possible, each house should have its own well, which should be surrounded by a high fence that will keep the public away from it. A small pump, such as can readily be bought in any town, is far safer than well buckets; and if a well is used by more than one family, it is especially important that a pump be provided.

CHAPTER XXV

THE DISPOSAL OF HUMAN AND ANIMAL WASTES

One of the most important problems of sanitation is what to do with human wastes. Very dangerous germs are always in the wastes from the bodies of persons sick with cholera, dysentery, typhoid fever, diarrhea, and consumption. The eggs of intestinal worms are found in wastes. A person who has recovered from an infectious disease may be a germ carrier; he may still have a few germs in his body, and germs will be found in the waste matter from his body. All the time and everywhere, human wastes are dangerous. As long as they are allowed to lie where germs may be scattered from them, we can never be free from infectious diseases.

What should not be done with the body wastes. The body wastes must not be left where flies get to them. They must not be left on the ground, because part of them will soak into the ground. Then if there is a well or spring near, they will get into the water. When it rains, the water runs off the ground into brooks and rivers, and carries the wastes with it to infect the streams. Animals or persons may walk over the wastes and may carry the germs about on their feet.

Sometimes wastes are thrown into a river. It is not right to do this, for people in towns down the river may drink the river water. A river can carry the germs of disease many miles.

A sewerage system. The best way to dispose of body wastes is by a sewerage system. This is the only safe way in large cities. Where there is a sewerage system, pipes go out from every house, under the ground. Underground in the streets are larger pipes. Every house in the city is connected with a large pipe in the street. All these large pipes empty into a big tank. In this way the waste matter from the whole city is brought to the tank, and there it is left until all the solid matter sinks. The liquid matter on top is drawn off and purified, and then is allowed to flow into a stream. The solid matter is used for fertilizer.

Manila has a sewerage system, but the great cities in China and Japan have none. All large cities in the United States and in western Europe have sewerage systems. This is the best way to dispose of wastes, but it costs a great deal of money to build a sewerage system. For many years to come, most of the towns in this country must dispose of wastes in some other way that will be safe, and will be cheaper than a sewerage system.

The pail system. The pail system is the best way to dispose of wastes in towns that cannot build a sewerage system. In the closet of each house a pail is placed under the seat. Every night the pail is taken away, and a clean, empty pail is put in its place. All the pails are taken to a place far from the houses, and far from springs, streams, and wells from which people get water. The pails are emptied into a pit and are cleaned. The matter that is put into the pit is covered with clean earth.

The cost of the pail system. A town that uses this system must have two pails for each house, and it must buy or hire carts to use in collecting the pails. It is cheaper for the whole town to do this work than for every family to do it. In some towns the people may not be willing to have the pail system because they think that too much money must be spent for pails and carts, and for wages to the men who do the work. They do not understand that it is better to spend money to avoid disease than to have the people in the town weak and sick, and to have many of them die of infectious diseases. They do not understand that people save money by keeping in health.

How the municipal government can set an example. The municipal government can set an example to the people. It can build closets with pails for the schools, for the municipal building, and for the market. The health officer of the town should see that they are kept clean.

How each family can dispose of wastes in a sanitary way. If the municipality does not have the pail system for the whole town, each family can do something to dispose of its own wastes in a sanitary way. Each family can build a closet and can buy a pail. If the pail is large enough, it need not be emptied for several days. But a box of fine earth must be kept in the closet, and every person who uses the closet must throw some of the earth into the pail. The earth will cover the wastes so that insects cannot get to them, and will prevent the closet from having an unpleasant smell. Lime may be used instead of earth. When the pail is to be emptied, it must be covered and taken to the fields, away from the houses. There the wastes may be buried.

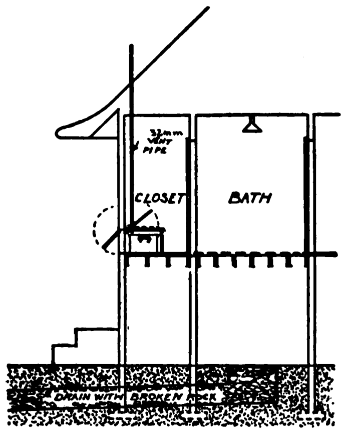


FIG. 87. How the ground under the house may be kept clean.

A family that cannot have a pail closet may build a pit closet. A pit is dug near the house, but not too near, and not near a well. A closet is built over the pit. Every person who uses the closet must throw in a little clean, dry earth. This kind of closet is not so good as a pail closet.

Keeping the closet clean. Any kind of closet,

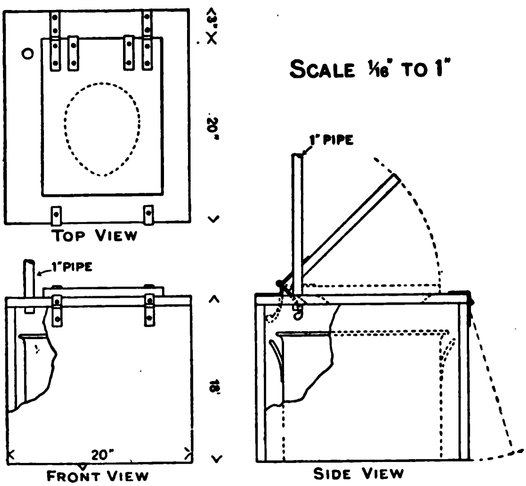


FIG. 88. A simple form of closet. A pipe carries all odors up into the air. A hinged door permits the removal of the pail for emptying.

whether it be a pail closet or a pit closet, must have a good seat. There must be a cover to the seat, and when the closet is not in use, the cover must be closed to keep out flies. The seat and the floor of the closet must be washed at least once a week. They should be washed oftener if they become soiled. If anybody in the house has an intestinal disease, it is best to wash the seat with a disinfectant every day.

How to dispose of animal wastes. It is insanitary to have animal wastes near a house because flies lay their eggs in such matter, and because the germs of some diseases, especially of tetanus, are found in animal wastes. The custom of keeping animals under the house is not a sanitary custom. The ground under the house and around it becomes damp and unclean. It is best to build stables and pig-pens. They must not be near a well or a spring, for fear of infecting the water. To keep a stable clean, all the manure should be swept up every day. It can be put into a large box or barrel, or into a large basket. Then it must be kept covered until it is taken to the fields, so that flies will not breed in it.

QUESTIONS

The germs of what diseases are often in human wastes? Mention some dangerous ways of disposing of wastes. Describe a sewerage system. What is done with the wastes where there is a sewerage system?

Describe the pail system. Is it cheaper for a town to pay for a safe way of removing waste matter, or to let it be scattered about? Why?

In places where there is no sewerage system, how may a family dispose safely of waste matter? How should a closet be cared for? Why is it insanitary to keep animals under a house? Where should stables and pig-pens be built? What should be done with the manure in a stable?

CHAPTER XXVI

WHAT EACH PERSON CAN DO FOR SANITATION

As you study this book, you may think, "I should like to do something to prevent these dreadful diseases from killing so many people. But I cannot do anything. I cannot build a water system, or a sewerage system; I cannot put a cement floor on the market; I cannot order the sellers in the market to cover their goods. There is nothing that a schoolboy or a schoolgirl can do." It is true that you cannot do anything so costly as building a water system, but you are mistaken when you think that there is nothing for a boy or a girl to do. *You can do a great deal to keep disease germs from getting into your own body.* This is very important, not only because it is unpleasant and dangerous for you to be sick, but also because other persons may get a disease from you. You are protecting other people as well as yourself when you keep germs out of your body. Another thing that you can do is this: *You can take care not to spread the germs of diseases.*

Keeping germs out of the body. If you want to keep disease germs out of your body, *you must be clean.* Especially must you keep your hands clean. This does not mean dipping them in water once a day. It means washing them carefully several times a day. You should always wash your hands after you have been to the closet. Remember that intestinal diseases are among the worst diseases that afflict Filipinos, and that germs from the body of a person who is not sick, or is not very sick, may be spread from the hands and may cause severe sickness in other persons. Your nails also must be clean. Germs gather in the dirt under the nails, and from them they get to food or anything that is touched.

FIG. 89. Washing the hands thoroughly with soap and water helps to free them from germs.

Keeping the body clean. To keep your body clean you must bathe. At least twice a week, you should wash your body carefully with soap. It is not wise to bathe after eating; the best time is in the morning before breakfast, or just before going to bed. Unless a person is sickly, a bath every morning is best.

Keeping the teeth clean. It is very important to keep the teeth clean. When food sticks between the teeth, it decays there and makes a good place for any germs that get into the mouth to grow and multiply. Then the teeth decay, and great numbers of germs go down the throat and cause trouble in the stomach and intestines. Every person should have his own toothbrush; he should never use another person's, and he should never allow another person to use his. He should be careful, too, to use only pure water for washing his teeth. Water that is bad to drink is bad to use in cleaning the teeth, for the germs in it get into the mouth and are swallowed.

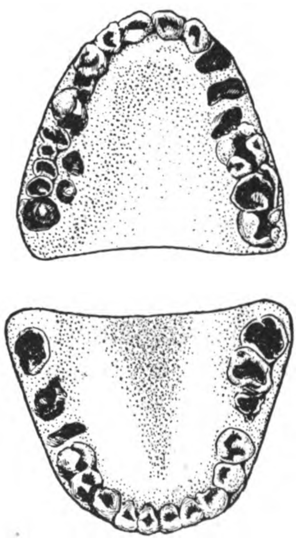


FIG. 90. Teeth like these furnish a place for the growth of disease germs.

Clothing. To keep the body clean the clothes, and especially the underclothes, must be changed often. Some persons sleep in the clothes that they wear all day. This is an unhealthful custom, for the clothes are damp with perspiration, and soiled by the perspiration and the scales that come from the skin.

Guarding the mouth. The germs of most diseases can get into the body through the mouth. It is necessary, therefore, to take care that germs do not get into the mouth. If you keep your hands clean, germs will not get into your mouth

FIG. 91. Keep the fingers away from the mouth, the nose, and the eyes.

from your hands. If you do not eat with your fingers from the same dish with other persons, and if you do not eat food that other persons have handled, you will not get germs from their hands. If you do not eat food that flies and cockroaches have been running over, you will not get the germs that those insects carry. If you do not drink from the same cup with other persons, you will not get from the drinking cup germs from other persons' mouths.

In guarding the mouth, remember what you learned in Chapter XI about putting into your mouth things that have been in the mouth of another person. Do not borrow pencils, whistles, or toys that other children have had in their mouths. Be careful not to borrow the books or toys of a child who has a cold.

Keep away from persons who have infectious diseases, unless you can do something to help them, for disease germs come from the bodies of the sick.

General directions for avoiding the spread of germs. It is necessary for you to take care to avoid spreading disease germs, as well as to avoid getting them into your own body. Many of the things to be done you have learned in this book. You will remember that many diseases are spread by people's hands. Here you see another reason for keeping your hands clean. Another way in which germs are often spread is in sputum. When you think how many persons die of consumption and other diseases of the air passages and lungs, you will understand why we say it is wrong to spit on the floor or on the street. From studying the chapters on intestinal diseases, you understand what harm people do when they are careless about the wastes from the body. *It is both indecent and insanitary to leave body wastes in any place except a closet.* When people are

FIG. 92. Do not put into your mouth anything that may have been in someone else's mouth.

working in the fields, far from the town, they should bury all waste matter and cover it well with earth. Intestinal worms are especially likely to be spread by wastes left in the fields.

Keeping the body strong. Our third great rule for avoiding germ diseases is this: Keep the body strong, so that it can fight disease germs that get into it. To do this you need good food, fresh air, and exercise. You will learn more about the needs of the body when you study physiology and hygiene. For the present, we shall speak of only a few habits that weaken the body, and so give disease germs a chance to grow in it.

Clearing the body of wastes. The body needs to be cleared of wastes every day. If this is not done, the unused food in the intestine makes a good home for germs. The germs make poisons in the intestine that weaken the body, and so give germs in other parts, as in the lungs, a chance to grow. Many headaches are caused by poisons made by germs growing in the intestine. You cannot keep your health unless the poisonous wastes are cleared out of the body every day.

Tobacco, alcohol, and opium. Tobacco, alcohol, and opium are all things that weaken the strength of the body. Smoking tobacco hurts the thin, moist lining of the air passages. Germs that get into the air passages find it easy to grow there.

Alcohol and opium weaken the body so that it cannot resist germs well.

Fresh air. Nothing strengthens the body more than breathing plenty of fresh air. The fresh outdoor air has a great deal of oxygen in it. When

FIG. 93. An insanitary and uncomfortable way to sleep.

we breathe this kind of air, the blood gets oxygen enough for the whole body. When we breathe the air of a close room where there are many other people, we do not get much oxygen. Instead, we get a great deal of the carbon dioxid that has come from the other people's lungs. At night many persons shut all their windows, and do not let any fresh air get into the bedroom. This is bad if only one person is sleeping in the room. But it is much worse if many persons sleep in the same room. The custom of covering the head also is bad, because the air that is breathed out must be breathed in again, and the

FIG. 94. A sanitary and comfortable way to sleep.

body gets back the carbon dioxid that it does not want, instead of getting the oxygen that it needs.

QUESTIONS

In what two ways can you help to check the spread of infectious diseases? Why must the hands be kept clean? Why is cleaning the teeth important? What causes teeth to decay?

What can be done that will help to keep germs from getting into the mouth? Mention some of the ways in which people spread germs. How can they avoid spreading germs in these ways?

What is the third great rule for fighting germ diseases? Why does it injure the body to have unused food lying in the intestine? Mention some things that weaken the body. Explain how it injures the body to be without fresh air.

CHAPTER XXVII

PUBLIC SANITATION

By public sanitation we mean the work that must be done by the town, the city, and the whole country, for the health of all the people. Whatever can be done better and cheaper by the government than by each family is public sanitation. Water systems, sewerage systems, the care of markets, the care of streets and roads, the building of hospitals — all these things are public work. They must be done by the government, because the government, which is all the people, can do the work cheaper and better than each family can do it for itself.

What a municipality should do for the health of its people. Part of the work of public sanitation must be done by the government of each municipality. The municipality must keep the town clean. It must try to get a good water supply for the people. It must keep the market in a sanitary condition. It must punish people who do anything that makes the town insanitary.

Sanitary work done by the government of the Philippine Islands. The government of the islands does a great deal for sanitation through the Bureau of Health in Manila. This bureau sends out vaccinators; it takes care of the lepers; it studies the diseases common in the islands and tries to help the people to avoid them; it sends doctors and nurses to places where there are epidemics. Another important part of the government work is the quarantine work at ports where ships from other countries come in.

The Bureau of Health also directs provincial and municipal officers in their sanitary work. It orders everybody to report to the health officer or to the municipal president every case of infectious disease. Sometimes the health officers quarantine the house; sometimes they isolate the patient; sometimes they send the patient to the hospital; almost always they disinfect the house and the patient's clothes.

Quarantine. When a town or a house is quarantined, no one may go out of it without the permission of the health officers. When a ship is quarantined, no person on the ship may go ashore without the permission of the quarantine officer. Quarantine is enforced to keep disease from spreading. It is especially valuable for ships, and is the only sure method of preventing the spread of disease from port to port. It is by quarantine that plague is kept out of this country; lepers are kept from coming in; and cases of infectious sore eyes are kept out.

Isolation. When a patient is isolated, he is put in a room by himself, and only the doctor and the persons who take care of the patient go into the room. Even when a person has only a mild disease, it is much better to isolate him, for germs from a mild case of a disease may cause a severe attack in another person. It is better for the patient, also; crowds of visitors excite and weaken him, and he will recover much sooner if his room is kept absolutely quiet.

Disinfection. There are several things that may be used for disinfecting houses, for disinfecting clothes, the hands, furniture, waste matter — anything that germs may be in. Some of these disinfectants are poisonous; some of them are good for clothes, but spoil metals; some are too strong for the skin, but may be used on clothes or furniture. It is best to ask a doctor or a druggist which disinfectant to use. The most common disinfectants are these:

Bichlorid of mercury. This is good for the hands, for washing floors and furniture, and for clothing that can be soaked in it. It is bad for metals, and it is not good for waste matter. It is very poisonous.

Biniodid of mercury. This is very good for disinfecting the hands and can be used on metals. It is put up in tablets ("germicidal discs") that contain besides the biniodid of mercury other substances to make the biniodid of mercury dissolve easily in water. It does not injure the hands.

Carbolic acid. Carbolic acid is useful for disinfecting anything. It is especially good for disinfecting sputum. Do not make the mistake of using a few spoonfuls of carbolic acid in a pailful of water when disinfecting, for this is too weak to kill germs. One part of the acid to twenty parts of the water must be used — a whole pint of the acid in a pailful of water.

Milk of lime. This is a cheap disinfectant, and is especially good for disinfecting the body wastes. To use it, put freshly slaked lime into four times its weight of water; or add the hard lumps of quicklime to the water and stir until you have a thick whitewash. Air-slaked lime (lime that has been in the air until it has crumbled to a fine powder) is worthless ; use only quicklime.

Sunlight as a disinfectant. Bright sunlight kills all kinds of disease germs. When clothing, furniture, or other articles cannot be disinfected in other ways, they should be placed where the sun will shine on all parts of them.

Hot water and fire as disinfectants. When you cannot get any of these disinfectants, remember that boiling water and fire will always kill germs.

Boil anything that can be boiled. Burn anything that is not of great value. Bury all wastes at once. Wash furniture and floors with hot water and plenty of soap. You can do a great deal in this way to prevent germs from your house from infecting the neighborhood.

Smell and disinfection. Some persons think that strong-smelling things will kill germs. This is a mistake. Germs are not injured by things burned in the sick-room, or by a little carbolic acid set out in a saucer. You would not try to cook rice by burning something else, or by setting it beside a pan of hot water. It is no more reasonable to try to kill germs by burning something else, or by putting a disinfectant near them.

Hospitals. A most important part of public sanitation is the building and maintaining of hospitals. In a place where there is a hospital, people who have any kind of disease can get good treatment. But hospitals are especially useful in epidemics. The patients are cared for by doctors and nurses who know what is best to do for each disease. They have the right medicine and the right food. In a hospital everything used by the patient can be disinfected. Germs from his body will not get to the food, the drinking water, the hands, or the clothes of other persons. There is no way of stopping the spread of a disease so sure as taking care of the patients in a hospital, where disinfection is understood.

What a village improvement society is. In many small towns in the United States, and in some towns in the Philippine Islands, there are societies or clubs called Village Improvement Societies. Such a society tries to find out what the town or village needs to make it a better place to live in. In some places, a new schoolhouse is needed; then the Society works to get a new schoolhouse. In another place, the streets are not kept clean; then the Society tries to get the town officers to clean the streets. In another place, perhaps, the plaza is illkept; the Society works to make the plaza a clean, pleasant place, with paths and shade trees. In short, whatever the town needs, the Society tries to get. Sometimes it raises money; sometimes it sends a petition to the municipal officers; sometimes the members give their time and do the work themselves.

What a village improvement society can do for sanitation. Is your town a sanitary town? Has it a good water supply? Has it a sanitary market? Do all the families have some sanitary way of disposing of wastes and garbage? Are there very few mosquitoes in the town? Is it well drained? Are there clean, convenient public closets for the schoolhouse, for the municipal building, and for the other public buildings? If there is anything that your town needs to make it sanitary, a Village Improvement Society should be formed. It will be easiest, at first, to interest the pupils in the school; but after a while the men and women in the town may be persuaded to join the Society. The Society should decide what the town needs most. It should try to find out how best to get it for the town; it should find out the best kind of thing to get or to do; it should find out the cost of doing it; it should try to interest all the people in the improvement of the town. If each member of the Society agrees to do what he can to keep his own house and yard in a sanitary condition, the town will be greatly benefited.

Who benefits by sanitation. Remember that it is the people of the town who suffer when the town is insanitary. They must stand the loss of time and money that comes from disease. Remember that it is the whole Filipino people that suffers when infectious diseases kill thousands of men, women, and children, and make many thousands more too helpless to support themselves. It is only by sanitation that the people can be protected against their enemies, the germs of disease. The whole people benefits by sanitary measures, for they make safe the life and the health of all the people. "We must bear in mind that in this most important of Philippine problems the ones directly interested are we ourselves, and only ourselves, the Filipinos. If these evils are not remedied, it is our people who suffer. . . . If, for economic reasons, we cannot at first solve the problem in all its largest extension, let us at least make a small beginning by putting into execution such measures as can be accomplished, measures of immediate practical application, without that being in any way detrimental to a realization, later, of the whole project."[1]

QUESTIONS

What is public sanitation? What are some of the things that a municipality should do for the health of the town? Mention some things that the government of the Philippine Islands does for the health of the people.

Explain the object and advantages of quarantine. What diseases are being kept out of the Philippine Islands by quarantine?

Name some disinfectants. How may germs be killed when we cannot get these disinfectants?

Why is it better to treat in hospitals persons sick with infectious diseases?

What can Village Improvement Societies do for their towns? What five things do you think your town most needs to make it a sanitary town? Can your school do anything to secure any of these things? Who is benefited by any sanitary work that is done in the Philippine Islands?

[1] From an address, *The Causes and Remedies of Infant Mortality in Manila*, by Dr. Fernando C. Calderon.

APPENDIX

THE USE AND ABUSE OF OPIUM

BY THE RIGHT REVEREND CHARLES H. BRENT

The Poppy. First let us see what opium is. It is a product of the poppy. The kind of poppy which produces opium is known as *Papaver somniferum*, or sleep-bearing poppy. The flower has petals of white or red, and leaves frosted with pale green bloom. It is hard to believe that this innocent-looking flower plays an important part in the world's history. But such is the fact. It is a valuable article of commerce. In India, China, Turkey, and Persia hundreds of thousands of hektars are under poppy cultivation. Millions of people are employed in caring for and gathering the crops. In India alone the profit to the government, or the revenue, reaches as high as ₱50,000,000 in a year. The poppy was once (1840–1843) the cause of a great war between England and China. China wished to prevent opium from coming into her territory from India. England refused to respect China's wishes, and the result was the Opium War.

Different countries have had commissions appointed to study the problem of controlling the use of opium. In 1909 thirteen great nations sent representatives to the International Opium Commission in Shanghai to study the question and make recommendations to guard against the abuse of opium.

Opium. The poppy is an important flower because it has medicinal value. The medical property of the poppy is opium. Properly used, it is a help in some forms of illness; wrongly used, it is an awful curse, destroying body, mind, and character.

Like all other blossoms, the poppy lives to bear fruit. At the close of its short life, the petals fall off and leave a green seed-pod or capsule. This capsule ripens into a brown, leathery shell. Before it is ripe its green coating is cut, or scored, and a milky juice flows out. This juice is caught in vessels and thickened into a gummy, brown paste. It is then made into balls or cakes of equal weight, when it is ready for the market.

Morphia. The most important drug derived from opium is morphia. It is used much in medicine. The dangers in its use are so great that doctors give it to sick people with caution.

Morphia is made chiefly in Germany from Turkish and Persian opium, which contains a larger percentage of the drug than Indian or Chinese opium. It takes the form of a white powder or tablet. Morphia is so powerful that as much as would cover this mark ● would be a strong dose, enough to send a person to sleep.

There are other drugs derived from opium. Some important ones are narcotine, codeine, heroin, and a liquid extract known as laudanum.

Medicinal use of opium. *Never use opium in any form except when a good doctor orders it.* It should then be taken only in the quantity and the way he directs.

The effect of opium is first to soothe the person who takes it. Soon after deep sleep follows. In countries where people do not have knowledge of medicine, they think that anything which quiets pain helps to cure sickness. For this reason in India, Formosa, and the

Philippine Islands opium is wrongly used to prevent or cure fevers like malaria. In India the natives eat it for this purpose. But fevers are not prevented or cured by opium. Because pain or discomfort is deadened, it does not follow that a cure is being worked. On the contrary, disease may only be increased.

Opium is given by doctors in one of the drugs mentioned. It is always prescribed in very small quantities. It is given through the mouth or else injected, usually into the arm, through a hollow needle. Good doctors give as small amounts and as few doses as possible.

The habit once formed of using any of these drugs is the hardest of all habits to break. The chief reason for using opium is to give momentary relief from severe pain. But even if the patient gets a little rest by using it, when he wakes he usually suffers unpleasant consequences. A craving is started for another dose.

Opium slows the pulse and retards the action of the bowels. An overdose stops the breathing, and death may follow from suffocation. If a person is poisoned with opium, give him strong coffee or an emetic like mustard and water, and use every means to rouse him from sleep.

Opium abuse. *Any use of opium except as a medicine is vicious and dangerous. Sooner or later it destroys manhood.* There are three chief forms which opium abuse takes: eating, smoking, and injecting.

1. *Eating opium.* In India the natives eat crude opium as an indulgence. About 2 per cent of the population have the habit. It frequently begins by fever patients taking opium as medicine. When they have once begun its use, they keep taking larger and

larger doses until body and mind and character are ruined.

2. *Smoking opium.* Opium smoking is one of the most harmful forms of opium abuse. You cannot compare it to tobacco smoking, which has not the awful results of opium smoking. Opium smoking is the chief indulgence of the Chinese. It is found also in the Philippine Islands.

Crude opium is specially prepared for the pipe. It takes the form of a thick liquid like molasses. The pipe is a hollow tube or stem with a small hole into the bowl on the side of the stem. A drop of prepared opium is cooked over a lamp and placed in the bowl. The smoker, lying down, takes a few puffs and inhales them. Then he sinks back into a dreamy stupor.

The effect of opium smoking is first to injure the digestion. The victim becomes thin and haggard. If he cannot get his dose at the usual hour, he grows nervous, has aches and pains, and is useless for work. A terrible craving for more opium seizes him. You have heard of the torture of travelers lost in a desert. Their thirst is no worse than the opium smoker's craving. He soon loses all moral decency. He will lie or steal to get a supply of the drug. Fathers have even sold their children to get money for opium. Misery, disease, and crime are the end of the opium smoker's career.

3. *Injecting opium.* It is in the form of morphia that opium is injected. Morphia should never be taken except under doctors' orders and in serious illness. Its frequent use forms a habit more quickly than opium smoking. Its consequences are similar, but it does its work of destruction to mind, body, and soul more rapidly.

It is possible for opium victims to be cured, though only after long suffering. Many so-called "opium cures" contain opium and only make the victim worse. An opium victim ought to be placed in the hands of a good doctor, whose advice should be followed. But an ounce of prevention is worth more than a pound of cure. Shun opium in every form as you would a poisonous snake. Never deceive yourself into thinking that you can experiment with opium. Persons who try it, "just to see what it is like," become slaves before they know it.

Opium legislation. The United States in all parts of her territory, including the Philippine Islands, prohibits the growth of the poppy and the manufacture of opium, which can be imported and used only for medicinal purposes. This law went into effect in the Philippine Islands on March 1, 1908.

Under Spanish rule the right to import and sell opium was annually sold, or farmed out, by the government to the highest bidder. Opium could be used only by the Chinese in the islands. Selling to Filipinos was prohibited, but the law was broken in some places.

After the American occupation there was no restriction on the sale of opium from 1901 to 1905. A duty was imposed on that which was imported. In 1903 a committee on opium legislation was appointed which recommended steps leading to the prohibitory law now in force. No licit or lawful opium, except for medicinal purposes, can now enter the islands. Some is brought in by smugglers.

The history of opium in China is interesting. It has been used there medicinally since the seventh century.

It did not become an alarming indulgence until people began to smoke it. Tobacco smoking was unknown in the Orient until the sixteenth century. The Spanish introduced it into the Philippine Islands from America, and quickly it spread throughout the East. The practice of mixing opium with tobacco began in Java in the seventeenth century. It was carried from there to Formosa. From Formosa it spread to Amoy and throughout the Chinese Empire.

Soon opium alone took the place of the mixture of opium and tobacco. The habit of opium smoking increased alarmingly, and in 1729 an Imperial Edict forbade it. From this time opium dealing became a crime in China, but the vice of smoking has spread until about 21,000,000 people are victims.

One reason why the vice is so bad in China is because England has annually sent large quantities of Indian opium into China for the last hundred years. In 1908, there were shipped to China 3,930,650 kilos of Indian opium. China herself also produces more than this amount annually. For many years China has fought against Indian opium, but England has been too strong for her and has kept on sending it to China. It means a large sum of money to India, for which country England is financially responsible. In 1907 England and China agreed that the Indian export for China should be decreased one tenth every year, and the production in China should also be decreased one tenth every year. Therefore after 1917 the opium trade will cease in China. The whole world is interested in the attempt of China to free herself from the vice of opium abuse.

CHOLERA CIRCULAR NO. 1

The circular here reprinted was issued by the Bureau of Health for the Philippine Islands: —

MANILA, P.I., *August 29, 1905.*

Cholera has reappeared in the city of Manila and its vicinity. *This disease can be introduced into the system only through the mouth.* It is caused by organisms too minute to be seen except with a microscope. These organisms are readily killed by heat, and the disease may therefore be successfully combated by the proper use of fire and hot water, which are at the disposal of every one.

To avoid cholera and prevent its spread observe the following precautions: —

1. Boil all drinking water and place it while hot in covered vessels. Do not dip up the water when needed, but *pour* it into drinking cups; otherwise cholera germs may get into the water from the hands.

2. Do not touch drinking water or food with the hands unless they have just been washed in water that has been boiled.

3. Eat only cooked food. Avoid all fruits, raw vegetables, and raw fish. Dried fish may be made safe by thoroughly heating. Fruits may be made comparatively safe by dipping them a few seconds into boiling water.

4. Flies may carry cholera germs on their feet from human excreta to food; therefore, to protect it from flies, cover all food immediately after it is cooked.

5. If cholera appears, build smudges under houses to drive flies away.

6. Boil all water used for diluting milk.

7. Cook all meats and fish thoroughly so as to heat the same throughout.

8. Keep kitchen and table dishes thoroughly clean and scald them before using.

9. Keep the place in which you live, the ground under the house, and everything pertaining to it, clean.

10. Outhouses, closets, and vaults can be made safe by putting in lime or carbolic acid. When this cannot be done, dejecta must be buried or thoroughly covered with earth.

11. Isolate all the sick. It is recommended that a house in each barrio be set aside for this purpose.

12. All the dead should be embedded in lime and buried three feet under the surface.

13. Filth or vomit and the dejecta of the sick should be promptly cleaned up with boiling water and buried.

14. Clothes and bedding used by sick persons must either be burned or boiled. Do not wash any clothes near wells or springs nor permit surface water to run into any well or spring.

15. Municipal presidents and municipal councilors should enact these rules as ordinances and see that they are enforced.

16. All school children are requested to inform their parents of these rules, which, if observed, will prevent great loss of life.

BOOK TWO

PHYSIOLOGY AND HYGIENE FOR THE TROPICS

We suffer from disease because of ignorance;
we escape it through knowledge.

RICHARDS

CHAPTER I

LIFE AND HEALTH

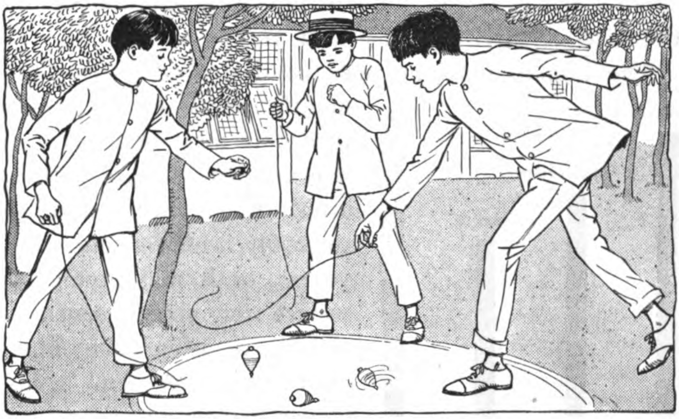


FIG. 1. The length of time a top will spin depends on the conditions under which the spinning is done.

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 the state of Massachusetts 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 Germany before the great European war human life was lengthening at the rate of three months each year.

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.

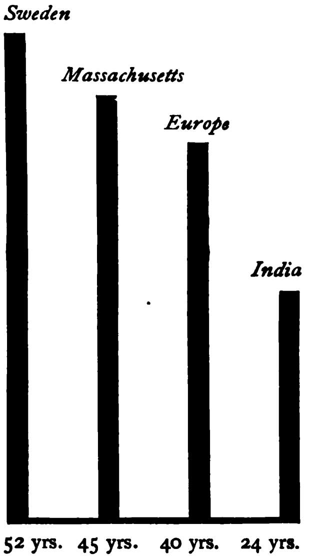


FIG. 2. A diagram showing the average length of life in different parts of the world. The length of time the human body lasts depends on the care that it receives.

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 New Zealand it was 18; and in Manila in 1914 it was 58. 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.

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. 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, people are still suffering from disease because of their ignorance. The ancient Greeks taught that knowledge is virtue and that ignorance is sin. 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.

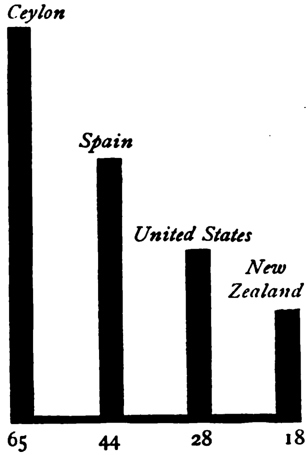


FIG. 3. A diagram showing the average daily number of sick persons per 1000 inhabitants in different countries in 1912. The amount of sickness in any country depends to a great extent on the degree of intelligence its people use in dealing with matters of health.

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 the second part of this book we shall study the human body and the laws of its life.

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

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 was human life lengthening in Germany before the great European war? 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 New Zealand? in Manila? 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?

SUGGESTIONS TO THE TEACHER

A person's general point of view has a great deal to do with his usefulness, and the teacher should gradually lead the class to see the advantages of a strong body. The pupils should understand that all wealth must come by labor; that a people can have only what it earns by its work; and that a weak or sick people is not able to do much work and therefore must remain poor. The intelligent care of the human machine and its use in an intelligent way is the basis of all civilization and progress, and one of the first duties of schools is to educate the pupils in matters that pertain to their own and the public welfare.

At all times, therefore, the teacher should attempt to teach not only the subject-matter of the lessons but the applications of the lessons to the lives of the pupils and to the community in which they live, and the class should be trained to the idea that much illness can be prevented by proper foresight.

CHAPTER II

THE HUMAN BODY

THE human body is a wonderful machine. It walks and runs, it breathes, it eats, it sees and feels, it thinks. It is made of hundreds of parts; yet all these parts work together as one whole. In all the world there is nothing else so wonderful as the body in which we live. In this chapter we shall study the plan upon which it is built.

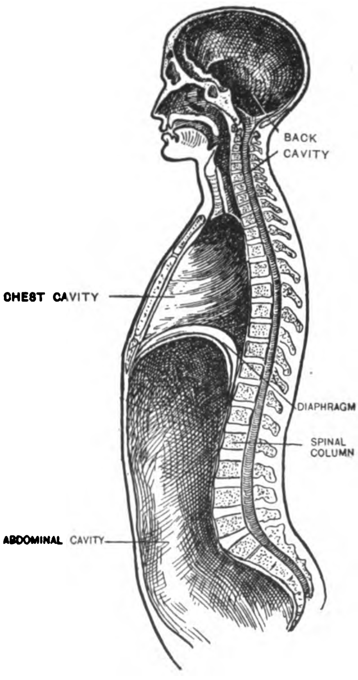


FIG. 5. The cavities of the body.

The three divisions of the body. The body has three great divisions: the head, the trunk, and the upper and lower limbs (arms and legs). Each of these divisions is made up of many parts. On the opposite page you can see a picture of the body and learn the names of some of its most important parts.

The two cavities of the body. There are two cavities in the body; and many organs (parts of the body) are in these cavities. One cavity is in the head and in the

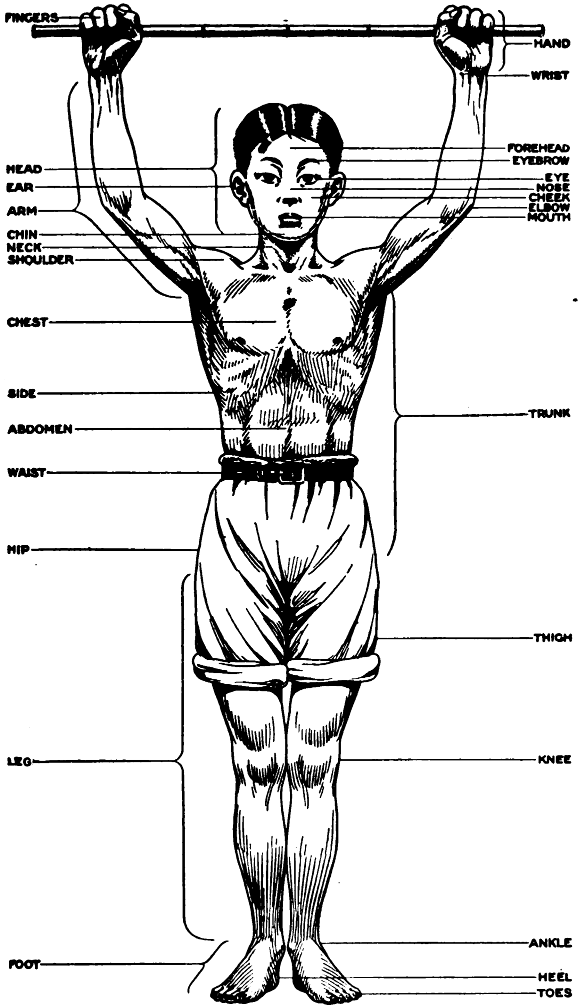


FIG. 6. Parts of the body.

bones of the back. The brain and the spinal cord are in this cavity. The other cavity is a great cavity in the trunk. It is divided by the diaphragm into an upper part (cavity of the chest) and a lower part (abdominal cavity). The heart and the lungs are in the chest. The stomach, liver, intestines, kidneys, and some other organs are in the abdominal cavity.

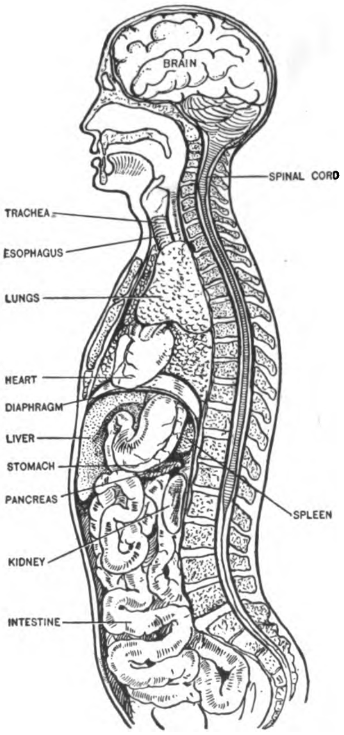


Fig. 7. Section of the body showing the position of the organs in the cavities.

The work of the body parts. The body is supported by the bones. It is moved by the muscles. The lungs take in oxygen for it from the air. The stomach and intestine and their helpers prepare food for it. The heart pumps the blood through the body, and the kidneys take poisonous wastes out of the blood. Each of the many body parts has a work to do, and unless each part does its work the body will die.

There is a story about a pair of arms that grew tired of always finding food for the lazy stomach. The arms said that the stomach did not work and yet it took all the food. So they got no more food for the stomach. But by and by all the body became hungry and sick, and the arms became weak and hungry too. Thus we

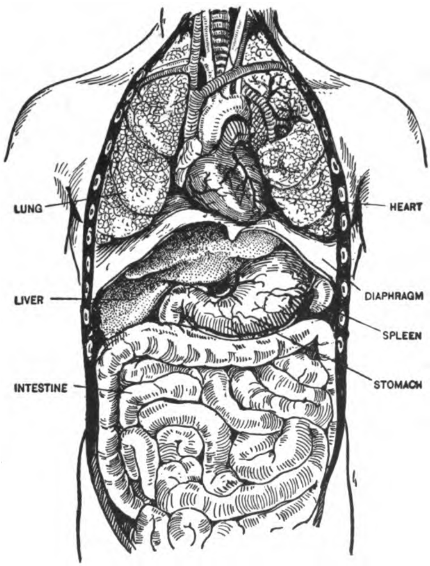


FIG. 8. The organs in the chest and abdominal cavities, seen from the front.

see that each part of the body must do its work, or the body cannot be well. The bones cannot do the work of the muscles, and the stomach cannot do the work of the lungs.

The ruler of the body. All parts of the body must be made to work together; over them all a ruler must be set. This ruler of the body is the nervous system — the brain and spinal cord, with the nerves that go out from them (Fig. 99). When we walk, it is the nervous system that causes the right muscles to move. When we eat, the nervous system sets the digestive organs to work. It governs the heart and lungs and controls all the body. *The nervous system governs all the body and causes all its parts to work together for the good of the whole.*

Anatomy, physiology, and hygiene. In this book, we shall study the parts of the body and the way they are joined together. This is *anatomy*. We shall study also the work that these parts do. This is *physiology*. We shall study also how to take care of the body so that it will not become sick. This is *hygiene*. Of all the subjects that you will study, either in school or after you leave school, hygiene is the most important; for when you study hygiene you are learning how to keep the Laws of Life.

QUESTIONS

What are the three great divisions of the body? Where is the brain? Where is the spinal cord?

What is the upper part of the cavity of the trunk called? What is the lower part called? What separates these two cavities? What organs are in the chest? What organs are in the abdominal cavity?

Tell the story of the arms that refused to get food for the stomach. What is the work of the nervous system?

What is anatomy? physiology? hygiene? Why is hygiene important?

CHAPTER III

THE SKELETON

THERE are two hundred and six bones in the human body. These bones are called the *skeleton.* Feel your body in almost any part, and under the skin and soft flesh you will find the hard bones. Under the hair and skin of the head, there are bones. In the fingers and in the toes, there are bones. Down the middle of the back, you can feel a row of bones under the skin. All through the body you will find bones, and each of these bones has a work to do. On page 193 you can see a picture of the skeleton and learn the names of the principal bones.

Work of the skeleton. The skeleton has three kinds of work to do. Its first and greatest work is to support the body. If there were no bones in the body, the body would be weak and soft and would fall down; but the bones are hard and strong and hold up the body so that it can stand upright.

The second work of the bones is to protect the parts of the body that are easily hurt. The brain, the heart, and the lungs are delicate organs, and they are protected by the bones of the head and the bones of the chest.

The other work of the bones is to help the muscles move the body. The work of the muscles (Fig. 22) is to move the body; but if there were no bones, they could not do this work. The muscles are fastened to the bones, and they make the body move by pulling on the bones. We shall learn more about the use of the skeleton in moving the body when we study about the muscles.

The skull. The *skull* is made up of the twenty-eight bones of the head. Eight of these bones make a strong box (the *cranium*) to protect the brain. Six little bones

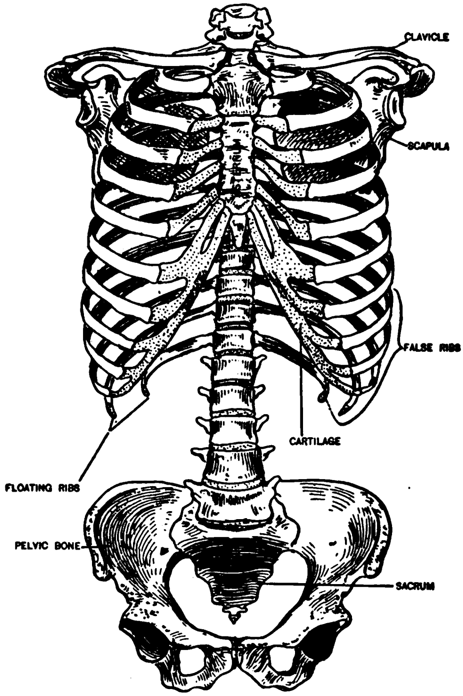


FIG. 9. The bones of the trunk.

are in the ears, and the other fourteen bones of the skull form the skeleton of the face.

The spinal column. The *spinal column* is the most important part of the skeleton for supporting the body. It holds up the trunk, and the head sits on top of it. The arms are fastened to the trunk, so that the spinal

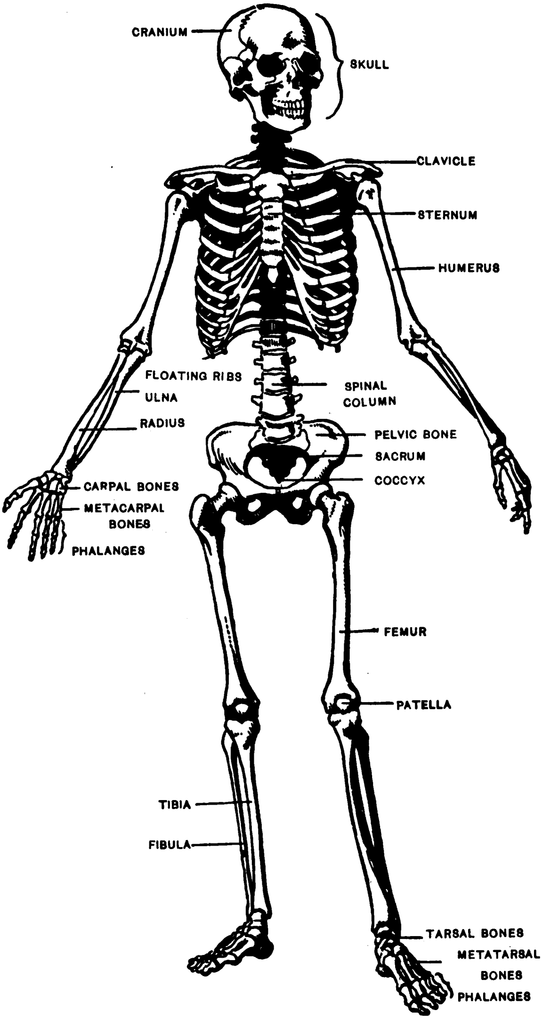


FIG. 10. The skeleton.

column must hold these up also. When a person's spinal column is broken, it is not possible for him to stand up or to walk, because the spinal column supports all the upper parts of the body. Examine Figure 10 and you will see that all the upper part of the body stands upon the spinal column as on a stem.

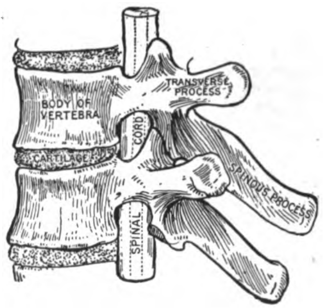


FIG. 11. Vertebræ.

The spinal column is made of many parts, and each one of these parts is called a *vertebra* (plural, *vertebræ*). If the spinal column were all one bone, we could not bend our bodies or move our heads as we do. But the spinal column bends a little between each pair of vertebræ, so that we can easily bend our bodies forward or backward or from side to side.

At the lower end of the spinal column, five of the vertebræ unite and form a large bone (the *sacrum*). Below the sacrum, three or four little vertebræ are united to form the *coccyx*. All together there are twenty-six bones in the spinal column.

The ribs. The *ribs* are twenty-four in number, twelve pairs. They are all joined to the vertebræ at the back. Seven pairs of ribs are joined to the *sternum* in front, three pairs are joined to the other ribs, and the two lower pairs have their front ends free. The ribs that are joined to the sternum are called the *true ribs*, those that are joined to the other ribs are called *false ribs*, and those that have their ends free are called *float-*

ing ribs. The ribs are long, slender, curved bones, and they go around the chest and protect the heart and lungs that lie within the chest. They are also used in breathing to move outward and upward the walls of the chest.

FIG. 12. The scapula. This flat bone has many muscles attached to it. The ridge strengthens the bone, and its end provides a point against which the clavicle can be propped.

Other bones of the trunk. The other bones of the trunk are the *pelvic bones* and the *shoulder bones.* The pelvic bones are large, strong bones. These two bones and the sacrum are all united and form the *pelvis,* or lower part of the skeleton of the trunk. The shoulder bones are called the *clavicle* and the *scapula.* The upper bone of the arm is joined to the scapula, and the clavicle goes from the scapula to the sternum and holds the scapula in place. When a person falls on his shoulder, the clavicle often is broken. Then the shoulder falls forward and downward.

The bones of the arms and legs. The bones of the arms and legs are very similar. The arm and the leg have each a large bone in the upper part and two smaller bones in the lower part. The arm has many small bones (*carpal bones*) in the wrist, and the leg has many small bones (*tarsal bones*) in the ankle. In the hand, between the wrist and the fingers, are five bones (*metacarpal* *bones*); and in each foot, between the ankle and the toes, are five bones (*metatarsal bones*). The fingers of each hand have fourteen bones (*phalanges*), and the toes of each foot also have fourteen bones (*phalanges*). The arms and legs have the same number of bones; but there is one more bone in the wrist than there is in the ankle, and the arm has no bone like the *patella*, or knee-cap (Fig. 10).

FIG. 13. A femur with the mineral matter removed.

The materials in bone. A bone has two kinds of materials in it: animal matter and mineral matter. The mineral matter is hard like stone. Through this mineral matter run little fibers (threads) of animal matter. Many of these fibers are found on the surface of a bone, forming a covering (the *periosteum*) like a tough skin on the outside of the bone. If you put a bone into the fire, all the animal matter (the fibers) will burn up, but the mineral matter will not burn. If a bone is put into acid, the acid will take out all the mineral matter and leave the animal matter.

The uses of mineral and animal matter. The mineral matter makes the bones strong and stiff so that they will support the body, but this mineral matter is very brittle (breaks easily). The animal matter bends easily and does not break, but it is not stiff enough to support the body. If you bend a bone that has been in the fire, it breaks easily, because there is no animal matter in it. A bone that has been in acid bends so easily that it can be tied in a knot. This is because the mineral matter is all gone. *The mineral matter makes the bones stiff, and the animal matter keeps them from breaking.*

Experiments. Burn a bone for a long time in a hot fire. What has the bone lost? Try bending it. What effect has the burning on the bone?

Fill a bottle with weak hydrochloric, sulfuric, or nitric acid (2–5% solution). Soak a slender bone in the acid until it is limber. The bone from the leg or wing of a chicken will serve for this purpose, and if no acid is at hand, strong vinegar may be used instead. What does the acid remove from the bone? What effect has this on the bone?

Bones of old persons and of children. The bones of an old person are very brittle, and if he falls they are likely to break. When a bone of an old person is broken, the ends grow together very slowly, and sometimes they will not grow together at all. An old person should not be expected to climb ladders or do anything that may cause him to fall; for to an old person a fall may be a very serious matter.

The bones of a little child have much animal matter in them. They bend easily, but it is difficult to break them, because the animal fibers bend and do not break. When the bones of a young person are broken, they grow together quickly, because there is much living matter in them.

Shapes of bones. Where the principal work of a bone is to protect some part of the body, or where many muscles are joined to a bone, the shape of the bone is usually flat. But where the chief work of a bone is to support the body, it is often round. The bones of the cranium and the sternum are examples of flat bones that protect internal organs. The scapula is a flat bone to which many muscles are joined. The long bones of the arms and legs are examples of round bones. The vertebræ of the spinal column have a round part for supporting the body, and a long, flat spine behind to which the muscles are attached (fastened).

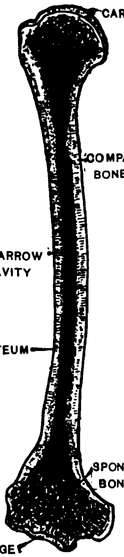


FIG. 14. Longitudinal section of the humerus.

Structure of bones. It is necessary that the great bones of the body be light, for if they were very heavy, the muscles could not move them. There are holes all through the bones to make them light. In the flat and small bones and in the ends of the long round bones you can see little holes like the holes in a sponge. This kind of bone is called *spongy bone.* The central parts of the long bones are made of hard bone; but even this hard bone is full of microscopic holes. In the center of the long bones there are long cavities (marrow cavities) filled with blood vessels, nerves, and fat. These holes and cavities in the bones make them light; and at the same time they are strong, as you can show by the following experiment:

Experiment. Hold a sheet of paper as you see in Figure 15. Set the paper on its end and lay your book on it. Will it support the book? Now roll a sheet of paper into a hollow cylinder. It is now shaped like the long bones of the arms and legs. Will it support the book? Is it stronger than it was before you rolled it? Is it heavier? Why is a bamboo so light and strong?

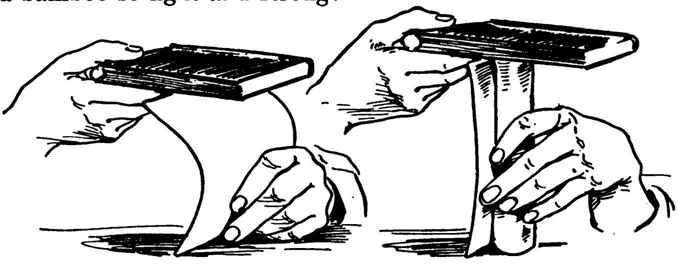


FIG. 15. Experiment showing that a hollow, cylindrical bone is strong.

QUESTIONS

Point to the different parts of your body and tell what bones are in each part. What three kinds of work does the skeleton do?

What is the upper and back part of the skull called? What part of the body does the spinal column support? How many ribs are there? To what are the ribs joined at the back? in front? How many bones are in the arms? in the legs?

What two kinds of material are there in bone? How can you take the animal matter out of bone? the mineral matter? What is the use of the mineral matter? of the animal matter? Explain why old persons should be protected from falls.

What kinds of work do flat bones do? round bones? Give examples of flat and round bones.

Give two reasons why some bones must be large. How are bones made light and at the same time strong?

CHAPTER IV

THE SKELETON (Continued)

JOINTS

CLOSE your hand and look at the fingers as they bend. There are three bones in each finger, and these bones do not bend when the hand is closed. The fingers bend only where the ends of two bones come together.

FIG. 16. The hip joint and the ligaments that hold the bones in place. This is a good example of a ball-and-socket joint.

The place where two bones come together is called a *joint*. You will understand how important the joints are when you know that it is only at the joints that any part of the skeleton can move. If we had no joints, we could not move our arms or our legs. We could not sit or walk. The body would be stiff and straight like a stick all the time, and we could not move it or bend it in any way.

Kinds of joints. The bones of the cranium are fastened firmly together and do not move at the joints. In the wrist and in the ankle are many small bones, and each one of these bones moves only a little. In the spinal column, each vertebra moves only a little. But where the ends of two long bones come together, the bones must move more than a little. In these places there are two principal kinds of joints: ***hinge joints*** and ***ball-and-socket joints.***

Hinge joints are very numerous in the body. A hinge joint, like the hinge of a door, moves in only two directions. The elbow joints, the knee joints, and the joints of the fingers and toes, are all examples of hinge joints. Examine any of these joints and you will find that you can move them forward and backward, but not from side to side.

Ball-and-socket joints permit the bones to move in any direction. A ball on one bone works in a socket in the other bone. The ball can turn in the socket in any way and the bone can move in any direction, out, in, forward, or back. The shoulder joint and the hip joint (Fig. 16) are ball-and-socket joints.

The two joints of the thumb toward the tip are hinge joints. You cannot bend the thumb from side to side at these joints. But the joint at the base of the thumb is a ball-and-socket joint, and at this joint the thumb moves in any direction. Examine your thumb and see how it moves at all the joints. Try how you can move your arm at the shoulder, and stand up and see in how many directions the hip joint permits the leg to move.

CARTILAGE

Almost all of the skeleton is made of bone, but a little of the skeleton is made of *cartilage.* Cartilage is white, and it is not so hard as bone. It is more like very hard, white rubber; it can bend easily, without breaking, and come back again to the same shape. There are thick pieces of cartilage between the vertebræ, and it is found in all the joints over the ends of the bones. The cartilages over the ends of the bones are very smooth, so that the joints work easily. In all the joints, the cartilages are wet with an oil-like liquid, and this liquid helps to make the bones move easily on each other.

Cartilage is also found in the front parts of the ribs. The ribs are slender bones, and if they were made all of bone they might get broken; but because part of each rib is made of cartilage, they can bend without breaking.

Ligaments

All around the joints are many very strong fibers called *ligaments*. The ligaments grow to the bones on each side of the joints and all around them, and hold the ends of the bones together. All the bones of the skeleton are fastened together by ligaments.

Hygiene of the Skeleton

By binding the heads of the children tightly against boards, certain tribes of the North American Indians flatten the back of the skull and make the head slope up to a peak at the back. By binding the feet of girl babies, the Chinese make the feet grow into unnatural shapes. By constantly carrying a young child astride the hip, the child's thigh bones can be bent outward. By writing at a high desk, a child can have its spinal column bent to one side and one shoulder raised higher than the other. Excepting the teeth, the skeleton is the hardest part of the body. Yet when it is growing it can be made to take almost any shape.

Care of the skeleton in youth. Little boys and girls should not carry heavy loads of water, grass, rice, and other things, because carrying heavy loads will bend the bones of the shoulders and will cause trouble with

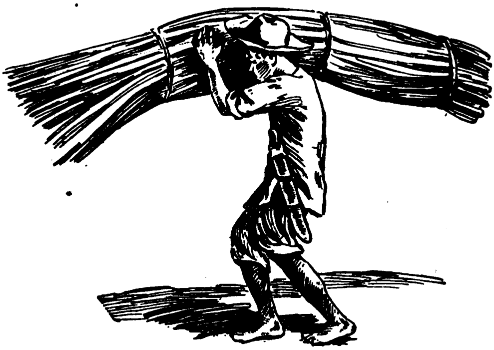


FIG. 17. Too heavy a load.

the feet. If the loads are always carried on the same shoulder, the spinal column will be bent to one side. This heavy work should be done by older boys and men, whose bones are hard.

Children should learn to stand and sit erect. Then, when they are older and their bones become hard, the parts of the skeleton will be in the proper positions. There should be low benches in the schoolrooms for the small children, so that the children's feet will touch the floor. If a child's legs and feet hang in the air, they will pull the head and shoulders forward, and the child will become stooped; but if the child can put his feet on the floor, he will have no difficulty in sitting upright.

Sitting down on the feet is a bad position, because in this position the head sticks forward instead of being upright, the ribs are pressed in on the heart and lungs, and the organs in the abdominal cavity are crowded together. A person who wishes his body to be healthy and beautiful should sit on a chair or a bench and not on his feet.

FIG. 18. A bad position.

Broken bones. When a bone is broken, it is necessary to place the broken ends together and keep them together until the bone is healed. If the broken ends move about, they cannot grow together. If the ends are not put together properly, the bone will be crooked when it is healed.

If the bone of a limb is broken, the limb should be pulled out straight so that the bone will be straight and the broken ends will be together. Then the limb should be wrapped in cloth; and outside the cloth, pieces of wood should be placed around the limb. Then cloths should be tied around outside the pieces of wood. This will hold the broken ends of the bones in place until they grow together. A physician should always be called to do this work, and he should come soon after the bone is broken. In a little time after the accident, the limb will be swollen, and it is then difficult to tell when the broken ends are together and the bone is straight. In places where there is no physician near, another person may set a broken bone, but a physician should always see it as soon as possible, because it is very difficult for any one but a physician to get the broken ends of the bone together properly.

In lifting or carrying a person with a broken arm or leg, keep the broken limb stretched out straight. This

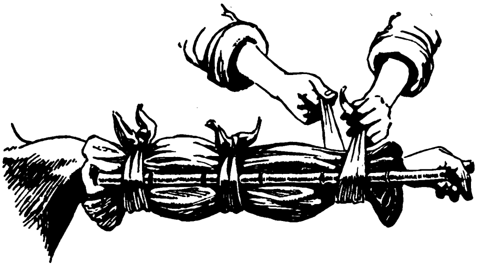


FIG. 19. Setting a broken bone before the physician arrives.

is important; for if the limb is allowed to bend, the sharp edges of the broken bone will cut the flesh. Lay the injured person on a bed, a cot, or a mat, and have one person support the broken limb.

Sprains. When a joint is bent too far, the ligaments around it are broken or pulled away from the bone. An injury of this kind is called a *sprain*. Often the ligaments of the ankle are hurt in this way. A sprain heals by new ligaments forming to take the place of those that are broken. A bad sprain often heals more slowly than a broken bone.

Treatment of sprains. Until a physician can be called, a sprained joint should be bathed in either hot or cold water. This will help to keep the injured part from swelling and becoming painful. It is also helpful to stroke and rub the injured part so as to press the blood up the limb toward the body. A sprained joint should be carefully bandaged to keep the bones from slipping about, and it should be exercised as soon as the pain will permit this to be done. Using an injured joint will keep it from being stiff after the injury has healed, but it is necessary to exercise a sprained joint with care, or the new ligaments may be broken up faster than they can be formed.

Dislocations. Sometimes the ligaments around a joint are broken and one of the bones gets out of place. It is then *dislocated*. It is necessary to put the bone back in its place and keep it in place until new ligaments grow around the joint. Usually no one but a physician can put a dislocated bone back in its place, and he should be called before the parts are swollen.

A dislocated joint should be treated like a sprain, but care must be used to keep the bones in place until the injury has healed. It should be carefully bandaged, and then gently exercised in a way that will not cause the bones to be dislocated again.

The Skeletons of Other Animals

The human skeleton like the skeleton of other animals. Many small animals have no bones in them, but all the larger animals have skeletons like the skeleton of a man in many ways.[1] Each of these skeletons has a spinal

[1] Man, the lord of the Animal Kingdom, is constructed after the same type as the cat which purrs at his feet, the ox which he eats, the horse which bears his burden, the bird which sings in his gilded cage, the snake which crawls hissing across his pathway, the toad which hides in his garden, and the fish which swims in his aquarium. All are modifications of one creative thought, showing how the Almighty Worker delights in repeating the same chord, with infinite variations. — Steele.

column, and in many higher animals we find ribs and a sternum. There are always bones that correspond to the human shoulder bones and pelvic bones, and four limbs are attached to these bones.

In the limbs of many different kinds of animals, — fishes, frogs, birds, bats, and animals that walk on four feet, — we find bones corresponding to the bones in the limbs of a man. In some animals, certain bones are very much longer than they are in man, as the phalanges in the wing of a bat and the metacarpals in the foot of a horse. Often the bones are united, as the tibia and fibula in a frog and the carpal and metacarpal bones in many animals. In some ways, the skeletons of these animals are very different from the skeleton of man; but in them, all the principal bones correspond to the principal bones in the human skeleton.

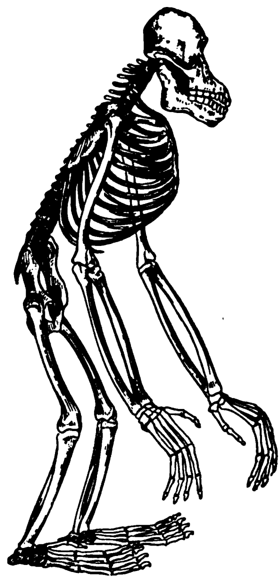


FIG. 20. Skeleton of an orang-utan.

The skeletons of monkeys, especially of the apes (large tailless monkeys), are very similar indeed to the human skeleton. In a monkey's skeleton you can find all the bones shown in Figure 10, and from it you can see how the different kinds of joints in the human skeleton work.

Differences between the human and other skeletons. There is one difference between the skeleton of a man and the skeletons of all other animals. In man, the pelvis is very wide, and the heads of the femurs are joined to the pelvis in such a way that the legs of a man are parallel to the spinal column. For this reason man walks upright. In all other animals, the legs are perpendicular to the body, and these animals must walk on four feet, with their bodies parallel to the ground. This is one great difference between the human skeleton and the skeleton of other animals.

Other peculiarities of the human skeleton are the very large cranium and the bending back of the spinal column at its upper end so that the skull balances easily on top of it. When an ape stands up, its head sticks out forward. This makes it very difficult for the muscles on the back of the neck and shoulders (Fig. 29) to hold the head from falling forward. The hand of a man differs from the hand of a monkey in the way the thumb works opposite the fingers, when the hand is holding anything; and the arms of a man are much shorter, in proportion to his height, than the arms of a monkey. When a monkey stands up, its arms reach below its knees.

QUESTIONS

What is a joint? Name two principal kinds of joints and give examples of each. In how many directions can a hinge joint move? a ball-and-socket joint?

What kind of joint is the elbow joint? the shoulder joint? the knee joint? the hip joint? the finger joint? Find other joints in your body, and tell whether they are ball-and-socket or hinge joints.

Where in the skeleton is cartilage found? Why is cartilage useful in joints? Of what advantage is the cartilage in

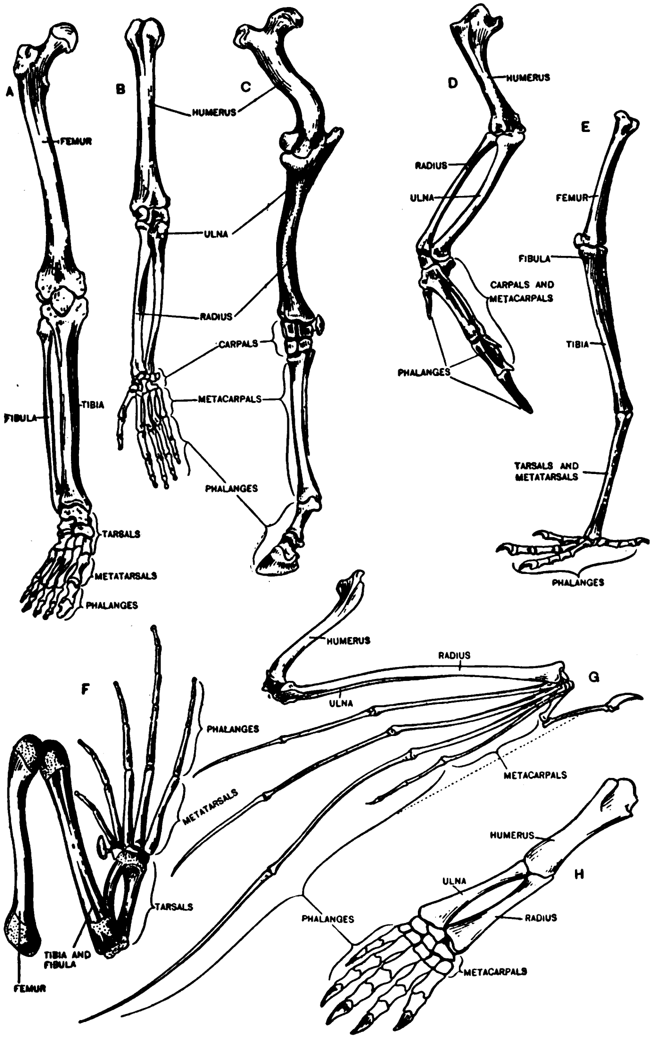


FIG. 21. The limbs of different animals. *A* is the human leg; *B*, the human arm; *C*, the fore leg of a horse; *D*, the wing of a bird; *E*, the foot of a bird; *F*, the hind leg of a frog; *G*, the wing of a bat; *H*, the fore leg of a tortoise.

the ribs? Where are ligaments found? What use have they?

Why is heavy work injurious to boys and girls? Why should children learn to stand and sit properly when they are young? Why should small children have low seats in the schoolroom? Explain why sitting down on the feet is a bad position.

Why must the ends of a broken bone be kept together? Tell how to set a broken bone. What is a sprain? a dislocation? What should be done at once for a dislocation or a sprain? Why should a joint that has been dislocated or sprained be exercised? Why must care be taken in exercising a joint that has been dislocated?

In what ways do the skeletons of the higher animals resemble the human skeleton?

Study Figure 21 and see how the animal limbs there pictured differ from each other and from the limb of a man. Get the bones of some animal's leg and name the different bones.

What is one great difference between the human and other skeletons? How does the human cranium differ from the cranium of other animals? the human spinal column? Why is it difficult for a monkey to hold its head upright?

SUGGESTIONS TO THE TEACHER

The lessons on the skeleton will be much more interesting if the teacher can show some bones to the class. Usually some of the pupils can bring the bones of animals for this purpose. Those that have been exposed to the weather for some time are the most pleasant to handle. One of the long bones should be sawed lengthwise to show the marrow cavity and the spongy and compact bone.

If the skeleton of a monkey can be prepared and kept in the school collection, it will be found very valuable for teaching purposes. The flesh can be removed by continued boiling and by scraping.

The skull must be opened and the brain removed, and then the whole skeleton should be boiled in alkali to remove grease. Lye, such as is used in soap-making, may be used for this purpose. Strong soap may also be used to remove the grease, or wood ashes may be stirred into the water in which the skeleton is boiled. Expose the skeleton where ants can have access to it, and they will remove all remaining particles of flesh. The bones may be fastened together by wires; if care is used in the preparation, many of the ligaments will remain in place. Any material that is collected or prepared should be saved for the use of future classes.

It is most important that pupils be comfortably seated in school. The larger pupils should be seated in the higher desks, and if there are no seats low enough for the younger children, small footstools should be provided for them. The seat should be of such a height that when the feet are flat on the floor (or footstool) the under sides of the legs back of the knees will rest very lightly on the seat. The desk should have a slope of about fifteen degrees, and should be of such a height that the forearm will rest easily on it when the elbow is held out a hand's breadth from the body. The edge of the desk should be directly over the edge of the seat; or, if it does not interfere with the pupil's getting into and out of the seat, the desk may overlap the seat an inch.

The pupils should be allowed to move about freely and change their positions in their seats. They will study better and can be kept quiet more easily if they are comfortable.

CHAPTER V

THE MUSCLES

In the last chapter we studied about the skeleton, and we learned that there are two hundred and six bones in the human body. In this chapter we shall study about the muscles of the body. There are over five hundred of these muscles. They cover the skeleton and help the bones to inclose the cavities of the trunk.

The size and shape of muscles. The muscles are of many different sizes and shapes because they must move the parts of the body in many different ways. In the pictures of the muscles, you will see that some muscles are flat and some are round; some are long and some are short; some are large and some are small. On your upper arm, you can feel the large muscle (the *biceps*) that bends the arm; and if you open and close your fingers, you can see the muscles that move the fingers working in the forearm. One of the great muscles that bend the leg is over half a meter long, while the six little muscles that move the eye (Fig. 130) are very small. Each muscle has the size and shape that is necessary for it to do its work.

The location of the muscles. Most of the muscles are attached to the bones; but a few are found inside the body and are not joined to the skeleton. The muscles inside the body are in the walls of the stomach and intestine (Fig. 41), in the walls of the blood vessels and heart (Fig. 72), and in the walls of other internal organs.

The work of the muscles. The muscles help the ligaments to hold the bones together, and they help the

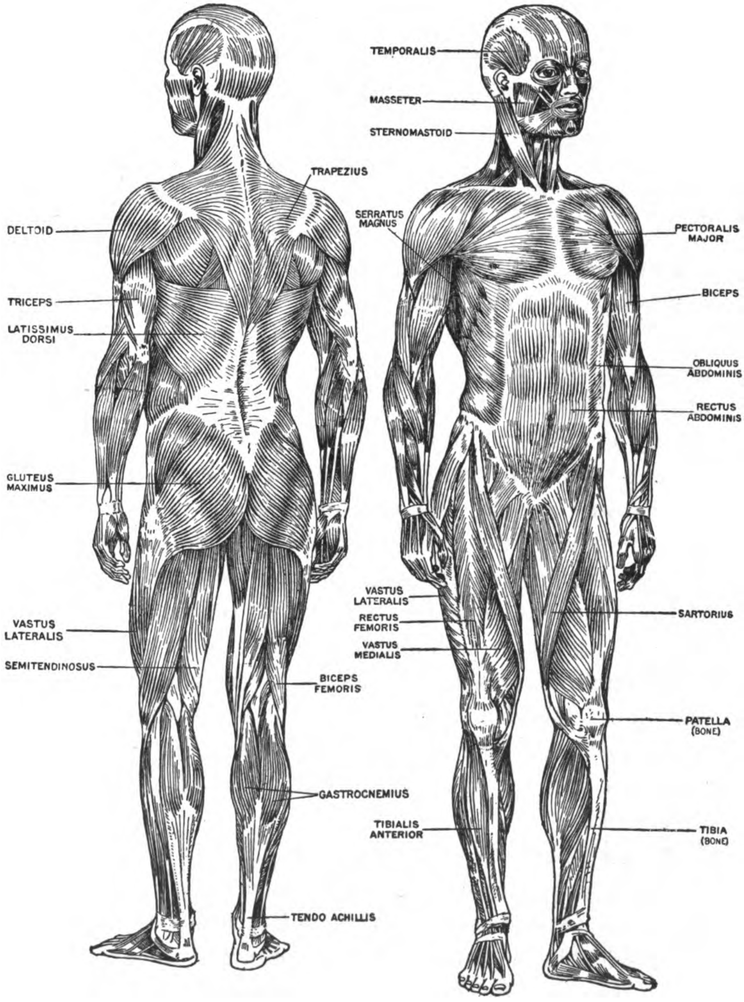


FIG. 22. The outer muscles of the body.

bones to protect the internal parts of the body; but *the great work of the muscles is to move the body.* It is the muscles that move the parts of the body when we walk or run, when we turn the head or the eyes, when we breathe, and when the heart beats. No part of the body can move in any way unless the muscles move it.

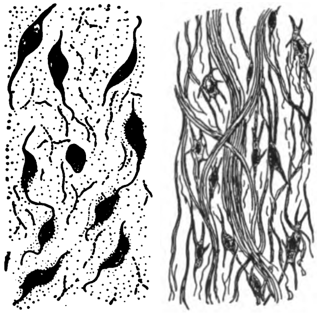
FIG. 23. An involuntary muscle fiber from the wall of the stomach.

Voluntary and involuntary muscles. We can move some of our muscles when we wish. These muscles are called *voluntary muscles.* But there are other muscles in the body (*involuntary muscles*) which we cannot move when we wish. If we wish to move our arms, we can do so, because the muscles of the arm are voluntary muscles. But the heart beats all the time. It is an involuntary muscle, and we cannot make it move and we cannot stop it. Most of the muscles that cover the skeleton and are attached to it are voluntary muscles, and most of the muscles that are in the walls of the internal organs are involuntary muscles.

Structure of muscles. Muscles are soft and have a red color. The lean meat of animals is muscle. Fat is sometimes found in a muscle, and there is often fat around a muscle; but it is the lean part of the muscle that works.

Muscle fibers. Under a microscope, one can see that a muscle is made of many little parts (*muscle fibers*). There are two kinds of muscles and there are two kinds of muscle fibers. The fibers of voluntary muscles are about three centimeters long and are very slender. They have rounded ends, and there are dark stripes across them. The fibers of the involuntary muscles are much shorter, their ends are sharp, and they are not striped.[1]

Connective tissue fibers. If you examine a muscle of an animal, you will see a covering like a thin skin all around the muscle. Cut the muscle across, and you can see partitions running all through the muscle and dividing it into many parts. You can see these partitions in a piece of lean meat where it has been cut across. A thin slice of dried beef shows them very well.



FIGS. 24 and 25. Connective tissue fibers. All through the body a framework of connective tissue runs, holding the cells, organs, and tissues in place. The young connective tissue cells form a soft substance about themselves (Fig. 24) that hardens into the fibers seen in Figure 25.

With a microscope we can see that the covering of the muscle and the partitions in the muscle are made of many fine, strong fibers (connective tissue fibers). From the partitions these fibers run out and go everywhere through the muscle. They form a network all through and around the muscle fibers and hold all the parts of the muscle together.

[1] The pupil who has studied agriculture will understand that all plants and animals are composed of cells. (See Clute's *Practical Lessons in Tropical Agriculture*, Book I.) The involuntary muscle fibers are long cells. A voluntary muscle fiber is a compound cell. It begins as an ordinary cell; its nucleus divides; and it grows in length. But no dividing cell walls come in, and we have a structure (the muscle fiber) that is like hundreds of cells placed end to end with the partitions between them removed. The fiber is filled with living material (protoplasm).

Attachment of muscles to bones. We learned in the third chapter that the surfaces of bones are covered by a thick network of connective tissue fibers called the periosteum. At the ends of the muscles, the connective tissue fibers come out of the muscles, spread out on the surfaces of the bones, and go in among the fibers of the periosteum. They wind themselves in among the fibers of the periosteum and attach the muscles to the bones.

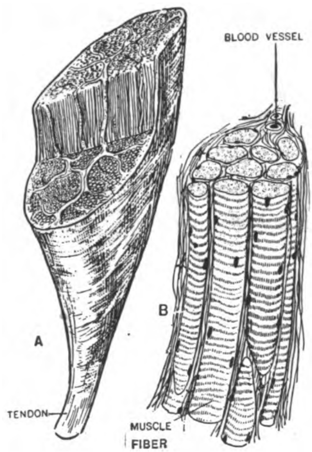


FIG. 26. *A* is a portion of a muscle showing the connective tissue covering and the connective tissue partitions which divide the muscles into bundles of muscle fibers. In *B* a part of a bundle of fibers is shown as they are seen under a microscope.

Tendons. Sometimes the fibers grow to a bone near the end of the muscle; but the connective tissue of a muscle may unite and make a strong white cord (string), called a *tendon.* The tendons go from the muscles to bones, — often to bones that are far away, — and there the fibers of the tendon run in among the periosteum fibers and join the tendon to the bone.

How the muscles move the body. A muscle fiber can become shorter and thicker. It can draw itself together as a worm does in crawling, or as a rubber band does when it has been stretched. When a fiber does this, it is said to *contract.* When the muscle fiber again becomes longer, it *relaxes.* When all the cells of a muscle contract at one time, the whole muscle becomes shorter. Where one end of a muscle is attached to one bone and the other end to another bone, the muscle pulls the bones together when it contracts. This makes the skeleton bend at the joint and move that part of the body.

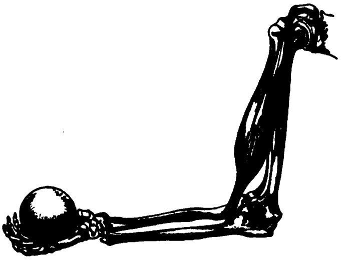


FIG. 27. Showing how the biceps muscle lifts the forearm.

Put your hand to your cheek and close your teeth. You can feel the muscle in your cheek as it draws the jaws together. Lay your hand on the front of your arm above the elbow and bend your arm. You can feel the biceps muscle shortening and thickening itself as it raises the forearm. In Figure 27, you can see how the biceps muscle bends the arm by pulling on the radius. All the movements of the body are made by the muscles pulling the parts of the body in this way.

Use of tendons. Some parts of the body, like the hands, must be small to do their work. Wherever it is necessary for a part of the body to be small, the muscles that move that part are in some other place and are joined to the bones by tendons. There are about thirty muscles to move the fingers of each hand, because the fingers move in many ways. If all the muscles that move the fingers were on the hand, the hand would be too large and thick to be beautiful or to do its work well. But the muscles that move the hand are in the forearm, and tendons from these muscles are attached to the bones of the fingers. When the muscles in the forearm contract, the tendons pull on the finger bones and open and close the fingers. If you open and close your hand,

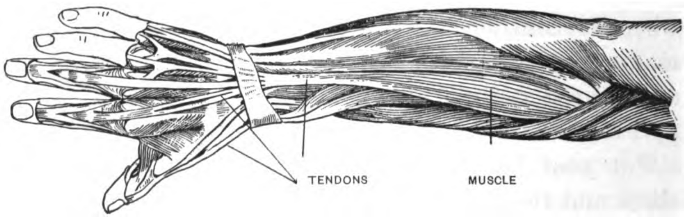


FIG. 28. The muscles of the forearm and the tendons that move the fingers.

you can see these muscles working in the forearm, and in the wrist you can see the movements of the tendons that go to the fingers.

Tendons run down along the ankles and feet to the toes in the same way that the tendons go to the fingers. If you cut off the leg of a chicken and look under the skin, you will find these tendons. They look like white strings. Pull on them, and they will move the toes. These tendons come from the muscles in the leg of the chicken, and the muscles move the toes by pulling on the tendons.

Circular muscles. Around the mouth and the eyes, the muscles run in circles; and when they contract, they close the mouth and eyes. If you put a string around the mouth of a bag and then pull the string, it will close the mouth of the bag in the same way.

Pairs of muscles. Very many of the muscles of the body are in pairs. One muscle pulls a part of the body one way, and another muscle pulls it the other way.

On the front of the upper arm is the *biceps* for lifting up the forearm; and on the back of the upper arm is another large muscle (the *triceps*) to pull the forearm out straight again.

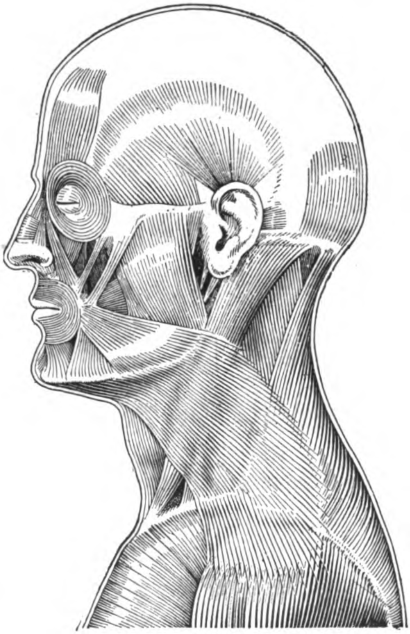


FIG. 29. The muscles of the head.

All through the body we find this arrangement of the muscles in pairs. We have muscles to open the fingers and other muscles to close them; muscles to bend the legs and other muscles to straighten them; muscles to make the body stoop and other muscles to pull it upright again.

Constant contraction of muscles. Straighten out your forearm and make your arm stiff so that it will not bend at the elbow. Now feel your triceps muscle. It is hard and contracted. The triceps keeps the arm from bending. It does this by pulling on the back of the ulna.

When we are sitting, standing, walking, or doing other things, there are many muscles that must always be contracted to make the body stiff. A dead body will not stand up, because the weight of the body makes the skeleton bend at the joints. But in the living body, when it is standing, there are muscles contracted so that they hold the body from bending at the ankles, knees, hips, back, and neck. If a man goes to sleep when he is sitting, his head will fall forward, because the muscles on the back of the neck are no longer contracted. Not only do muscles contract when the body moves, but whenever any part of the body is upright there must be many muscles contracted to hold it in this position.

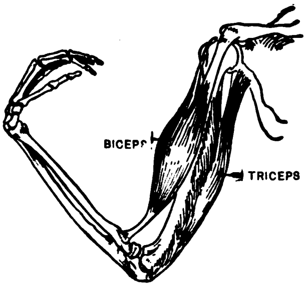


FIG. 30. The action of the biceps and triceps muscles.

Good positions for work. In a certain factory the work of one man was to put the finished machines together. The parts of the machine were laid on the floor, and working on the floor the man was able to put together two machines in an hour.

By and by the man was given a table on which to work, and the parts of the machine were laid on the table for him. At once he was able to set up five machines in an hour, and at the end of the day he was less tired than he was before. When he worked on the floor, he used more of his strength in holding his body in a stooping position than he used in his work.

People everywhere waste much of their strength by working in awkward positions. They work on the floor or on the ground when they could do the work far more quickly and easily standing up or sitting at a table. The more work people can do, the more money they can have, and it is useless for a person to tire himself out for nothing. Study all the time how you can do your work more easily. *Let your head save your back.*

Hygiene of the muscles. Good food, good air, exercise, and rest are necessary to keep the muscles strong. These four things are necessary not only for the muscles, but also for all the other organs of the body. In the chapter on exercise, we shall study the effects of these things on the muscles.

QUESTIONS

Why do muscles differ in size and shape? In Figure 22 point out some long muscles; some flat muscles; some round muscles. What three kinds of work do the muscles do? What is their chief work? What is a voluntary muscle? an involuntary muscle? Give examples of each.

Of what is a muscle made? Where do we find connective tissue fibers in a muscle? What is the work of these fibers? How is a muscle attached to a bone? How is a tendon united to a bone?

When a muscle contracts, what change is there in its shape? What change is there when it relaxes? Explain how the arm is moved by the contraction of the biceps. Move different parts of the body and find where the muscles are that move these parts. Explain the use of tendons.

Where in the body are there circular muscles? Show by a string in the mouth of a bag how these muscles work. Find some pairs of muscles that work in opposite directions. Tell what muscles must be contracted to hold the body upright.

What persons have you seen working in awkward positions?

SUGGESTIONS TO THE TEACHER

One always takes more interest in a machine if one knows how it works, and the pupils are much more likely to become interested in hygiene if they understand something of how the body is built and of how its different parts carry on their work. It is well, therefore, to teach the names, the location, and the action of a few of the more important muscles. The pupils should feel these on their own bodies, and the body of a frog can be used to demonstrate the action of muscles in bending the limbs. Kill the frog, remove the skin, and allow the pupils to examine the muscles of the hind legs. Ritchie's *Human Physiology* and Hartman's *Laboratory Manual for Human Physiology* will provide the teacher with much help and many experiments for teaching this and other chapters in this book.

The importance of saving muscular strength by studying out easier ways of doing things and by using animals and machinery in place of hand labor may be called to the attention of the class. Houses, clothes, crops, books, roads, and all other property and improvements come through labor. This fundamental fact ought to be clearly understood by the pupils, and they should be trained to look with disfavor on all useless and inefficient labor, waste, and needless losses (as through preventable fires, diseases of men and animals, locusts, etc.). This point of view gives a new regard for the dignity of labor, it lifts the workman into the class of thinking beings, and the idea of studying constantly how work can be done more easily and efficiently is more important in the advancement of a person or of a people than the knowledge of how to do any one particular thing. It is well, therefore, for the teacher to make the class see the great usefulness of the muscles as servants, but at the same time to point out the desirability of always having these servants carefully directed by the brain.

At this time the class should have a review on what has been learned of the general structure of the body. A set of questions is provided for this purpose on the next page, and similar sets of questions will be found at appropriate places throughout the book. These should be used to review and impress on the minds of the children the most important facts that have been learned.

REVIEW QUESTIONS

Chapter I. What was the length of the average life in Europe 300 years ago? What was it in 1910? What is the average length of life in Sweden today? in India? How many persons are sick each day for each 1000 inhabitants in Manila? in New Zealand? What is the wise course to follow with regard to Nature's laws?

Chapter II. Name the divisions of the human body. What is in the back cavity of the body? the chest cavity? the abdominal cavity? Name some of the principal organs of the body and describe their work. What is the function of the nervous system? What is anatomy? physiology? hygiene?

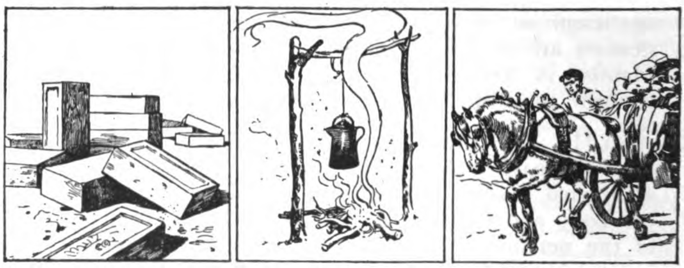
Chapter III. Name the bones of the body. Give three functions of the skeleton. Of what two kinds of material is a bone composed? What is the function of each kind of material? Why should old persons be protected from falls? How are bones made light and at the same time strong?

Chapter IV. Name two principal kinds of joints and give examples of each. Why is cartilage useful in joints? What are ligaments and what is their use? What effect has heavy work on the skeletons of young persons? Why should young children have low seats in schoolrooms? Tell how to set a broken bone. How should a sprain or a dislocation be treated? How does the human skeleton resemble the skeleton of other animals? How does it differ from them?

Chapter V. How many muscles are there in the body? What three functions do they have? Give examples of voluntary and involuntary muscles. Of what is a muscle composed? How is it held together and attached to a bone? Explain what happens when a muscle contracts. How does a muscle cause movement? Explain the use of tendons. What muscles must be contracted to hold the body erect? Why is it wasteful to work in an awkward position?

CHAPTER VI

FOODS AND WHY WE NEED THEM



FIGS. 31, 32, and 33. Foods furnish the body with building material, heat, and strength.

TODAY we take in food. Tomorrow the food is gone and again we are hungry. We eat again, and the next day find our need for food as great as it was at first. We spend our lives working for food and eating food, and yet only a few short hours behind, hunger is always following on our trail. Why cannot we forget all about food? What makes us want to eat? Why must we spend our money for something that we cannot keep? Why not give up eating and have time to rest and enjoy life? Let us see if we can learn the answer to some of these questions.

Food gives power to work. We think of an automobile as a swift and powerful machine. In reality the power comes from the gasoline that is used in the engine, and without gasoline an automobile has no more power to move itself than has a stone.

Every other machine that moves must be run by power that comes from outside itself. The windmill runs by the force of the wind; the cart moves by the force of the animal that draws it; the waterwheel is turned by the power of the falling water; and the steam that is formed by the burning of the fuel under the boiler enables the steam engine to do its work.

The human body cannot give itself strength to work. This strength comes from the food that is eaten. The food that you eat furnishes the power that you use when you walk or when you run. *The first use of food is to furnish the body with power to work.* Without food the muscles cannot contract and cause the movements of the body parts.

Food gives the body warmth. A stove in which kerosene or wood is burned gives off heat. The heat does not come from the stove itself, but from the wood or oil that is burned in it.

Feel your body and you will find it warm; it is giving off heat. This heat comes from the food that you eat. Without it the body would become cold and die. *The second use of food is to furnish heat to the body.*

Food furnishes building material to the body. The outer part of the skin is all the time falling away in scales as the bark falls from a tree. The living matter in all the internal parts of the body also wastes away. Why, then, does your body not become lighter and thinner instead of growing larger and heavier? It is because every particle of material that wastes away in heart or muscle or brain or skin is replaced by new materials, and at the same time new living matter is built up for making the body larger. This new material for growth and repair is made from the foods that we eat.[1] *A third use of food is to furnish the body with building material.*

Different foods composed of different materials. Sweet potatoes are a good food, but if a man had nothing but sweet potatoes to eat he would die. Fruits are very beneficial to the health, but one cannot live on fruit alone. Meat gives the body strength and vigor, but it would be unwise to have nothing but meat for food. We need a variety of foods to keep us in health. Let us see why this is the case.

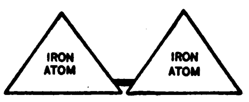


FIG. 34. Diagram illustrating the composition of a molecule of iron. Iron is an element because the atoms in its molecule are of the same kind.

Atoms and molecules. When you study chemistry, you will learn that everything is made up of very small bodies called *atoms*. These atoms unite and make larger bodies called *molecules*. Chemists have discovered many things about atoms and about how atoms make up molecules, although both atoms and molecules are so very small that no one has ever seen them.

Elements. Some substances are pure; that is, the atoms in their molecules are all of the same kind. A substance of this kind is called an *element*. Iron is an element because its molecules are each made up of two atoms of iron, as you see in Figure 34. Gold also is an element, because its molecules have in them only one kind of atom. Oxygen, nitrogen, hydrogen, silver, lead, copper, and sulfur are a few common elements. All together there are more than eighty elements, and the atoms in each element are different from those in

[1] "What we eat today is walking around and talking tomorrow."

every other element. There are, therefore, more than eighty different kinds of atoms.

Compounds. Compounds are impure substances; they have more than one kind of atoms in their molecules. Hydrogen is a gas, and oxygen is a gas. When two atoms of hydrogen and one atom of oxygen unite, they form water. Water is a compound because its molecules have two kinds of atoms in them. It is unlike the two elements from which it is formed, because it is usually a liquid and not a gas.

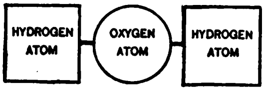


FIG. 35. Diagram illustrating the composition of a molecule of water. Water is a compound because it has more than one kind of atoms in its molecules.

Carbon is the black solid which you see on the burnt end of a match, and oxygen is one of the gases of the air. If one atom of carbon and two atoms of oxygen unite, they form a poisonous gas, carbon dioxid. This is a compound, because its molecules have two kinds of atoms in them. In the same way that water is made by combining atoms of hydrogen and oxygen, and carbon dioxid is made by combining atoms of carbon and oxygen, thousands of other compounds are made by combining the atoms of the eighty elements in different ways.

The language of chemists. Chemists do not write the whole names of substances. Often they write only the first letters of the names of elements, as *H* for "hydrogen" and *O* for "oxygen." For water, they write H_2O, meaning that in a molecule of water there are two atoms of hydrogen and one atom of oxygen. "Carbon dioxid" is written CO_2, because each of its molecules is made of one atom of carbon and two atoms of oxygen.

The elements in foods and in the body. Of the elements in foods, carbon is the most abundant. Hydrogen and oxygen are also present in large quantities, and some foods contain nitrogen, sulfur, and other elements in small amounts. The body is composed of fourteen elements, and these elements must be supplied to the body in the food and water taken into it.[1]

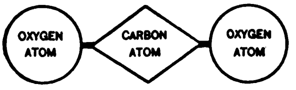


FIG. 36. Diagram illustrating the composition of a molecule of carbon dioxid. This gas is a compound; its molecules have in them two kinds of atoms.

Foods are compounds. Charcoal is almost pure carbon, but the body cannot supply itself with carbon by eating charcoal. Four fifths of the air is nitrogen, yet we make no use of the great amounts of this gas that we breathe into our lungs. Phosphorus is necessary for health; yet phosphorus is a deadly poison, and if we were to eat pure phosphorus it would prove to be anything but a food. Before we can use these elements in our bodies they must be built into compounds, — large molecules that are composed of a number of elements. This building of foods is done by plants and animals.[2] We live by eating substances that have been part of the bodies of animals and plants. "We can build our houses only of materials that we have taken from the walls of other houses."

[1] The elements of which the body is composed are: carbon, oxygen, hydrogen, nitrogen, phosphorus, calcium, sulfur, sodium, potassium, chlorin, iron, magnesium, fluorin, and silicon.

[2] In reality all building of foods is done by plants, for the animals that we eat live on plants.

Classes of foods. Not including water, certain minerals, and the oxygen that we get from the air, foods

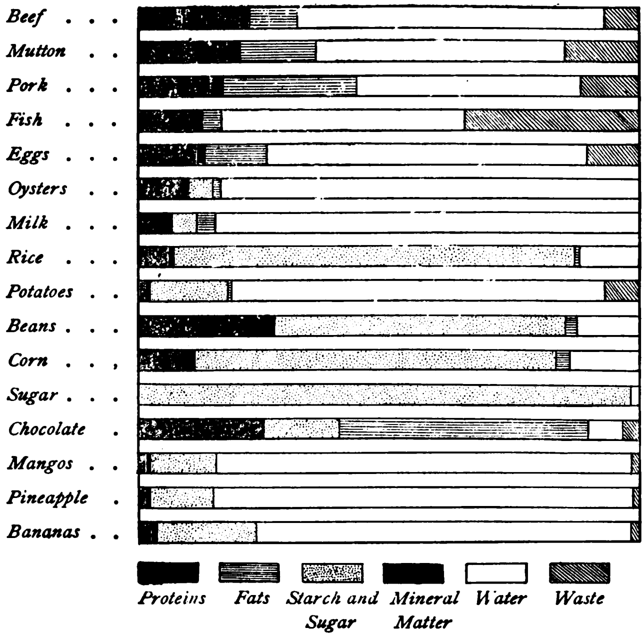


FIG. 37. Table showing the composition of some common foods. From this table, it will be seen that meats and beans contain much protein, while rice contains much starch. Chocolate is a very rich food, containing much fat and also protein and starch. Fruits are composed principally of water and sugar.

may be divided into three classes. These are (1) the starches and sugars, (2) the fats and oils, and (3) the proteins, or building foods.

Starches and sugars. Almost all the starch and sugar that we eat comes from plants. Rice has very much starch in it. Potatoes and many roots, like caladium (gabi), sincamas, ubi, and cassava (camoting-cahoy), are starchy. Corn also contains much starch.

Sugar is found in sugarcane, in honey, in ripe bananas, and in many other fruits. Sweet potatoes (camotes)

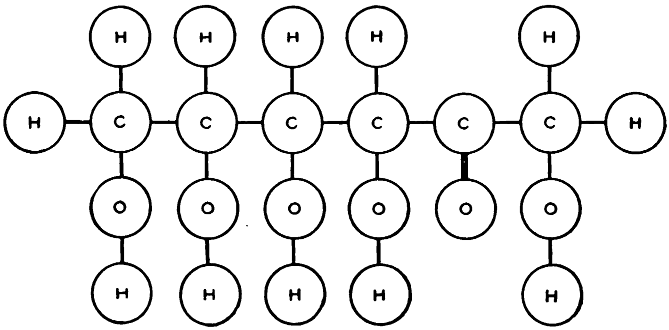


FIG. 38. **Diagram of a molecule of fruit sugar.**

contain both sugar and starch and are a very good food. Corn, milk, and many other foods contain a little sugar.

Fats. Fats and oils are the same, except that fats are solid and oils are liquid. If you heat fat, it will become liquid. Then it is oil. Most of the fats that we use for food come from animals. Many oils come from plants, but a few oils come from animals. For use as food, there is no difference between fats and oils, and they are all spoken of as fats or fatty foods.

Butter is fat taken from milk. Lard and other animal fats are much used in cooking. Chocolate has oil in it, and the meat and milk of the coconut contain much oil. Oil is also made from the fruit of the olive and from the seed of the cotton plant.

Proteins. Most of the foods that we get from animals are proteins. Lean meats, eggs, fish, and frogs contain much protein matter. Milk and cheese also have proteins in them. Of the plant foods, peas and beans are the richest in proteins. Peanuts and corn also contain proteins, and many starchy or fatty foods have a small amount of proteins in them. The diagram on page 229 will show you the composition of some common foods.

Composition of the different classes of foods. The fats and the starches and sugars are made up of the three elements, carbon, hydrogen, and oxygen. In a molecule of fruit sugar, there are six atoms of carbon, twelve atoms of hydrogen, and six atoms of oxygen ($C_6H_{12}O_6$ = fruit sugar). In Figure 38 you can see how these atoms are put together. Starch is made up by uniting very many of these atoms into one molecule. Almost all the different kinds of plants have different kinds of starch, and there are many kinds of sugars and fats; but all these different substances are made up by combining atoms of carbon, hydrogen, and oxygen. *The differences in these substances are caused by the different numbers of atoms in their molecules and the different ways in which these atoms are joined together.*[1] The substances all have the same kind of atoms in them.

Proteins also have carbon, hydrogen, and oxygen in them; but in addition to these elements they have nitrogen and usually a little sulfur. The molecules of

[1] A carpenter can make from a pile of boards a chair, a desk, or a box. So a plant can make sugar, starch, or wood from the same materials (oxygen, hydrogen, and carbon), and animals build the foods that they eat into many different forms. Substances, therefore, differ not only in the atoms that they contain but in the way these atoms are built together.

proteins are very large, usually containing many hundreds of atoms.

Plants can make proteins. They can take nitrogen from the soil and combine it with carbon, hydrogen, and oxygen, in this way making proteins. A few plants (legumes) can take nitrogen from the air. But animals are not able to make proteins. They must get all their proteins from plants or from other animals which they use for food.

FIG. 39. Material for the repair and growth of the cells is furnished by the proteins in the food.

Uses of the different classes of foods. We have already learned that the three uses of the foods are to warm the body, to give strength to the muscles, and to build up new parts of the body. Fats, starches, and sugars are all made up of the same kinds of atoms, they all make the same compounds when they are burned in the body, and they all do the same kinds of work. They are excellent foods for warming the body and for giving the muscles strength; but they cannot be used for building up the cells of the body.

All the important parts of the body have in them atoms of carbon, hydrogen, oxygen, nitrogen, and sulfur. Only the proteins can be used in making these parts, because only the proteins contain all these different kinds of atoms. It is because the fats, starches, and sugars have no nitrogen and sulfur in them, that they cannot be used for building up the body. The proteins are burned in the body and are used in warming and

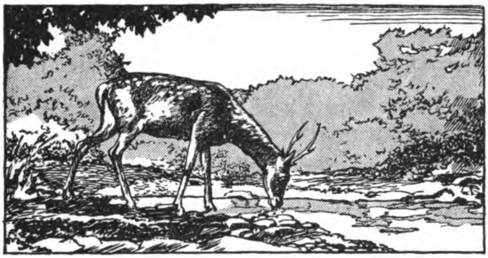


FIG. 40. Wild animals often travel long distances for salt. Man supplies himself with salt, but he should eat a variety of foods to make sure that he gets enough of all the other minerals that he needs.

strengthening the body the same as the other foods; but the great use of the proteins is in building new cells and parts of cells.

Minerals necessary to the body. Small quantities of certain minerals are necessary to the body. We must have iron for the blood and calcium to build the bones and teeth; and small amounts of potassium, phosphorus, and other minerals are necessary for health and life. These minerals we get in food and water, and the way to make sure of a good supply of them is to eat a variety of foods. In general, milk, eggs, whole grains (rice and corn), beans, and fresh vegetables and fruits supply minerals most abundantly. In grains the minerals are mainly in the outside layer, and when rice is polished and wheat is ground into fine flour, a great part of the minerals is lost.

The importance of good food. There are two rules of hygiene that are far more important than all others. The first is: *Protect the body from disease germs.* This subject we have discussed in the first part of this book and you can easily understand its importance. If a tiger is allowed to attack a child, the child will not have good health, no matter how well fed or well clothed it may be. So neither the Filipino people nor any other people can live in health until they stamp out the germ diseases that are among them; for cholera germs and smallpox germs can attack and kill well-fed people with rich blood as well as hungry people with thin blood (page 13).

The second great rule of hygiene is: *Provide the body with the food that it needs to keep it in health.* No matter what else a person may do for himself, he cannot be strong and abounding in health unless he gives his body the food that it needs. Nothing, except the checking of germ diseases, would so improve the health of the Filipino people as giving every person in the Philippines an abundance of well-cooked, wholesome, nutritious food. This subject we shall discuss in later chapters (pages 261 to 269).

QUESTIONS

Give three reasons why the body needs food. What is an atom? a molecule? How many kinds of atoms are in the molecules of an element? Why is iron an element? What is a compound? The atoms of what two elements are in a molecule of water? how many atoms of hydrogen are in a molecule of water? how many atoms of oxygen? Why is water a compound?

Where can you see carbon? Where is oxygen found? How is carbon dioxid formed? Why is it a compound? What elements are most common in food? Are foods elements or compounds? By what are foods built?

Name the three classes of foods. Give some examples of starchy foods; of foods with sugar in them; of fatty foods. Give examples of foods that contain proteins.

Name the elements that are in starches and sugars; in fats; in proteins. In what two ways are the fats, starches, and sugars used in the body? In what three ways are the proteins used? Why are proteins always necessary for life? Name some minerals that are needed by the body. What foods supply minerals in abundance? Give the two most important rules of hygiene.

SUGGESTIONS TO THE TEACHER

The whole subject of the nutrition of the body is a most important one, and the teacher can spend much time in studying it if he desires to do so. *Primer of Physiology* and *Human Physiology* give much additional information on the subject, and *Laboratory Manual for Human Physiology* gives directions for performing experiments in chemistry and digestion that will interest the class and help in giving an understanding of the subject. The principles contained in this chapter should be carefully taught; for they apply equally in the study of physiology, domestic science, and agriculture.

If possible, the teacher should secure from the school officials a few pesos to purchase chemicals and other materials for a few simple experiments. It will add to the interest of the work and give the pupils a much better understanding of all their science lessons.

CHAPTER VII

THE DIGESTIVE ORGANS AND DIGESTION

SUPPOSE that you have some bread and meat on your plate. Your muscles, your brain, all the parts of your body need the food to nourish them. You eat the bread and meat. It is now on the way to the brain and muscles. How does it get to them? How must it be changed before it can be used? What do we mean when we speak of the digestion of the food? What are the digestive organs and why do we have them? We shall discuss these questions in this chapter.

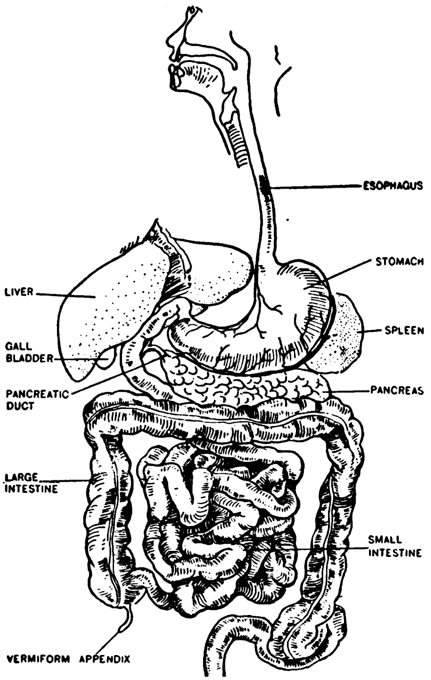


FIG. 41. The digestive organs.

The digestive organs. The principal part of the digestive system is the *alimentary canal.* This is a long passageway through the body. Its principal divisions are the *mouth*, *throat*, *esophagus*, *stomach*, *small intestine*, and *large intestine*. Other digestive organs are the *teeth*, *salivary glands* (Fig. 42), *liver*, and *pancreas*. This great system of organs fills the greater part of the abdominal cavity, and it is most important to understand their work and how to care for them.

Digestion. If you put a little salt in water, the salt will dissolve. The salt molecules separate and go out all through the water. You cannot see the salt molecules in the water, because they are so small; but if you taste any part of the water, you will find that the salt is everywhere in the water.

The foods that we eat must be changed before we can use them. The large molecules of which they are composed must be broken up into small molecules, so that the foods can be dissolved. Then they can pass through the walls of the intestine into the blood and can be carried all through the body to the cells. *Digestion is the process of breaking up and dissolving the food so that it can be taken into the blood.*

The work of the teeth. If you put a large lump of salt in water, it will be a long time before the salt is all dissolved. But if you break the lump of salt into many little pieces, it will dissolve quickly. In the same way, the food is digested much more easily when it is broken into little pieces than when it is in big pieces.

The work of the teeth is to grind or break the food into small pieces so that it will be digested quickly. The front teeth are flat and sharp for biting off the food, and the back teeth are large and strong for grinding it into pieces. While the teeth are grinding the food, the tongue pushes the food out to the sides of the mouth and holds it between the teeth.

The salivary glands. The *saliva* is made by the salivary glands. There are six of these glands. Two of them are in the cheeks, in front of the ears. Two other salivary glands are under the back corners of the lower jaw, and two more are under the tongue. The saliva comes to the mouth from each of these glands through a little duct.

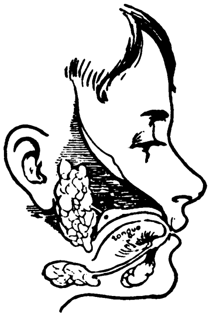


FIG. 42. The salivary glands.

The work of the salivary glands. If you put some sugar in water, it will dissolve; but if you put starch in water, it will not dissolve. The sugar can go into the body from the alimentary canal, but the starch cannot go into the body, because it cannot dissolve. The saliva digests the starch. It does this by breaking up the great starch molecules into smaller molecules of sugar. The sugar dissolves and goes through the walls of the intestine into the blood. The work of the salivary glands is to make saliva so that the starch will be changed to sugar and taken into the body. The saliva is also useful for moistening food and making it easier to swallow. Without it dry foods, like crackers, would become dust in the mouth.

The esophagus and the stomach. After the teeth have chewed the food, the tongue pushes it into the back part of the mouth and it is swallowed. The muscles in the back part of the mouth and in the walls of the esophagus contract above the food and squeeze it downward into the stomach.[1]

The stomach. The stomach is in the left side of the abdomen (Fig. 8), just below the diaphragm. When the stomach is empty, it is small; but when it is full of food or water, the walls stretch so that it can hold about one and a half liters. One function of the stomach is to serve as a storehouse for food, so that enough can be eaten at one time to supply the body for several hours.

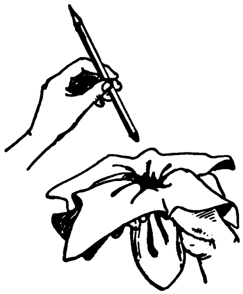


FIG. 43. To illustrate how a gastric gland is formed by an infolding of the stomach wall.

The glands of the stomach. In the inner coat of the stomach wall are great numbers of *gastric glands*. Each gland is like a little well in the wall of the stomach. You can understand the shape of a simple gland and the way it lies in the stomach wall by spreading a handkerchief over the hand and thrusting it down into the hand with a pencil, as shown in Figure 43. Some of the gastric glands branch in their lower parts; but they are all formed by folding the inner layer of the stomach wall into deep, narrow pockets. Figure 44 shows how closely these glands are packed together, and it shows also how small they must be; for they do not reach more than halfway through the stomach wall, although the wall itself is little thicker than a piece of heavy cloth.

[1] Watch the neck of a horse that is drinking. The wave of contraction that runs along the esophagus as the water is forced into the stomach can be plainly seen.

The gastric juice. The gastric glands make *gastric juice*, and this juice flows out of the glands into the stomach. The gastric juice looks like water, but it

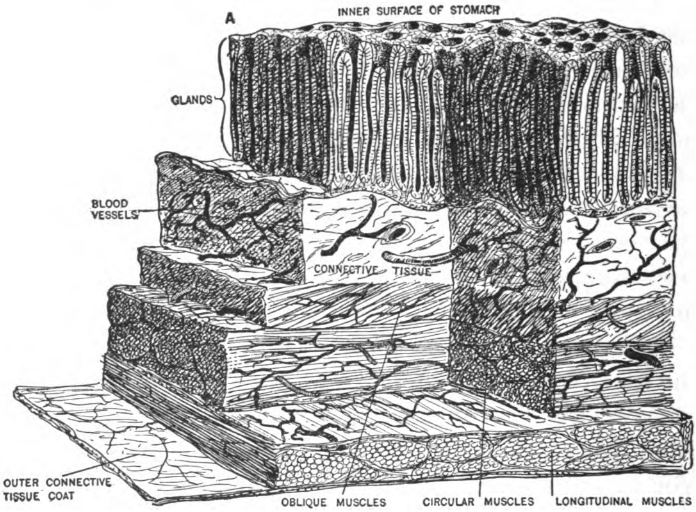


FIG. 44. A section of the wall of the stomach, showing muscles and glands.

contains a substance, called *pepsin*, for digesting the protein foods. It contains also an acid which kills many of the bacteria that are taken into the stomach. This keeps the bacteria from getting into the intestine and causing trouble there. From $1\frac{1}{4}$ to $2\frac{1}{2}$ liters of gastric juice are secreted in a day.[1]

The muscles of the stomach. The walls of the stomach contain strong layers of muscle fibers. When the stomach is filled with food, the muscles in its walls contract. Waves of contraction run over the stomach

[1] When a liquid flows from a gland, the gland is said to *secrete*.

from the upper to the lower part, squeezing the food in the stomach about. In this way the food is mixed with the gastric juice, so that the gastric juice can digest the protein.

Where the stomach joins the small intestine, there is a strong ring of muscle in the wall. While the muscles of the stomach are squeezing the foods about and the gastric juice is digesting the protein, this ring of muscle is contracted and the opening between the stomach and intestine is closed. But after the proteins are digested, the ring of muscle opens and lets the food pass into the small intestine.

The small intestine. The small intestine is almost seven meters long. It is very much coiled in the abdomen, and the food passes slowly through it. Along the walls of the intestine are little glands, like the glands in the stomach, which make juices to digest the food. The liver and the pancreas also send juices into the small intestine, and here the digestion of all the food is finished. All through the walls of the small intestine there are muscles; and by contracting above the food, these muscles keep the food moving onward through the intestine. At its lower end the small intestine opens into the large intestine, and the indigestible parts of the food, along with considerable liquid, pass on into the large intestine.[1]

The villi. All over the walls of the small intestine are small projections called *villi* (singular, *villus*), stand-

[1] The waste material in food consists of the woody and fibrous parts of vegetables, the skins of fruits and the tough particles in their pulps, the tough fibers of meats, and other similar matter.

ing up among the dissolved food. In the villi are many blood vessels. *It is the work of the villi to take the digested food into the vessels within them.* Then the blood carries the food away to the cells in all parts of the body.

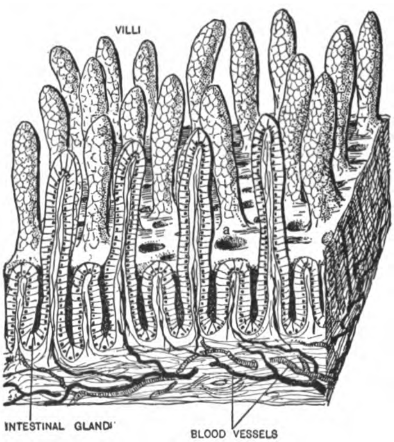


FIG. 45. Villi and intestinal glands.

The pancreas. The pancreas lies under and a little behind the stomach. It is a great gland that makes the *pancreatic juice* and sends it into the small intestine through a little duct. The pancreatic juice is the most important of all the juices in digesting the foods. It digests the starch and the proteins that have escaped the saliva and the gastric juice, and it also digests the fats. The saliva can digest starch; the gastric juice can digest proteins; but the pancreatic juice can digest all the foods.

The liver. The liver is in the right side of the abdominal cavity, close to the stomach. It makes a bitter, greenish yellow fluid called *bile*. On the under side of the liver there is a little sac called the *gall bladder*. The liver makes bile all the time and stores it in the gall bladder. Then when the food comes into the small intestine, the bile from the gall bladder is emptied through the bile duct into the small intestine.

The bile itself does not digest the food, but in some way it helps the pancreatic juice to do its work. When there is no bile in the intestine, the pancreatic juice digests the food very slowly. The bile also causes the digested food to be absorbed more rapidly from the intestine.[1]

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, runs across the body under the diaphragm, and then turns downward (Fig. 41). Just below where the small intestine opens into the large intestine there is a little, wormlike structure called the *vermiform appendix*.[2] There are muscles in the walls of the large intestine that move the wastes along, as the foods are moved through the other 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 crush the food into small pieces and mix it with saliva. The saliva at once begins the process of digestion by attacking the starch that is in bread, rice, corn, and many other foods, and changing it to sugar.

After the food has been chewed, the tongue draws it back into the opening of the throat. The walls of the throat then grasp it and press it backward and downward

[1] When food and water pass through the wall of the intestine into the blood, they are said to be *absorbed*.

[2] When germs grow in the vermiform appendix, they cause the disease called *appendicitis*.

into the esophagus, through which it is carried to the stomach. When the food reaches the stomach, the

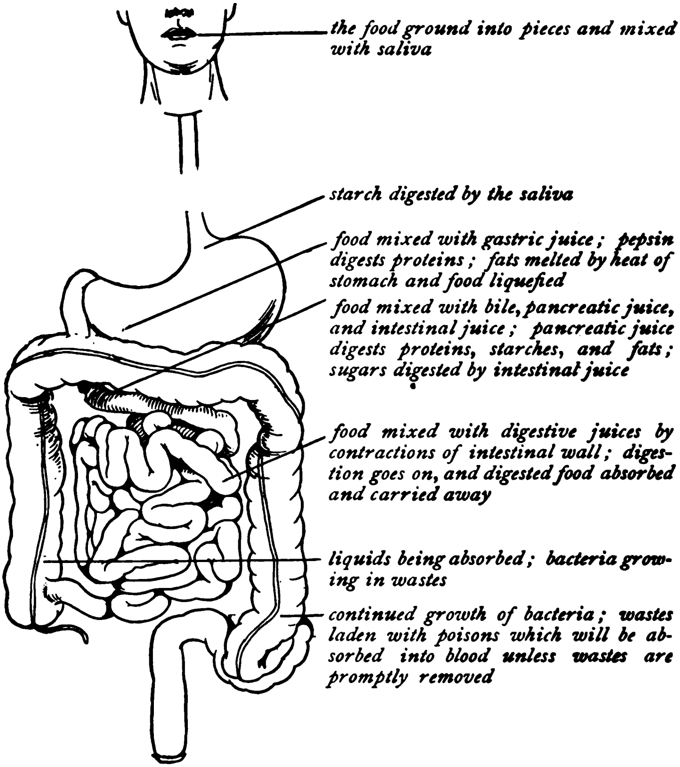


FIG. 46. A diagram illustrating the changes that take place in the food during its journey through the different parts of the alimentary canal.

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 muscles 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] In the intestine a flood of digestive juices is poured in upon it. Greenish yellow bile comes from the liver; great quantities of juice for digesting proteins, starches, and fats are secreted by the pancreas; and all along the small intestine, juices are poured out by the thousands of little glands that are in the wall. The muscles in the walls of the intestine keep contracting on the food and mixing it with the digestive juices. Gradually the food is worked along the intestine, while the digestive juices are breaking it up and causing it to dissolve.

As we follow the food in its course through the intestine, we notice that the liquid becomes less and less in amount, and that finally 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 blood vessels that are

[1] It should be understood that during stomach digestion the food is continually 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.

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. A waterfall keeps the same form, but it is made up of rapidly passing water; and our bodies, that seem to us to be the same year by year, are composed of materials that are always changing. 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 a horse are built of grass, and the human body is built of the food that man eats.

The waste matter in the large intestine. After the refuse matter from the food enters the large intestine, the liquid is quickly absorbed and only the solid materials remain. Millions of bacteria grow in this waste material and cause it to decay. They form poisons in it, and if the wastes are not promptly removed from the body these poisons are absorbed into the blood and the whole body is injured by them. Nothing is more important to the health than that the waste matter be passed quickly along the large intestine. This subject we shall discuss in another chapter (page 254).

QUESTIONS

Name the principal parts of the alimentary canal. Name the other digestive organs. Why must foods be digested? What is digestion?

What is the function of the teeth? How many salivary glands are there? Where are they located? What is their function?

Locate and describe the stomach. What are its functions?

Describe the gastric glands. Tell about the gastric juice. Describe the muscles of the stomach. Describe the small intestine; the villi; the pancreas; the liver; the large intestine. Tell the story of the digestion of the food. Why is it necessary that the wastes in the large intestine be removed from the body quickly?

SUGGESTIONS TO THE TEACHER

The teacher should make this and the following chapter as practical as possible by discussing with the class the troubles that they have with their digestive systems. Pineapple and papaya both contain substances similar to pepsin that aid the digestion; many foods are easy of digestion; and other foods are very difficult of digestion. Important topics for discussion are proper diet for hard-working men, for students, and for young children; the best ways of cooking different foods; the effect of exercise on digestion; and the preservation of the teeth. Encourage any pupil whose diet does not seem to agree with him to try changing his food or his ways of eating. If classes in cooking are being taught in the school, the relation of the work of these classes to health should be made clear to the class.

CHAPTER VIII

THE CARE OF THE DIGESTIVE ORGANS

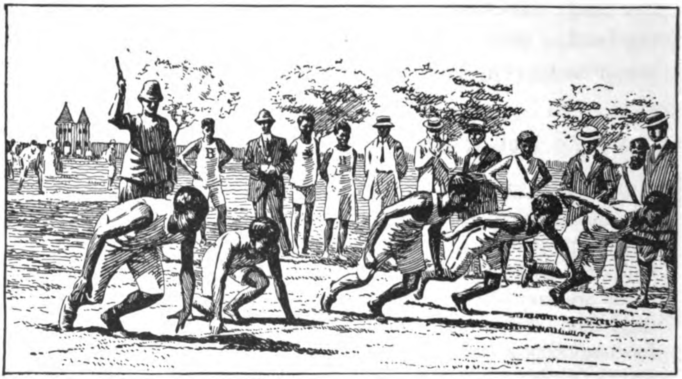


FIG. 47. Exercise helps to keep the digestive organs in health.

To a great extent the health of the body depends on the way the digestive organs do their work. It is most important, therefore, for us to understand how to give these organs proper care. In this chapter we shall discuss this subject, but after you have studied the chapter you must put into practice what you have learned; for it is what you do and not what you read in a book that will give you a good digestion. It requires *doing* as well as *knowing* to set us on the way to health.

The digestive organs controlled by the nervous system. When you are hungry, the sight or smell of food will "make your mouth water." This means that the nervous system starts the salivary glands to work. The glands of the stomach also are controlled by the nervous system, as the following experiments on a dog showed:

The esophagus of a dog was divided, and when the animal was hungry, he was given some fresh beef. The dog thought he was eating a good dinner, but a tube had been connected to the esophagus in such a way that the beef did not go into the stomach but into a dish beside the dog. Nevertheless, the gastric glands promptly began to pour gastric juice into the stomach. Merely showing the food to the dog was enough to start the secretion of the glands. The experiment showed clearly that *the mind affects the glands of the stomach* as well as the salivary glands.

At another time a tube was fitted to the part of the esophagus which was connected with the stomach, and beef was introduced into the stomach without the dog's knowing that he was being fed. In this case, the gastric juice was secreted very slowly, and the meat lay in the stomach a long time before it was digested.

These experiments show plainly that the nervous system has a great effect on the digestive organs, since the taste or smell of food, or even the sight of food, will start the secretions to flowing from some of the digestive glands. They teach us that it is very important for our food to be pleasant to the taste, in order that a good supply of juices may be secreted to digest it. They show how indigestion may be caused by eating food which is distasteful, and by eating when food is not wanted. They also explain some things that have long been known, — that a cheerful, happy life brings with it a good digestion, and that anger, quarreling, melancholy, sorrow, homesickness, and pain interfere with the digestion of the food. Our food, therefore, should be well cooked; it should be served on a clean table; every one should come to the table in a cheerful frame of mind and should avoid all disagreeable topics of conversation, and all unpleasant thoughts should be laid aside until the meal is over. "Laugh and grow fat" is a wise old saying which we shall do well to heed. *One of the most important points in the care of the digestive organs is to keep the nervous system calm and in health.*

Exercise and digestion. Exercise not only keeps the muscles strong but it also adds vigor to the nervous system, it strengthens the heart, and sets all the internal organs of the body to working with increased power. Nearly every one who leads a lazy life and allows his muscles to become flabby and soft suffers from indigestion. *Exercise of the muscles is necessary to keep the digestive organs in health.*

Some rules for keeping the digestive organs in health. The following are some important points in the care of the digestive organs:

1. *Eat slowly and chew the food thoroughly.* The reasons for this rule you have already learned.

2. *Eat only as much food as can be digested in a reasonable time.* When food lies in the stomach for a long time without digestion, too much acid collects in the stomach. Sometimes the stomach becomes so sour with these acids that it throws its contents out to get rid of them. It is bad for the health, therefore, to eat too much at one time, just because one is hungry or because he likes the food that is set before him.

FIGS. 48 and 49. You should eat slowly and chew your food thoroughly.

3. *Do not eat too much of one kind of food.* When different kinds of food are eaten, all the different digestive juices can take part in digestion. But if only one kind of food is eaten, all the work will be thrown on one or two juices. This delays digestion and has the same effect as eating too much food. Do not make a whole meal of rice, bananas, or any one food, but eat several kinds of food at each meal.

4. *Eat at regular times.* We should eat at the same times each day and we should not eat between these times.[1] We should not go without food very long at a time, and we should eat in the morning before we work much or long. Going without food when one is hungry needlessly distresses the mind and weakens the body.

[1] The feeling of hunger is caused by the muscles of the stomach contracting and drawing the stomach together. If a person has regular hours for his meals, hunger will come at these times. His stomach will tell him that he should eat, and he will also have a good appetite for his food.

5. *Have the food appetizing and well cooked.* If not properly cooked, some foods are hard to digest, but the greatest evil in bad cooking is that the food is not pleasant to the taste, and the digestive juices are not secreted abundantly. Some foods that contain little nourishment, as jams, jellies, and soups, are important chiefly because they make it possible for us to eat with a relish and to digest large quantities of rather tasteless but nourishing foods like bread and vegetables.

FIG. 50. Anger and unpleasant thoughts interfere with the work of the digestive organs.

6. *Do not talk or think about unpleasant things at mealtime.* This interferes with the secretion of the digestive juices. The movements of the stomach and the flow of the gastric juice were almost stopped in a dog that was made angry by a cat brought near it when it was eating, and the full amount of juice was not secreted again for two days. The table should be neat, the dishes clean, and every one in good spirits when a meal is eaten.

7. *Do not work hard or study hard immediately before or after eating.* When the digestive organs are at work, they need a full supply of blood. Work causes the blood to go to the muscles, and study causes it to go to the brain. This takes the blood away from the digestive glands when they need it to make the digestive juices.

8. *Take a sufficient amount of exercise.* The reasons for this have already been discussed (page 250).

9. *Do not overwork or overstudy.* Either overwork or overstudy will bring on indigestion. Probably the nervous system is first injured, and the trouble with the

FIGS. 51 and 52. Many cases of indigestion are cured by fitting the eyes with glasses.

digestive organs comes from a lack of proper nervous control.

10. *Have any trouble with the eyes looked after.* Many cases of headache and stomach trouble are cured at once by fitting the eyes with proper spectacles or eye-glasses. Probably bad eyesight, like overwork, injures the nervous system, and the nervous system then fails properly to regulate the digestive organs. Persons who do much reading, writing, or other close work are the ones who suffer most from this cause.

11. *Do not eat too much sugar or sweets at one time.* Sugar is a good food, but if it is taken in too large amounts it injures the stomach. Molasses should be eaten with large quantities of other foods, and sweets should not be taken when the stomach is empty. These foods are too strong to be taken into the stomach alone.

12. *Drink moderately of water at your meals.* The digestive juices do their work better if water is drunk

with the meals and the food moistened with it, but it is a bad practice to wash the food down without chewing it. The water should be taken in small mouthfuls from time to time and not all at once.

The care of foods. Certain foods like meat, fish, milk, cooked rice, and many other cooked foods spoil quickly. They spoil because bacteria grow in them, and spoiled or sour food is filled with many millions of bacteria. Cold keeps bacteria from growing, and foods can be kept safely for some time on ice. Where ice cannot be obtained, foods that spoil quickly should be used while they are fresh. Spoiled foods should never be eaten, for they carry into the stomach and intestine millions of bacteria, and many cases of sickness and poisoning come from eating spoiled food.

QUESTIONS

How do we know that the salivary glands are controlled by the nervous system? Describe an experiment which proves that the glands of the stomach are also controlled by the nervous system. Discuss the rules that are given for keeping the digestive organs in health and give a reason for each rule.

Why are spoiled foods injurious to the health?

CHAPTER IX

THE FATE OF THE FOODS IN THE BODY

WE have now studied about how our foods are digested. We have learned that the blood carries them through the body to all its parts. What does the body do with the food? What becomes of the food after the body has finished with it? Why does not the body become so full of food that we cannot eat more? Perhaps we may find the answer to this question by studying something else that you have all seen.

FIG. 53. When the candle burns, the atoms in it are not destroyed.

You have seen a lighted candle grow shorter and shorter as it burned. What becomes of the material of which the candle is made? Can you destroy atoms by burning them? You must study chemistry before you will really understand all these questions. At present we can only explain that atoms cannot be destroyed. When the candle burns, its molecules are broken up and the oxygen of the air unites with the atoms in the candle and forms gases (carbon dioxid and water vapor) that pass off into the air. *The materials in the candle are not destroyed; they are only changed to another form.*

In the same way a stick of wood will change to gas and pass off into the air if you put it into the fire. There may be a few ashes left, but these are only a little mineral that was in the wood. The molecules of the wood have been broken up and the atoms of which they were built have united with oxygen and have formed new molecules. These new molecules are gases that disappear into the air.

FIG. 54. Burning low for lack of oxygen.

Experiments. Light a candle. As the candle burns, the oxygen of the air is uniting with the atoms of the candle. Set a glass over the candle. Soon the candle begins to burn more dimly; the oxygen in the vessel is beginning to fail. Finally the flame dies out; there is no more oxygen in the air to unite with the atoms of the candle. *Burning is uniting with oxygen.*

Wrap cold wet cloths around a glass to keep it cool, and hold it over a lighted candle. In a little while you will see drops of water on the inside of the glass. This is the water that passes off into the air when the atoms of hydrogen and oxygen unite in the burning candle. The glass must be kept cool or the experiment will not succeed.

The foods burned within the body. The foods that are taken into the body are burned. We breathe oxygen into the body and the atoms of oxygen unite with the atoms of food, just as oxygen unites with the atoms of a piece of wood in a fire. When the foods are burned, they are changed into other substances and they pass out of the body as wastes. We must all the time keep eating more food, because the food in the body is all the time being burned and carried out of the body as wastes.

The principal body wastes. When starches, sugars, fats, and oils are burned, they form carbon dioxid and water. When proteins are burned, they form carbon dioxid and water, and they also form *urea*.[1] The principal body wastes, therefore, are carbon dioxid, water, and urea. The carbon dioxid is breathed out of the body from the lungs; the water leaves the body through the skin, the lungs, and the kidneys; and urea is taken out of the body by the kidneys. In later chapters we shall learn more about the lungs and skin and the work that they do. Let us now study the kidneys and how they remove body wastes.

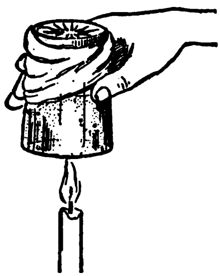


FIG. 55. Catching the water which passes off from a burning candle.

The kidneys. Fastened to the back wall of the body are two bean-shaped organs called the *kidneys*. Each kidney has in it thousands of little tubes. All these little tubes drain into a larger tube called the *ureter*, which empties into the *bladder* (Fig. 56). As the blood flows through the kidneys, the water from the blood drains out through the little tubes into the ureter. Certain mineral salts, the most abundant of which is the salt that we eat, also are dissolved in the urine.

[1] There are several protein wastes besides urea (among them uric acid, creatinin, and ammonia). Urea is by far the most important in amount, however, and for convenience we shall speak of urea as though it were the only protein waste. It is a solid substance and leaves the body dissolved in the water that passes out through the kidneys.

The function of the kidneys is to take water, salts, and urea out of the body.

Where the food is burned in the body. We have learned that the muscles are made of small fibers, which are large cells. All the other parts of the body also are made of cells. If you could examine a little piece of liver, kidney, brain, or stomach under a microscope, you would find that they all are made of thousands of little cells. The cells in the different parts of the body are of different kinds. There is one kind of cell in the liver, another kind in the skin, and still other kinds in the eyes and in the brain. Each cell takes in food and oxygen from the blood, and within the cells the foods are burned.[1] This gives the cells heat and power to work.

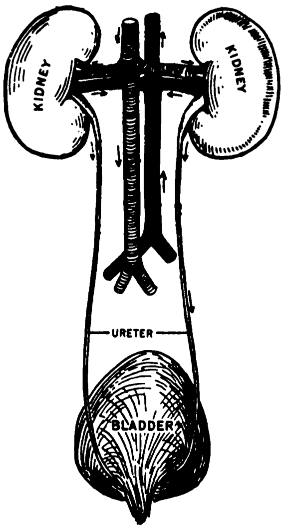


FIG. 56. The kidneys and the bladder seen from behind.

Food used for building purposes. Part of the protein foods that we eat are used for building purposes in the body.[2] When they are digested, the large protein

[1] The muscle cells burn more food than any of the other cells in the body, because the muscles have much work to do in moving the body. Why does a person become hot when he works or when he runs?

[2] It should be understood that the living matter of the cells is continually uniting with oxygen and wasting away, and that the food that is used for building purposes is in the end burned and changed into wastes.

molecules are split into smaller parts. These smaller parts are carried to the cells and are used as "building stones" to repair the wastes in the cells, and until the body is grown they are used also to build new cells.

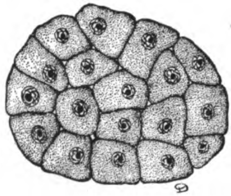


FIG. 57. Cells from a young seed of a lily as seen under a microscope. The bodies of all living things, both plants and animals, are made of cells.

It has been proved that certain proteins that are found in grains (rice, wheat, corn) are "repair" proteins but not "growth" proteins. They supply building stones for repairing the body when it wears out, but they do not furnish the kind of building stones a young animal needs to make its body larger. Therefore, they will keep a grown animal in health, but they will not cause a young animal to grow.

Legumes contain the proteins that are needed for growth,[1] meats are rich in them, and eggs and milk contain them in great abundance. It is most important, therefore, that children have milk and, as soon as they are old enough, eggs and meat. If they are fed only on rice, corn, bananas, and vegetables, they may be slow in growing for lack of some of the materials that they need.

Storage of foods. The body can store only small amounts of sugar or protein; but when it has very much

[1] In feeding animals it has been found that the leaves and vines of legumes as well as their seeds contain the proteins needed for growth. The tops of cowpeas and peanuts are therefore more valuable than grass for feeding a young animal; that is, they cause it to grow faster. Sincamas is a legume, and it would seem that the root ought to be a very valuable food for children, — more valuable than gabi, potatoes, or other plants that are not legumes.

fat and does not need it all, it stores up some of the fat. The body can also change starches and sugars to fats and store them away. The fat is stored under the skin, around the kidneys and intestines, and in other places inside the body. This fat makes the body round and beautiful, and the coat of fat under the skin keeps the body warm. But the great use of the fat is to give food to our bodies when we are sick. Then we can eat little; sometimes we can eat nothing. The cells die if they are without food for even a very little time; so when we cannot eat, our bodies use the fat for food.

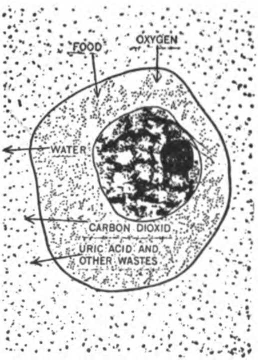


FIG. 58. The foods pass into a cell and are changed to wastes within the cell.

In times of sickness or starvation the body draws on the muscles for its supply of protein. Breaking down the muscles and using them weakens the body, but it is more important to provide food for the heart and brain than it is to keep up the strength of the muscles. After a person has been sick for a long time, his body becomes very thin, because the fat has been used and the muscles have been broken down to support the other parts of the body.

The necessity of good food for the cells. The cells of the muscles, the brain, the heart, and other parts of the body lie in their places and wait for food. If the blood brings them a supply of all the foods they need, they take it in and use it. This gives them health and vigor, and the person feels well and strong. If the cells lack food, their life is faint and slow, and the person feels weak and sick; his mind is dull, and he is stupid at his work.

In a country where food is abundant, the people are strong and vigorous; in a country where food is scarce, the people are weak and slow and without interest in their work. Every family should first of all plan for a good supply of food for all its members, and the first duty of any government is to make it possible for the people to obtain food.

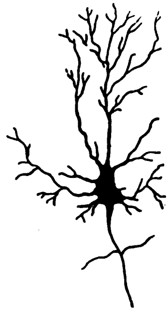


FIG. 59. A cell from the brain. A proper food supply is necessary to keep the cells in health.

QUESTIONS

When a candle burns, what becomes of the atoms of which it is made? What becomes of the foods that are taken into the body? Name the principal body wastes.

How does carbon dioxid leave the body? How does water leave the body? How does urea leave the body? Describe the kidneys. What is their function?

Where is the food burned in the body? What do the cells get from the food that is burned in them?

What foods are used for building purposes? Name some foods that contain repair proteins; some foods that contain an abundance of growth proteins. How is food stored in the body? Of what advantage is a store of food in the body? What effect has an abundant food supply on the life of the cells?

CHAPTER X

FOODS AND HEALTH

A TIGER lives on meat; a deer feeds on grass and leaves; and the smaller bats use insects for their food.

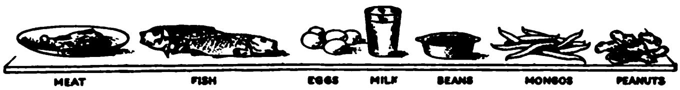


FIG. 60. These foods are rich in protein.

These animals have no difficulty in knowing what they should eat. They are fitted to live on one kind of food, and when they can find this food their problem is solved.

Man eats many different foods. Meats, grains, fruits, vegetables, eggs, and milk are all used by him. Which of all these foods are best for him? How much of each should he eat? How may he know if he is feeding his body properly? These questions we shall study in this chapter.

Amount of protein needed by the body. A man must have about 60 grams of dry protein daily to keep him alive. The best-nourished races eat twice this amount. A diet of rice, corn, vegetables, and fruits does not contain sufficient protein, and persons who live entirely on these foods suffer from ill health on account of it. They lack the energy and vigor that a progressive people must have; for progress requires the carrying through of long and hard tasks, and it takes strength and will power to do this.

Foods rich in protein. Meat, milk, and eggs are rich in protein. Grains contain a moderate amount of protein, and of all vegetable foods the legumes (beans, peas, mongos, peanuts) supply the most protein to the body.

The Filipino people need to eat more of the protein foods. They ought to raise more cattle, sheep, goats,

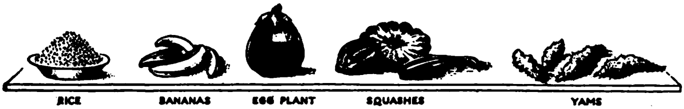


FIG. 61. These foods are low in protein.

and pigs for the meat. They ought to keep cows and goats for the milk. They ought to raise more chickens and ducks for the eggs and meat. To do this, they must improve their agriculture and control the animal diseases that have been so common in the Philippines. Until every family can have a reasonable amount of these animal foods, beans, mongos, and other legumes should be extensively raised and used.

Vitamins. Within the last few years it has been discovered that certain substances called *vitamins* are necessary for health. Very small quantities of these are found in our foods, and a good diet must contain enough of them to supply the body's needs. Vitamins are partly destroyed by cooking, and they are entirely destroyed by great heat. For this reason, they are not found in canned goods, and any one who tries to live without fresh foods in time loses his health. We do not know how many vitamins there are, but there are four diseases that seem to be caused by a lack of them. Two of these diseases, scurvy and beriberi, are almost certainly due to a lack of vitamins. The other two, pellagra and rickets, are not so well understood. It has also been proved that a vitamin that is necessary for growth is found in butter, in the yolk of eggs, and in the fat from the livers of animals.

Scurvy. Scurvy is a disease that is found among sailors and others who live without fresh meats, fresh fruits, or fresh vegetables. One symptom is bleeding from the gums. It can be cured by eating fresh vegetables or fruits, or by the use of the juice of oranges, lemons, or limes.

Scurvy is found among babies also. Usually it appears between the ages of six and eighteen months. Only a physician can recognize the disease in its early stages, but one symptom is pain and tenderness when the child is touched or lifted, or when the arms or legs are bent.[1] Later the gums of the upper jaw become sore and swollen, and bleed very easily when they are touched. The disease can be cured by giving the child a little juice from some ripe fruit each day. Orange juice (from as sweet oranges as can be secured) is most commonly used in Europe and America. A physician should be asked what are the best of the fruits to be obtained in the locality for this purpose.

Preventing scurvy. It is believed that in a nursing baby scurvy is caused by bad feeding of the mother. The vitamins are not in her food, and consequently they are not in her milk. The mother should therefore have a good diet; she should have moderate amounts of fresh meat, eggs, and legumes, and she should eat also fresh fruits and vegetables.

[1] On account of the pain in the limbs, scurvy is often mistaken for rheumatism.

Rickets. Rickets is a disease of children in which there is not enough mineral matter in the bones. It usually shows itself between the third and twelfth months, but may appear earlier or later. In this disease the head is larger than is natural, and the skull becomes cubical in shape and flat on the top. The bones are weak, and the legs may bend under the weight of the body. Often there are enlargements on the ribs where the bone and cartilage join. A row of these enlargements may be felt under the skin on each side of the sternum. The chest often becomes pointed in front.

The cause of rickets is not well understood, but the trouble is in the food. To prevent and to cure the disease, mother and baby should have a variety of good foods.

Pellagra. This is a very severe disease found among people who live chiefly on corn. It is common in Italy, and there are many cases in the southern part of the United States. In this disease the nervous system is affected, and the person often becomes insane. Another symptom is whiteness and scaliness of the skin, along with great itching and pain.

The people who have pellagra live chiefly on vegetables and foods made from corn. Before the corn is used, it is ground fine in mills. The vitamin that prevents the disease is in the outer part of the grain, and the fine meal that is made from the corn lacks this important substance. The disease can be prevented and cured by using fresh meat, eggs, milk, peas, beans, and other good foods. This disease is not found in the

Philippines, but another disease of the same kind, beriberi, is very common among the Filipinos.

Beriberi. Beriberi is found at times among sailors who live on white wheat flour, salt meat, and canned goods. It is most common, however, among rice-eating peoples, and is one of the worst diseases among the Filipinos. It is caused by the lack of a vitamin in the food, and the disease is found among those who live largely on polished rice. Like pellagra, the disease chiefly affects the nervous system. The brain and nerves need something that the food does not provide them with. Cases of beriberi, unless they are too far advanced, can be cured by supplying the proper food.

FIG. 62. A pigeon ill of nervous disease because it was fed on a diet of polished rice. (Photograph by Funk.)

Preventing beriberi. There are two ways of preventing beriberi. *The first way is to use unpolished rice.* Again and again it has been proved by experiments in the Japanese army and navy, in the Philippine Scouts, in the Government schools, in Bilibid Prison, and in the leper colony at Culión, that beriberi dies away when unpolished rice is used. Moreover, it is possible to cure the disease by mixing rice polishings (tiki-tiki) with the food. By treating the polishings with water and alcohol, the vitamin can be secured from them. This can then be used as a medicine for the cure of beriberi, and in early cases it gives wonderful results. It will thus be seen that the difficulty is not with the rice. As

Nature made it, this is a good food for man. The trouble is that man polishes away the vitamins that are in the outer coat before he uses it.[1] Most rice that is dark in color will not cause beriberi.

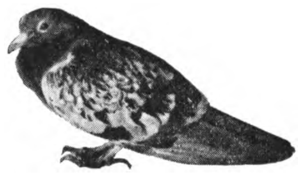


FIG. 63. The same pigeon after being treated with vitamin extracted from rice polishings. When pigeons are fed on unpolished rice the vitamin is taken with the food and they do not become ill. (Photograph by Funk.)

The other way of preventing beriberi is to use other foods besides rice to furnish the vitamin. Legumes, milk, eggs, fresh beef, and fresh fish will supply this vitamin. It is most important that the diet of the Filipinos be changed so as to prevent this disease; for every year there are 25,000 deaths from beriberi and many thousands of cases of the disease in the islands.

Beriberi in infants. It is estimated that in the Philippines 20,000 babies die each year of beriberi.[2] The reason is that the mothers do not have the proper diet. The vitamin is not in the mother's food, and it is not in the milk that the baby gets. The only way to prevent this difficulty is for the mother to change her diet. Before the baby is born and as long after it is born as she nurses it, she should have a nourishing diet of different kinds of foods. If she cannot afford meat and eggs, she should eat unpolished rice and legumes,

[1] In a few cases beriberi does develop when unpolished rice is eaten. In these cases the difficulty is with the other foods. The person is trying to get all his vitamins from rice and is not eating enough meat, eggs, or legumes.

[2] Infantile beriberi is often called *taon*.

especially mongos and beans. She should not try to live on polished rice and a little fish; for if she does, both she and her child will suffer.

Bulk necessary in the diet. If a person lives entirely on rich foods like meat, eggs, milk, and sugar, there is little refuse matter to go into the large intestine. The result is that the waste material in the large intestine is moved along very slowly, and the poisons in it are absorbed into the blood and carried through the body. A certain amount of coarse vegetable food is needed to provide a large amount of waste material which will be moved rapidly along the intestine and promptly cleared out of the body. In general, it is the richer class of people who suffer from a lack of bulk in the diet.

A mixed diet best. The question of a good diet is very difficult. There is much about foods that even

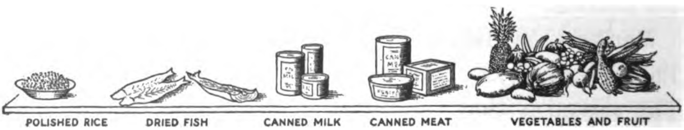


FIG. 64. Foods that cause beriberi.

the wisest scientists and physicians do not understand. The safest rule, therefore, in selecting our food is: *Eat a number of different kinds of food.* To eat only rice, corn, and camotes would not be following this rule; for these are all starchy foods. To eat only meat, eggs, and mongos would not be following it; for these are all rich in protein and have little refuse matter in them. Every day we should eat some foods that are rich in protein, some foods that supply fats, and some foods that contain starch, sugar, and minerals. This we shall do if we live on a diet made up of meat, eggs, milk, bread, grains, vegetables, and fruits. Man is fitted

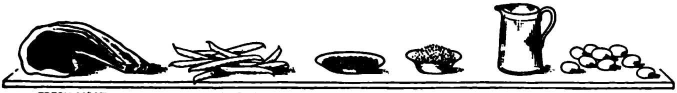


FIG. 65. Foods that prevent beriberi.

to use all these kinds of foods, and if he attempts to live on only a part of them his health is likely to suffer.

Increasing the food supply in the Philippines. Many of the poorer Filipino people need more and better food. They live day after day on rice and fish, and this does not supply them with all the materials that they need for health. How shall they improve their diet?

The people need to give more attention to gardening and to raise and eat great quantities of beans and other legumes. They ought also to build up their agriculture in every way, for agriculture furnishes food to the city and country alike. In particular they need to drive out the diseases that destroy their animals and cut off the supply of meat and other animal foods. They should improve the breed of their hogs so that they will have more meat, and they ought to raise chickens that will lay more eggs. One point in particular that they should remember is that milk is the best food that has yet been found for

FIG. 66. A Norwegian woman milking a dairy goat.

children, and that a supply of milk needs to be provided in the Philippines. It would seem that the keeping of dairy goats would be worth a careful trial; for these animals furnish the milk supply in many countries. A goat can easily be kept by a single family, and goats are less subject to disease than many other animals. The Department of Agriculture at Manila has brought some of these animals to the Philippines, and they seem to do well in this country.

QUESTIONS

How much protein is necessary to keep a man alive? How much protein do the best-nourished races eat? What kind of diet is low in protein? Name some foods that are rich in protein. How can the Filipino people increase their supply of these foods?

What are vitamins? What diseases are caused by a lack of vitamins? Give some of the symptoms of scurvy. At what age does it usually appear in children? How can scurvy be prevented and cured?

Describe the symptoms of rickets. What is supposed to be the cause of rickets? What is pellagra? What is the cause of pellagra?

What is the cause of beriberi? How has this been proved? In what two ways may beriberi be prevented? How many babies die each year in the Philippines of beriberi? How can these deaths be prevented?

Why is bulk necessary in the food? What kinds of foods provide bulk in the diet?

Give the safest general rule that can be followed in selecting food. How can the food supply of the Philippines be increased?

SUGGESTIONS TO THE TEACHER

The diagram on page 417 will show how important the question of a sufficient food supply is in the Philippines. Not only does beriberi cause a great number of deaths, but it also enfeebles and injures the health and working power of hundreds of thousands of Filipinos who do not die from it. The lack of proper food also makes people more susceptible to many kinds of germs, so that much of the sickness that is caused by germ diseases can be prevented only by a better standard of living.

The class should understand these facts, and the attention of all the pupils should be directed toward possible ways of increasing the amount of protein foods in the community.

CHAPTER XI

THE TEETH AND THEIR CARE

In an American school twenty-seven children whose teeth were badly decayed were selected for an experiment. First of all, they were examined as to the condition of their health. They were also made to solve problems and given other tests that would show the quickness and power of their minds. Then they were taken to a dentist and the cavities in their teeth were filled. If a child was suffering from sore gums, these also were treated, and the mouths of all of them were put into as good condition as possible. The children were given toothbrushes and were told to wash their teeth after each meal.

FIG. 67. Good teeth improve both the appearance and the health.

A year later it was found that these children had greatly improved in health. Their digestion was better, their complexions were clearer, and one girl who had been weak and subject to headaches had become strong and well. Their minds also were greatly improved, for they had more than twice the power to do mental work that they had when the first test was made. Six of them finished a year's work in school in a half year, and one boy who had failed the year before passed through two entire grades in the year. Undoubtedly the children had been suffering greatly in both their bodies and their minds because of the condition of their teeth.

How bad teeth injure the health. Bad teeth cause a person to swallow his food quickly and in big pieces. Then the food is digested very slowly. The large pieces of food will stay in the stomach for a long time, and they may become sour and cause indigestion (sickness of the stomach). Without a set of clean, sound teeth, it is hardly possible to have a good digestion and good health.

A second way in which bad teeth injure the health is by furnishing a breeding place for dangerous kinds of germs. When the teeth are decayed, the gums often become sore, and in many cases great colonies of pus-forming bacteria grow about their roots. The poisons that are produced by these germs constantly pass into the blood and poison the cells, and often the germs themselves float away in the blood and grow in other parts of the body. Sometimes they grow in the joints and cause rheumatism; sometimes they grow in the heart, kidneys, or walls of the blood vessels and cause very serious diseases of these organs. Decay of the teeth not only causes the loss of the teeth themselves, but is dangerous to the other parts of the body. We should therefore give our teeth every possible care.

The two sets of teeth. Each person has two sets of teeth. In childhood the jaws are small and we have a set of twenty small teeth. These are called the *temporary teeth.* Later, as the jaws grow, the larger *permanent teeth* come in. There are thirty-two permanent teeth, sixteen in the upper jaw and sixteen in the lower jaw.

Kinds of teeth. There are four kinds of teeth: *incisors, cuspids* (or *canines*), *bicuspids*, and *molars.* Counting the temporary teeth in one jaw, there are four incisors, two cuspids, and four molars. In the permanent set there are in one jaw four incisors in front;

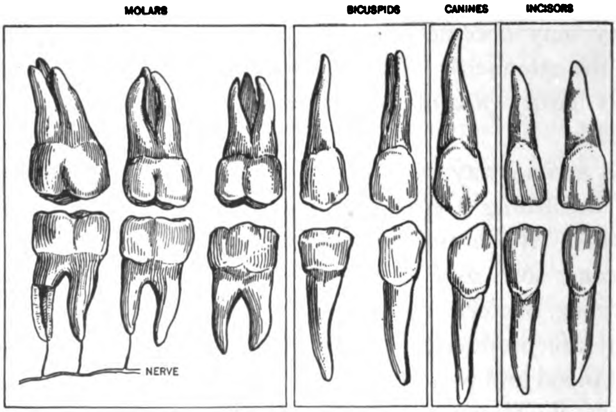


FIG. 68. One half of the permanent teeth.

then two cuspids, one on each side of the incisors; then four bicuspids, two on each side behind the cuspids; and six molars, three on each side behind the bicuspids (4 incisors + 2 cuspids + 4 bicuspids + 6 molars = 16 teeth in one jaw). The age at which the different teeth usually appear is shown in Figures 70 and 71. In some persons, however, they appear much earlier or later than usual.

The structure of a tooth. Each tooth has a *crown* and one or two *roots*. A few of the large back teeth may have three roots. The roots stand in sockets (holes) in the jawbones. Around the roots of the teeth in the sockets there is a hard, bony substance called *cement*. A thick red skin (the *gum*) covers the jawbones and comes up around each tooth to the crown. The outside coat of the crown is very hard, so that it will not break when we bite our food. This hard coat is called the *enamel*. Under the enamel is the *dentine*. This is harder than bone, but it is not so hard as the enamel. In the center of the crown there is a little cavity, which is filled with nerves and blood vessels. These nerves and blood vessels run down through little holes in the roots of the tooth and join the nerves and vessels in the bone of the jaw.

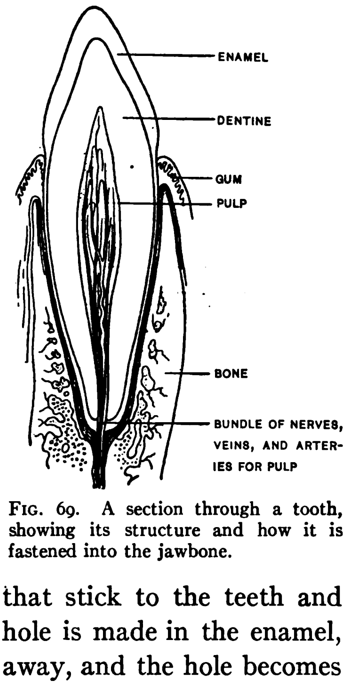


FIG. 69. A section through a tooth, showing its structure and how it is fastened into the jawbone.

The care of the teeth. Decay of the teeth is caused by bacteria that grow in the food particles that stick to the teeth and lodge between them. If a hole is made in the enamel, the dentine is quickly eaten away, and the hole becomes deeper and deeper. By and by the hole reaches the cavity where the nerves and vessels are. Then the tooth aches and must be filled at once, or soon it must be pulled out.

The way to keep the teeth from decaying is to keep them clean. Then the bacteria will not be able to grow between them. The teeth should be brushed both inside and outside after a meal. Pure soap or a good tooth powder[1] or paste assists in cleaning them. A moderately stiff brush is best. The gums as well as the teeth should be brushed. At first the gums may bleed when the brush touches them, but they will soon become harder and firmer. Food that has lodged between the teeth should be carefully removed after eating. A toothpick made from the quill of a large feather is good for this purpose. Charcoal and other gritty substances should not be used in cleaning the teeth, as they scratch the surface and leave little grooves in which food and bacteria collect. The teeth should not be brushed crosswise, but from the gums toward the crown.

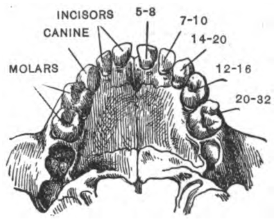


FIG. 70. The upper temporary teeth of a child about three years old, with the average time of eruption given in months. The lower teeth usually appear a few weeks earlier than the upper. The first permanent molars, which at this time are being formed in the jaws, are shown behind the temporary teeth.

Caring for the teeth of children. About the sixth year the first permanent molars come in behind the temporary molars. These teeth are often mistaken for temporary teeth and are allowed to decay, because the parents think that other teeth will come in to take their places. Count the double teeth in the mouth of a six- or seven-year-old child. If there are three double teeth on one side of the jaw, the back one is a permanent tooth. Decayed temporary teeth should be pulled

[1] A very good tooth powder can be made of equal parts of precipitated chalk and powdered orris root. These may usually be purchased from a druggist. Some excellent tooth pastes are also on the market.

before it is time for the second teeth to appear; for if this is not done, the roots of the first teeth may remain in the jaw and crowd the permanent teeth out of their places.

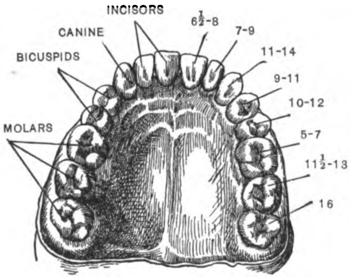


FIG. 71. The upper permanent teeth of a man twenty-six years old, with the time of eruption given in years. The lower teeth usually appear two or three months earlier than the corresponding upper ones.

Visiting the dentist. When a shoe gets a hole in it, we take it to the shoemaker to have it patched. When a tooth gets a hole in it, we ought to go to the dentist and have it filled. There is more reason for having a tooth mended than for having a shoe mended, because we can buy new shoes and we cannot buy new natural teeth. At least once a year every person should go to a dentist and have his teeth examined. If there are small holes in them, they should be filled. If a hard, dark-colored substance has collected on them near the gums, the dentist should remove this. By following this plan and by keeping the teeth clean they will be kept sound and fit for their work.

Care of the mouth of a baby. Little babies often suffer from sore mouth. This is caused by germs and is usually brought on by lack of cleanliness. A physician should be consulted for this disease, because it makes the child nervous and injures its digestion. When the teeth are cutting through the gums, the mouth should be examined, and if there are little sores on the gums, a physician or dentist should be consulted. One of the best ways of preventing trouble in the mouth of a baby is to wipe out the mouth with a clean cloth dipped in water that has borax or boric acid dissolved in it. This should be done each time after the baby is fed.

QUESTIONS

Describe the experiment on the teeth of certain school children and the results. In what two ways do bad teeth injure the health?

Name the two sets of teeth. How many teeth are there in each set? Name the different kinds of teeth. How many teeth of each kind are there in the temporary set? in the permanent set? Describe the structure of a tooth. What causes the teeth to decay? How may the teeth be kept from decaying? Explain how the teeth should be brushed. How may the first permanent molars be distinguished from the temporary molars? What should be done if a tooth begins to decay?

SUGGESTIONS TO THE TEACHER

It has been found that good teeth are far more important in preserving the health than had formerly been supposed. Teachers should, therefore, in every possible way encourage the pupils to secure toothbrushes and to use them. After each meal the teeth should be brushed, and it is especially important that they should be cleaned before going to bed, so that bacteria will not be able to multiply in the food particles on and between the teeth at night.

It is very important that the provincial towns shall be provided with dentists as soon as possible, and teachers should encourage the pupils and their parents to patronize dentists and give them their support. Young persons, especially, should have any decayed teeth filled, for the loss of the teeth may cause the loss of health and working power long before the time of life when the strength should fail.

REVIEW QUESTIONS

Chapter VI. Give three reasons why the body needs food. Explain what is meant by atoms, molecules, elements, and compounds. Name the three classes of foods and the elements in each class. What foods are rich in protein? starch? sugar? fats? How are fats, starches, and sugars used in the body? How are proteins used? Name some minerals important to the body. What foods are rich in these minerals?

Chapter VII. Name and describe the different parts of the alimentary canal. Describe the other digestive organs. Tell the story of the digestion of a meal. What becomes of the food after it is digested?

Chapter VIII. Describe an experiment which proves that the nervous system controls the glands of the stomach. Give five rules that you think are very important in keeping the digestive organs in health. Why do foods spoil? How may this be prevented? Why is bulk in the diet important?

Chapter IX. When a candle burns, what becomes of the atoms of which the candle is made? What becomes of the foods in the body? What wastes are formed when the foods burn? Describe the kidneys. What is their function? Where are the foods burned in the body? What foods contain growth proteins? How is food stored in the body?

Chapter X. How much protein does a man need each day? How could the supply of protein foods in the Philippines be increased? What are vitamins? What diseases are thought to be due to a lack of vitamins? What foods contain the vitamin that prevents scurvy? On what food do the people who suffer from pellagra live? What disease is caused by living on polished rice? How many persons die from this disease each year in the Philippines? What foods should a mother who is nursing a baby eat? What foods will prevent beriberi?

Chapter XI. Describe the two sets of teeth. What causes the teeth to decay? How can this be prevented? What should be done when a tooth decays? How can sore mouth in a baby be prevented?

CHAPTER XII

THE HEART AND THE CIRCULATION OF THE BLOOD

WE have learned that the body is made of cells and that these cells must have oxygen, food, and water. We know that the food and water are taken into the alimentary canal and go through its walls into the blood. In the next chapter, we shall study about how we breathe oxygen into the lungs, and we shall learn that the oxygen also goes into the blood. We know also that poisons are made in the body when the foods are burned, and that these poisons must be taken out of the body. All this means that there is much carrying to be done in the body; the food and oxygen must be carried all through the body to the cells, and the wastes must be carried away from the cells. This carrying is done by the blood. *The function of the blood is to carry food, water, and oxygen to the cells and to carry the wastes of the body away from the cells.*

The circulation of the blood. All through the body there is a great system of tubes called *blood vessels.* In Figure 78, you can see a diagram showing how the blood vessels pass through the body. They are all connected with the heart, and the blood is always passing away from the heart in these vessels and going out through the body and then coming again to the heart. From the time we are born until we die, the blood moves through the body, going to the heart and then out through the body and coming back to the heart again and again. This movement of the blood is called the *circulation.* As the blood circulates through the body, it carries useful things to the cells and takes away from the cells the things that are harmful. If the blood did not circulate, the body would die, because its cells could get no food, no water, and no oxygen, and because there would be poisons in the body.

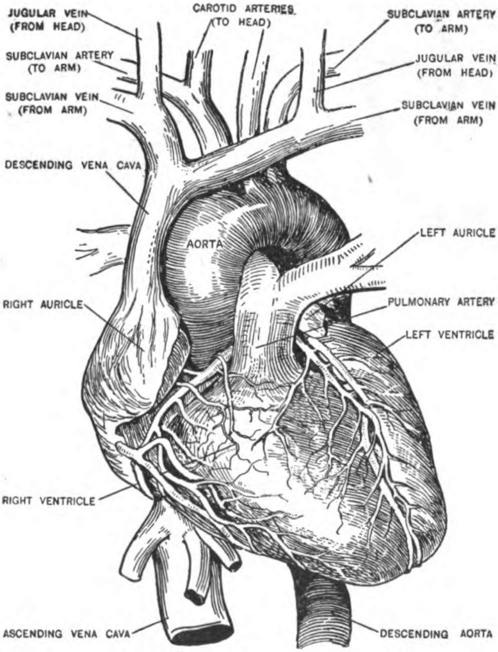
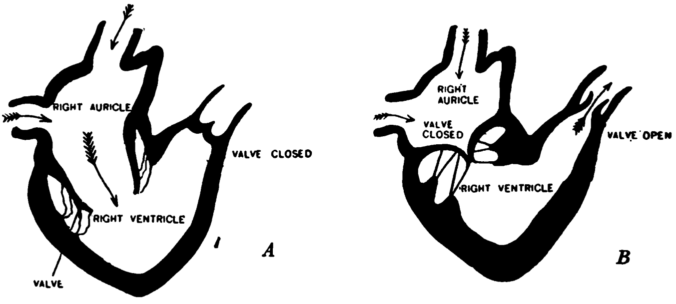


FIG. 72. The heart and the bases of the great vessels.

THE CIRCULATORY ORGANS

The organs that make the blood move through the body are called the *circulatory organs*. These organs are the heart and the blood vessels (*arteries*, *veins*, and *capillaries*).

The heart. A person's heart is about the size of his closed hand. It is in the chest a little to the left of the center of the body. It is made of muscle cells and is

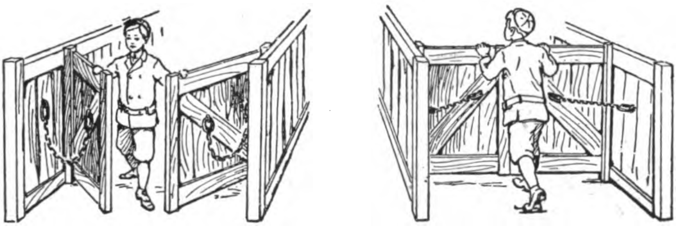


FIGS. 73 and 74. A diagram of the right side of the heart showing the working of the valves. When the blood flows into the auricles and the ventricles relax, the valves of the heart are as shown in *A*. When the ventricles contract and the blood flows out into the arteries, the valves are as shown in *B*.

divided into four parts, with a cavity in each part. The two upper cavities are called *auricles*, and the two lower cavities are called *ventricles*. The heart is full of blood, and blood vessels are connected with all its cavities — veins with the auricles, and arteries with the ventricles. *The work of the heart is to make the blood circulate through the body.* We shall now learn how it does this work.

The beating of the heart. From the veins, the blood comes into the auricles. When the auricles are full of blood, their walls contract and squeeze the blood into the ventricles. Then the walls of the ventricles contract and squeeze the blood out into the arteries, and the blood goes all through the body and lungs and comes again to the auricles.

If you place your hand on the left side of your chest, you can feel your heart move (beat) when the ventricles contract. Count how often your heart beats in one minute. All day and all night the heart works to send the blood through the body.



FIGS. 75 and 76. These gates work like the valves of the heart. When the boy pushes on them one way, they open; but when he pushes on them the other way, the chains hold them so that they will not open.

The valves of the heart. Between the auricles and the ventricles, there are *valves*. The valves are like little doors. When the auricles contract, the valves open down into the ventricles and let the blood pass into the ventricles. When the ventricles contract, the blood pushes up under the valves and lifts them. Little ligaments run from the valves to the walls of the ventricles. *These ligaments hold the valves so that they cannot be pushed up into the auricles.* In this way *the valves close the openings between the auricles and ventricles* so that the blood cannot go back into the auricles. Then the blood must go into the arteries. In these arteries are other valves that keep the blood from coming back into the ventricles. The blood can never go back because of the valves, but must always move in the same way — from the auricles into the ventricles, from the ventricles into the aorta and pulmonary artery, and then through the small vessels of the body and lungs and through the great veins back to the auricles.

Blood vessels. *Arteries take the blood away from the heart. Veins bring the blood to the heart.* The aorta takes the blood from the left ventricle through all parts of the body, and the pulmonary artery and its branches take the blood from the right ventricle through the lungs. The arteries are very large near the heart, but soon they divide and make smaller arteries. These smaller arteries divide again and again until they are very small — so small that they are microscopic. These little vessels are called *capillaries*.

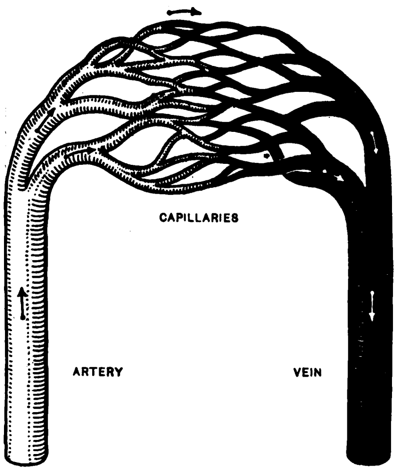


FIG. 77. Diagram showing how the blood passes through the capillaries from an artery to a vein.

The capillaries go everywhere among the cells of the body and the lungs, and then they begin to unite. More and more of them unite and make larger veins, and at last all the veins join in very large veins (the *venæ cavæ*) that open into the heart.

The course of the circulation. The blood leaves the ventricles and goes out through the arteries. Then it goes into the capillaries and on into the veins and back to the heart again. Study the pictures of the heart and of the circulation and you will see that the blood passes through the heart and blood vessels in the following way:

From two great veins into the right auricle.
From the right auricle into the right ventricle.
From the right ventricle into the pulmonary artery and its branches.
From the branches of the pulmonary artery into the capillaries of the lungs.
From the capillaries of the lungs into four pulmonary veins.
From the pulmonary veins into the left auricle.
From the left auricle into the left ventricle.
From the left ventricle into the aorta and its branches.
From the branches of the aorta into the capillaries of the body.
From the capillaries of the body into the smaller veins.
From the smaller veins into the two great veins called the *ascending* and *descending venæ cavæ*, and then back into the right auricle.

Time of the circulation. The blood goes through the body very swiftly. When it goes to a part of the body that is near the heart and comes back again to the heart, it takes little time; but when it goes to parts far away from the heart, it takes more time. On an average, the blood leaves the heart and goes through the body and comes back again to the heart in a little less than a minute. All the blood in the body is sent swiftly through the body again and again.

The Care of the Heart

The heart is a muscle, and we have learned that it is necessary for a muscle to rest. If a muscle works very hard and has no time to rest, the cells of the muscle will change to fat. When a cell changes to fat, it cannot contract any more, and when many of the cells in a muscle are changed to fat, the muscle becomes weak.

All our lives the heart beats from seventy to eighty times a minute and rests only a little after each beat. Anything that makes the heart beat faster, shortens the time it has for rest. When it beats too fast, it may become enlarged, and its cells may change to fat. People often die from disease of the heart (page 417), and we should take the best of care of this important organ.

The heart while the body is growing. When the body grows, the heart also must grow in order that it may be large enough and strong enough to send the blood through the enlarged body. When the body becomes large very quickly, the heart sometimes has difficulty in growing fast enough to do its work. Anything is injurious which makes the work of the heart very hard when the body is growing rapidly. Some things which a grown person may do with little or no injury are very harmful to boys and girls.

Exercise and the heart. Very hard and long-continued exercise may injure the heart by making it work too hard. Boys sometimes injure their hearts by fast bicycle-riding. Very heavy and long-continued work should not be done by either young persons or old persons. You must understand, however, that it is long-continued severe exercise that you are being warned against.

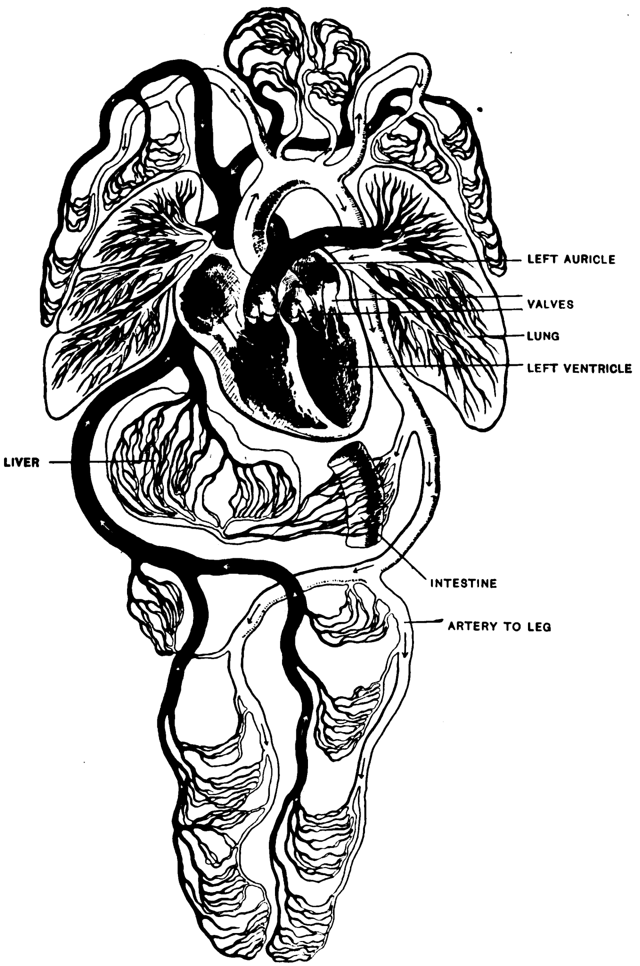


FIG. 78. Diagram showing the circulation of the blood. Name the vessels in the different parts of the diagram and trace the blood through them.

Both moderate exercise and hard exercise taken for short periods of time benefit the heart.

Tobacco and the heart. To smoke or chew tobacco often makes the heart weak. Then the heart does not send the blood through the body well, and therefore the cells do not get enough food and oxygen and the wastes are not carried away from them. Many people who use much tobacco cannot do hard work because their hearts are weak. When they work hard, their hearts beat very quickly and they feel sick.

QUESTIONS

What is the function of the blood? What does the blood carry to the cells? What does it carry away from the cells? What is meant by the *circulation* of the blood?

Name the organs of circulation. Where is the heart? What are the divisions in it? What are connected with the cavities of the heart? What is the work of the heart? Where do the ventricles send the blood? To what part of the heart does it come back? Explain how the valves of the heart work.

What is the work of the arteries? of the veins? Where are the large arteries? Explain how capillaries are formed. When the capillaries unite, what do they make? Trace the course of the blood from the right auricle to the right auricle.

What effect has too much work on a muscle? How often does the heart beat? When does it rest? Explain why the work of the heart is hard while the body is growing. What effect has very hard exercise on the heart? How do boys sometimes injure their hearts?

What effect has tobacco on the heart?

CHAPTER XIII

THE BLOOD AND THE LYMPH

ACCORDING to one estimate, the human body is composed of more than four hundred billions of cells. These little cells are built together as stones are built into a wall. Each of the cells is alive; each must have food and oxygen and must get rid of its wastes. To supply the needs of the cells, the blood flows among them through thousands of little capillaries. About one twentieth of the weight of the body is blood; so if a boy weighs forty kilograms, he will have in his body about two kilograms of blood.

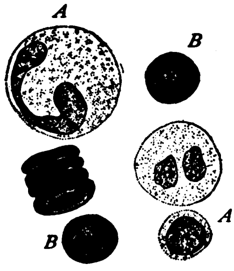


FIG. 79. *A* shows the white and *B* the red corpuscles of the blood as they appear under a microscope.[1]

Plasma and corpuscles. Blood is made of *plasma* and *corpuscles.* The plasma is a yellow liquid. If you wound the skin a little, you can see the plasma coming through the skin like yellow water. The plasma is nine tenths water; and, dissolved in this water, there is much food and a little of many other substances.

The corpuscles are small bodies that float in the blood plasma. A few of the corpuscles are white, but most of them are red. The red corpuscles are circular, and they are so small that there are five millions of them in a drop of blood the size of the head of a pin. The red corpuscles are formed chiefly in the cavities of the spongy bone, and when they die, the liver uses them in making bile.

[1] The dark bodies in the white corpuscles are the nuclei of the cells.

Work of the red corpuscles. *The work of the red corpuscles is to carry oxygen to the cells of the body.* We take air into the lungs, and there is oxygen in this air. The corpuscles come to the lungs, and there they take up the oxygen. Then the corpuscles go back to the heart, and the heart sends them to all parts of the body. They carry the oxygen out through the body, and from them the cells of the body take the oxygen. With this oxygen, the cells burn their food and the old parts of the cells, and so get heat and strength. If the lungs do not breathe in oxygen, and if the corpuscles do not carry the oxygen to the cells, the body dies. We cannot live for even a minute without oxygen.[1]

Color of the blood. When the corpuscles are full of oxygen, they have a red color and make all the blood look red. When they lose the oxygen, they become dark in color and the blood looks dark. The blood has oxygen when it comes from the lungs, so the blood in the left side of the heart is red. The oxygen is lost in the body, so the blood is dark when it comes back to the right side of the heart.

In light-skinned persons you can see the dark blood in the veins of the forearm. The blood in these veins is coming back from the hand, and the corpuscles have given their oxygen to the cells of the hand. For this reason, the veins of the forearm look blue.

[1] The red corpuscles are like little boats. They float through the lungs and there take in loads of oxygen. They then float out into the capillaries and give up their oxygen to the cells. Then they return to the lungs for another load.

The work of the white corpuscles. A white corpuscle is composed of a little piece of soft, jelly-like material. It is able to change its shape and flow slowly about. *The work of the white corpuscles is to kill disease germs.* They are the soldiers of the body. When germs get into the body, the white corpuscles collect about them, flow around them, and digest them. When the corpuscles are able to kill all the germs in this way, the disease is checked; but if the germs are very powerful, they may be able to poison the corpuscles and kill them. Then the disease will go on.[1]

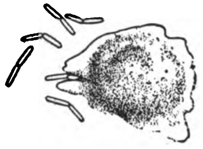


FIG. 80. A white corpuscle taking in a bacterium.

Foods and wastes carried in the plasma. The foods are dissolved in the plasma and are carried by the plasma to the cells. When they are burned in the cells they

[1] If we could see what is happening in a boil, a wonderful battle would be witnessed. First of all we should see a few germs that had worked down into a hair follicle (page 324) or in some other way had got into the lower part of the skin. Then we should see the white corpuscles begin to creep out through the walls of the capillaries and surround this group of enemies. The corpuscles eat many of the germs, but the germs are so poisonous that often the corpuscles are killed and the germs use their dead bodies for food. All the time hundreds of millions of corpuscles are gathering about the spot from all parts of the body, and by and by the corpuscles form a solid wall about the germs. In the center of this mass, the germs poison the cells and kill millions of the corpuscles until the central part of the boil softens and breaks, and pus flows out. This pus is composed of dead corpuscles, dead cells of the body, germs, and liquid from the blood. When the corpuscles are victorious, they form a solid, thick wall about the boil, keep the germs from spreading through the body, and finally conquer them. In some cases the germs poison more and more of the corpuscles and finally break through the ring of soldiers about them. They then spread through all the body, and we say that the person has *blood poisoning.*

make water, carbon dioxid, urea, and other wastes (page 258). These wastes pass out of the cells into the plasma and are carried away by the blood. The carbon dioxid is a poisonous gas. The blood takes it to the lungs, and there it is breathed out into the air. The urea is carried to the kidneys and is there taken out of the blood. *The plasma carries food and oxygen to the cells and carries wastes away from the cells.*

How food and oxygen go to the cells. The walls of the capillaries are very thin, and the plasma passes through them and flows out into the spaces and openings among the cells. This escaped plasma is called *lymph*, and all the cells of the body have lymph around them. The food is dissolved in the lymph, and each cell takes from the lymph the food that it needs.

The red corpuscles cannot go out through the walls of the capillaries to the cells, but the oxygen leaves the corpuscles and passes through the walls of the capillaries into the lymph among the cells. The carbon dioxid and other wastes leave the cells by passing through the cell walls into the lymph and then on through the walls of the capillaries into the blood (Figs. 58 and 81).

The Lymphatic System and the Lymph

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 duct runs up the back of the cavities of the abdomen and chest, and empties into the large vein in the left shoulder.

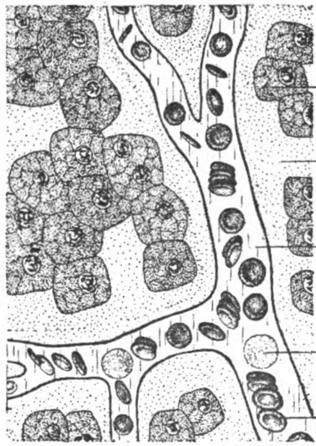


FIG. 81. Diagram showing how the cells are bathed in lymph, which is plasma that escapes through the thin walls of the small blood vessels.

The lymphatic vessels of the intestine. There are very many lymphatic capillaries in the walls of the intestine and in the villi. These do the same work as the other lymphatic vessels, and they do also another kind of work. *They take the fats from the intestine and empty them into the blood.* When the proteins and the starches and sugars are digested, they go into the blood capillaries; but when the fats are digested, they pass into the lymphatic capillaries. These capillaries unite and make larger vessels, and the larger vessels take the fats to the thoracic duct. Then the fats go into the blood and go all over the body in the blood as food for the cells.

The lymph nodes. Scattered throughout the body are many white bodies called *lymph nodes*.[1] The largest are about the size of a Lima bean, but they are somewhat flattened. If you could examine a lymph node, you would find that it is a little connective tissue sac filled with white blood corpuscles. One set of lymphatic vessels flows into this sac and pours the lymph in among the white corpuscles. The lymph flows among the corpuscles as water flows among grains of sand and then enters a set of vessels that carry the lymph away from the node. As the lymph flows through the nodes, *any germs that may be in it are stopped and killed. The lymph nodes also serve as breeding places for the white corpuscles.*

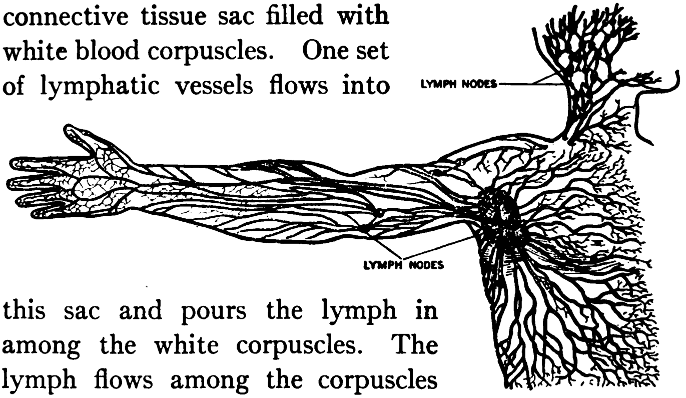


FIG. 82. The lymphatic vessels and nodes of a part of the body.

CHECKING BLEEDING FROM A WOUND

The capillaries are so numerous in the body that if you cut the skin on any part of the body a little, you cut many capillaries, and the blood escapes.

When the blood comes out to the air, it coagulates, or becomes thick. When only capillaries and small

[1] In the body there are 600 or 700 lymph nodes large enough to be seen without a microscope.

arteries and veins are cut, this thick blood will stop up the ends of the vessels so that no more blood can escape. But if a large vessel, like one of the larger arteries or veins, is cut, the thick blood cannot close the end of the vessel. Then we must stop the blood from escaping, or the person who is wounded will die, because he will not have enough blood to carry oxygen through the body.

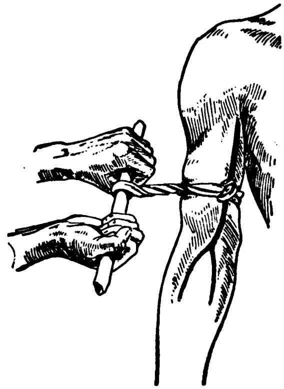


FIG. 83. Stopping bleeding from an artery in the arm.

Bleeding from arteries and veins. Most of the large arteries are deep in the body and are so well protected by the bones and muscles that they are not often cut. But sometimes one of the arteries in the limbs may be cut. One can always tell when this has been done, because where an artery is cut, the blood comes out in leaps, or jumps. Each time the heart beats, the blood leaps out.

If an artery in an arm or leg is cut, press with your thumbs *above* the wound (that is, between the wound and the heart) until you stop the bleeding. Then tie a knot in the center of a handkerchief (or use a piece of cloth or rope). Tie the handkerchief around the limb between the wound and the heart, and place the knot so that it will press down on the artery. Then put a stick through the handkerchief and twist it very tight.[1] If the knot is not large enough to close the artery

[1] The blood should not be cut off from a limb in this way for more than twenty minutes. If a physician cannot be secured quickly, loosen

and stop the bleeding, put a small, clean stone or a piece of wood under the handkerchief. The best places to put the knot are on the inside of the upper arm, the inside of the thigh, and behind the knee. In these places, the artery will be pressed against the bone and closed.

When a vein is cut, the blood comes out more slowly and does not come in leaps. Usually we can stop bleeding from a vein by putting a thick cloth over the wound and pressing or tying it down tight. If much blood escapes, twist a handkerchief around the limb the same as if an artery were cut, but put it *below* the wound (that is, toward the hand or foot).

In an artery, the blood flows toward the hand or foot and away from the heart. Therefore, when an artery is cut, the handkerchief should be placed between the wound and the heart. But in a vein, the blood flows away from the hand or foot and toward the heart. Therefore, when a vein is cut, the handkerchief should be farther down the limb (closer to the hand or foot) than where the wound is.

If the wound is in some other part of the body, place a thick cloth tightly over it, and always raise any part of the body from which the blood is escaping. The blood goes more easily to a part of the body that is low.

When a large artery is cut, it is necessary to call a physician and have him tie a cord around the end of the artery. If this is not done, the bleeding will begin again when the handkerchief is taken off. In any bad case of bleeding, a physician should be called.

the bandage from time to time, pressing on the artery with the thumbs to keep the bleeding in check.

Bleeding from the nose. Sometimes the skin on the inside of the nose breaks. Then the little vessels in this skin are also broken, and the nose bleeds. When blood comes from the nose, the person should be quiet. It is better to sit than to lie down, because the head should be kept high. Sometimes the bleeding can be stopped by pressing the upper lip against the teeth or against a ball of paper placed between the lip and the teeth. Sometimes holding the nose for a few minutes will check the flow of the blood. Cold water put on the back of the neck and on the forehead often helps to stop the bleeding, because it makes the arteries contract so that less blood goes to the head. Do not blow the nose, for this will often start the bleeding again.

QUESTIONS

If one twentieth of your weight is blood, how much blood is in your body? Describe the blood plasma. What is the function of the red corpuscles? When is the blood red? When is it dark? What is the work of the white corpuscles?

How are the foods carried to the cells? What is made when the foods are burned in the cells? Where does the carbon dioxid go? How does the blood take the carbon dioxid out of the body? Why is this necessary?

How does the plasma go to the cells? What is the plasma called after it escapes from the capillaries? What do the cells take from the lymph? Explain how the oxygen gets from the red corpuscles to the cells. How does the carbon dioxid pass from the cells into the blood?

Describe the lymphatic vessels. What is the work of the lymphatic vessels? Describe a lymph node. What is the function of the lymph nodes?

What does blood do when it comes out to the air? How can you tell when an artery is cut? Explain how to stop bleeding from a cut artery. On which side of the wound should you close the vessel to stop bleeding from an artery? from a vein? What can be done to stop bleeding from the nose?

SUGGESTIONS TO THE TEACHER

If the people of a community are wasting their money by buying "blood purifiers" or other medicines for the blood, the teacher should discuss the foolishness of this practice. The blood is composed of the food that we eat, the water that we drink, the corpuscles that come from the bone marrow and the lymph nodes, and certain minerals that are supplied in our food and drink. It is made by the body, and we can change the blood only by changing the functions of certain organs of the body. The way to have rich, pure blood, therefore, is to keep the body free from disease and intestinal worms, to eat good food, and to build up the general health. There is no medicine that can be taken that will affect the blood directly, and the class ought to understand this fact.

Show the pupils how to stop bleeding from a wound, and make sure they understand the danger of keeping the blood cut off too long from any part of the body.

CHAPTER XIV

RESPIRATION AND VENTILATION

WATCH the chest of some boy or girl who is near you. You will see that the chest rises and falls about sixteen times every minute. When the chest rises and falls, air passes into and out of the lungs. This passing in and out of the air is called *breathing* or *respiration*.

The object of respiration. *The object of respiration is to take oxygen into the body and to give off carbon dioxid from the body.* We know that the cells of the body must have oxygen, and that the blood brings the oxygen to them. There is oxygen in the air; and when we breathe the air into the lungs, the oxygen goes into the red corpuscles of the blood and the corpuscles carry it to the cells. The cells use this oxygen to burn the foods, and when the foods are burned, they make carbon dioxid. The carbon dioxid is a poison, and the red corpuscles carry it away from the cells to the lungs, where it passes out of the corpuscles into the air in the lungs. Then, when this air is breathed out of the lungs, the carbon dioxid passes out of the body into the outside air.

How we respire (breathe). The lungs are in the cavity of the chest, and there are two ways of making this cavity larger so that the air will go into the lungs.

One way of doing this is by pulling down the diaphragm. The diaphragm is stretched across the cavity of the trunk, between the chest and the abdomen. It is made of connective tissue with many muscle cells among the fibers. The diaphragm is circular, and its center stands up higher than the edges, so that it is bell-shaped. From the center of the diaphragm, the muscles run down all around and join the body wall. When we take in air, the muscles of the diaphragm contract and pull its center down. This makes the chest larger, and more air comes into the lungs and expands them. When we breathe out the air, the diaphragm comes up and pushes the air out of the lungs.

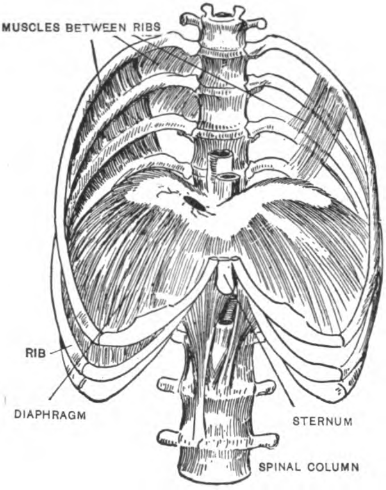


FIG. 84. The diaphragm.

The other way of making the chest larger is by lifting the ribs. There are many muscles attached to the ribs, and when these muscles contract, they pull the ribs up and out. The air then goes into the lungs. When the ribs sink down again, they force the air out of the lungs. Put your hands on your sides and feel your ribs rising and falling as you breathe.

How the air enters the lungs. If you stand before a mirror with your mouth wide open, you can see two holes (the *back nostrils*) opening from the nose into the back of the mouth. We breathe air into the nose through the *nostrils* (holes in the nose), and it goes into the back of the mouth through the back nostrils. Then it passes on down into the *trachea*. The trachea divides into two great branches, or *bronchi* (singular, *bronchus*), and one branch, or bronchus, goes to each lung. Each bronchus divides into very many little branches, and the air goes through these little branches to all parts of the

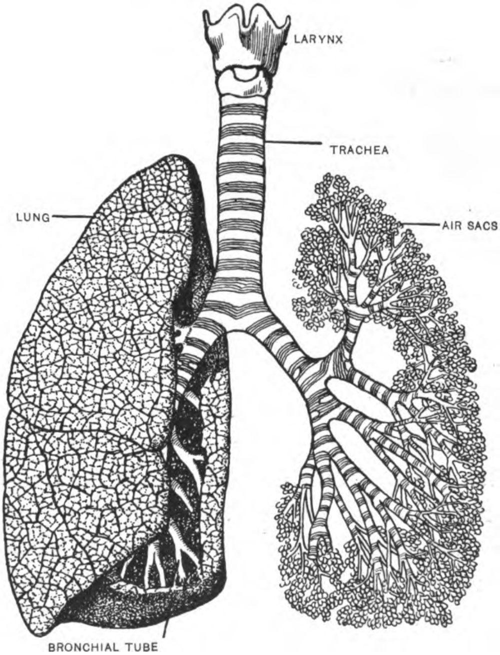


FIG. 85. The lungs.

lungs. The trachea and all its larger branches have rings of cartilage in their walls, so that the walls cannot close together and stop the air from going in and out.

Changes in the air in the lungs. On the ends of the smallest branches of the bronchi there are many little air sacs. The lungs are made up of these little air sacs, which are so numerous that if all the sacs in a man's lungs were opened and spread out side by side, they would cover the floor of a room sixteen meters square.

The walls of the air sacs are very thin, and in these walls there are many capillaries. The air comes down into the sacs, and the oxygen of the air goes through the walls of the sacs into the blood corpuscles. The carbon dioxid comes out of the corpuscles into the air in the sacs, and then we breathe out the air. In this way, oxygen goes into the body and carbon dioxid comes out of the body.

FIG. 86. A small bronchial tube and the air sacs in which it ends.

Water also comes out of the blood into the air which is in the lungs. If you breathe on a mirror or a piece of cool glass, you can see the water that comes from the lungs. About one fourth of a liter of water comes from the lungs in a day.

The air. About four fifths of the air is nitrogen, and about one fifth of it is oxygen. Besides the oxygen and nitrogen, there is a little of several other gases in the air. Whenever anything is burned or decays, carbon dioxid is formed, and all animals breathe out carbon dioxid, so that there is always a little of this in the air. There is also water vapor in the air, often so much that it forms raindrops and falls to the earth.

A man takes in about eight tenths of a kilogram of oxygen from the air in twenty-four hours. This oxygen weighs more than the food (without the water of the food) which he eats. A person breathes out nearly a kilogram of carbon dioxid in twenty-four hours. It is very important to have good air, so that we can get this oxygen and so that we may not breathe the poisonous carbon dioxid into our lungs again.

Amount of air needed. In an hour, a man breathes about a cubic meter of air. If there are one hundred persons in a room, they breathe one hundred cubic meters in an hour. Much fresh air must come in, or the air in the room will become full of carbon dioxid. Where there are very many people in a room, it is difficult to get enough air into the room to give them all good air. Each person should have fifty cubic meters of space in a room, and then all the air must be changed five times every hour. This will give two hundred and fifty cubic meters of air to one person in an hour, and this amount is not too much. Fires and lamps take oxygen out of the air and give off carbon dioxid, and where these are burning in a room, even more fresh air will be needed.

Where a house is made of bamboo and nipa, plenty of fresh air will come through the walls and floors. But when the sides of a house are made of cement or wood and the floors are tight, the air must come in through the windows and doors. These should be opened enough to let in fresh air. It is not well to close a house at night where there are people sleeping, because the air will become very bad before morning. Some people are afraid of night air, but the air around a house at night is the same as the air around the house in daylight. Covering the head at night is a very bad custom, because it causes the person to breathe the same air again and again.

An important point in ventilation. One very important point in ventilation is made clear by the following experiment:

Experiment. Break the bottom from a bottle and stopper the bottle tightly. Then push it down, stopper up, into a vessel of water. The water does not enter the bottle. The bottle is already full of air, the air cannot escape, and the water cannot enter. Now remove the stopper from the bottle. The water at once rushes into the bottle. The opening at the top of the bottle allows the water to push the air out. Then the water can enter the bottle and take the place of the air.

Air cannot come in at a window unless it can push the air already in the room out of its way. There must be a way for the air already in the room to escape. It is most important, therefore, to have openings on two or three sides of the room, so that the air can blow across the room. Notice how a breeze almost always blows across a room when the windows are open on opposite sides of it, and how the breeze can be stopped by shutting the windows on one side of the room. "Through ventilation" is especially important in crowded rooms (schoolrooms, churches, theaters) and in hot weather, when motion in the air is needed to cool the body (page 320).

Treatment for Apparent Drowning

When a person is under water, the air passages become filled with water and no air can go into his lungs. If he stays under the water long, he will die, because his body gets no oxygen. But if he is taken out of the water before the heart stops beating, he will not die if the air can be made to go into his lungs again.

Draining the water from the lungs. When the person has been taken out of the water, the first thing to do is to get the water out of the lungs. Quickly turn the person on his face, and standing over him, catch him under the waist and lift him in the way shown in the picture (Fig. 87). Lift him up two or three times, so that all the water will run out of his mouth from the lungs. Do this quickly (in about half a minute). Another way of draining the water from the lungs is to lay the patient over the shoulder with his head hanging down behind. By raising the waist and moving the body on the shoulder the water can be made to run out of the lungs.

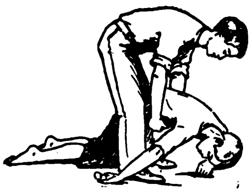


FIG. 87. Draining the water from the lungs.

Artificial respiration. Lay the patient in the position shown in Figure 88. If possible, place something under his chest. Stand astride the patient and place your hands on either side of his back over the lower ribs. Then throw the weight of your body steadily downward on your hands and drive the air out of his lungs. Take the pressure off the body without lifting the hands, and allow the air to come back into the lungs. Then again press the air out of the lungs. Repeat this 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. Another advantage is that when the patient is laid face down, the tongue does not fall back and block the throat.

Other treatment. Rubbing the arms and legs along the veins toward the body causes the blood to circulate and should be kept up if there is a second person to do it. Keep the patient warm. A hot-water bottle or a warm stone wrapped in a cloth and placed at the head is especially useful, but nothing that feels uncomfortably hot to the skin of the elbow should be used. When the patient is able to drink, give him a little strong hot coffee. A little alcohol in water or fifteen drops of ammonia in a glass of water are also useful stimulants. Artificial respiration should be kept up for an hour or longer if the patient does not recover sooner.

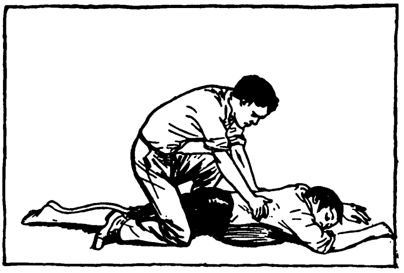


FIG. 88. Carrying on artificial respiration.

QUESTIONS

What is the object of respiration? When air is taken into the lungs, where does the oxygen go? How do the cells use the oxygen? Where do the corpuscles carry the carbon dioxid? How does it pass out of the lungs?

Where are the lungs? What are the two ways of making the cavity of the chest larger? What does the diaphragm do when we take air into the lungs? when we breathe air out of the lungs? How are the ribs moved? Trace the course of the air into the lungs. What keep the walls of the trachea and bronchi open?

How much space would the lung sacs of a man cover, if they were spread out flat? Describe the walls of the sacs. Tell about the exchange of oxygen and carbon dioxid in the air sacs of the lungs. How can you tell that water comes from the lungs?

Of what gases is the air composed? In twenty-four hours, how much oxygen does a person take in? How does this compare with the amount of food he eats in the same time? How much carbon dioxid does a person breathe out in twenty-four hours?

How much air space should each person in a room have? How often should the air in a room be changed? Should the windows in a house be closed at night? Why?

What is meant by "through ventilation"? Why is it important?

Show how a person who has been under water should be treated.

SUGGESTIONS TO THE TEACHER

Light a candle and set it in a room where the windows are closed on one side. Is the candle flame blown aside by the air entering the room? Now open the windows on the opposite side of the room and see if the wind blows across the room more freely. It is very important in a hot climate like that of the Philippines for the air to be kept in motion in offices, schoolrooms, and factories during the heat of the day, and the pupils should be made to understand this point.

Lay a boy on the table or the floor and demonstrate artificial respiration on him. There are many deaths from drowning in the Philippines, and many lives could be saved if artificial respiration were used as promptly as possible when persons are taken out of the water.

CHAPTER XV

THE CARE OF THE RESPIRATORY ORGANS

It is easy for germs to enter the air passages through the nose and mouth. Diseases of these parts are, therefore, very common. In this chapter we shall study some parts of the air passages in more detail, and shall consider what we can do to keep them in health.

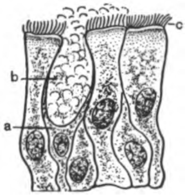


Fig. 89. Cells from the lining of the trachea. *a* is a cell that manufactures sticky mucus (*b*) in which dust and germs from the air are caught. The cilia (*c*) on the other cells beat upward and sweep the mucus, dirt, and germs up out of the air passages and lungs.

The air passages lined with cilia. The inside walls of the nose and of the trachea and its branches are covered with *cilia* (singular, *cilium*). These cilia are like very fine, small hairs that stand up on the walls. The cilia move back and forth all the time, as a field of rice moves in the wind. But they move more quickly when they bend up than they do when they bend down, and for this reason they bring anything that is on the walls upward.

Mucous glands. Among the cilia, there are glands (mucous glands) in the walls of the air passages. These glands make a sticky, white substance called ***mucus***.[1] The mucus makes the walls sticky, and if dust is breathed into the air passages, it sticks to the walls and does not go down into the lungs. In the trachea and its branches the cilia move the mucus and the dust up and up until it comes to the top of the trachea and is coughed out.

[1] In some parts of the air passages mucus is formed not only by glands but also by single cells in the walls (Fig. 89).

Sometimes, when the lungs or the walls of the air passages are diseased, the cilia bring up much mucus from them.

The chambers of the nose. The long, narrow nasal passages 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. When the air is drawn through these chambers, it is warmed, and the dust and germs in the air are caught on the moist, sticky skin that lines the walls. *The nose cleanses the air and protects the throat and lungs from dust and germs.*

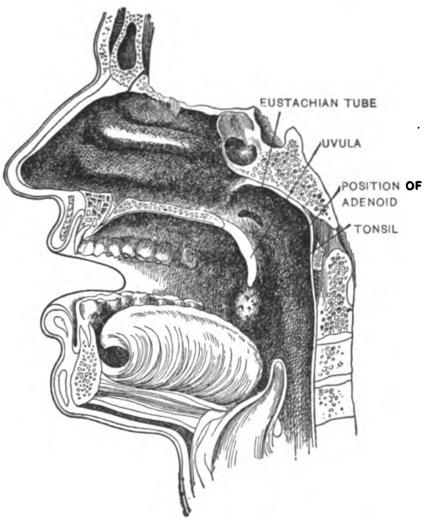


FIG. 90. The nasal passages, mouth, and throat.

The throat. The throat curves backward and downward around the root of the tongue. In its walls are six openings. Two in front lead to the nose; a small opening high in each side wall leads to the ears (page 367); and two openings at the bottom lead to the stomach and the lungs.

Where the mouth opens into the throat, a soft, curtainlike structure called the *uvula* hangs down from above. When we swallow food or water, the uvula is pushed back and covers the openings from the nose. If air comes up the trachea (as when one laughs) when there is food or water in the back of the mouth, the air will push the uvula forward and the food and water will go up behind the uvula into the nose.

The larynx. The upper part of the trachea is called the *larynx*. It is in front of the esophagus, and the food and water that we swallow must pass over the top of the larynx. To keep food and drink from falling down into the trachea, there is a little cover, called the *epiglottis*, over the top of the larynx. When we swallow, the larynx rises and presses against the epiglottis. When we breathe, the larynx drops down, leaving the trachea open so that the air can pass into and out of the lungs. If a person laughs when he is drinking, the air comes up from the lungs and pushes up the epiglottis. Then the water gets into the trachea and makes him cough.

The tonsils. In the walls of the throat there are four *tonsils*. Two of them lie in the sides of the throat just behind and below the corners of the lower jaws. One very small tonsil is on the back of the tongue. The fourth one lies high up in the back wall of the throat; it is above the uvula and behind the openings from the nose.

The tonsils are of soft, spongy structure, and very commonly germs grow in them and cause them to become greatly swollen. Sometimes the tonsil in the back of the throat becomes so large that it blocks the air passages from the nose to the throat. Then the person cannot breathe through his nose. This soft, spongy growth is called an *adenoid*, or *adenoid growths*. They are common in children, but older persons do not suffer so much from them. This is partly because the adenoids often disappear in older persons and partly because the throat grows until they do not entirely fill it.

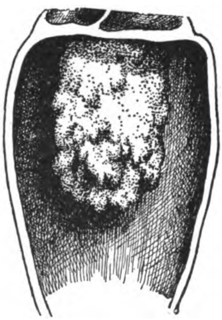


FIG. 91. Adenoids in the throat seen from the front. (*After Wingrave*.)

The symptoms of adenoids. The most common symptom of adenoids is breathing through the mouth. The adenoid closes the back nostrils, and when the child closes his mouth he cannot draw the air through his nose. Sometimes the passages of the nose may be only partly closed. Then the child can breathe a little through his nose, but cannot breathe well. Often when a child has had adenoids for a long time the lips become thick; the upper lip shortens and is turned out; and the teeth turn forward. In many cases of adenoids, the germs work their way up the tubes to the ears (page 367) and cause earache. Often when a person with an adenoid speaks, he sounds as though he were "talking through his nose," and it is very difficult for a child suffering with adenoids to pronounce his words clearly. A child with this trouble usually snores when he is sleeping and sometimes gasps and struggles for breath during sleep. In many cases the child suffers from indigestion and does not grow as he should.

Adenoids also affect the nervous system and the mind. Children who suffer from them are very restless, and they cannot keep their attention fixed on their work. Often they are stupid at their books and fall behind in their school work. Usually they are fretful and quarrelsome; they lack self-control and become angry without cause.

FIG. 92. An adenoid face.

The remedy for adenoids. The remedy for adenoids is to have them removed by a surgeon. Only a physician or a surgeon who is skillful in this operation should attempt to remove adenoids; but if they can be taken out, there is a wonderful improvement in the child. Usually they will disappear or become less troublesome after one has grown up, but they leave the nostrils narrow, the teeth turned forward, the upper lip short and thick, and often cause disease of the ears that leads to deafness. They are a serious disease, and if possible a child that is suffering from them should have medical treatment.

The voice. Feel the hard structure under the skin on the front of the neck. This is the larynx. Its walls are made of stiff cartilages, and the *vocal cords* are fastened to these cartilages. The vocal cords are flat strings. They are made of fibers and are fastened to the cartilages at the front and back ends and all along one side. When we talk or sing, we pass the air over the free edges of these cords. The air passing over the cords makes the sound of the voice in the same way that the air passing over the reeds of a harmonica makes a sound. If we wish the voice to be loud, we blow the air hard over the cords. If we wish the voice to be soft, we blow only a little air over the cords.

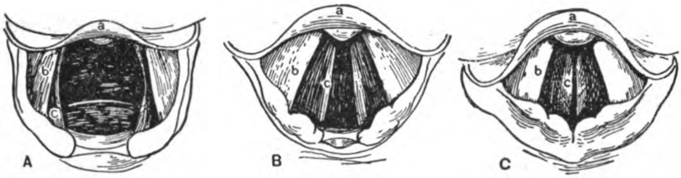


FIG. 93. The mouth of the larynx viewed from above. *A* shows the position of the vocal cords (*c*) in deep breathing; *B* is their position in ordinary breathing; and *C* shows them brought together for speaking or singing. *a* is the epiglottis.

The pitch of the voice. The big strings of a guitar give a low sound, and the little strings give a high sound; a short string gives a high sound, and a tight string gives a higher sound than a loose string. People who have small, short vocal cords have high voices. The larynx of a man is larger than the larynx of a woman. His vocal cords are larger and longer, and his voice is lower. You can feel the large, hard cartilages of the larynx in the front of a man's neck.

When we wish to make our voices high, as when we sing high, we make the vocal cords tight. When we wish to sing low, we make the cords loose. There are little muscles in the larynx that make the cords tight and loose.

Deep breathing. Many persons do not take the air down deep into the lungs. A very good exercise is to stand with the head erect and the shoulders back, breathe in slowly all the air that the lungs can hold, and then slowly breathe it out again. It helps to expand the lungs if one rises on the toes as one takes in the air. Four or five times a day several of these deep breaths should be taken.

Correct position. We should not stand or sit in a way that will not give the lungs room to expand and take in air. The head should be held erect and the shoulders back. In walking, a person should hold his head as high as possible (but not forward), as though he were hanging by the top of the head. This will keep the chin close to the neck and the shoulders and ribs lifted up off the lungs. Many Filipinos walk with their heads well up because they carry things on their heads, and when one does this, it is necessary to hold the head upright to keep the things from falling off.

Tobacco smoking injurious to the respiratory organs. Smoking tobacco is very bad for the throat. There is a disease of the throat called "smoker's sore throat." Singers do not smoke, because it injures the voice.

Some cigarette smokers breathe the smoke into the lungs. This is very harmful. The poison in the tobacco smoke passes through the walls of the air sacs into the blood and goes through the whole body. This is bad for the body. The smoke also injures the walls of the trachea and the bronchi and causes a cough.

Dust injurious to the respiratory organs. Dust makes wounds in the delicate lining of the air passages, and germs grow in these wounds. Breathing dust is, therefore, very injurious. Persons who work at dusty trades always suffer greatly from tuberculosis and other respiratory diseases. Whenever it is possible, streets should be sprinkled during the dry season, and in every way possible dust ought to be kept out of the air that we breathe.

QUESTIONS

Describe the cilia in the respiratory passages. Where does the mucus in the respiratory passages come from? What is its use? Describe the chambers of the nose. How does the nose protect the throat and lungs?

Describe the throat. What openings are in its walls? Describe the uvula and explain its use. What is the larynx? the epiglottis? What is the use of the epiglottis?

Where are the tonsils? What are adenoids? What are the symptoms of adenoids? What is the remedy for them?

Describe the vocal cords. What makes the sound of the voice? Explain the pitch of the voice.

How should the head and shoulders be held in sitting and standing?

What is "smoker's sore throat"? Why do singers not smoke tobacco? Why is it bad to breathe in cigarette smoke?

How does dust injure the air passages?

SUGGESTIONS TO THE TEACHER

In many of the Philippine towns there is, of course, no surgeon prepared to treat cases of adenoids and enlarged tonsils, but where a child is obviously suffering from diseases of these parts the parents should be encouraged to take him to Manila or to one of the other large cities, for examination by a skilled physician.

Interesting experiments on the pitch of strings can be performed by bringing a stringed musical instrument to school and tightening and loosening the strings, and by placing the finger on the strings so that the vibrating part will be shortened.

CHAPTER XVI

THE SKIN AND THE BODY HEAT

In health the temperature, or heat, of a man's body is the same all the time, when he is asleep and when he is awake, when he is hungry and thirsty and when he has had enough to eat and to drink, and whether he lives in a cold country or in a hot country. A thermometer put under his tongue will show that the temperature of the body is near 37° C. (98.5° F.). At times, when he is exposed to great heat or cold, it may be a degree warmer or colder, but it always stands near this point. The temperature of the body is regulated by the skin.

Work of the skin. The skin does three kinds of work. Its first work is to protect the body. It keeps the body from being injured, and it keeps bacteria from getting in among the cells.

The second work of the skin is to feel the things which we touch. It is the nerves in the skin that do this work.

The third work that the skin does is to keep the temperature of the body at the right point.

Structure of the skin. The skin has two layers, the *epidermis* and the *dermis* (Fig. 94). The outer layer (epidermis) is tough and has no blood vessels and no nerves in it. You can run a pin into the epidermis, and the epidermis will not bleed and you will feel no pain.

The cells in the lower part of the epidermis constantly divide and make new cells. The cells on the outer part of the epidermis become flat and die and fall off the skin. When the skin is wet, you can often rub off the dead outside part of the epidermis.

Color of the skin. The outer cells of the epidermis have no color. They are transparent, like glass; but some of the lower epidermal cells have a dark coloring matter (*pigment*) in them, and it is this pigment that gives the color to the skin. We look through the transparent outer cells of the epidermis and see the pigment in the cells below.

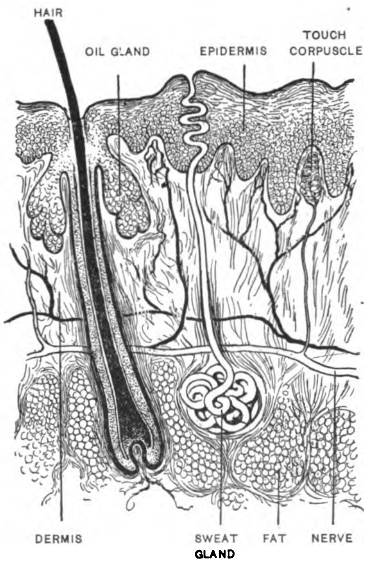


FIG. 94. A section of the skin.

In the epidermis of the white races of men there is very little pigment. The brown and yellow races have more pigment than the white races, and the black races have the most pigment of all. In all races there are a few persons (albinos) who have no pigment in the skin, the eyes, or the hair. In albinos, these parts lack color, but the skin and eyes of an albino look pink because of the blood vessels in them. Blood vessels are in the skin and eyes of other persons the same as they are in the skin and eyes of albinos, but we cannot see them because of the pigment.

The dermis. The under layer of the skin (the dermis) is made of connective tissue fibers. Among the fibers are blood vessels and nerves. Under the dermis and in its lower parts, the body stores up much fat. Hairs and sweat glands go down through the epidermis into the dermis.

Sweat glands. The sweat glands are long ducts, or hollow tubes, that are coiled up in the dermis. One end of the duct comes through the epidermis to the outside. Under a microscope you can see little holes in the skin. These are the mouths of the sweat glands. In some parts of the body there are more than twenty-five hundred sweat glands in a square inch of the skin. All around the lower ends of the sweat glands are capillaries. The water of the blood comes out of the capillaries and goes into the sweat glands and comes out on the skin. This water is called *perspiration* or *sweat*.

How the skin regulates the body heat. The body is always making some heat, and some heat is always leaving the body. When we do not move our muscles, only a little heat is made in the body; but when we run or do other hard work, the muscle cells burn much food and there is much heat in the body. To keep the body always at 37° C., the skin must at some times let only a little heat pass out of the body and at other times let very much heat leave the body. The skin regulates in two ways the amount of heat that leaves the body.

The first way of regulating the escape of heat is through the circulation of the blood. In the walls of the arteries there are muscles. When these muscles are contracted, the arteries are small, and when they are relaxed, the arteries open and become large. When there is not much heat in the body, or when the air is cold so that it takes the heat from the skin very quickly, the small arteries in the skin contract. Then only a little blood comes to the outside parts of the body, and not much heat leaves the body. The blood stays in the internal parts of the body where it is warm, and the heat cannot escape. But if the body is warm, the arteries in the skin open up and let more blood come out into the skin. Then the heat of the blood goes off into the air and the body is cooled.

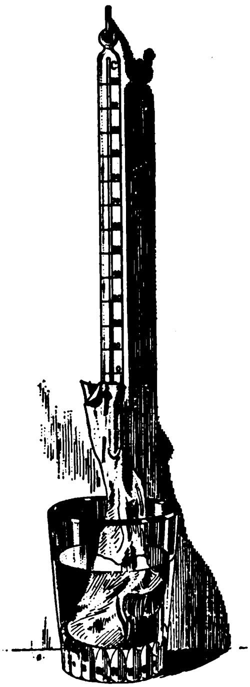


FIG. 95.

The other way in which the skin regulates the heat of the body is by the sweat glands. When the body is hot, the sweat glands pour out much sweat on the skin. The sweat evaporates (changes to vapor and goes off into the air), and in doing this it makes the body cool. If you put water into a clay jar, some of the water will come through the walls of the jar and evaporate. This will make the water in the jar cool. In the same way, the evaporation of the sweat makes the body cool.

By opening up its vessels when the body is warm and by making sweat, the skin cools the body and keeps its temperature always the same.

Experiment. Note the temperature of the air with a thermometer. Then wrap a thin piece of cloth about the bulb of the thermometer, as shown in Figure 95. Set the thermometer so that the end of the cloth is in a glass of water.

The water should be of the same temperature as the air, and it should rise through the cloth and wet the bulb of the thermometer. After about five minutes read the thermometer. Why does it become cooler?

Now fan the thermometer very vigorously for a few minutes. The wind will cause the water to evaporate more rapidly from the cloth and the thermometer will become still cooler. Read the thermometer again. What temperature does it record?

The human body like a wet thermometer. The sweat glands make the body like a wet thermometer. They pour out water on the skin, and when the water evaporates it cools the body.[1] If the air is in motion, the sweat evaporates faster and the body is cooled more rapidly. We suffer from the heat especially on warm, still days when the air is full of moisture. This is because the sweat evaporates very slowly when the air is moist, and because there is little motion in the air to cool the body.

Ventilation and the body heat. On hot days it is very important to have good ventilation to carry away the body heat. Out of doors there is always some motion in the air, but in schoolrooms, offices, and factories the outside breezes will be cut off unless "through ventilation" is provided for (page 304). In hot rooms the temperature of the body often rises above 37° C., and

[1] The sweat glands of a newcomer in the tropics work less freely than do those of persons accustomed to the heat. A person who has just come to a tropical country, therefore, often suffers from the climate more than do those who are accustomed to it. This is especially true of white persons; for in the white race there are fewer sweat glands scattered over the body than in the dark-skinned races.

then the person does not feel able to go on with his work. He is sleepy and does not keep his attention on what he is doing, and if the heat becomes too great, he will become ill.

FIG. 96. A good costume for a warm climate.

Providing a sufficient water supply for the body. In hot weather one should drink very freely of water in order that there may be an abundant supply for the sweat glands. An abundant water supply is also of advantage in carrying off the wastes through the kidneys, and it causes the wastes to move more freely through the intestine (page 268). A supply of good water should be placed near where persons are working or in some place where they will frequently pass it. The sight of the water will often cause a person to take a drink when he would not do so if the water were not near him.

Clothing and the body heat. The larger the extent of the body surface that is left uncovered, the more perspiration evaporates from the skin. The thinner the clothing is, the more easily the air passes through it and evaporates the sweat. In hot weather, therefore, the thinner the clothing the better, and from the standpoint of health it is advisable to wear only as much clothing as social customs demand. Garments that are cut low and open at the neck allow the heated air to rise from around the body. They are therefore much cooler than clothes that fit tightly around the neck. Low shoes are also much cooler than high shoes, because they allow the air to circulate more freely about the feet.

When the weather is cold, there is danger of taking cold unless enough clothing is worn to keep the body warm. Persons who are sick and weak should have enough clothing to keep them warm in the mornings and evenings, and the clothing of young children should have especial care. Wet clothing takes heat out of the body, and should be changed for dry as soon as possible. In dealing with the question of clothing, however, the person as well as the weather must be kept in mind. What will harm a baby will not hurt a strong man.

The color of clothing. When one is exposed to the sun, the color of the clothing is important. White clothing is the coolest and black is the warmest. At Baguio a white rabbit, a gray rabbit, and a black rabbit were placed in the sun at nine o'clock in the morning. In 33 minutes the temperature of the black rabbit rose from 37.7° to 47.8°, and the animal died. The gray rabbit died in an hour and 32 minutes, when its temperature was 44.9°. In the same time the temperature of the white rabbit rose to 43.7°, and it recovered when it was taken out of the sun. It was cooler than the other rabbits because white reflects light, while black absorbs it and turns it into heat. This you can prove in the following manner:

Experiment. Secure two thermometers. Place them in the sun and cover one with a black cloth and one with a white cloth. After some time read each thermometer. Under which cloth is it hotter?

Repeat the experiment, using different-colored cloths. (The results will be better if you can secure enough thermometers to test all the colors at once.) Write down some of the "warm colors"; the "cool colors." Would a red-roofed, a green-roofed, or a white-roofed house be coolest?

FIG. 97. A wide hat is a great protection from the sun.

These experiments will show you that in a strong light, light-colored clothing is cooler than dark clothing.

Escaping the rays of the sun. The Filipinos have a custom of working in the cool hours of the morning and evening, and sleeping when the sun is hot. This is very sensible; for the noonday sun makes the body too hot and injures it. The Filipino workmen have a custom of wearing large hats, which also is sensible; for these hats shade not only the head but a large part of the body. As you will understand, a white hat is cooler than a dark hat, and a hat that allows the air to circulate about the head is cooler than a tight-fitting hat. A hat should also protect the eyes, and should shade at least the neck and upper part of the back from the sun.

Temperature of the body in sickness. When we are sick, the sweat glands often do not work. Then the body becomes too hot, and we have fever. When one has fever, the skin is dry and hot, because no sweat comes out on it. Sometimes physicians have the skin of a person who has fever rubbed with water or with alcohol. The water or alcohol, like the sweat, evaporates from the skin and takes the heat out of the body. Formerly physicians often refused to allow persons with a fever to drink much water, but this has been found to be a great mistake.

A temperature of 40° C. (104° F.) is a very hot fever, and 41.5° C. (104.9° F.) is dangerous. If the fever rises above 43° C. (109.4° F.) for more than a little while, the patient will almost surely die. In a few cases where persons are thin and weak, the temperature of the body falls below the normal heat of the healthy body. If it goes below 33° C. (91.4° F.) for any considerable time, death will follow.

Covering at night. When a person is sleeping, his heart beats more slowly, he breathes more slowly, and his muscles do not use as much food as they do when the body is moving about. Then not much heat is made in the body, and unless the person is vigorous and well protected with fat, he may become cold. This chilling of the body causes it to lose its power to resist germs, and brings on colds, bronchitis, pneumonia, and diseases of the intestine. The abdomen should be covered when one is asleep, and when the weather is cold the whole body should be covered during sleep. Especially should young children, old persons, and those who are weak or ill be kept warm at night.

The hair. Hairs grow on almost all parts of the body. A hair grows in a little pocket (*hair follicle*) in the skin. It grows from a little body called a *papilla* at the bottom of the follicle. The cells in the papilla grow and make new cells and push the hair up, so that it grows longer all the time. At the sides of the follicles are little glands that make oil for the hair. This oil comes from the glands into the follicles and out on the skin. If the hair is brushed, the oil will spread all along the hairs and make them shiny and oily. The hair should occasionally be washed with good soap (or gogo bark) to take off the old oil and the dust. It is not necessary to put oil on the hair, if the hair is well brushed. Too much oil will make dust stick to the hair, and soon the oil will smell bad. Brushing the hair makes the blood come into the skin of the head and bring food to the cells from which the hair grows.

The nails. The nails, like the hair, grow from the epidermis. They grow at the back ends and push forward. If part of a nail is hurt, it will become black and die. The new nail behind the black spot will then grow and push the spot forward until it comes off at the tip of the nail. If all of a nail is killed, a new nail will grow in its place. But if the epidermis under the nail (the "root" of the nail) is killed, no new nail will grow. The nails are useful to protect our fingers and to help us in picking up little things.

Corns. Where anything presses for a long time on the skin, the epidermal cells grow very fast and make the epidermis thick. Where men carry heavy loads on their shoulders, the epidermis becomes thick and hard; and there is a thick epidermis on the inside of the hands and on the bottom of the feet.

If a shoe presses very much on any part of the foot, the epidermis will become thick on that part and form a *corn*, which is often very painful. A shoe should be of the right size and should press equally on all parts of the foot. Sharp-pointed shoes are bad for the feet, because they press on the toes, bending the bones of the feet and causing corns. A shoe should be straight, it should have a wide toe, and there should be a piece of heavy leather in the front part of the shoe to hold the shoe up off the toes. A shoe of this kind will not press on the sides or the tops of the toes and will not cause corns.

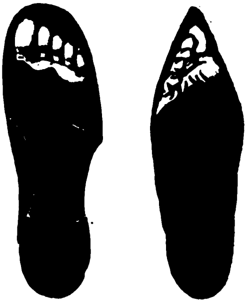


FIG. 98. What troubles will the shoe at the right cause?

QUESTIONS

What is the normal temperature of the human body? What three kinds of work does the skin do? How many layers has the skin? What are they called? Can you feel pain in the epidermis? Will it bleed when cut? Why? Of what is the dermis made? What are among the fibers? What is stored in the lower part of the dermis?

Describe the sweat glands. What is perspiration? Explain how it comes out on the skin. What is the chief function of the skin?

Explain how the skin keeps the body always at the same temperature. How is the size of the blood vessels changed? When do they contract? When do they expand? When the body is hot, what do the sweat glands do? Explain how the sweat cools the body. How does motion in the air cool the body? When do we suffer most from heat? Why? Why is ventilation especially important on hot days? Why should water be drunk freely?

What kind of clothing is best for hot weather? Tell of the experiment with the rabbits at Baguio. Which color is coolest in the sunshine? Why? Which color is hottest in the sunshine? Why?

Why is it best to keep out of the sun during the middle of the day? What kind of hat is best for a hot climate?

Why do we have fever during sickness? How may the body of a fever patient be cooled? Why does a person need covering at night? What bad effect comes from chilling the body?

In what does a hair grow? What causes a hair to grow longer? What are at the sides of the follicle? What do these glands make? Why does brushing make the hair shiny and oily?

From what do the nails grow? What will happen if all of a nail is killed? What will happen if the epidermis under the nail is killed?

What is the cause of corns? What are some of the points that are found in a good shoe?

SUGGESTIONS TO THE TEACHER

In the tropics an important part of hygiene is to keep the body from becoming overheated. Discuss with the class any points connected with clothing, ventilation, or habits of living that may help in solving this problem. In cities and towns the planting of shade trees along the streets is desirable, so that persons can walk through the streets without being exposed to the heat of the sun. What trees can be used for this purpose that would be valuable for the foods that they yield? Which trees would draw mosquitoes, and which ones would furnish shade without at the same time giving a favorable home for mosquitoes?

REVIEW QUESTIONS

Chapter XII. What is the function of the blood? Describe the heart and blood vessels. Explain how the blood circulates through the body. Mention some important points in the care of the heart.

Chapter XIII. Of what is blood composed? What is the function of the red corpuscles? of the white corpuscles? of the plasma? Explain how the food and oxygen pass from the blood to the cells. What is the function of the lymphatic vessels? of the lymph nodes? Show how to stop bleeding from a wound.

Chapter XIV. What is the object of respiration? Trace the course of the air into the lungs. What does the air take from the blood in the lungs? What does it give to the blood? How much oxygen does a man take from the air in twenty-four hours? How much carbon dioxid does he breathe out? How much fresh air does a person need each hour? Mention an important point in ventilation. Show how artificial respiration is carried on.

Chapter XV. How are dust and germs carried out of the air passages? Describe the nose. What is its function? Describe the throat; the larynx; the tonsils. What are adenoid growths? What are the symptoms of them? What is the remedy for them? How is the sound of the voice produced? Upon what does the pitch of the voice depend? Describe a correct standing position. What effect has smoking on the throat? How does dust injure the respiratory organs? How may it be prevented?

Chapter XVI. Give three functions of the skin. How does the skin regulate the body heat? How does the sweat cool the body? How does "through ventilation" help to cool the body? What kind of clothing is best for a hot day? What colored clothing is coolest in the sunshine? What bad effect has chilling the body at night? Mention some of the points of a good shoe.

CHAPTER XVII

THE NERVOUS SYSTEM

We have learned that the body is made up of many different parts and that each of the separate parts has a work to do. We know that the lungs must take in oxygen for all parts of the body. We have studied about how the stomach digests food for the whole body. We know that the blood must carry food and oxygen to every part of the body. We know that the heart works all the time to make the blood circulate and that the lungs and kidneys must take carbon dioxid, water, and urea out of the body. Every part of the body must work, or the whole body will become sick and die.

The function of the nervous system. *One function of the nervous system is to make all the parts of the body work at the right times, in the right way, and as much as is necessary.* When we wish to walk, the nervous system makes the muscles move. When we eat, it makes the digestive glands secrete juices to digest the food. It makes the lungs and the heart work, and governs all parts of the body. The nervous system is the ruler, or governor, of the body.

A second function of the nervous system is to act as the organ of the mind. We shall learn more of this subject when we study the brain.

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 (Fig. 99). The nervous system also includes many little masses of

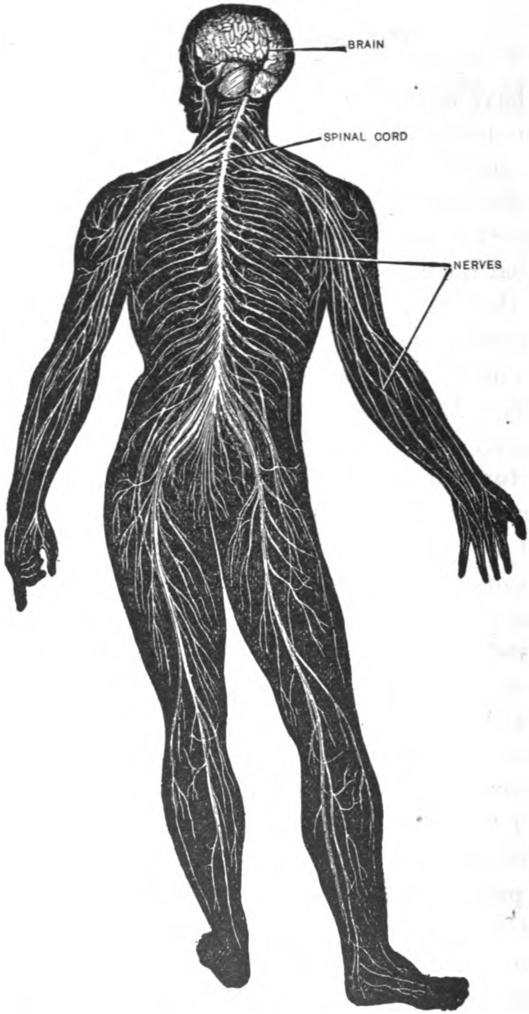


FIG. 99. The nervous system. From the brain and spinal cord, nerves run to all parts of the body.

nerve cells, called *ganglia* (singular, *ganglion*), that are found among the inner organs of the body, and a great network of nerves that run among these organs.

The nervous system composed of cells and fibers. The nervous system is made up of nerve cells and of nerve fibers. Most of the nerve cells are in the brain and spinal cord, but a few of them are found in the ganglia that are in the inner organs. The nerve cells have a gray color, and the nervous system looks gray in the parts where there are many cells.

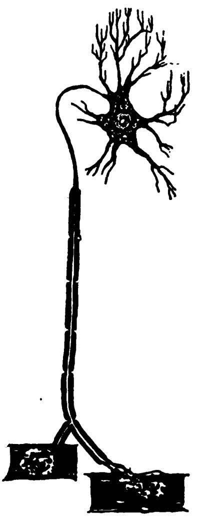


FIG. 100. A nerve cell and nerve fiber. At the lower end the attachment of the nerve fiber to the muscle fibers is shown.

The nerve fibers connect the nerve cells with all the other parts of the body. They reach from the brain and the spinal cord to the farthest parts of the body. The large white nerves which we see in the body of an animal are made up of many long white nerve fibers. *The function of the nerve fibers is to carry messages between the nerve cells and the other parts of the body.*

Motor nerve fibers. A nerve goes to each muscle in the body. Inside the muscle, this nerve branches again and again until there are very many little branches. One of these branches goes to each muscle cell. When a person wishes to use a muscle, the nerve cells in his brain send a message through the nerve fibers and tell the muscle to move. The message goes down all the fibers to every cell in the muscle, and all the muscle cells contract at the same time. This makes the muscle shorter and so moves that part of the body. The nerve fibers which carry messages to the muscles and make them move are called *motor fibers*. Where all the fibers in a nerve are motor fibers, the nerve is called a *motor nerve*.

Sensory nerve fibers. Other nerve fibers carry messages from the outside of the body to the spinal cord and brain. The ends of these fibers are in the skin, the eye, the ear, and other parts of the body. If anything touches the skin, or if light falls in the eye, or a sound wave strikes the ear, these fibers carry messages to the brain. When the messages reach the brain, they cause us to feel, to see, and to hear. They cause *sensations* in the brain, and the fibers over which they pass to reach the brain are called *sensory fibers*. A nerve made entirely of sensory fibers is a *sensory nerve*.

The brain. The brain has three divisions, — the *cerebrum*, the *cerebellum*, and the *medulla oblongata*. It is a very delicate organ, and it is protected from injury by the strong walls of the cranium. The brain is also protected by a layer of liquid all around it, which keeps it from striking against the walls of the cranium.

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 outer layer of the cerebrum is composed of nerve cells, and therefore has a gray color.[1] To make more room for these cells, the whole surface of the cerebrum is folded

[1] It is estimated that there are 1,200,000,000 cells in the gray matter in the surface of the cerebrum.

and wrinkled. These folds in the cerebrum are called *convolutions*. The lower parts of the cerebrum are made up chiefly of the nerve fibers that connect the cells of the cerebrum with the other body parts.

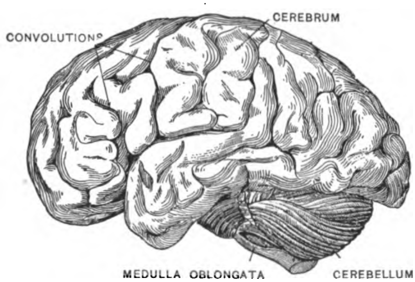


FIG. 101. The brain seen from the side, showing the three principal divisions.

The function of the cerebrum. *The cerebrum is the seat of the mind.* When it is removed, all power of moving the voluntary muscles is gone. Without it all sensations of light, sound, taste, smell, touch, heat, and hunger are lost. 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. It is the part of the brain that thinks and feels; that causes us to remember and to know; to love and to hate; to be glad and to be sad. 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 itself and of the world about it.

The cerebellum. The cerebellum is at the back of the brain, under the back part of the cerebrum. The fibers are chiefly in the center of the cerebellum and they branch out from the center as a tree branches. These fibers make a white body called the *arbor vitæ* (tree of life). The cerebellum causes all the muscles to keep the proper amount of contraction, and it assists in governing the muscles that are used in standing and walking. When the cerebellum is injured, a person will stagger like a drunken man.

The medulla oblongata. The medulla is in front of the cerebellum and below the cerebrum. The nerve

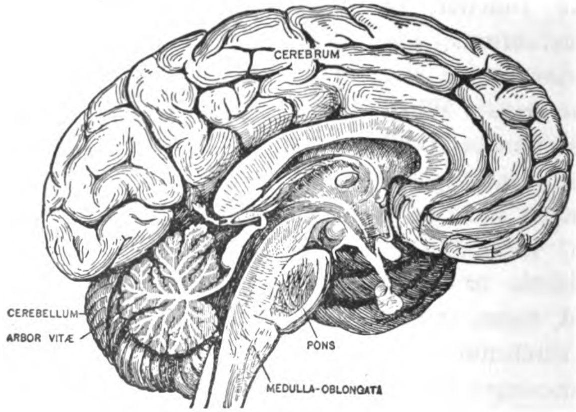


FIG. 102. Longitudinal section of the brain.

cells of the medulla are in its center, and they are the most important cells in the body, because they govern the heart and the lungs. If the medulla is hurt, the heart and lungs stop working and the person dies at once. Sometimes, after he has lost part of the cerebrum, a man still lives, and can think and move the same as before. If the cerebellum is hurt, a person cannot govern his muscles, but he still lives; but if the medulla is hurt, no one can live for even a little while.

The crossing of the fibers in the medulla. The fibers that come from the cerebrum go down in the outside part of the medulla. These fibers cross each other on the front of the medulla. From the right side of the cerebrum, the fibers go to the left side of the body; and from the left side of the cerebrum, the fibers go to the right side of the body. If the right side of a man's cerebrum is badly hurt, he cannot move the left side of his body, and if the left side of his cerebrum is hurt, he cannot move the right side of the body. When one is struck on the head, part of the body may be paralyzed (cannot move). We can tell which side of the brain is hurt by the part that is paralyzed. If the right arm or the right foot is paralyzed, we know that it is the left side of the cerebrum that is injured and can send out no messages to move the muscles. If the left arm or the left leg is paralyzed, then it is the right side of the cerebrum that is hurt.

The spinal cord. At its largest place the spinal cord is about an inch in diameter, and it is about eighteen inches long. It weighs about an ounce. It lies in the canal of the spinal column and is protected by the bones about it. The spinal cord enters the cranium through a large opening in the base of the skull and joins the brain. The center of the spinal cord is composed of cells (gray matter), and the outer part is composed of many thousands of fibers. The function of these fibers is to carry messages between the different parts of the body and the brain. Some of them are sensory fibers, over which messages from the body pass up to the brain. Others are motor fibers, which carry commands from the brain to the different body parts.

The telegrapher and the telegraph wires. The brain and spinal cord are like a telegrapher who sits in an office (the cranium and spinal canal), and the nerves that run through the body are like telegraph wires that run out from the office in all directions. On some of these wires (sensory nerves) messages come to the brain and tell it if the parts of the body are hot or cold, if they are suffering or if they feel well. They tell the brain about the things that we see and hear and feel and taste and smell.

The telegrapher not only receives the messages from the outside parts of the body, but he also sends other messages on the other wires (motor nerves) and makes the muscles move. If we wish to walk, the brain commands the muscles to make the body stand up and to move the legs. If the messages which come from the eye tell the brain that a snake is close to the feet, the brain will send messages to the muscles and make them move the body away very quickly. If the nerves from the finger tell the brain and spinal cord that the finger is touching something hot, the brain and spinal cord will command the muscles to move the finger. If we had no nerves, we could not tell that the finger was being burned, and we might not move the finger before it was burned up. The nerves tell the brain and spinal cord about all the parts of the body, and the brain and cord move these parts as they wish.

The Nervous Systems of Other Animals

When we studied about the bones, we learned that the skeletons of many animals are similar to the human skeleton. The body of one of these animals is like the body of a man in many other ways. In it you would find muscles, digestive organs, a heart and blood vessels, lungs, and kidneys. The higher animals all have nervous systems composed of a brain, spinal cord, and nerves.

The brain in all these animals is divided into a cerebrum, a cerebellum, and a medulla. The nerve cells of the cerebrum are on its surface. Many convolutions in the cerebrum give room for many cells on the surface. Some animals, like fishes, frogs, and snakes, have only a few nerve cells in their cerebrums, and they have no convolutions. There is room enough for all their nerve cells on a little smooth cerebrum. Other animals, like the horse, cat, monkey, and especially man, have very many nerve cells in their cerebrums. Therefore they must have large cerebrums and many convolutions, so that there will be room for all these cells on the surface of the brain.

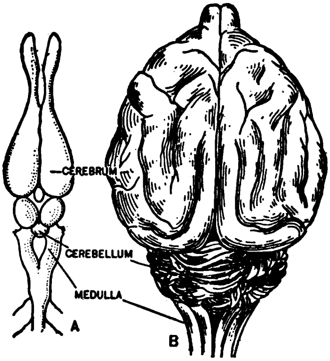


FIG. 103. The brain of a snake (*A*), and of a cat (*B*).

Animals with large cerebrums and many convolutions are intelligent, and animals with small cerebrums and few convolutions are stupid. The shark has a very small cerebrum and no convolutions, and it can remember nothing. The cerebrum of a snake is also small and smooth, and the snake knows very little. The cerebrum of a dog is large and convoluted, and dogs are very intelligent animals. The human cerebrum is very large, coming down behind and covering the cerebellum. It is more convoluted than the cerebrum of any other animal, and man is the most intelligent of all animals.

QUESTIONS

Give two functions of the nervous system. Name the parts of the nervous system. Where are the nerve cells found? the nerve fibers? What is the function of the nerve fibers? What is a motor nerve fiber? Explain how the brain makes a muscle move. What is a sensory nerve fiber?

Name the three divisions of the brain. How is the brain protected? Describe the cerebrum. What is its function? What is the arbor vitæ? What is the function of the cerebellum? Where is the medulla oblongata? Why are its nerve cells the most important in the body? How large is the spinal cord? What does it weigh? Where is it found? What is the function of the fibers in the spinal cord?

In what ways are the bodies of higher animals like the body of a man? Describe the nervous system of the higher animals. Of what use are the convolutions in the brain? What is the difference between the brain of a stupid animal and that of an intelligent animal?

CHAPTER XVIII

THE CARE OF THE NERVOUS SYSTEM

FIG. 104. Sleep and rest are necessary for the health of the nervous system.

THE nervous system is the ruler of all the body, and if it is not kept in health, the whole body must suffer. To keep it in health, all the things are required that are needed to keep up the general health. For example, if the body is poisoned by disease germs, the nervous system will suffer along with the other body parts; if the body lacks food, the nervous system will not have the vigor to drive the muscles or to think clearly; and if the body is not supplied with fresh air, the nervous system will be dull and slow. The nervous system also needs exercise, rest, sleep, and quietness of mind.

Exercise and the nervous system. One great part of the work of the nervous system is to drive the muscles. It needs practice in this work to keep it in health, and playing outdoor games is the best way of furnishing this practice. There is something about outdoor sports that causes them to be of more benefit than comes simply from exercising the muscles. The enjoyment of the game, the forgetting of work, and the freedom of the mind from all worry and care give vigor to the nervous system and cause it to do all its work in a surer way.

The necessity for rest. 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. Some earnest, ambitious persons 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] They are always tired and can never do their best work. In general, it has been found best to have regular hours for working hard at one's tasks, 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 take up a different kind of occupation.

Sleep necessary for the nervous system. The nervous system has one need that the other parts of the body do not have. This is the need for sleep. It is only when we are asleep that the nervous system can

[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.

rest completely, and if we do not have plenty of sleep, our nervous systems cannot be healthy. Little babies should sleep from fifteen to twenty hours a day, older children from ten to fourteen hours, and grown people from seven to ten hours. Some persons need even more sleep than this.

Time for sleeping. In cold countries people usually sleep only at night; but in warm climates it is often customary to sleep in the middle of the day. This is a sensible custom, because it is very unhealthful to go out in the hot midday sun. If a man gets up early and does his work in the morning and in the evening, and sleeps in the middle of the day, he will have better health than if he works out in the sun in the hottest part of the day. It makes little difference to the nervous system when a person sleeps, but it is very important that he sleep enough and that he sleep at the same time every day.

Pain injurious to the nervous system. The suffering of pain has a very bad effect on the nervous system. Ill health and disease bring on old age faster than the passing of the years, and one reason why sickness so often leaves the body weakened and aged is that the nervous system has been wrecked by the pain that it has borne. A week of toothache or of earache is a great drain on the nervous system. A sore that is continually causing pain can do as much to wear out your nervous system as an hour's extra work each day, and a baby's nervous system may be almost broken down by the constant torment of itching hands or feet. Pain is nature's danger signal; it is a call for help from some part of the body. The nervous system can no more rest when these calls are coming to it night and day, than you could rest with the screams of some one who is calling for help constantly coming to your ears.

FIG. 105. The pain caused by toothache does great injury to the nervous system.

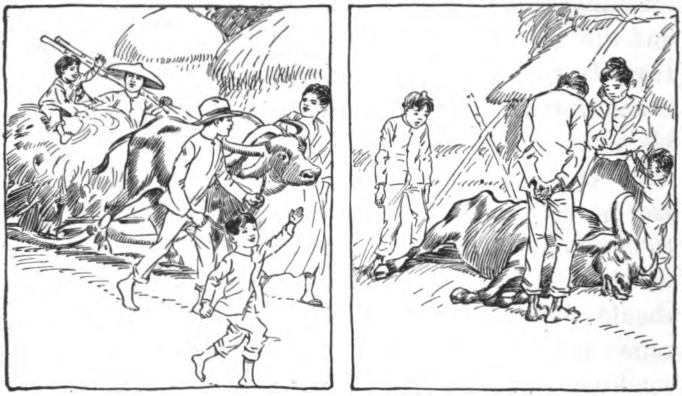
Have you a toothache? Have you an earache? Have you headaches? Do your eyes pain you? Have you sores or itching of the skin? Have you pain in any other part of your body? If so, ask your parents to take you to a dentist or to a physician. For you ought to get up in the morning feeling fresh and rested; and you ought to go to bed, tired and sleepy perhaps, but free from pain.

Quietness of mind beneficial to the nervous system. Sorrow, anger, or any strong feeling has a great effect on the nervous system, and in keeping the nervous system in health, nothing is more important than calmness and happiness. No one can think properly when he is excited, and the regulation of the different organs of the body is not properly carried on when the nervous system is worried and confused (page 358). We should study out what we wish to do; then do it quietly. Loud talking and excitement exhaust the nervous system for nothing; they use the nervous strength that should be saved for thought and work.

A person should therefore at all times go about his work quietly and without excitement; he should keep himself from flying into fits of anger; and he should not worry about things that he cannot help. He should also plan for the future and arrange his affairs so that he will be protected from the storms of fate. The boy who gets a good education or becomes a skilled workman knows that he can earn a living, and this gives him a peace of mind that the man who fears starvation cannot know. The man who owns his home or who has money in the bank has something between him and poverty, and this enables him to live in a quietness that the man who has nothing cannot know. We should therefore keep our minds as calm and quiet as possible in the conditions under which we live, and we should plan to make the conditions of our life such that we shall be free from anxiety and care.

FIG. 106. A baby's nervous system may be almost broken down by the constant torment of itching hands and feet.

One thing that is necessary for the peace of mind of the Filipino people is the control of the germ diseases of both man and animals, that are so common among them. While Filipinos must see their friends and relatives dying of tuberculosis, typhoid fever, dysentery, cholera, smallpox, and other similar diseases, they will not be happy. As long as they are burying the strong men who should be earning a living for the women and little children, they will not have peace of mind. As long as their animals are swept away by rinderpest, surra, hog cholera, and other diseases, and many of them are left in poverty and without sufficient food, they cannot be free from worry and care. A progressive people can be contented only by progress; an ambitious people only when their wants and desires can be satisfied. To give the nervous system quietness and freedom from worry, we must think of the future as well as



FIGS. 107 and 108. One family has a sure food supply and enjoys peace and quietness of mind. The other family is burdened with a load of anxiety and care.

of the present, and wise persons and wise peoples do this to a marked degree.

QUESTIONS

Why is it necessary for the health of the body that the nervous system be kept in health? Name four things that are necessary for the health of the nervous system. What kind of exercise is best for the nervous system? How is it best to arrange our work and rest periods? Why is sleep necessary for the nervous system? How much sleep do grown persons need? In a warm country, what is the best time for working?

Explain how pain injures the nervous system. What is the purpose of pain? What should one do if he suffers pain? What effect have worry and excitement on the nervous system? What are some of the things that we should do to free our minds from worry and care?

CHAPTER XIX

EDUCATION, OR TRAINING THE NERVOUS SYSTEM

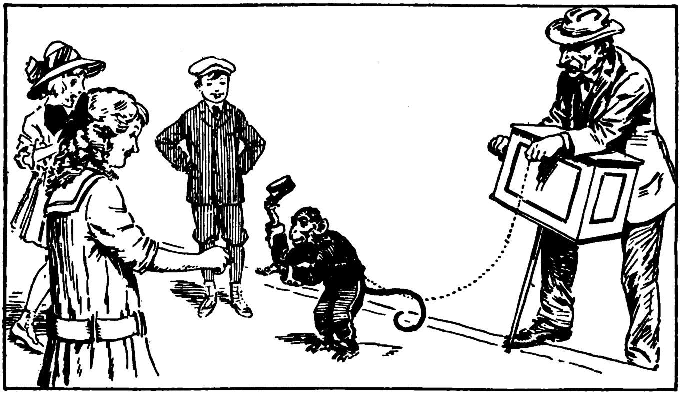
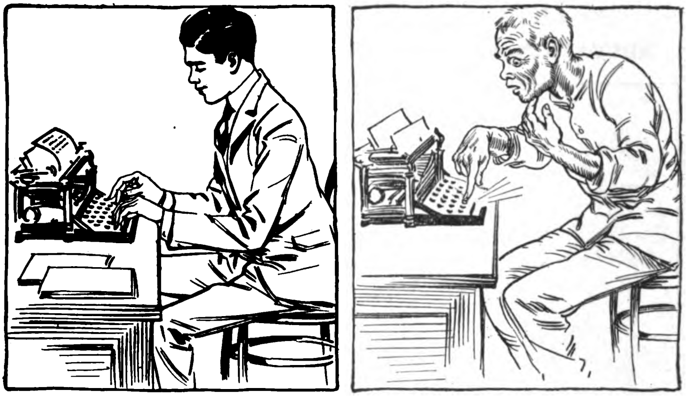


FIG. 109. The monkey acts differently from a wild monkey because it has been trained.

ON the streets of cities in the United States one sometimes sees a man with a hand organ and a monkey. The monkey is dressed in a pair of trousers, a coat, and a little cap. The man begins playing a tune on the organ, and the children come running to see the monkey. After the music is finished the monkey will go up to the children and hold out his hand for money, and if a child gives him a piece of money he will put it in his pocket, take off his cap, and bow to the child.

Why does the monkey hold out its hand or take off its hat? It has been taught to do these things. It is an *educated* monkey; it has been trained, and acts in a way that a wild monkey would not act.

The nervous system changed by education. We cannot educate the bones; we cannot train the liver or



FIGS. 110 and 111. Education changes the action of the nervous system.

the kidneys; no matter how often we repeat an act, the muscles do not learn anything. What we can educate is the nervous system which guides the muscles and controls the body parts. The monkey that lifts his hat has had his nervous system changed so that it governs his muscles differently, and an educated person has had his nervous system changed so that he thinks and acts differently from an ignorant person.

The purpose of education. All of us by nature do things that we ought not to do, and we fail to do things that we ought to do. By education we try to improve the actions of people; we wish to make them kinder to each other and more skillful and more intelligent in their work. Compare the actions of an ignorant person and of a person who has been carefully educated, and you will see the effect that training has on us. *The purpose of education is to change the nervous system so that it will cause one to act differently.*

How the action of the nervous system can be changed. The way the nervous system acts can be changed by *making it form habits*, by *training it to feel in certain ways toward persons and things*, and by *giving it information* (*having it learn*). For these reasons children are carefully trained in what they shall do; they spend years studying in schools; and they are carefully taught to love the things that are good and hate the things that are evil. It is by habits, by ideals, and by knowledge that the conduct of men is controlled.

FIG. 112. 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.*

Natural reflex actions. Set a duckling in the water. Its feet will begin to move and it will swim. Its nervous system is built in such a way that the muscles of the legs work in the proper way to make it swim when the water touches its feet.

Set food before a flock of baby chicks. They will peck at it without being taught to do so. Without any training they move their legs properly in walking, they follow the cluck of the mother hen, and they run to her when she gives the call to come for food or to hide from an enemy.

Strike quickly toward the eye of another person with your hand. Without thought the eye will close.

Cross your legs, and strike yourself just below the kneecap with the hand. If you strike the right place, you will start messages to the spinal cord. This, without any thought on your part, will cause messages to pass down the motor nerves into the muscles of the leg. The muscles will then contract and cause the foot to jerk.

Stand facing the light with a mirror and cover one eye with your hand. Remove the hand quickly and examine the pupil of the eye in the mirror (Fig. 131). The pupil becomes large in the dark and smaller when the light shines into the eye.

All the above actions are *reflex actions*. Something outside the nervous system happens, and then without thought by the brain the muscles are made to move. Many of our actions and nearly all of the governing of the inner parts of the body are carried out in this way.

Reflex actions that we learn through practice. The reflex actions that we have been discussing are natural; we do them without learning them. There are other reflex actions that we learn through practice. A man must learn to swim, but after he has learned, a skillful swimmer does not think how he shall move his hands and legs. The baseball player does not think how he shall move his arm when he throws a ball, or how he is contracting his muscles when he hits the ball with the bat. We walk without giving attention to the muscles that we move; we open our mouths to take in food without thinking; we chew our food without noticing that we are chewing; we write without thinking about the shapes of the letters. All these things we have done so often that we have learned to do them without thought.

When we have performed an act so often that we go through it without thought, we have formed a *habit.*

Habits. All of us are, to a great extent, bundles of habits; we act as we do because we have learned to act

FIGS. 113 and 114. It is doing and not talking that forms habits.

this way. By building up habits a person changes his nervous system so that it causes him to act differently, and by changing his habits a person can change himself from one kind of person into another kind of person. The chief purpose of all the training and education that you will receive from your parents and in school is to cause you to form good habits.

Habits formed by doing. By chewing your finger nails for a few days you can form the habit of doing this until you will put your finger into your mouth without knowing it. By keeping your hands away from your mouth for a few days you can break yourself of this bad habit. In the same way we form the habit of industry by working; of kindness by being kind; of being truthful by telling the truth. Decide what kind of person you want to become. Then act as this kind of person would act, and you will become more like your ideal day by day. *It is not thinking or talking, but doing, that forms habits.* By your acts you are building the person you will later be.

An important rule in forming habits. The great rule in forming a habit is *always to do the thing.* The boy who holds his pen correctly and writes carefully only when the teacher is looking at him, is not forming the habit of writing correctly. At one time by his careful work he is building up this habit; in a few minutes by his careless work he is tearing the habit down. The boy who tells the truth at one time and an untruth at another time is not forming the habit of truthfulness, nor is the boy who learns his lessons one day and fails to learn them the next day forming the habit of study. You cannot climb a ladder by going up a step and then coming down. After weeks of such work you would still be at the bottom. To reach the top you must keep going up. So we cannot form a habit by doing one thing at one time and a different thing at another time. We must keep doing the same thing all the time.

Forming correct habits. All of you are forming either good habits or bad habits. You are doing things day by day that are changing your nervous systems and will influence your acts as long as you live. If you act correctly, you are forming good habits; if you act incorrectly, you are forming bad habits. In learning to do anything, therefore, the great thing is to do it right, so that you will form a habit of the right kind. Then, as long as you live, the part of your work that depends on this action will take care of itself, and you will be free to spend your thought on the new problems that arise from day to day. An old proverb says that "practice makes perfect," but this proverb is only in part true; for practicing anything in the wrong way is worse than not practicing it at all. The more you practice writing carelessly, the worse writer you will become; the more you practice reading and talking carelessly, the worse the pronunciation of your words will be; the oftener you misspell a word, the more difficult will it be to learn to spell it correctly. Correct practice makes perfect, and incorrect practice has exactly the opposite effect.

Youth the time when habits are easily formed. Two or three days are enough to form or break a habit in a baby, but the older we become the harder it is for us to break old habits and to form new ones. Just as the skeleton hardens as we become older, with whatever shape it had in youth, so the nervous system becomes set in its ways of doing things as we advance in years. It is very important, therefore, for a young person to learn to hold his pen in the right way and to make the letters of the correct shape, so that the right habit in writing will be learned. Then he will be a good writer all his life without further thought. He ought to learn to pronounce his words properly and to speak clearly in reading so that these matters will attend to themselves when he goes into the higher school work. A young person ought also to take great care to say "please" and "thank you"; to keep his voice low so that it will not become loud 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 those other things that go to make up pleasant manners; for no one will ever have good manners who has not formed habits so that he will be able to do what he ought to do without thinking of his actions. In every way, you should try to form a set of habits while you are young that will carry you on to a successful, respected, truthful manhood and womanhood; for youth is the time when lasting habits are formed.

FIG. 115. When this tree was young, a boy tied it in a knot. Now all the men in the world could not untie it. The habits that we form in youth are knots that we cannot untie in later years.

Habits and health. It is not single acts, but habits, that destroy the health. It is not single acts, but habits, that build up the health.

You will not become stooped by bending over a desk one day, nor will you become straight by holding yourself erect some one time when you are walking down the street. Eating your dinner hurriedly one day and rushing back to school will not cause dyspepsia, nor will taking time to eat a few meals slowly cure it. The teeth decay, not because we leave them uncleaned for one day, but because we make a habit of leaving them uncleaned. The nervous system is injured, not by staying up late one evening, but by the habit of staying up late. The race for health is a long one, and it is not the short, excited dash, but the patient plodding onward in the right course, that wins it. Habits and not acts are the important things in keeping the body in health.

Eight hygienic habits that you ought to form. Among the habits that are important in preserving the health are the following:

1. Eating a variety of good food.
2. Keeping the teeth clean.
3. Chewing the food thoroughly.
4. Breathing pure air whenever it is possible to do so.
5. Going to bed regularly at a reasonable hour.
6. Taking proper exercise and holding the body erect.
7. Learning to rest and to keep the mind calm.
8. Guarding against disease germs as far as it is possible to do so.

Form these eight habits and they will do more than all the medicines in the land to keep you in health.

Making hygienic habits a part of our lives. Our habits become a part of our way of living and doing things, and we do not think of them as something that it requires extra work to carry out. If you will form the habits that we have mentioned above, you will soon clean your teeth as a matter of course and wonder how any one can feel comfortable without doing so. You will find yourself surprised that any one should want to make himself sick by eating the wrong kind of food. You will feel your own hard muscles and almost pity the flabby-muscled people whom you meet. You will get out of patience with the person who does not take enough sleep, and you will be amused when you see some one excited over nothing and running around like


Correct practice makes perfect.
Correct practice makes perfect.
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FIG. 116.

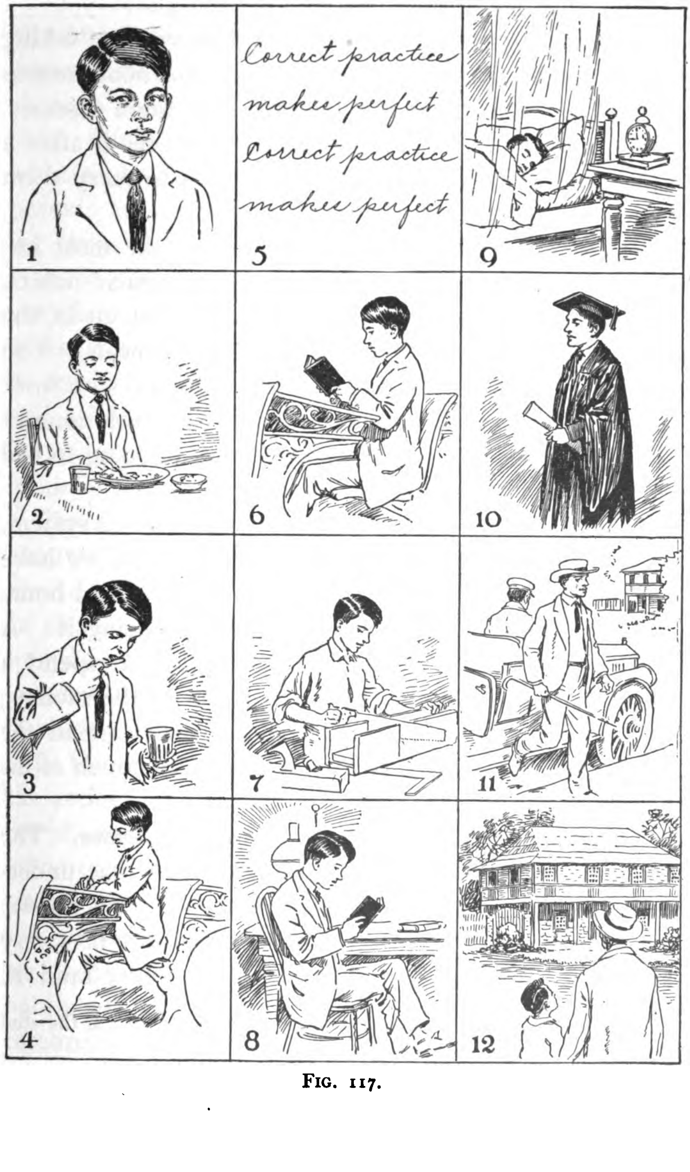
1
5
Correct practice
makes perfect
Correct practice
makes perfect
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FIG. 117.

an ant that has lost its way. You will guard yourself from disease germs without feeling that you are taking extra trouble, and you will feel sorry for the poor persons all about you who needlessly suffer from germ diseases. Put into practice these health habits, and see if after a little while it is any special work for you to carry them out.

Learning habits of regularity. One of the most important qualities for a successful life is regular habits. You should have a certain hour for getting up in the morning and regular times for eating your meals. You should be at work by a certain hour each day, stop work regularly at a time that will give you a reasonable amount of rest and recreation, and make a habit of going to bed at the same hour each night.

Unless our lives are planned according to a system, we do not give our bodies proper care; and if we have no regular time for work, many precious days and hours will be passed in idleness without our realizing it. A man who would attempt without a plan to spend a great sum of money would waste much of the money; so any one who attempts without a plan to spend the time of which his life is made, will find that much of his life has been lost.[1]

Knowledge and the action of the cerebrum. The cerebrum is the part of the nervous system that understands, and its action depends greatly on what it knows. On a farm a man who understands agriculture acts very differently from a man who does not understand it.

[1] Dost thou love life? Then waste not time; for time is the stuff of which life is made. — BENJAMIN FRANKLIN.

On a boat a sailor acts very differently from a man who has never seen a boat. All the time we keep learning many things, and these are stored in the brain. This changes the brain in some way so that we remember these things, and when we act we are influenced by what we have learned in the past. Because this is true, parents are constantly educating their children by telling them of the things about them, and children spend years in school. Here they learn many things that are very important for them to know, the things that the wisest men of all ages and of all nations have found to be true. They also study subjects like reading, writing, and arithmetic, that can be used all their lives as tools in gaining more knowledge. *The function of the cerebrum is to cause us to act more intelligently.*

The advantage of having a cerebrum. If you think about it, you can stop any act that you do through habit. This is a great advantage to us in two ways. In the first place, it enables us to form the habits that we wish. We can decide what we should do and how we should do it, and then the cerebrum can guide the muscles through the action until the habit is formed.

In the second place, the control of the cerebrum over the actions may keep us from acting according to natural reflex actions and habits when it would be to our disadvantage to do so. Every day we find ourselves in situations that require the use of intelligence, and it is the cerebrum that tells us how to act. The reason why we need a mind is to guide us when reflex actions and habits are not sufficient for our needs. Without the cerebrum and the mind, we should learn nothing from what we do; we should be like the moth that flies into the flame again and again until it loses its life.

Using the cerebrum. The worst fault of man is that he often fails to use his brain. We go through foolish

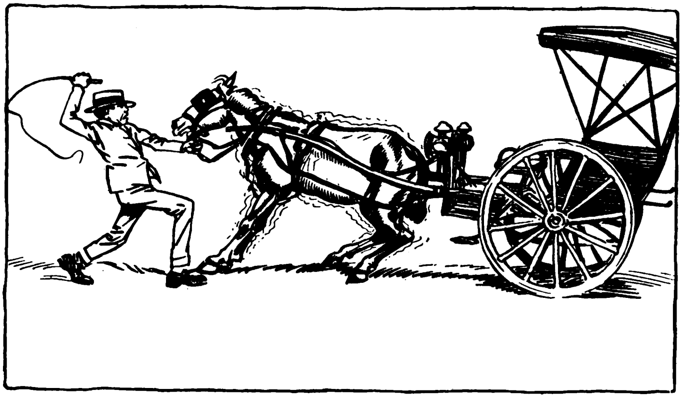


FIG. 118. This man is acting according to his feelings; he is not using his cerebrum to help him in his work.

actions because of habits we have formed; because it is the custom to do so; or because we follow our feelings instead of our knowledge. Again and again, when some difficulty arises, we see persons become excited or angry instead of using their minds to solve the problem. When a person does this, we say he has "lost his head"; that is, he is acting without the help of the cerebrum, which he most needs at this particular time. Great men do not do this. At all times they use their brains to help them in their work. You should learn, therefore, to be calm, to think before you act, and to act, not according to some habit or natural reflex action, but in such a way that you will accomplish your purpose. Act like a great person, and some day you may be one.

Feelings and actions. To act wisely and rightly, a person must understand and desire what is wise and right. It is to help children to this understanding that we tell them of the lives of great and good men. American children have been taught to call George Washington the Father of His Country, and through him to admire and respect truthfulness, courage, and unselfish devotion to duty. Filipino children are taught to love the name of José Rizal, and to think of him as a hero.

It is equally important to understand what actions or ideas are foolish and unwise. Educated people know that such things as demons and dragons do not exist, but in countries where people fear these monsters even an educated person can hardly keep from being afraid of them.

A part of the education of every person, therefore, is to learn to feel right. Our nervous systems must be trained so that we will come to approve good and dislike evil; to admire good and brave men and dislike bad men; to have respect for those things that are sensible and that we know to be true; and to feel that superstitions and foolish ideas are unworthy of the attention of an intelligent person. The way we feel has a great effect on our actions, and it is most important that the nervous system be trained so that its feelings and ideals will be correct.

Training the feelings. The way we feel toward different persons and about the different matters of life is changed by what we do, by what we learn, and by the example of others. If we wish our feelings to be right, we must act rightly; we must study and be intelligent so that we shall know what is right; and we should read about great and good men and associate with persons who think and act in a high-minded way. All this will gradually change our nervous systems, so that they will know the right, love the right, and make us act rightly. The purpose of the education that you are receiving is to make this change in you.

QUESTIONS

What part of the body can be changed by education? What is the purpose of education? In what three ways can the action of the nervous system be changed? Give examples of natural reflex actions. Give examples of reflex actions that may be learned.

What is a habit? How is a habit formed? Give an important rule in forming habits. How can we form correct habits? At what time of life are habits most easily formed? Why are correct hygienic habits important? Mention eight important hygienic habits. Why should we make healthful habits a part of our lives? Why are habits of regularity important?

Explain the effect that knowledge has on the actions of a person. Mention two advantages of having a cerebrum. What is the worst fault of man?

Explain why it is important that our feelings should be correctly trained. How can we educate our feelings in the right way?

CHAPTER XX

THE SENSES: FEELING, TASTING, SMELLING, HEARING

IT is the work of the sensory nerve fibers to carry messages to the brain. Some of these messages tell the brain when we are tired, sick, faint, or sleepy. These messages come from all over the body, and the feelings which the messages cause in the brain are called *general sensations*. But in the skin, eye, ear, nose, and mouth there are nerves which take other messages to the brain. These messages make the brain feel, see, hear, smell, and taste. They come only from certain parts of the body, and the feelings that they cause in the brain are called *special sensations*. The parts of the body that have in them the outer ends of these nerves are called *sense organs*, and feeling, tasting, smelling, hearing, and seeing are called the *five special senses*.

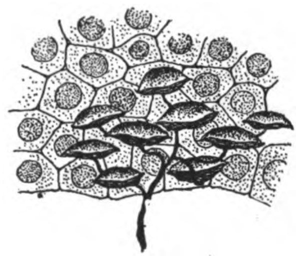


FIG. 119. A nerve fiber ending around the bases of the cells in the epidermis.

FEELING

How we feel. All over the body many nerve fibers end in the skin. When we touch anything, the epidermis presses down on the nerves. This makes them take messages to the brain. There are some nerves in the skin to tell the brain when we touch anything, other nerves to tell the brain if the thing is hot, and still other nerves to tell the brain if the thing is cold. Not all the nerves do the same kind of work.

Experiment. Warm the end of a piece of wire or other piece of metal, and pass the warm end slowly over the inside of your finger. You can feel in some places that the wire is hot, and in other places you cannot feel the heat. Put a little ink on each place where you can feel the heat, and you will mark the places where there are nerves for feeling heat. Now put the wire on ice and cool it. Move it over the same parts of the finger that you touched with the hot wire. In some places you can feel the cold, but these are not the same places where you felt the heat. The nerves for feeling cold and the nerves for feeling heat are not in the same places; therefore there must be some nerves for heat and other nerves for cold.

Where the sense of feeling is best. In some parts of the skin the nerves are very close together, and in these parts the sense of feeling is very acute, or keen. The sense of feeling is best in the tip of the tongue. It is also very acute in the lips. Over the body, the sense of feeling is not so good, and it is poorest of all in the back.

If you put two pins through a piece of soft wood, as you see in Figure 120, and touch them to the front of your finger, you can feel that there are two points. But if you touch them to the back of your hand, you cannot tell that there are two pins until they are more than two centimeters apart.

In the middle of the back, the pins must be more than five centimeters apart before we can feel the two points, while on the fronts of the fingers we can tell that there are two pins when they are only two millimeters apart.

Experiment. Tie a handkerchief over the eyes of one of the boys. Put pins through a piece of wood and touch different parts of his body. Sometimes put one pin and at other times put two or three pins through the wood. See how far apart the pins must be before the boy can tell how many pins there are. Try this on different parts of his body and on your own body.

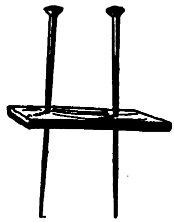


FIG. 120.

The work of the brain in feeling. The messages travel up the nerves when we touch anything. It is the brain that decides what these messages mean. If, when we are touching anything, all the nerve endings have the same amount of pressure on them, we know that we are feeling a smooth surface. If some of the nerves are pressed harder than others, we know that the surface is rough. If the object presses on a large area of the skin, we know that it is large; and if the pressure comes in two places with nerves between that are not being pressed on, we decide that there are two objects. It is not, therefore, the hand that knows about the objects that we feel, but the brain, which receives the messages from the hand.

Experiment. Cross your fingers (Fig. 121) and rub the end of your nose. How many noses do you seem to feel? Why?

Pain. When anything touches the epidermis over the nerves, we can tell whether the thing is hot or cold, smooth or rough. But if the epidermis is broken, we can tell nothing about the thing which touches the nerves. We feel only pain. If a knife touches the epidermis, it may feel smooth; but if it cuts through the epidermis and touches the nerve, we do not feel the smoothness of the knife. We feel pain. When the skin is burned so that the epidermis comes off, we cannot tell whether the air is hot or cold. The air makes us feel pain only. Without the epidermis, all sense of feeling is lost, except the feeling of pain.

FIG. 121.

TASTE

The nerves of touch are all over the body, but the nerves of taste are only in the mouth. These nerves end in the skin of the tongue and in the skin of the back parts of the mouth. In the skin of the tongue, there are little bodies called *taste buds*. The taste buds open at the outer ends into the mouth. They have long, slender cells in the center, and the outer ends of these cells are very slender, looking very much like cilia (Fig. 122). These cilia-like ends stand up in the opening into the taste bud. The nerves of taste come into the taste buds and branch out among its cells. The food cannot be tasted until it is dissolved, but when it is dissolved, it goes down into the taste buds around the cilia-like cell ends. Then the taste

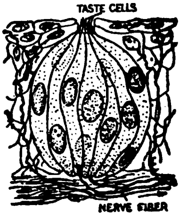


FIG. 122. A taste bud.

nerves send messages to the brain and tell the brain about the taste of the food.

Smell

The nerves of smell are in the inside of the nose. The cells in this part of the nose are called *olfactory cells*, and the nerve of smell is called the *olfactory nerve*. Each olfactory cell has several cilia-like ends. Whenever we take the odor from anything into the nose, and the odor touches the ends of these cells, the olfactory nerve carries messages to the brain about the odor. Many molecules are coming off into the air all the time from those things which have odors. The molecules go up into the nose; and when they touch the ends of the nerve cells of the nose, the olfactory nerve messages go to the brain and make us smell. When we wish to smell anything, we breathe the air into the nose quickly. This takes the air far up into the nose and brings the molecules up to the olfactory cells.

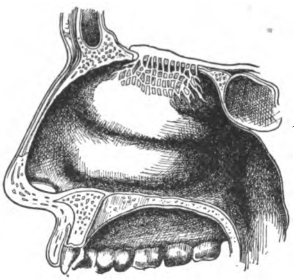


FIG. 123. The nerve of smell ending in the mucous membrane of the nasal chamber.

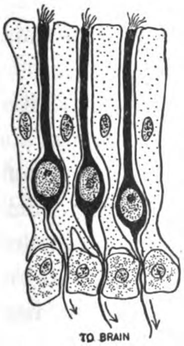


FIG. 124. A portion of the olfactory mucous membrane. The slender cells with the cilia-like processes on them are the olfactory cells.

The sense of smell is much more acute in some animals than it is in man. A dog can smell the tracks of a deer or other animal and follow them many hours after the animal has passed. In man the sense of smell is of use chiefly in telling whether or not our food is good.

Hearing

Hearing is caused by waves of air striking against the ear. In order to understand this, we must first understand more about the air.

When the wind blows, we can feel the molecules of the air as they fly along. The molecules strike the body and push against it, and we say that the wind is blowing against us. When the wind blows hard, as it does in a typhoon, the molecules of the air fly very fast. Sometimes they travel a mile in one minute, and in very hard typhoons they travel two miles in a minute. When they are moving so fast, they strike very hard against anything in their path — so hard that they sometimes carry away houses and trees.

When you throw a stone into water, the stone strikes the water and moves its molecules. The moving of the molecules causes waves to run out in the water from the place where the stone falls. When you ring a bell, the bell vibrates (shakes) and strikes the air molecules. This moves the air molecules and makes waves run out in the air. When these waves strike the ear, we hear the bell ring. Big air waves cause loud sounds, and small air waves cause gentle sounds.

The ear. *The work of the ear is to collect the sound waves and to make them strike on the nerve of hearing.* This causes the nerve of hearing (*auditory nerve*) to take messages to the brain, and the messages make us hear. The ear has three divisions: the external (outer) ear, the middle ear, and the internal (inner) ear.

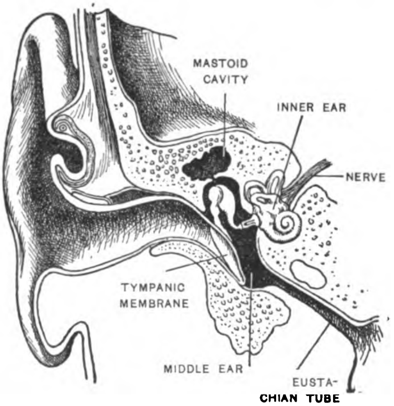


FIG. 125. Diagram of the ear.

The external ear. The part of the ear which we see and the canal which runs down from it into the head, make up the external ear. It is the work of the external ear to catch the waves of air (sound waves) and make them pass down the canal into the middle ear. When animals wish to hear, they hold up their ears to catch the sound waves. Sometimes a man will hold up his hand behind his ear to catch the air waves and turn them down into the ear.

The middle ear. The middle ear is a little cavity in the bone of the skull. This cavity is shaped like a drum, and the middle ear is often called the *tympanum*, or ear drum. The canal from the external ear comes into the middle ear. At the bottom of this canal there is a little membrane, the *tympanic membrane.* The tympanic membrane is like a thin skin across the bottom of the canal and separates the outer from the middle ear.

In the middle ear there are three little bones called the *malleus* (hammer), *incus* (anvil), and *stapes* (stirrup). The malleus is fastened to the tympanic membrane, and the stapes fits into an opening in the wall that divides the middle ear from the internal ear. The incus is between the malleus and the stapes. These three bones make a chain across the middle ear from the outside to the inside.

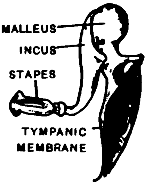


FIG. 126. The chain of bones of the ear connecting with the tympanic membrane.

The Eustachian tubes. The middle part of the ear is full of air, and from each middle ear a tube, the *Eustachian tube*, goes to the throat. This tube lets the air pass out of and into the middle ear. Sometimes the air outside becomes lighter, and sometimes it becomes heavier. When the outside air becomes lighter, some of the air in the middle ear will pass out. When the outside air becomes heavier, more air will pass into the middle ear from the throat. If the air does not press equally on both sides of the tympanic membrane, we cannot hear well. Sometimes, when the skin in the throat is sore and swollen, the Eustachian tubes may close up. Then the air cannot pass out of and into the middle ear, whenever the pressure of the outside air changes. The air in the ear may become lighter or heavier than the air outside, and then we cannot hear well.

When men fire a cannon, they put pieces of wood between their teeth to keep their mouths open. Then, when the sound wave pushes in the tympanic membrane, the air in the middle ear can go down the Eustachian tube to the throat and out of the mouth. Sometimes a very loud sound has been known to break the tympanic membrane. This is because the sound wave strikes very hard against the membrane. A great sound wave will shake houses and may even break the glass in the windows of a house.

The internal ear. The internal ear is deep in the temporal bone. It has three parts. The central part is called the *vestibule*, the front part is called the *cochlea*, and the back part is called the *semicircular canals*. In the wall between the middle ear and the vestibule, there is a hole like a very little window. In this hole the end of the stapes is fastened. The front of the internal ear is coiled up like a shell; and the back part is made up of the three semicircular canals. These canals open at both ends into the vestibule, and run out from the vestibule in half circles through the bone of the skull. All the inner ear is full of fluid. The fibers of the auditory nerve come into the inner ear. Cells with cilia-like ends are found in the internal ear, their ends standing out in the fluid.

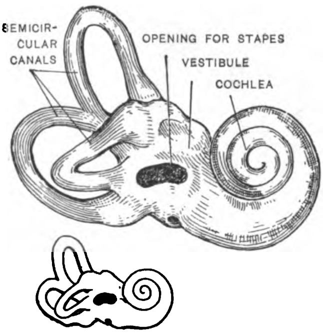


FIG. 127. The inner ear. The lower figure shows the natural size of the inner ear.

How we hear sound. The external ear catches the sound waves. These waves pass down the canal and strike against the tympanic membrane. The blow makes the membrane move out and in, and moves the malleus. Then the malleus strikes the incus, and the incus pushes the stapes. The stapes then pushes into the opening into the inner ear, and this makes waves in the fluid in the inner ear. The waves in this fluid then strike against the cilia-like ends of the cells. This makes the auditory nerve take messages to the brain, and when the messages reach the brain, we hear the sound.

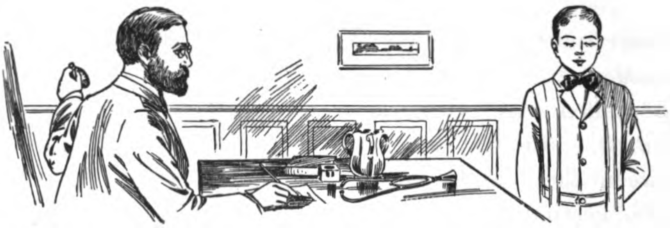


FIG. 128. Testing the hearing.

Work of the semicircular canals. The nerves of hearing are in the cochlea, and in the semicircular canals there are nerves that have a different kind of work. *It is the work of these canals to tell the brain when the body is falling.* The semicircular canals all run in different directions. When the body moves, it moves the head; and when the head moves, it moves the fluid in these canals. The movement of the fluid then causes the nerves to take messages to the brain and tell it how the body is moving. If the body should move very far to the side, it would fall down. The nerves in the canal tell the brain when the body is moving, and the brain sends messages to the muscles, so that they will hold the body up.

QUESTIONS

Name some general sensations. Name the five special senses. What makes the nerves take messages to the brain when we touch anything? What different kinds of work do different nerves of feeling do? In what parts of the skin is the sense of feeling acute? Why? Where is it poor? Where poorest? What do we feel when the epidermis is broken? Explain the part of the brain in feeling.

Where are the nerves of taste? Describe the taste buds. Where are the ends of the nerves of taste? What must be done to the food before it can be tasted?

Where are the nerves of smell? Describe the olfactory cells. What is it that causes us to smell objects?

How is hearing caused? When the wind blows, what do we feel? When a stone strikes the water, what does it move? What does this cause? When you ring a bell, what does it do? What does this cause? Why do we hear the bell ring? What kind of sounds do big waves cause? Small waves?

What is the work of the ear? What does the auditory nerve do? Name the three divisions of the ear. What is the work of the external ear? Describe the middle ear. Where is the tympanic membrane? Where are the Eustachian tubes? What is the work of the Eustachian tubes? Why can we not hear well if the Eustachian tubes are closed?

Name the three parts of the internal ear. Describe the front part of the internal ear; the back part. What is in the inner ear? Where are the ends of the auditory nerve fibers? Trace the course of the sound wave from the air to the brain. What is the work of the semicircular canals?

SUGGESTIONS TO THE TEACHER

In most cases of ear trouble the child has adenoids or enlarged tonsils and the germs have spread from the throat up the Eustachian tube to the ear. A child that has earache should, therefore, be taken to a physician.

In testing the hearing, one ear at a time should be tested. Without letting the pupil know it, hold the watch at times behind the back so that it can be determined whether the pupil really hears the watch or only imagines he is hearing it.

CHAPTER XXI

THE SENSES (Continued): SEEING

OUR eyes are so constructed that light causes the nerves in them to take messages to the brain. The eye is very wonderful. It makes a picture of everything it sees, and the nerves from the eye tell the brain about these pictures. Then we understand many things about the objects which we see.

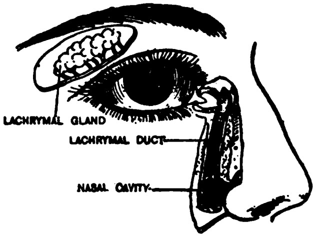


FIG. 129. The tear gland and the duct that carries tears to the nose.

Protection of the eyes. The eyes are very important and very delicate, and therefore must be well protected. In the front of the skull there are two hollows (*sockets* of the eyes), and the eyes are in these hollows. The bones around the eyes protect them so that it is difficult for anything to strike them. In the eye socket, behind the eye, is a bed of soft fat for the eye to rest on and to turn on.

The eyes are protected also by the *eyelids*, the *eyelashes*, and the *eyebrows*. The eyelids keep the dust out of the eyes. They can also close quickly and protect the eyes when anything is about to strike the eyes or when the light is too strong. The eyelashes keep dust out of the eyes and shade the eyes from strong light. The eyebrows keep the sweat from running down from the forehead into the eyes.

The tear glands. Under the outer part of the upper eyelid of each eye there is a little gland (*tear gland*) that secretes *tears* and pours them into the eye. The tears run across the eye and down into the nose, through a little opening (the *lachrymal duct*) in the inside corner of the eye. As the tears go across the eye, they wash away the dust and dirt and cleanse the eye.

Great sorrow and, in some persons, anger will cause the tear glands to secrete very freely. Then the tears cannot all go through the little duct into the nose, and some of them run over the edges of the eyelids and flow down the cheeks. When this happens, we say that the person weeps.

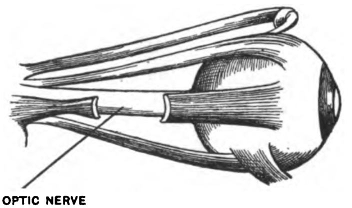


FIG. 130. The muscles that move the eye.

The muscles of the eyes. There are six muscles to move each eye. The back ends of these muscles are fastened to the walls of the eye sockets, and the other ends are fastened to the eyes. When we wish to look at anything that is in front of us, we need not turn the head. The muscles of the eyes can move them up or down, in or out. They can turn the eyes toward the thing which we wish to see.

Structure of the eye. Around the outside of the eye is a tough, hard, white coat, the *sclerotic* coat. Inside this is a dark-colored coat, the *choroid* coat, and in the back part of the eye is a third coat, the *retina*. The retina is a thin, white coat, and in it are the nerves of sight. In the center of the eye is a large cavity, which is filled with a transparent, soft substance about like clear, thick honey.

The sclerotic coat. The sclerotic coat is made of strong white connective-tissue fibers placed very close

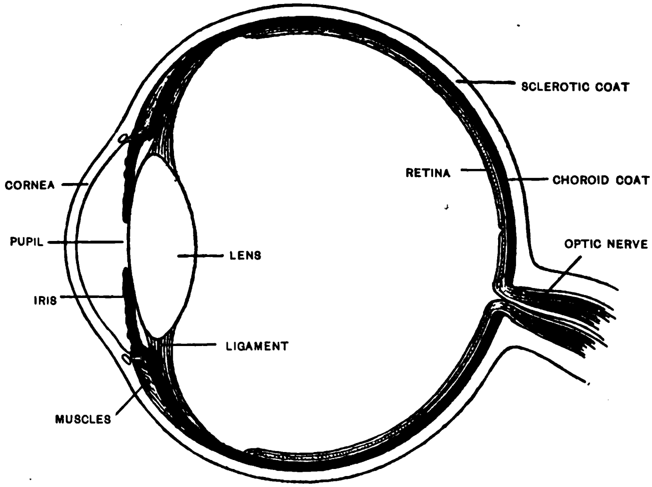


FIG. 131. A diagram showing the structure of the eye.

together. It is white everywhere except in front. In front it is transparent, so that the light can pass through it into the interior of the eye. This transparent place in the front is called the *cornea*. It is like a little window through which we look out and see the world.

The choroid coat and the iris. The choroid coat is dark in color, and its front part is called the *iris*. The iris is circular and lies behind the cornea, and it is the iris that gives the color to the eye. The cornea has no color. It is transparent, and we look through it and see the color in the iris. The iris is blue, brown, or black, and we say a person is blue-eyed, brown-eyed, or black-eyed, according to the color of his iris.

In the center of the iris is a little hole. This hole looks dark, and is called the *pupil* of the eye. The light goes through the pupil to the back part of the eye.

The function of the iris. *The function of the iris is to regulate the amount of light that goes into the eye.* It does this by making the pupil large or small. When we are in a weak light and the eye gets little light, the pupil opens up wide and lets in as much light as possible. When we go from a dark place into a very bright light, we cannot see well, because the pupil is large and lets too much light into the eye. If we stay in the bright light, the pupil will contract in a short time, and then we can see in the bright light. If we go out of a brightly lighted house at night, we cannot see anything. The pupil is small and does not let in enough light for us to see in the weak light out of doors. But after we have been out in the night a little while, our pupils become larger and we see better.

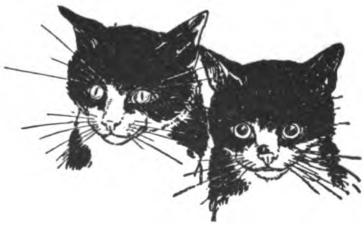


FIG. 132. One cat has been in the dark; the other has been in the light.

If you look at the eye of a cat in a bright light, the pupil will be long and narrow. But if you put the cat in the dark and then look at its eyes again, you will see that the pupils are large and round.

The lens. The lens lies close to the iris and behind it. The lens is a little circular sac filled with a substance about like very thick honey. All around at its edges the sac is fastened to the outer wall of the eye. It is thick in the middle and thin at the edges. Both the sac and the soft matter in the sac are transparent, so that the light can go through them to the back of the eye.

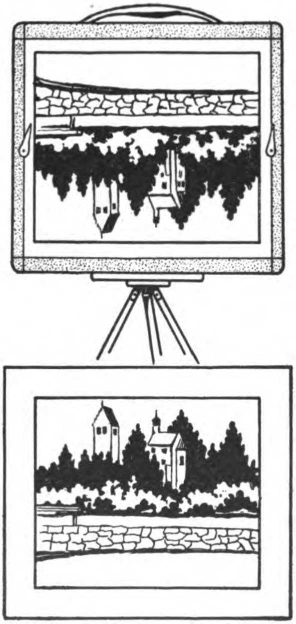


FIG. 133. The lens in the camera forms images on the glass in the back of the camera.

The function of the lens. *The function of the lens is to make images (pictures) of the things which we see on the back of the eye (retina).* If you look on the glass in the back of a camera, you will see an image on the glass. The lens in the front of the camera makes the image by gathering up the rays of light that come from an object and causing them all to meet on the glass. In the same way, the lens of the eye makes pictures on the back of the eye of the things we see.[1]

The retina. The *optic nerve* comes out from the cerebrum through a hole in the back of the eye socket. This large nerve passes through the sclerotic and choroid coats into the interior of the eye. Inside the eye the

[1] The image in a camera is upside down. The images in the eye also are upside down, but the brain is used to this and is accustomed to forming judgments from the images of objects made in this way.

optic nerve spreads out in a thin coat over all the back of the eye. This coat is the *retina*, and it is on the retina that the pictures are made. The ends of the nerves of sight are in the retina; and when the lens makes the pictures, these nerves take messages to the brain about the pictures. This causes us to see.

Humors of the eye. Between the cornea and the lens there is a little space in the eye. The iris is in this space, and all around the iris there is a watery fluid called the *aqueous humor*. Behind the lens there is a great cavity, and this is filled with a sticky, transparent substance very much like the material of which the lens is made. This substance is called the *vitreous humor*, and it fills up the whole inside of the eye behind the lens.

Seeing near and distant objects. For an object to be seen clearly, the lens must make a clear picture of it on the retina. To make a clear picture of a near object, the lens must be more rounded than is necessary to make a clear picture of a distant object. We must therefore change the shape of the lens when we look at objects that are at different distances from us. There are little muscles in the eye to make the lens more round or more flat, as we wish. You can show how the muscles change the shape of the lens, if you have a rubber bag or the bladder of a fish or other animal.

Experiment. Fill the bag with air or water. Then pull on the ends of the bag and you will pull the bag out flat. The lens is shaped like this when we look at distant objects. Now let the ends of the bag go loose, and the bag will again become round. The lens is like this when we look at objects close to the eye.

The lens is a circular sac filled with a thick fluid, and the sac is fastened to the choroid coat by fibers that go out all around from the edge of the sac. These fibers are tight, and they pull on the sac and make the lens flat. The eye can then see distant objects. When the little muscles in the eye contract, they pull the choroid coat forward, bringing it closer to the lens. This loosens the fibers that fasten the lens to the choroid coat, and the lens becomes round. We can then see near objects.

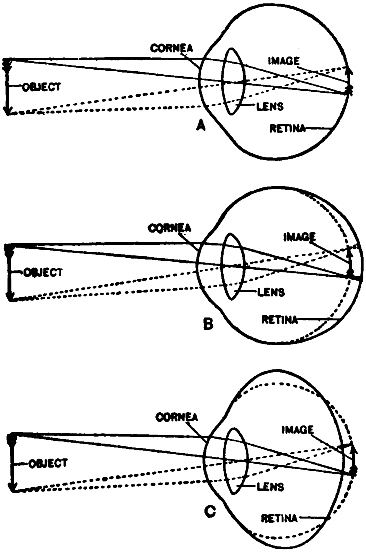


FIG. 134. *A*, normal; *B*, near-sighted; and *C*, far-sighted eye.

Near-sighted and far-sighted persons. In some persons the eyes are long from the front to the back, and the rays of light meet before they come to the back of the eye. This does not make a good image on the retina, and such persons cannot see well. They can see things that are near better than they can see things that are far away, and they are said to be *near-sighted.* If a person is near-sighted, he will hold a book very close to his eyes, when he is reading.

The eyes of some other persons are too short from front to back. In eyes of this kind the retina is so close to the lens that the rays of light strike the retina before they meet. Persons with eyes of this kind see distant objects better than they see near objects, and they are said to be *far-sighted.*

Eyes of old persons. When we become old, the material in the sac of the lens becomes hard and stiff. Then when we loosen the fibers that go out from the sac of the lens, the lens will not become round, because the material in the sac is hard. Many old persons cannot see objects that are close to them, because their lenses will not become round. These old persons must wear glasses (spectacles).

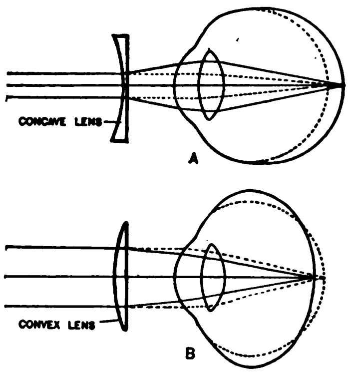


FIG. 135. How glasses cause the rays of light to meet on the retina.

Spectacles. When the eye is too long or too short, so that the image does not fall on the retina, glasses should be worn. The lenses in the spectacles will make the image fall on the retina of the eye. Near-sighted persons should wear glasses that are concave (have hollows in the surfaces). Concave glasses bend the rays of light apart so that they do not meet so quickly. This makes them meet on the retina of a near-sighted eye. (Fig. 135, upper diagram.)

Far-sighted persons need convex (rounded out) glasses. Convex lenses help to bend the rays of light together and make them meet more quickly. This makes the image fall on the retina in a far-sighted eye. Far-sighted persons often injure their eyes when reading or studying, because the muscles in their eyes must be contracted all the time to make the lenses of the eyes round.

Work of the brain in seeing. The eyes make pictures of objects, and the optic nerves take messages to the brain about these pictures, but it is the brain that understands and knows about the objects. From the messages that go to the brain, we can tell the size, form, and color of objects. We can also tell whether an object is rough or smooth, how far away it is, and many other things about the objects that we see. That the brain sometimes makes mistakes in judging of the objects that we see, you can tell by looking at Figure 136.[1]

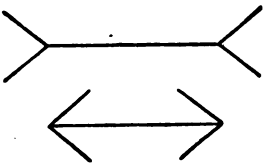


FIG. 136. Which line is longer?

HYGIENE OF THE EYE

Without his eyes, a man cannot work, and his friends must take care of him. He cannot enjoy any of the beautiful things that we see all about us. He cannot read, and it is difficult for him to walk about. He can do nothing but sit in the house all day, and his life is very miserable. Since our eyes are so important, and

[1] The following are some of the common optical illusions that may be mentioned: The figure "8" and the letter "s" must be made larger at the bottom than the top to prevent their seeming larger at the top; the sun and moon appear larger near the horizon than when they are high in the sky; from a railway train the landscape appears to be moving; and when a person looks at the moon through the treetops, while running, the moon appears to be running with him.

since they are easily injured, we should take good care of them.

If the images in our eyes do not fall on the retina, we shall always have trouble with our eyes. Very often near-sighted or far-sighted eyes cause headaches and make one sick at the stomach. If our eyes hurt, we should go to a good oculist (physician for the eyes) to find out if we need glasses. If one is a little near-sighted, he needs glasses that are a little concave; and if he is very near-sighted, he should have glasses that are strongly concave. One who is only a little far-sighted needs glasses with a little convexity, and one who is very far-sighted needs glasses that are strongly convex. A physician, or some one who understands spectacles, should examine our eyes and tell us what kind of glasses we need.

When a person reads, he should have a good light, and he should sit so that the light will fall on his book and will not shine in his eyes. If it is necessary to work facing a light or window, a shade should be worn over the eyes. One should not read without a lamp in the evening when it is growing dark. He will hurt his eyes in the weak light. Candlelight is too weak to be good to study by. A lamp or an electric light is much better. It is not good for the eyes to read when one is lying down, because too much blood then goes to the eyes. Hold the head up when using the eyes. A person should stop his work for a few moments when his eyes feel tired, and rest them. At such times he should close his eyes or look at something far away. This will let the muscles of the eye rest.

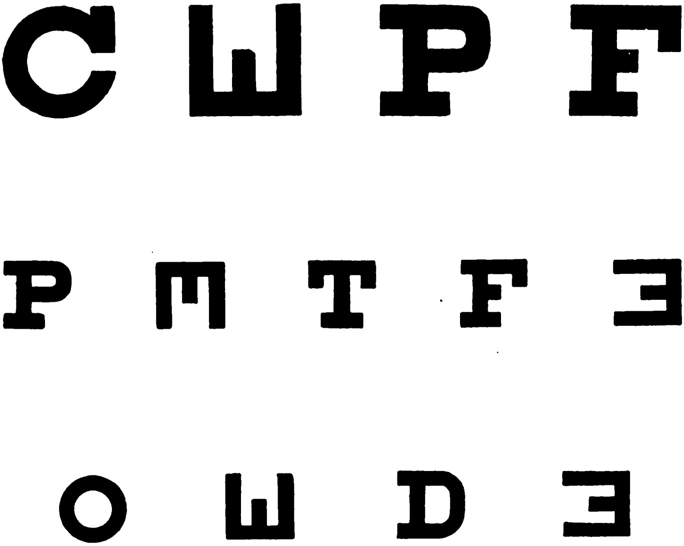


FIG. 137. You should be able to read the upper line at a distance of 30 feet, and the two lower lines at a distance of 20 feet.

Dust is very bad for the eyes, and will cause them to become red and sore. The dust wounds the eyelids, and germs may grow in the wounds. It is good for inflamed eyes to wash them in either hot or cold water that has been boiled. A little boric acid dissolved in water and dropped into the eyes once or twice a day will often help red and sore eyes. But where there is anything the matter with our eyes, we should go to a physician.

Tobacco and alcohol. The smoke of tobacco is bad for the eyes; and if people use much tobacco, they sometimes become color-blind (unable to tell the colors of things). Every one who has seen the red eyes of drunkards knows the bad effect of alcohol on the eyes.

QUESTIONS

How do the bones of the skull protect the eyes? In what other ways are the eyes protected? Where are the tear glands? What is their function? What is the use of the tears? How many muscles move each eye? Where are they fastened?

Describe the sclerotic coat. Where is the choroid coat? What color is it? Describe the retina. Where are the nerves of sight? What is in the center of the eye? What is the cornea? Describe the iris. What gives color to the eye? What is the pupil of the eye? What is the function of the iris? What does the pupil do in weak light? in bright light?

Where is the lens of the eye? With what is it filled? What shape is it? What is the work of the lens? Trace the optic nerve from the brain to the interior of the eye. What is the function of the optic nerve? Where is the aqueous humor? Describe it. Where is the vitreous humor? Describe it.

How must the shape of the lens be changed to see things that are distant and things that are near? What is the difficulty in a near-sighted eye? in a far-sighted eye? in the eye of an old person? When should we wear glasses? What do the lenses of the spectacles do? Why does studying without glasses sometimes injure the eyes of far-sighted people?

In seeing, what is the work of the eye? of the optic nerve? of the brain? What do the nerve messages tell the brain about the objects that we see?

Why should we take good care of our eyes? What sicknesses do near-sighted and far-sighted eyes sometimes cause? How should the light fall on the book when a person is reading?

Tell some things that are bad for the eyes. How may we rest our eyes when they become tired? What should we do for eyes that are red and sore? What is the effect of tobacco on the eyes? of alcohol?

SUGGESTIONS TO THE TEACHER

Most eyes are good enough instruments for ordinary use, but about 25 per cent of persons need glasses when they do office work or other work that requires close use of the eyes. Bad cases of eye trouble may be found by testing the eyes with the letters on page 382. Each eye should be tested separately. The following instructions will help the teacher to make the test:

Have a good light on the letters that are to be read. Seat the pupil at a distance of 20 feet from them. Test persons who wear glasses with their glasses on. Cover one eye with a card (but do not press on it) while the other is being tested.

The upper line should be read at a distance of 30 feet and the lower lines at a distance of 20 feet. In case either eye fails to measure up to this standard, glasses are needed. Persons who cannot read may be tested by asking them whether the letter E in the chart is open at the right, left, top, or bottom. In case the pupil knows the chart by heart, cut a small opening in a piece of cardboard and expose only one character at a time while the test is being made.

Failure to read the letters by children under seven years of age does not necessarily mean that glasses are required.

There may be defects of the eye that will not be revealed by this test. When there are symptoms of eyestrain, an eye specialist should be consulted. Any children who are near-sighted should be seated in the front of the room so that they can see the blackboard.

REVIEW QUESTIONS

Chapter XVII. Give two functions of the nervous system. Of what is the nervous system composed? What is the function of the nerve fibers? What is a motor nerve? a sensory nerve? Name the three parts of the brain. What is the function of the cerebrum? of the cerebellum? of the medulla oblongata? of the spinal cord? Compare the nervous system to a telegrapher and a telegraph system. How does the nervous system of man differ from the nervous systems of other animals?

Chapter XVIII. Mention three things that are necessary for the health of the nervous system. What effect has pain on the nervous system? What should a person do who suffers pain? Why should a person try to keep his mind quiet? Mention some things that are necessary for the peace of mind of the Filipinos.

Chapter XIX. What is the purpose of education? How may the nervous system be changed? Give examples of natural reflex actions. Give examples of acquired (learned) reflex actions. In a reflex action, where does the impulse start? What is a habit? How are habits formed? Give an important rule in forming habits. How are correct habits formed? When are habits most easily formed? Mention some important hygienic habits. What is the function of the cerebrum? What is a common fault of man? Give examples of feelings that influence action. How may the feelings be rightly trained?

Chapter XX. Name the special senses. Explain how a message is started in a nerve of feeling; in a nerve of a tooth; in a nerve of smell. Describe the ear. What is a sound wave? How does it cause us to hear? What is the function of the semicircular canals?

Chapter XXI. Name the coats of the eye. What is the function of the iris? of the lens? What is the trouble in a near-sighted eye? in a far-sighted eye? How may these troubles be remedied? What is the part of the brain in seeing? Mention some important points in the care of the eye.

CHAPTER XXII

POISONS

FIG. 138. As clean water is necessary for the health of the fish, so is pure lymph necessary for the health of the cells.

FROM what you have now learned, you understand that the body is composed of millions of little cells, each of which is alive; that the cells are bathed in the lymph and surrounded by it; and that the cells get their food from the lymph and give off their wastes into it. The cells live in the lymph as a fish lives in water; each one takes in the food and oxygen that come to it and gives off its wastes into the liquid about it. To keep the cells in health, the lymph must be rich in food and oxygen, and the poisonous wastes must be carried away as fast as they are formed.

The causes of sickness. Why do we at times become ill? *We become ill either because our cells lack something that they need or because there is something in the lymph that poisons them.* Sometimes it is because the cells are not furnished with proper food. Sometimes the heart or the lungs fail, — oxygen is not supplied to the cells and the carbon dioxid is not carried away from them. Sometimes it is because the kidneys do not take the protein wastes out of the blood. Sometimes it is because poisons are absorbed from the intestines. Very often it is because disease germs grow in the body and produce substances that poison the cells. In former chapters we have learned something about the different organs of the body and how they must all work together to keep the lymph about the cells rich and pure.

Drugs and medicines. There are certain medicines like quinine, strychnin, and calomel that physicians use in the treatment of diseases. There are other drugs, as alcohol, tobacco, betel-nut, and opium, that men fall into the habit of taking. Many persons also buy medicines from drug stores and take them. Are these substances of benefit to man or do they harm him? In the hands of a wise physician they are a great blessing, but when used by an ignorant person they can do much harm.

Why the use of drugs is dangerous. Suppose you had a vessel crowded full of small fish and suppose that you began putting into the water various substances like quinine, calomel, strychnin, and alcohol. Would these substances help or harm the fish? You can understand that you might easily do great injury to the fish by putting these substances into the water.

It is estimated that there are 400,000,000,000 cells in the body. They are crowded together in a great mass in the lymph, and drugs or medicines that we take are dissolved in the lymph among the cells. Most medicines that we use are strong poisons, and unless a person understands what he is doing, he ought not to take these poisons in among the delicate cells of his brain, heart, kidneys, and other organs. Even a physician, who for years has studied how to tell what is the matter with the body and how to treat diseases, needs to be very careful in the use of drugs.

The use of alcohol. All over the world men use alcohol. Does it help them or harm them? A man who uses it thinks he is stronger after drinking it; but when we measure his strength, he is weaker. He thinks his mind works better; but when we test his mind, we find he thinks less clearly. Men think that alcohol saves them from disease; but when we investigate, we find that users of alcohol always suffer more from sickness than those who do not use it. The leading men of the world are agreed that the use of drinks that contain alcohol (beer, wine, whisky, bino) causes much evil, and that this is true every intelligent person knows. That alcohol injures the human body is proved beyond doubt by the following facts:

In 1909 forty-three of the leading life insurance companies of the United States and Canada decided to work together to investigate the death rates among different classes of their policy holders. The investigation included the histories of more than 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 number of deaths 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]

In the above-mentioned investigation, no study of the death rate among abstainers was made, but one American company that made such a study secured the following data:

	MORTALITY
Total abstainers	59 %
Occasional users	71 %
Temperate users	84 %
Moderate users	125 %

These figures show a mortality rate among abstainers of less than half that among moderate drinkers.

Tobacco. Tobacco contains a poison called nicotin. When a person smokes tobacco, the nicotin is absorbed into the blood and is carried all through the body to the cells. It is a very strong poison and has a marked effect on the heart and nervous system especially. It is particularly injurious to the young, for it prevents their growth.

[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 per cent, 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.

Experiment. Boil a cigarette in water. Pour this water into a vessel that contains a small fish. What is the effect on the fish? Do you think the cells of the fish are benefited or harmed by the nicotin in the water? Will it help or harm your cells to have nicotin in the lymph in which they are bathed?

Opium. This drug has a very powerful effect on the cells. The dangers of its use are well known, and its sale in the Philippines is now strictly guarded by law.

Betel-nut. The betel-nut contains a drug so strong that only a little of it will make a person not accustomed to it violently ill. Do you think the use of betel-nut benefits or injures the cells?

Coal-tar remedies. When coal is heated, a black, sticky substance called *coal tar* flows from it. From coal tar many chemicals are made, — coloring matter for ink and for dyeing cloth, and a number of drugs that are used as medicines. Among these drugs are acetanilid, phenacetin, and antipyrin. All of them deaden the nervous system so that to a certain extent it loses its power to feel. When they are used for headaches and other pains, people think they are being cured because they no longer feel the pain. In reality the drug does not take away the cause of the headache; it puts the nervous system to sleep so that the pain is not felt, but the disease is still there. You will readily understand that this is doing nothing to cure the disease. Coal-tar remedies also slow the beating of the heart, and one who uses them may injure this important organ. They must, therefore, be considered as very dangerous drugs.

The use of pain. If you touch fire with your hand, you will feel pain. What is the advantage of this pain? It tells you that your hand is in danger and makes you take it away. If you have something wrong with some part of your body, you feel pain. What is the use of this? It is a warning to you that the body is in trouble and that you had better find out what the difficulty is and remove it. Would it save your hand from being burned if you took a powerful drug that so deadened your nervous system that you did not feel the pain? [1] Will it save your body from being injured by disease if you take a drug that keeps you from feeling the disease? These questions you can answer for yourself; and if for any reason you are suffering from pain, you should go to a good physician who can find the cause of the pain and remove it.

Patent medicines. Many persons go to drug stores and buy medicines for themselves. Often it is claimed that these medicines will cure tuberculosis, cancer, diseases of the kidneys and heart, and other serious ailments. These claims are not true. There is no medicine known that will kill the germs of tuberculosis; we have no medicine that will stop the growth of cancer; there are no medicines that will repair the damage done to the kidneys or the heart by severe diseases of these organs. The skillful physicians who are in our hospitals and medical schools know about all the medicines that are good for the body; they teach their pupils how to use them; and when any one claims to have a

[1] Ether, chloroform, and other drugs that produce unconsciousness are drugs of this kind.

medicine that will make wonderful cures of cases that physicians cannot help, he is not telling the truth. The truth is that nearly all these medicines contain

FIG. 139. If these were at the bottom of the sea, it would be better for the men on land and worse for the fishes in the water.

alcohol, opium, coal-tar drugs, or something else to keep one from feeling pain. *They do not cure disease.* They cover the disease up and keep the person from going to a physician for treatment for the real difficulty, while day by day both the drugs and the disease are breaking down the body.

It is important, therefore, for you to remember that you have only one heart, one brain, one liver, and one pair of kidneys. Do not poison the delicate cells of these organs with alcohol, tobacco, or betel-nut. If you are attacked by sickness, have a physician give you the medicines that you need, but do not poison your body with all kinds of medicines that you do not understand. Remember that in the hands of an ignorant person medicines are like a sharp knife in the hands of a little child, and that because of the careless way in which they are used a great physician has said, "If all medicines were at the bottom of the sea, it would be better for the men on land and worse for the fishes in the water."

QUESTIONS

Why do we sometimes become ill? Mention some of the causes of illness. Why do men use drugs and medicines? Explain why drugs are dangerous.

What do leading scientists think of the use of alcohol? What effect has alcohol on length of life? What poison is in tobacco? What organs of the body are especially affected by this poison? Mention two other drugs that are used in the Philippines. What effect have coal-tar remedies on the nervous system? on the heart?

What is the use of pain? How do most patent medicines affect the body? What drugs are commonly found in these medicines? To whom should a person go when he needs medicine?

SUGGESTIONS TO THE TEACHER

The idea that any diseases can be cured by taking a little bitter medicine into the body has come to us from the days of alchemy and superstition. Now that we have found the real causes of sickness, we know that there are only a few diseases that can be cured by medicine and that in most cases nature herself must do the healing. The Filipino teacher can do no greater service to his people than to spread the knowledge that the true way to deal with disease is to prevent it, and that it requires a physician of the greatest skill to use medicines without doing more harm than good with them. There should be a highly educated physician in every Philippine town. These physicians will come only when the Filipino people go to them for treatment of their diseases instead of spending their money for worse than useless medicines.

CHAPTER XXIII

EXERCISE

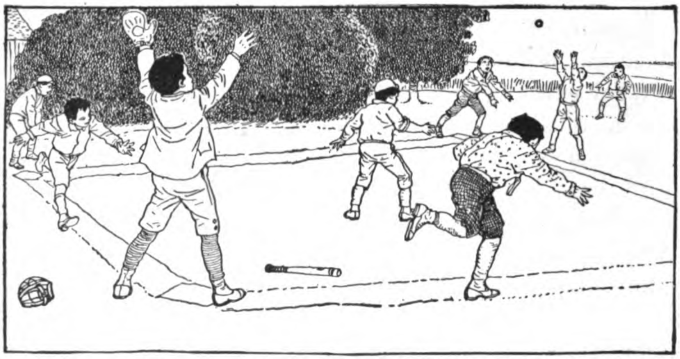


FIG. 140. **Outdoor games furnish the best exercise because they bring into use all the muscles of the body, they take the mind off its tasks, and they keep us out in the fresh air.**

EXERCISE affects not only the muscles, but all the other organs of the body. It makes the digestive glands work better and thus helps in the digestion of the food. It has a great effect on the nervous system, enabling the brain to control the muscles quickly and easily, and it makes the mind clearer and brighter. It strengthens the heart and quickens the circulation of the blood, and gives vigor to all the body parts. We do not understand how exercising the muscles affects all these different organs, but we do know that exercise gives strength, beauty, and health to the body. Students and others who are not doing muscular work should therefore exercise regularly every day.

Exercise and the development of the muscles. One very important reason for exercising is to develop the muscles. If a limb is broken and the muscles of the limb are not used for a long time, they become very small and weak. If a man does no work, his muscles will be small and soft even though he have plenty of good food. But exercise makes the fibers of the muscles take in food and grow large and strong.

The benefits of outdoor games. For most persons the best of all ways of taking exercise is to play in the open air. Running, playing ball, playing tennis, swimming, rowing, and fast walking for long distances are good forms of exercise. The open air and the pleasure of the sport stimulate the nervous system and add to the benefit that comes from exercise of this kind.

Rest necessary for the muscles. Rest as well as exercise is necessary for the development of a muscle. After work, a muscle must have time to get rid of the waste matter in its fibers and to take in food and build up the fibers. If a muscle works very much and does not have time for rest, it will become small and weak. If men use the same muscles all day, as busy telegraphers do, these muscles may become paralyzed. Too much work also causes the muscle cells to change to fat. This weakens the muscles, because fat cannot contract and do work as can the muscle cells. In this connection we must always remember that the heart is a muscle and that the fibers in its walls are the hardest worked of all the muscle fibers of the body. Like other muscles, the heart must have time to rest, or it will become weak and unable to do its work. In a former chapter (page 286) we have spoken of the danger of overworking the heart in the playing of games, and young persons especially should have this danger in mind.

Exercising all the muscles. Since we do not want some of our muscles to be very large and strong and some of them small and weak, they should all be exercised and developed. Exercises in gymnasiums and schools often give excellent results because they bring into action some muscles that are little used. In taking these exercises, it is a great advantage to have a teacher who understands how the different muscles work and how to exercise each muscle. Such a teacher will know which muscles are weak and how to develop them.

Exercise in schools. After children have been sitting quietly in school for some time, the respiration is shallow, the air being taken only into the parts of the lungs close to the larger branches of the bronchi. The circulation is slow, many of the muscles are tired, and the mind is dull and inactive. At least twice a day — in the middle of the forenoon and in the middle of the afternoon — the children should be given from two to five minutes of stretching and breathing exercises. These exercises rest the tired muscles, make the breathing deeper, and cause the heart to beat quicker and harder, thus sending more blood and oxygen through the body. This is good for both the mind and the body. It is an excellent thing for any one who sits quietly working or studying for considerable periods of time to stand up occasionally and go through a few exercises. Students should do this at home when they become tired with studying.

Exercises

The following are a few simple exercises that can be given in schools. They will suggest other exercises to the thoughtful teacher. The school should go through with them in a quiet, orderly way, so that little time will be lost from the lessons. In a large school, the teacher should select some of the older pupils as assistants and put each of these in charge of a group of the smaller children. All the pupils in one room should go through the exercises together while the teacher counts and gives the commands. The assistants can see that the smaller children do this quietly and that the movements are properly executed. The windows should always be opened before beginning the exercises. The exercises should be given out of doors when the weather permits. This will insure good air and plenty of room.

The teacher should each day select exercises that will bring into use the muscles of the whole body. One arm exercise, one leg exercise, one body exercise, and one breathing exercise should be given, if there is time for only four exercises. The breathing exercises are the most important of all. When there is time for only one exercise, give Exercise 20 on page 405.

Position while exercising. The most important point is the position of the head. The head should be stretched up as high as possible, as though the body were hanging by the back of the top of the head. This will straighten out the spinal column, hold the neck straight with the chin close to the neck, and lift the ribs up off the lungs.

In the following exercises, whenever the command *position* is given, it means that the head is to be held in this way, with the hands at the sides. The best position for resting is to stand with the feet even (the same distance forward) and wide apart, the arms crossed behind the back and resting on the backs of the hips. The trunk and head should be held erect but not rigid (stiff) while resting. The command *in place* means to take this position, and the command *rest* means to remain in the resting position until the next command is given. The command *in place, rest,* should be given after each exercise.

Commands. There are always two parts in the commands; one part tells *what* to do, and the other part tells *when* to do it. In the commands for these exercises, the parts which tell when to do a thing are printed in black letters. For example, the command, *hands on hips,* **place**, means to place your hands on your hips when the teacher says **place**. In some of the exercises, the complete commands and counting have not been given. The teacher will easily understand what these should be and will give them.

A. **Arm raisings.**

EXERCISE 1. Arm raisings through front horizontals to high over the head.

Raise the arms high over the head, knuckles leading (*i.e.* the backs of the hands going before the palms), through a front horizontal position. Keep the arms and fingers stretched out stiff and straight. The teacher should count 1 as the arms are raised, and 2 as they are lowered. Keep the head stretched up.

Command: *Position.*

Arm raisings through front horizontals to high over the head, **raise — sink.**[1]

(Teacher counts:)

1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2.[2]

In place, **rest.**

EXERCISE 2. Arm raisings through front horizontals to high over the head, rising on the toes.

The same as Exercise 1, but rise on the toes as the arms are raised and bring the heels down as the arms descend.

Command: *Position.*

Arm raisings through front horizontals to high over the head, rising on toes, **raise — sink.**

1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2.

In place, **rest.**

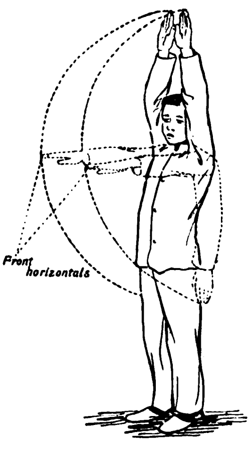


FIG. 141.

EXERCISE 3. Arm raisings through side horizontals to high over the head.

Directions as for Exercise 1, but raise the arms through a side horizontal position, bringing them up over the head with the palms forward, thumbs touching. Do not bend the arms at the elbows.

Command: *Position.*

Arm raisings through side horizontals to high over the head, **raise — sink.**

[1] If preferred, the command **up — down** may be used.

[2] If preferred, the teacher may count 1, 2, 3, 4, 5, 6, 7, 8.

1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2.

In place, **rest**.

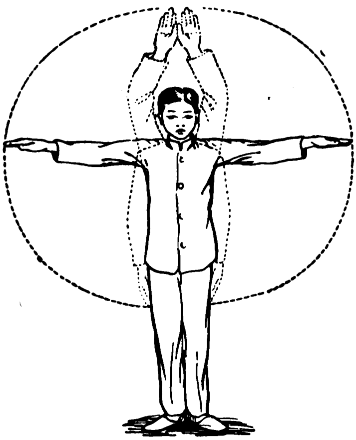


FIG. 142.

EXERCISE 4. Arm raisings through front horizontals, descending through side horizontals.

Raise the arms as in Exercise 1, and bring them down as in Exercise 3. Vary the exercise by sometimes rising on the toes.

Command: *Position. Arm raisings through front horizontals, descending through side horizontals*, **raise** — **sink**.

1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2.

In place, **rest**.

These arm exercises can be varied by having the pupils go through them with either the right or left arm, with both arms, or with the right and left arms alternately.

B. **Leg exercises.**

I. *Leg raisings.*

EXERCISE 5. Leg raising to front horizontal.

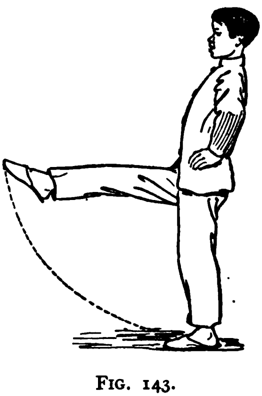


FIG. 143.

Bring the leg forward and upward with the foot as nearly as possible in a straight line with the leg. Do not bend the leg at the knee. Head and trunk erect; *i.e.* "stand tall."

Command: *Position, hands on hips,* **place.**

Leg raising to front horizontal, right leg, **raise — sink.**

1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2; 1, 2.

Left leg, **raise.**[1]

1, 2; (repeat eight times).

In place, **rest.**

FIG. 144.

EXERCISE 6. Leg raising to side horizontal.

Count and position of leg and foot as in Exercise 5, but raise leg to the side. Do not let the body lean over to the side.

Command: *Position, hands on hips,* **place.**

Leg raising to side horizontal, **raise — sink.**

EXERCISE 7. Leg raising to back horizontal.

Count and position of leg and foot as in Exercise 5, but raise leg to the back.

Command: *Position, hands on hips,* **place.**

Leg raising to back horizontal, **raise — sink.**

II. *Leg flexions (bendings).*

EXERCISE 8. Leg flexion forward. Position of toe as in Exercise 5. Leg from knee down should be *vertical.* Raise knee toward chin as far as possible, keeping the body and head erect.

[1] This command should be given instead of the last three counts while the right leg is being raised. The exercise will not then be stopped while the command is being given.

Command: *Position.*

Hands on hips, **place.**

Leg flexion forward, right leg, **raise — sink.**

1, 2; (repeat eight times).

Left leg, **raise — sink.**

1, 2; (repeat eight times).

In place, **rest.**

EXERCISE 9. Leg flexion backward.

Count and position of foot as in Exercise 5. Bend the leg backward at the knee. Raise the foot as high as possible, *keeping the knees close together and even.*

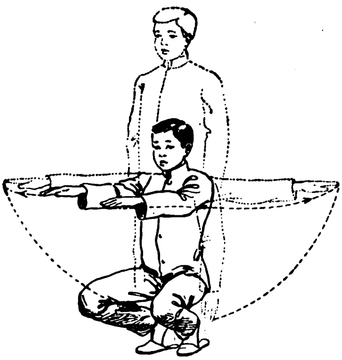


FIG. 145.

Command: *Position.*

Hands on hips, **place.**

Leg flexion backward, right leg, **raise — sink.**

III. *Squat.*

EXERCISE 10. Half squat, with arms to front (or side horizontals).

Lower the body, raising the heels, bending only at the knees and hips. The knees should be turned out so that they will be in a straight line with the toes. As the body descends, raise the arms to front horizontal (extended straight out in front, palms down), or to side horizontal (extended out at sides); now lower the arms to the sides as legs are straightened. *Head and trunk erect.*

Command: *Position.*

Half squat, with arms front (or side) horizontals, **squat.**

1 (lower body and raise arms), 2 (lower arms and raise body); (repeat eight times).

In place, **rest.**

C. **Body flexions** (bendings).

EXERCISE 11. Trunk forward flexion.

Place the hands on the hips, and bend the body forward. Keep the legs straight at the knees and the head in a straight line with the trunk, the body bending only at the hips.

The count for body movements should be slower than for limb movements.

Command: *Position.*

Hands on hips, **place.**

Trunk forward, **bend** — *upward,* **raise.**

1, 2; (repeat four times).

In place, **rest.**

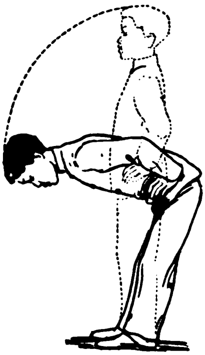


FIG. 146.

EXERCISE 12. Trunk sidewise flexion.

Position as for Exercise 11. Do not let the head bend over toward the shoulders. Bend alternately to the right and to the left.

Command: *Position.*

Hands on hips, **place.**

Trunk sidewise, **bend** — *upward,* **raise.**

1, 2; (repeat four times).

In place, **rest.**

EXERCISE 13. Trunk backward flexion.

Position and directions as for Exercise 11. Bend the body backward. Do not let the legs bend at the knees.

Command: *Position.*

Hands on hips, **place.**

Trunk backward, **bend** — *upward*, **stretch.**

1, 2; (repeat four times).

In place, **rest.**

EXERCISE 14. Alternate trunk flexions.

Bend forward, then to the right, then to the left, and then backward.

Command: *Position.*

Hands on hips, **place.**

Alternate trunk bendings, **bend.**

1, 2; (bend each way and repeat once).

In place, **rest.**

The exercises in bending may be varied by clasping the hands together and placing them on top of the head instead of on the hips.

D. **Breathing exercises.**

EXERCISE 15. Breathing exercise, hands at sides.

Inhale and exhale slowly and steadily through the nostrils. Keep the head and body erect as the air is exhaled. At the command **inhale**, take in a full breath, and hold until the command **exhale**. In all breathing exercises, stand tall.

Command: *Position.*

Breathing exercise with hands at sides, **inhale** — **exhale** (repeat four times).

In place, **rest.**

EXERCISE 16. Breathing exercise, hands on ribs.

Place the hands over the lower ribs, and as the air is exhaled, press on the ribs with the hands.

Command: *Position, hands on ribs*, **place.**

Breathing exercise, hands on ribs, **inhale** — **exhale** (repeat four times).

In place, **rest**.

EXERCISE 17. Breathing exercise, arms raised through front horizontals high over the head.

As the air is inhaled, slowly raise the arms as in Exercise 1, and let them come down again slowly as the air is exhaled. Keep the arms and fingers stretched out straight and stiff.

Command: *Position.*

Breathing exercise, arms raised through front horizontals to high over the head, **inhale** — **exhale** (repeat four times).

In place, **rest**.

EXERCISE 18. Breathing exercise, arms raised through side horizontals to high over the head.

Position and movement of arms as in Exercise 2. Raise the arms as the air is inhaled and lower them as the air is exhaled. *Head, arms, and fingers stretched up.*

Command: *Position.*

Breathing exercise, arms raised through side horizontal to high over the head, **inhale** — **exhale** (repeat four times).

In place, **rest**.

EXERCISE 19. Breathing exercise, arms raised through front horizontals and lowered through side horizontals.

The same as Exercise 17, but move the arms as in Exercise 3.

EXERCISE 20. Breathing exercise, arms raised through front horizontals high over the head, rising on toes.

The same as Exercise 17, but rise on the toes as the air is inhaled and slowly bring the heels down as the air is exhaled.

QUESTIONS

Mention some of the beneficial effects of exercise on the body. What effect has exercise on a muscle? Why do the muscles of a broken limb become small and weak? What is the best form of exercise for most persons?

Why must a muscle have rest after it has been exercised? What sometimes causes paralysis of the muscles?

What muscle in the body is especially likely to be injured by overwork? What advantage is there in exercising in a gymnasium under the instruction of a teacher? Why are exercises in schools useful?

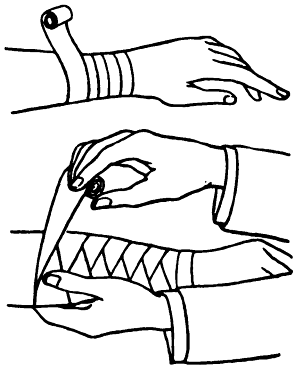
SUGGESTIONS TO THE TEACHER

Games and physical exercises give people an interest in their bodies and in their health, and they are always to be encouraged. It is worth while, therefore, for the teacher to give time to the organization of athletic teams in the school and to the holding of athletic contests with other schools. Where it can be done it is better to have the physical exercise taken in games rather than in gymnastic exercises. It is important, however, that this work be organized so that all the pupils will take part in it. A school should not have a few pupils who are spending all their time in games and who have all their interest in sports, while the great mass of pupils are only spectators at the games.

CHAPTER XXIV

ACCIDENTS

WHEN a person is badly hurt, a physician should always be called as soon as possible. But sometimes it is necessary to do something before the physician comes, or the person will die. We have already studied about how to take care of a broken bone, how to stop bleeding, and how to care for a person who has been long under water.[1] We shall now learn what to do in case of accidents of other kinds.

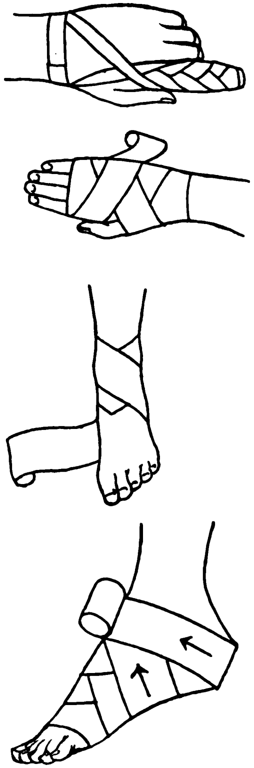


FIGS. 147 and 148. Showing a circular bandage and the method of reversing a bandage.

Preparation for accidents. 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 piece of clean soap; threaded needles, scissors, and safety pins; borated vaselin;[2] bichlorid or biniodid of mercury disks; a bottle of 5% alcoholic solution of iodin; and powdered boric acid. Accidents come without warning, and

[1] See pages 205, 295, and 305.

[2] Borated vaselin is made by mixing powdered boric acid with vaselin.



FIGS. 149, 150, 151, and 152. A reversed bandage and a figure-of-eight bandage on the hand; a figure-of-eight bandage and a reversed bandage on the foot.

having these supplies ready may save suffering or even life.

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 size 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 147 to 152. 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.

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 is free from dirt, it may be bandaged without any treatment at all, or bandaged after being dusted with powdered boric acid. A wound that has dirt in it 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. If inflammation sets in, however, the cloth should be removed every day and the wound either dusted with boric acid or treated with iodin.

Burns. If your clothing should take fire, *do not start to run.* Take the burning clothing off, if this can be done very quickly. If there is water near that you can get into, jump in. If a person cannot take the clothing off or get into water very quickly, some kind of heavy cloth or a mat should be wrapped around the burning clothes. A blanket or a coat is good for this purpose. Hold the blanket before the face and keep the mouth closed, so that the hot air will not go into the lungs; for to breathe in hot air is often fatal (causes death).

When nothing else can be done, the person should lie down and roll over and over. In any case, he should *lie down;* for if he stands up, the flames will come up around his head. He should lie down to prevent this. Rolling over will help to put out the fire.

The treatment of burns. After the fire is out, the clothing should be cut away from the parts of the skin that are burned. Moisten the clothing with water, if it sticks to the skin, and do not tear the skin. Wet long strips of cotton cloth in good coconut oil (old oil should not be used for this purpose), and cover the burnt places with the cloths. It is much better if a teaspoonful of carbolic acid and a teaspoonful of glycerin are mixed with a pint of the coconut oil before using. If you have no oil, put into water all the soda that will dissolve, and wet the cloths in this. When one has nothing else, the white of eggs or starch wet in water may be put on the burn. Anything that keeps out the air is good. If the person is weak, give him some ammonia (fifteen drops in one third of a glass of water) or alcohol in water. Cloths wet with cold water and laid on the burned skin will help soothe the pain.

If oil has been put on the burn, the cloths should be kept wet with oil. The cloths should also be sprinkled two or three times a day with water containing carbolic acid *in water* (one teaspoonful of the acid in a pint of water) to kill germs. Do not take the bandages off the wound unless germs get into it; but if the burnt part becomes red and swollen or has white matter in it, like the matter in a boil, the cloths must be taken off every day and the wound dusted with boric acid. The inflammation is caused by germs, and the wound cannot heal until the germs are killed. If large blisters rise, make little holes in the sides of them with a needle and let out the water, but do not break the skin over the blisters. If a burn is made by hot water or in any other way besides by fire, treat it in the same way. Where there is a large burn, a physician should be called.

Treatment for poisoning. When a person swallows poison, always make him vomit, unless the poison is an acid. Make the person drink a large amount of hot water, and if he does not vomit in fifteen minutes, give him more. Putting a feather or the finger far back into the throat will often cause vomiting. Give the person hot water, and then put something into his throat to make him vomit.

Acids. If an acid has been swallowed, give soda in water, chalk in water, or soap dissolved in water. Give warm water also. Oil or milk is also useful. For carbolic acid poisoning, alcohol (whisky or brandy will do) is useful.

Mercuric chlorid (also called bichlorid of mercury and corrosive sublimate). Give milk and the white of an egg, or both of these. Flour or starch mixed with milk and eggs is good.

Phosphorus. This is found on the ends of matches and is sometimes eaten by little children. Give hot water to cause vomiting. Give magnesia or chalk in water and the white of eggs. Do not give milk or oil.

Opium or laudanum. Give strong coffee and ammonia (fifteen drops in water) every fifteen minutes as long as the patient is sleepy. Make the patient walk out in the cool air, and do not let him sleep. Throw cold water on him, and strike him with wet towels to keep him awake.

Stramonium. Stramonium is the name of a poison found in the leaves and more abundantly in the seeds of datura (English, jimson-weed; Filipino, talamponai, cachubong). In case of poisoning with stramonium, treat the patient the same as for poisoning with opium.

Strychnin. A little chloroform or ether inhaled by the patient helps to keep him quiet. Give him a little ammonia (fifteen drops) in water, or camphor in water. Throw cold water over him, and give him five grains of bromid of sodium every half hour.

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.

Foreign bodies in the eye. If a particle of dust 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 will be found soothing and useful in preventing the growth of germs.

Preventing accidents. Accidents, like diseases, should be prevented. Drowning comes from the use of old boats, or from taking too great risks in deep water or during stormy weather. Most cases of poisoning result from placing disinfectants or acids among medicines. Falls come from steep stairways and broken ladders. Burns and fires are usually the consequence of carelessness with fire, and most wounds could be avoided by a little care.

A study of persons who caused accidents by reckless automobile driving showed that they were below the average in intelligence, so we should consider the taking of foolish risks not a mark of courage but rather an indication of a lack of sense. It is the intelligent person who has his boat in good condition before he goes to sea; who keeps poisons away from children and where they will not be mistaken for medicines; who avoids needless risks in working with animals and machinery; and who makes as safe as possible all the conditions under which he lives and works. Our brains are given to us in order that we may foresee and prevent that which otherwise might come to pass, and we should use our intelligence in the prevention of accidents as well as in the prevention of disease.

QUESTIONS

Show how to bandage different parts of the body. How should a clean wound be treated? a wound that has dirt in it?

What should a person do when his clothing takes fire? Explain how a burn should be treated.

What should be done when a person is poisoned? when a person faints? How may a foreign body be removed from the eye?

Were you ever in an accident? Could the accident have been prevented by care?

SUGGESTIONS TO THE TEACHER

The best way of teaching this chapter is to give practical demonstrations of what is to be done in case of each accident. Have the pupils bandage different parts of the body; pretend that a pupil has received a wound or a burn and dress it; and show what to do in case a person's clothing has taken fire, in a case of poisoning, or when a person faints. Where a physician cannot be called quickly, it is especially important that the pupils be trained how to act in case of accidents.

Count up with the class the different serious accidents that have happened in the last year in the community and decide in each case whether the accident was preventable.

Discuss means of preventing accidents and how the conditions under which the pupils live and work can be arranged so that it will be difficult for accidents to occur.

CHAPTER XXV

REALIZING HEALTH POSSIBILITIES

We have now finished our study of the human body and its needs. We have seen that in some parts of the world there is more sickness than there is in other parts of the world; that in a country like New Zealand, for example, the people have far better health than the people of the Philippines have. Why do people become ill? Would it be possible to have a country where every one was well? What can the Filipino people do to prevent the sickness from which they suffer? These problems we have already studied, and in this final chapter we shall review what we have learned.

Fig. 153. Louis Cornaro, an Italian nobleman who lived from 1464 to 1566. When 40 years of age he was told by his physicians that he would die, but he gave great attention to hygiene, regained his health, and lived to be over one hundred years old.

The causes of illness in plants. Sometimes a coconut tree becomes diseased. The bud in the top of the tree rots and the tree dies. Why does the tree become diseased? It is because a germ attacks it and causes it to become sick.

In the dry season many of the small plants in the Philippines gradually turn brown and wither in the sun. Why do they die? It is because they lack water. Their needs are not supplied and they must die.

But suppose you have a plant growing in the fertile soil, and that you water it and keep it free from germs. Will it become ill as we do when we have fevers, aches, and pains? Or will it flourish and grow and go through its life in vigor and health? *A plant will be healthy if its needs are supplied and it is free from germs.*

Health natural to the human body. Is the human body less perfect than a plant? Do we become sick because our bodies are poorly built machines? Or do we, like plants, suffer illness because we are attacked by germs or because the needs of our bodies are not supplied? Everything that we know about the body leads us to believe that it is a splendidly built machine, and that if it is properly cared for and kept free from germs it will remain in health. We may, therefore, think of health as the natural condition of the body, and we may hope that a time will come when people will live from birth to old age without sickness or pain.

The causes of illness in the Philippines. The diagram on page 417 shows the important causes of deaths in Manila in 1914. The great branch on the right shows the number of deaths that were caused by disease germs. The branch marked "Physiological Diseases" shows the deaths from diseases where there was something wrong with the body itself, — diseases like beriberi, where the food does not supply what the body needs, or other diseases that we do not yet understand. The lower branch on the left side of the tree represents deaths not caused by disease, — deaths due to old age, accidents where the body was injured from without, or deaths of young infants that did not receive proper

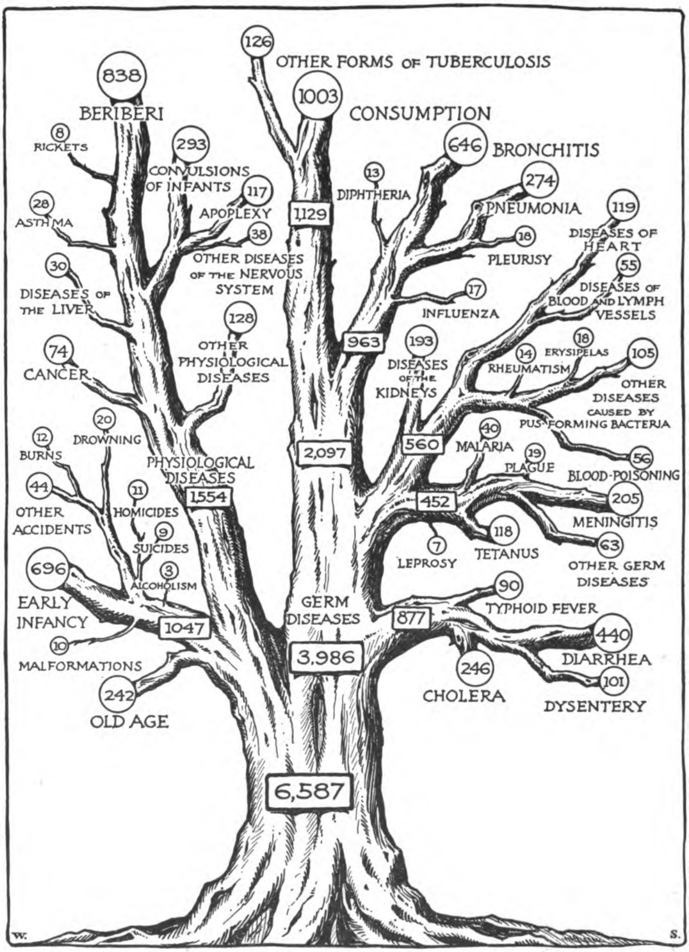


FIG. 154. A diagram showing the number of deaths in Manila from the most important causes in 1914.

care or that failed to get a proper start in life. Generally speaking, the same diseases that are found in Manila prevail in other parts of the Philippines, and if you multiply the numbers on this tree by 30, you will have the approximate number of deaths from the causes here shown in all the Philippines. It must be remembered, however, that most epidemic diseases, such as cholera and plague, appear only at certain times and places; that some regions are entirely free from malaria, while in others one half of all deaths are due to this one disease; and that in some respects the health problems of different communities are certain to be different.

It should be understood also that the importance of a disease is not always shown by the number of deaths that it causes; for a case of a long, lingering disease like consumption is much more expensive than a short attack of typhoid fever or pneumonia; a disease that carries off men and women in their working years costs a country more than one that takes infants and aged persons; and diseases like malaria, hookworm, and rheumatism, that keep thousands of people who do not die of them ill and weak for long periods of time, may be more important than other diseases that are causing a greater number of deaths. We must take account of all these things when we consider which diseases it is most important for us to fight, but from the tree on page 417 we can get a general idea of the health problem of the Philippines as a whole.

Preventing illness in the Philippines. What can the Filipino people do to prevent the illness that is among them? They can, in general, care for their bodies, and they can make a special fight against sickness in the following ways:

1. *By making their towns and homes sanitary, so that it will be difficult for germs to pass from one person to another.* Safe water supplies, safe methods of disposing of human wastes, and sanitary markets must be provided before germ diseases in the Philippines can be controlled.

2. *By employing skilled health officers to prevent the spread of germs.* A great man does not try to know everything; he does not try to do everything himself. He uses the knowledge and the skill of other men in his work, and in this way he carries through great tasks that no man could do by himself. In the same way, a progressive nation uses skilled men when it has a great work to do, and the Filipino people should use the best men they can find to free them from infectious diseases. They should say to these men: "We do not want to die of cholera; we do not want commerce to be interfered with by plague; we want you to stop the typhoid fever and dysentery that are among us; we are weak and ill from malaria, and we want you to rid us of the mosquitoes that keep us infected with this disease. Tell us what you need for your work and we will give it to you and help you in every way with your work. But free us of all this sickness; for it keeps us poor and prevents our enjoying life."

Each province and each town in the Philippines ought to find a health officer and say this to him; and then if he does not protect the people from the diseases that we know how to prevent, they should discharge him and get a man who will do so. Work out some of the problems on pages 425 and 426, and you will understand why the Filipino people can afford to spend large sums of money for health work.

3. *By employing skilled physicians.* There are certain slow diseases like malaria, hookworm disease, bronchitis, and rheumatism that a skilled physician can do much to cure. The Filipino people need to stop buying patent medicines and trying to treat themselves for these diseases. They should have the best physicians that they can reach treat them when they are ill, and they should not feel too poor to afford this; for time is money, and any person who can be cured of his sickness so that he can work, can earn the money to pay the physician who restored him to health. Sensible men use the skill and knowledge of others to help them, and the Filipinos must follow this plan in the treatment of their diseases.

4. *By providing a better food supply.* The great branch marked "beriberi" on the tree on page 417 is a direct result of poor food, and many of the deaths from germ diseases would be avoided if the body were built up so that it could resist its small enemies. It is poor economy to try to run an automobile on unclean, impure gasoline, and it is poor economy to try to run the human machine without good food.

5. *By preventing overcrowding in the homes.* When the Panama Canal was building, the laborers at first lived in large barracks and many of them ate together. Pneumonia became so common among them that they

were separated and made to live in small houses. At once the number of cases of pneumonia was greatly reduced. The managers of the diamond mines in South Africa had exactly the same experience with their workmen. When they were kept crowded together, they suffered greatly with a very dangerous form of pneumonia, but when they lived in small houses apart from each other, the epidemic ceased.

All our experiences show that it is very dangerous for many people to be crowded together in one building, because if any person in the group gets a disease, all the others get the germs from him. It is not wise, therefore, for many persons to live together in one house or for a whole family to be crowded together in one or two rooms. Each family should have its own house, and this house should be large enough for the family not to be crowded in it. It is likewise important that houses be not placed too close together, and no more people should be admitted to schools, churches, theaters, and motion-picture exhibitions than can be comfortably cared for. When animals live alone they retain their health, but when they are kept in herds they suffer from disease. Man is like other animals in this respect.

6. *By employing skilled scientists to gather information about the diseases that are among them.* In the temperate zones great numbers of scientists spend all their time investigating the diseases that are found in those regions and finding out how those diseases can be prevented. There are few such workers in tropical countries, and more information in regard to tropical diseases

is needed before we can know the best way of controlling them. As a result of the investigations of the Bureau of Science in Manila, thousands of lives are already being saved each year in the Philippines, and the Filipino people ought to give this Bureau their heartiest support. In sanitation, as in other affairs of life, "knowledge is power," and if the most advanced countries in the world find it profitable to spend millions of pesos each year in investigating the diseases that trouble them, a country like the Philippines, that has many unsolved sanitary problems, can profitably employ experts to find out the best ways of keeping its people in health.

7. *By educating the people in regard to matters of health.* This is necessary, because ignorant people have not the intelligence either to care for their own health or to employ health officers and physicians to save them from disease. A country that spreads a knowledge of hygiene and sanitation among its people will in the end free itself from disease, and a teacher of hygiene is a true patriot who is helping to bring health to his land.

The future population of the Philippines. From the Batanes Islands on the north to the Sulu Archipelago on the south, the Philippine Islands stretch along the eastern border of the China Sea. This great chain of islands is blessed with a rich rainfall and a fertile soil. Great forests cover its mountains and a hundred rivers find their way through its rich valleys to the sea. If it were as densely inhabited as Java, it would have a population of 75,000,000 people; but we find it a sparsely settled region, with not more than one tenth of the people that it might support.

Why are there so few Filipinos? Why do they not multiply until they fill their land? It is because many different diseases are constantly sweeping them away. When these diseases are controlled, the Filipinos will become a great people and their country one of the most productive parts of the earth.

QUESTIONS

What causes illness in plants? Is health or illness the natural condition of the human body? What are the two great classes of diseases? Name the most important disease of each class in the Philippines. Why may some diseases that cause only a few deaths be more important than other diseases that cause more deaths?

How does making towns and homes sanitary prevent sickness? How can the Filipino people use health officers to prevent disease? How can physicians prevent illness? How does a poor food supply favor sickness? How can a better food supply be provided in the Philippines? Why should people not be crowded in houses? Why should a people employ skilled scientists to investigate its health problems? Why should people be educated in matters of health?

What is the population of the Philippines? What population would the Philippines have if they were as densely populated as Java? What prevents the Philippines from having a large population?

SUGGESTIONS TO THE TEACHER

If possible, arrange the work so that there will be time for a general review of the whole book. In the review emphasize especially the sanitary and hygienic aspects of the subject.

REVIEW QUESTIONS

Chapter XXII. Why do we become ill? Why are drugs dangerous? Give some figures which prove that alcohol shortens life. How can you prove that tobacco contains a poison? What effect have coal-tar drugs on the nervous system? on the heart? What is the purpose of pain? What claims are made for patent medicines? What drugs do these medicines usually contain? What effect have they on disease? What is the best course to follow in respect to drugs?

Chapter XXIII. What are some of the good effects of exercise on the body? What is the best way to take exercise? What effect has too much exercise on a muscle? What muscle in the body is especially likely to be overworked?

Chapter XXIV. What articles should be kept in the "accident box"? How should a wound be treated? a burn? What should a person do if his clothing takes fire? In general, what should be done in case of poisoning? What should be done in case of fainting? How are most accidents caused? How may they be prevented?

Chapter XXV. Why does a plant become sick? What are the two general causes of most of the sickness from which people suffer? What two classes of disease are found in the Philippines? What are some of the most important diseases of each class? In what ways may the Filipino people decrease the amount of sickness among them?

APPENDIX

PROBLEMS

1. A man began work at twenty years of age and worked until he was sixty years of age. During that time he earned on an average ₱200 a year, and the cost of his living was ₱100 a year. During the forty years that he worked, how much more did he earn than was necessary for his own support? If he had died at 20 years of age, how many pesos would have been lost?

2. A farmer and his wife had a son and a daughter. They bought food for them, clothed them, and sent them to school, and by the time the children were eighteen years old, they had cost their parents ₱500 each. Suppose that at eighteen the son had died of dysentery and the daughter of typhoid fever. How much money would the parents have lost?

3. Suppose that on an average there are 500,000 persons in the Philippines sick each day, and that when they are well each of them can earn, on an average, a peseta a day. What is the value of the time lost each day in the Philippines on account of sickness?

4. Counting 300 working days to the year, what is the value of the time lost in a year?

5. If the other costs of sickness (caring for the sick, burying the dead, and the loss of valuable members of society) are as great as the value of the time lost by those who are sick, what is the total cost of illness to the Filipinos each year?

6. If there are 8,000,000 inhabitants in the Philippines, what is the average loss for each person in a year from sickness?

7. If there are on an average five persons in a Filipino family, what is the average loss of each family from sickness in a year?

8. In 1913 the Philippine Bureau of Health spent about ₱300,000 in fighting disease. What per cent is this sum of the total loss caused by illness in the Philippines each year?

9. There are 40,000 deaths in the Philippines from tuberculosis each year, and on an average a consumptive is sick about three years. If the lives lost through this disease are worth ₱1000 each, and the cost of caring for a patient is ₱100 a year, what is the annual cost of the disease in the Philippines?

10. It is estimated that there are 210,000 children born in the Philippines each year and that only one third of them live to the age of five years. How many children under five years of age die in the Philippines in ten years?

11. If there are 30 times as many deaths in the Philippines as there are in Manila (page 417), how many persons die in the Archipelago each year?

12. By extending the work of health officials and physicians it would be possible to prevent at least one half of these deaths. How many lives would be saved in the Philippines each year if this were done?

13. If the death rate in the Philippines were reduced to a reasonable rate, the population should double in 25 years. If this should happen, how many inhabitants would there be in the islands at the end of 100 years?

14. A workman who was suffering from beriberi was able to earn only 50 centavos a day. By expending 10 centavos more each day for food he regained his health and was able to earn ₱1.00 a day. Counting 300 working days to the year, how much more money would he earn in five years?

15. A city with a population of 30,000 had one half its inhabitants infected with malaria. If the earning power of each citizen is a peseta a day, what was the daily loss to the city if the earning power of those suffering from the disease was reduced one half? How much would the city lose in a year?

16. Suppose that by the expenditure of ₱3000 a year the breeding of the malaria-carrying mosquitoes in the town could be prevented. How much would be gained by carrying out the work?

17. If the loss from sickness in your province is the same for each person (see problem 6) as it is in the Philippines as a whole, how much does the province lose each year through sickness?

18. Figuring on the same basis, how much does your town or city lose each year from sickness?

19. In some Philippine towns the introduction of artesian water reduced the amount of sickness one half and prevented one half the deaths that occurred when impure water was used. How much could your town afford to spend each year for a pure water supply if in this way one half its present losses from illness and death could be prevented?

GLOSSARY

abdomen (ab-dō'men)
abdominal (ab-dŏm'i-nal)
acetanilid (ăs-ĕt-ăn'ĭ-lid)
adenoid (ăd'en-oid)
alimentary (ăl-ĭ-mĕn'ta-ry)
Anopheles (a-nŏf'ĕ-lēz)
ameba (a-mē'ba)
antipyrin (ăn-tĭ-pī'rin)
aorta (ā-or'ta)
appendicitis (ap-pen-dĭ-sī'tis)
aqueous (ă'qwē-ŭs)
arbor vitæ (ar'bor vī'tē)
artery (ar'ter-y)
auricle (o'ri-cl)
bacillus (ba-sĭl'lŭs)
bacillary (bă'sĭl-la-ry)
biceps (bī'seps)
bichlorid (bī-klō'rid)
bicuspid (bī-kŭs'pid)
biniodid (bī-nī'ō-did)
boracic (bō-răs'ik)
bronchitis (brong-kī'tis)
bronchus, bronchi (brong'kus, brong'kī)
canine (ka-nīn')
capillary (kăp'il-lā-ry)
carbolic (kar-bŏl'ik)
cartilage (kar'tĭl-ĕj)
cerebellum (sĕr-ĕ-bĕl'um)
cerebrum (ser'ĕ-brum)
choroid (kō'roid)
cilia, cilium (sĭl'i-a, sĭl'i-um)
clavicle (klăv'i-cl)
coccyx (kŏk'six)
cochlea (kŏk'le-a)
cornea (kor'ne-a)
corpuscle (kor'pusl)
cranium (krā'ni-um)
diaphragm (dī'a-fram)
diarrhea (dī-a-rē'a)
diphtheria (dif-thē'ri-a)
dioxid (dī-ox'id)
dysentery (dĭs'en-ter-y)
epidermis (ĕp-ĭ derm'is)
epiglottis (ĕp-ĭ-glot'tis)
erysipelas (ĕr-ĭ-sĭp'e-las)
esophagus (ē-sŏf'a-gŭs)
Eustachian (yu-stăk'ke-an)
femur (fē'mur)
fibula (fi'byu-la)
germ (jerm)
humerus (hyu'me-rus)
hydrogen (hī'drō-jĕn)
hygiene (hī'jēn)
hygienic (hī-je-ĕn'ik)
incisor (in-sī'sor)
incus (in'kus)
influenza (in-flu-en'za)
intestine (in-tĕs'tin)
iris (ī'ris)
lachrymal (lăk'ri-mal)
larynx (lăr'ĭnks)
laudanum (law'da-num)
ligament (lig'a-ment)
lymphatic (lim-făt'ik)
malleus (mal'e-us)
measles (mēz'lz)
medulla oblongata (med-ŭl'la ŏb-lon-gah'ta)
mercuric (mer-kyur'ik)
metatarsal (me-ta-tars'al)
molecule (mŏ'le-kyul)
muscle (mŭ'sl)
nitrogen (nī'trō-jen)
olfactory (ŏl-fak'to-ry)
oxygen (ŏx'ĭ-jĕn)

pancreas (păn'kre-as)
pancreatic (pan-kre-ăt'ic)
papilla (pap-il'la)
patella (pat-el'la)
pellagra (pĕ-lăg'ra *or* pĕ-lah'gra)
periosteum (pĕ-ri-ŏs'te-um)
phalanges (fa-lăn'jēz)
phenacetin (fĕ-năs'e-tin)
phosphorus (fŏs'fo-rus)
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