CANADIAN HEALTH SERIES

PHYSIOLOGY AND HYGIENE

THE EDUCATIONAL BOOK CO., LIMITED
TORONTO

Junior Red Cross

Rules of the HEALTH GAME

1. Wash the hands before touching food, and after using the toilet.
2. Keep the finger-nails clean.
3. Brush the teeth every night and every morning.
4. Take a warm bath at least once a week.
5. Use a handkerchief over the mouth when coughing or sneezing.
6. Do not spit.
7. Keep fingers, pencils, pens, erasers, and rulers away from mouth and nose.
8. Hold the body straight while sitting and standing.
9. Drink plenty of water every day, but no tea or coffee.
10. Eat plenty of vegetables and fresh fruit every day, but not much meat.
11. Play out-of-doors every day.
12. Sleep with the windows open. Be in bed at least ten hours every night.

CANADIAN HEALTH SERIES

PHYSIOLOGY AND HYGIENE FOR PUBLIC SCHOOLS

BY

JOHN W. RITCHIE

AND

JOSEPH S. CALDWELL

AUTHORIZED BY THE MINISTER OF EDUCATION
FOR USE IN THE PUBLIC SCHOOLS OF ALBERTA

TORONTO
THE EDUCATIONAL BOOK COMPANY, LIMITED
1927
4

CONTENTS

PHYSIOLOGY AND HYGIENE

CHAPTER I

THE HUMAN BODY AND THE GREAT LAWS OF HEALTH

Have you ever watched a little plant push its way out of a seed, thrust its roots downward into the earth, and unfold its leaves to the light? And have you seen such a plant grow larger day by day, until finally it blossomed and bore seeds like the parent seed from which it grew?

If you could examine a small portion of a leaf or other living part of a plant under a microscope, you would find that it is composed of little parts built together, as stones are built together to make a wall. The little parts of which the plant is built are called *cells*. Each cell is composed of a half-liquid living material, which is inclosed by a cell wall. In the centre of the living matter is a denser portion, which is called the *nucleus*. All the living parts of a plant are composed of cells.

The human body, like the body of a plant, is made up of cells. Each of the four hundred thousand million cells that are estimated to be in the human body is alive; each must have food and oxygen and all the things that the body as a whole needs; the life of the body is the sum of the life of all its cells. When we study how to keep the body in health, therefore, we are only studying how to keep the cells in health; for health means that the cells are in good condition, and sickness means that there is trouble among the delicate little parts of which the body is built.

The parts of the human body.—The human body is composed of a head, a trunk, and two pairs of limbs. It is supported by a strong framework of bones on which the whole body is built. The muscles to move this framework of bones are stretched over it in strong bands, and the skin forms a tough covering over the whole body.

The organs of the body.—The bones and muscles form a thick wall about a large cavity in the trunk of the body. In this cavity are found many of the organs that do the work of the body. In the upper part of the cavity we find the heart and lungs. In its lower part are the stomach, the intestines, the liver, the kidneys, and some other organs. In Figure 1 the organs are shown as they lie in place in the cavity of the trunk.

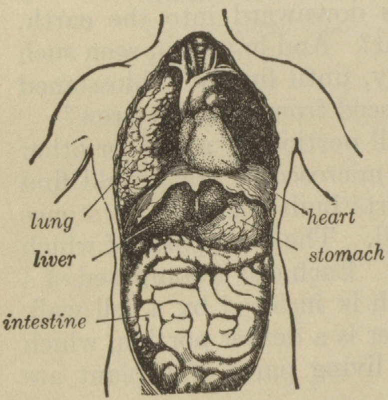


Fig. 1. The principal organs of the body. The left lung has been removed and the edge of the right lung turned back to show the heart and blood vessels more clearly.

The uses of the organs.—Each part of the body has a work to do. The bones give shape and strength to every part. Without them we should be as limp and shapeless as bags of sand. The muscles move all the body parts, and without the muscles we should be as motionless as trees or stones. The stomach and intestines receive food and prepare it for use; the heart keeps the blood moving through the body; and the lungs take in oxygen from the air. The hand has a work that the foot cannot do, and the eye has a work that the tongue cannot do. In the same way, each part of the body has a work of its own that can be done by no other part.

The great laws of health.—If we hope to have strong, healthy bodies, we must not only understand the importance of keeping the laws of health, but also we must know what these laws are and how we can keep them. The following are the great laws of health that we should understand and observe:

1. The body must have a proper supply of food.
2. It must have an abundance of fresh air.
3. It must get rid of its poisonous wastes.
4. It must be sheltered from the weather so that it will not be too hot or too cold.
5. It must have exercise, rest, and sleep.
6. It must be kept free from pain.
7. The mind must be cheerful, and not disturbed by constant fretting, anxiety, or care.
8. Disease germs must not be allowed to get into the body and poison it.

Every one of these laws must be followed, if we are to keep our health and our strength; for, as a lily in the garden flourishes when it has a fertile soil and other favorable conditions, so will your body have strength and vigor if its needs are satisfied and it is allowed to live in accordance with the laws of health. And as surely as the lily wilts when its food or its supply of water fails, so surely must your body be injured if you break the great laws of its life. In later chapters of this book we shall discuss each of these laws and point out how each may best be followed.

CHAPTER II

THE FRAMEWORK OF THE BODY

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

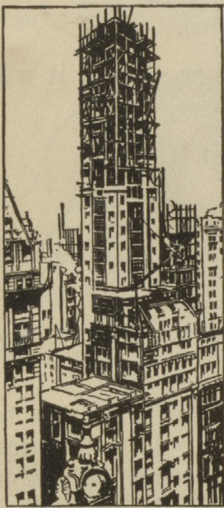


Fig. 2. The weight of the building is carried by the steel framework.

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

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

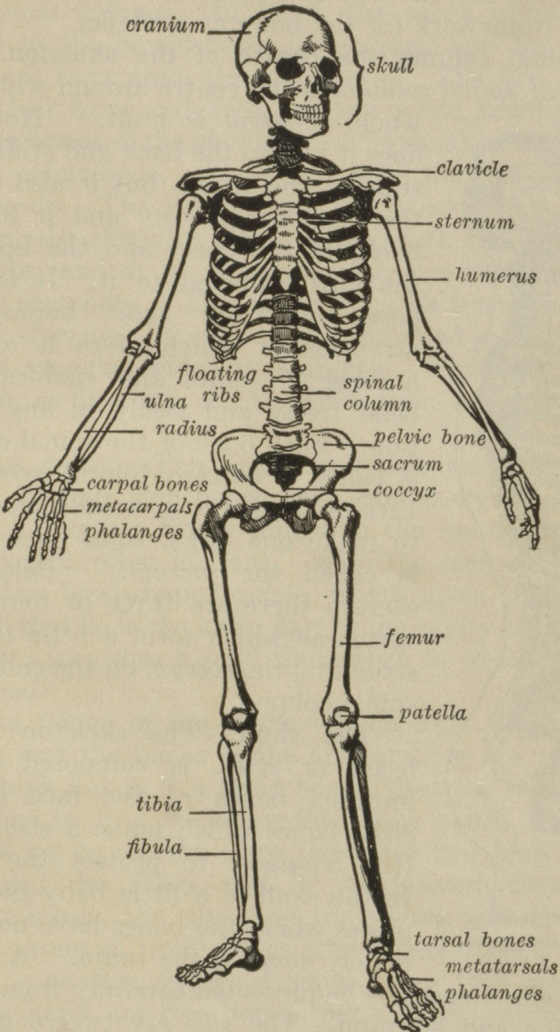


Fig. 3. The skeleton.

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

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

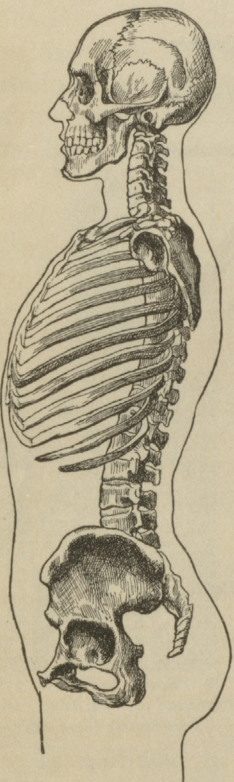


Fig. 4. The skeleton of the head and trunk.

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

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

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

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

The bones of the limbs.—Each limb has in it thirty bones, and the bones of the arm and leg are very similar. The thigh has in it a great bone called the *femur*, and the arm has in it a corresponding bone called the *humerus.* In the leg below the knee there are two long bones, the *tibia* and the *fibula*, and in the forearm there are two similar bones, the *ulna* and the *radius.* In the wrist we find a group of small bones (the *carpal* bones), and in the ankle is another group of small bones (the *tarsal* bones). In the hand are five bones (*metacarpals*), each bearing a finger, and in the foot are five bones (*metatarsals*), each bearing a toe. Finally, the fingers of each hand have in them fourteen bones (*phalanges*), and the toes have the same number of bones arranged in the same way. The arms and legs are built on the same general plan, but the wrist has one more bone than the ankle, and the elbow has no bone corresponding to the kneecap (*patella*) on the front of the knee.

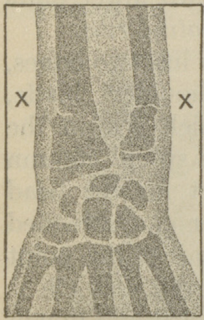
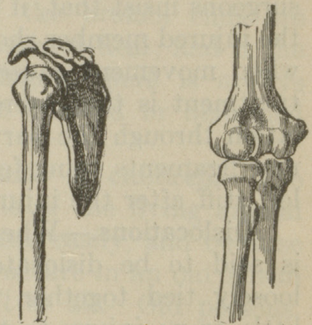


Fig. 5. From an X-ray photograph of a broken forearm and a wrist. The crosses show where the bones are broken.

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

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

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



Figs. 6 and 7. On the left is shown the shoulder joint, an example of a ball-and-socket joint. On the right is the elbow joint, an example of a hinge joint.

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

The treatment of sprains.—When a joint is bent too far, the ligaments about it are either torn loose from the bones or broken. An injury of this kind is called a *sprain*. It most commonly occurs at the wrist or the ankle, and the swelling which accompanies it is due to bleeding from the torn blood vessel of the ligament affected.

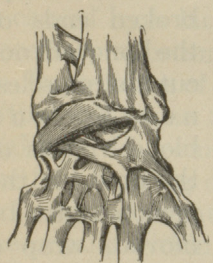


Fig 8. The ligaments of the wrist.

In all cases the first treatment is the same. To prevent the swelling, pain, and tension and to arrest bleeding, elevate the part and apply ice or cold water. Then apply a snug bandage and place the joint at rest in the most comfortable position. After the acute stage has passed and the swelling has gone down, hot compresses may be applied and the part gently massaged toward the body. At this stage some movement of the part should be begun to avoid stiffness.

There is a widespread idea that a sprained joint heals most rapidly when it is given complete rest, but many surgeons insist that, if the joint can be properly supported, the injured member should be used as soon as possible, even when movement causes pain. The reason given for this treatment is that exercise helps to keep up a good circulation through the part and also lessens the danger of the new ligaments being formed so short that the joint will be left stiff after the injured tissues have healed.

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

Broken bones.—When an arm or a leg is broken, it should be kept stretched out straight, so that the sharp, broken ends of the bone will not cut the muscles, nerves, and blood vessels of the limb. If the person must be moved, wrap a pillow, coat, or blanket about the injured member, using sticks or something else stiff enough to keep it from bending, as shown in Figure 9. An injured person may be carried in a blanket, but a door, a cot, or other solid support is better. In lifting the person, take the greatest care to keep the injured limb from bending sharply at the break.

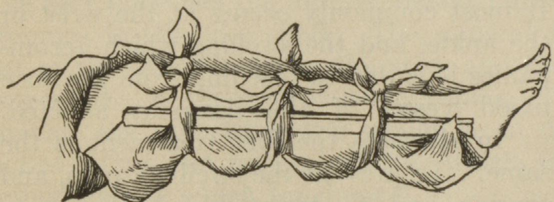


Fig. 9. A broken limb bandaged for moving the patient.

The two parts of a fractured bone are cemented solidly together by a jelly-like, white substance which appears on the broken ends and hardens. If the broken ends are not brought together, the fracture cannot heal; and if the injured part is not properly bandaged, there is always great danger that the bone will be crooked or deformed after it has healed.

The skeletons of old persons and of children.—The bones of old persons have very little of the living animal matter in them. They therefore break easily, and because they contain little living matter, a fracture in an old person heals very slowly or refuses to heal at all. Old persons, therefore, should be saved as much as possible from climbing stairs and from doing other things that may cause them to fall.

In little children, on the other hand, there is a small quantity of the mineral matter in the skeleton, and the bones can easily be bent into almost any shape. During the growing years, large amounts of lime are needed for building and hardening the skeleton, and in most cases of defects and deformities of the skeleton, the real trouble is caused by a lack of proper building materials or of other necessary substances in the food.

Importance of caring for the skeleton in youth.—Heavy lifting will cause the shoulders of a child to droop forward, making him round-shouldered; making children sit with the feet hanging over the edge of a seat will cause the legs to be bowed; tight clothing may bend in the ribs and cramp the organs within the body; habitually sitting or standing in a stooped position will cause the skeleton to harden in an incorrect shape; and many persons have the face and head slightly one-sided because when they were babies they were allowed to lie on one side more than on the other. The skeleton should have special care in youth; for, after the bones have hardened, it is difficult to change their shape.

CHAPTER III

THE MUSCLES AND THE CARRIAGE OF THE BODY

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

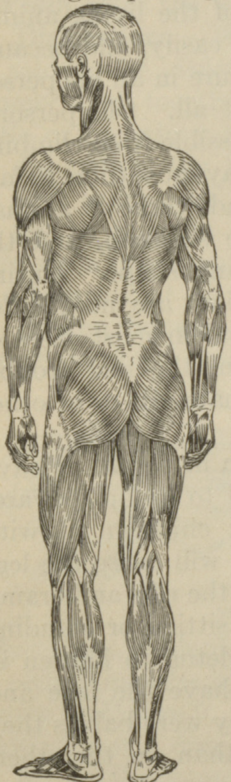


Fig. 10. The muscles.

You can lift your arms; you can extend your legs; you can move your whole body from place to place. Something must be pushing or pulling the different parts of the body to cause these movements. What is it that does this work? It is the muscles that are stretched upon the framework of the body. There are more than five hundred of these muscles, and they make up two-fifths of the body weight.

You are familiar with the lean meat in the body of an animal, and as this is muscle, you already know something of the appearance and texture of this "master tissue" of the body.

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

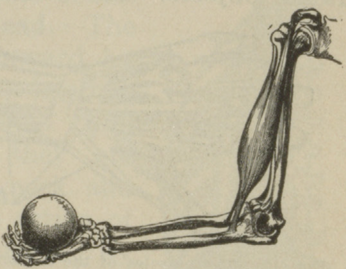


Fig 11. Showing how the muscles of the arm lift the forearm.

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

How the muscles move the different parts of the body. The muscles stretch across the joints of the skeleton, and when a muscle contracts, it pulls the bones together and causes a bending at the joint. Exactly how this is done you can best understand by a study of Figure 11.

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

How the muscles move the body as a whole.—You cannot stand on a ladder and pull the ladder up after you. You cannot sit on a chair and lift it. Yet you can move your whole body by muscles that are a part of your body. This is possible because you have a jointed skeleton that allows you to thrust out parts of the body and push against outside objects. How this is done you can best under-

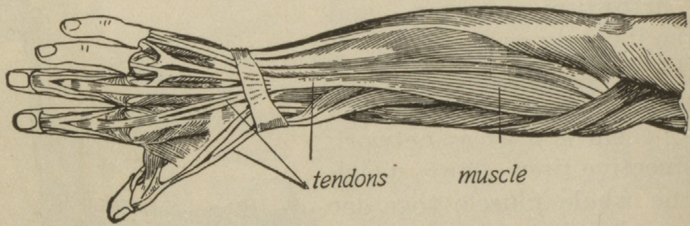


Fig. 12. The muscles of the forearm and the tendons that move the fingers.

stand through an experiment. Stand close to the wall, place your hands against the wall, and straighten out your arms. This pushes you away from the wall and moves your whole body.

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

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

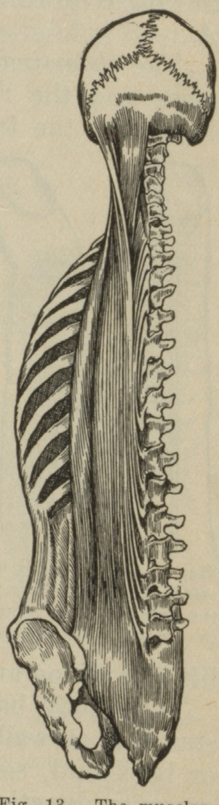


Fig. 13. The muscles that lie along the back of the spinal column.

Muscles that support the head.—The head is held from drooping forward by muscles which rise from the vertebrae of the trunk, from the ribs, and from the bones of the shoulder; they are attached to the bones of the neck and to the back of the skull. The action of these muscles can be illustrated by attaching a string to the first joint of the finger, as is shown in Figure 14. Other muscles on the front of the neck keep the head from being drawn too far backward.

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

The muscles along the back of the spinal column rise from the sacrum and pelvic bones and run up the back as high as the base of the neck (Fig. 13). Their function is to keep the trunk from falling forward. Their action may be illustrated by attaching a cord to the finger and drawing it down the back of the hand, as is shown in Figure 14.

The *abdominal muscles* are stretched between the pelvic bones and the ribs and sternum. When they contract, they draw the trunk forward and cause it to stoop, and they keep the body from being drawn over backward by the muscles of the back. By examining Figures 3 and 4, you will see how these muscles are attached, and you will readily understand how they work in opposition to the muscles of the back.

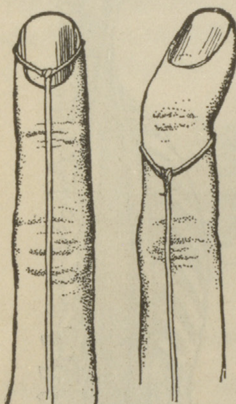


Fig. 14. Illustrating the attachment and action of the muscles that support the head and trunk.

The pull of the muscles along the back causes a forward curve in the spinal column at the waist. The spinal column is therefore supported in front in this region by strong muscles that brace it against the back muscles and keep it from bending too far forward. The lower ends of these muscles are attached to the femurs, which they lift in walking and running (Fig. 15).

The body balanced over the feet in standing.—If, in standing or walking, part of the body is too far forward or backward, some other part must be thrust out in the opposite direction to keep the balance over the feet. If the head droops forward, the spinal column between the shoulders will sink backward in a balancing curve. The same effect is produced by the shoulders falling forward so that the weight of the arms pulls forward instead of downward at the sides. If the back bends inward at the waist, thrusting the abdomen forward, the upper part of the body will be bent backward, throwing the chest up in front. Each part must be held in correct position, for one part out of position is sure to force other parts out of position also. The following rules may be helpful in keeping the body in correct position in standing and walking:

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

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

Hold the chin close to the neck.

Press the back of the neck against the collar button.

Keep the abdomen in.

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

In walking turn the toes in.

Health and vigor are most important in acquiring a correct carriage, for if the muscles that hold the body upright lie weak and slack on the skeleton, they must all the time be forced to do the work that they ought to do naturally and without effort.

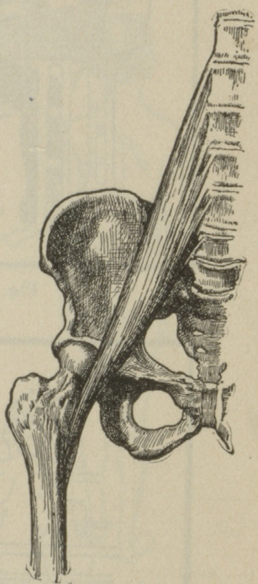


Fig. 15. View from the front of one of the muscles that keep the spinal column from bending too far forward at the waist.

The importance of holding the body erect in youth.—The bones of a little child are easily bent, and by beginning in time they may be made to take almost any form, without causing much pain to the child. As a person grows older, the bones harden, and it is then impossible to change their shape. If you want to have a straight, beautiful body,

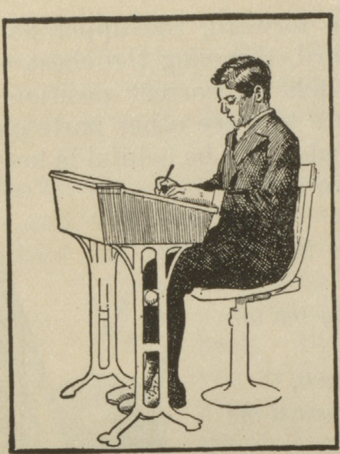


Fig. 16

Fig. 17

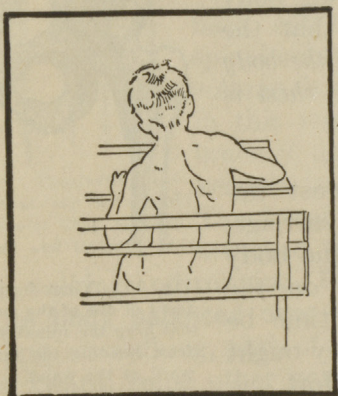


Fig. 18

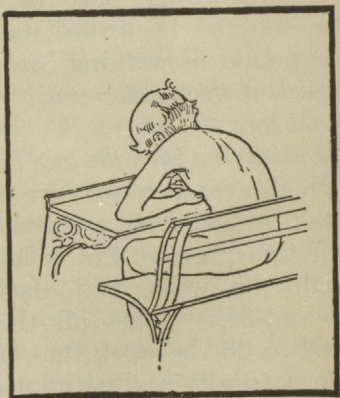
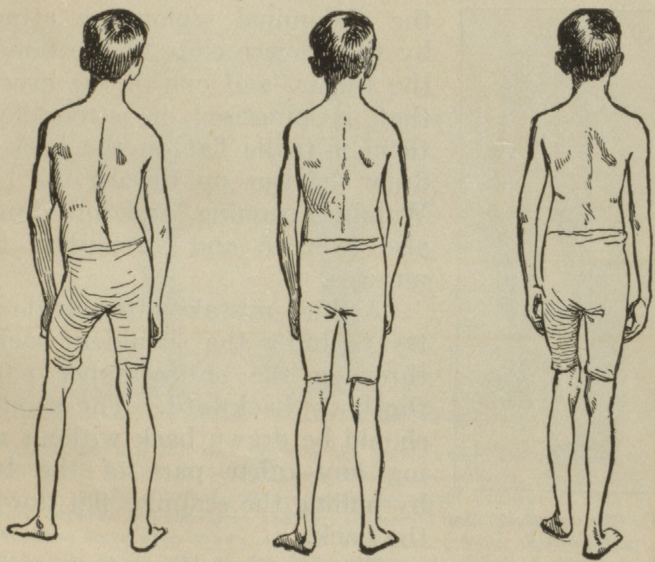


Fig. 19

In Figure 16 the seat and desk are of such a height that the feet rest squarely on the floor, the body is held easily erect, and the shoulders are even. In Figure 17 the desk is too high and too far away from the seat. In Figure 18 the desk is too high, causing lateral curvature of the spine and uneven height of the shoulders. Figure 19 shows the bending over caused by too low a desk. (*After Shaw.*)

you cannot put off beginning to hold yourself erect. The grown man or woman whose bones have hardened in a stooped position can never straighten up, but must go through life with cramped heart and lungs. "Stand up and be a man!"



Figs. 20, 21, and 22. Standing in the first position and throwing all the weight of the body on one leg twists the spinal column. Standing with the feet even, or with one foot only slightly in advance of the other, keeps the spinal column straight. (*After Mosher.*)

Mistakes made in trying to secure an erect carriage. When the head droops forward, the mistake is often made of trying to bring it to an upright position by pulling the shoulders back. The true remedy is to tighten the muscles along the back of the neck and bring to an upright position the upper part of the spinal column.

Another mistake commonly made is to throw the head and chest back, and at the same time allow the back to be bent in at the waist and the abdomen to be thrust forward. In this case, again, the remedy is to straighten the curve in the spinal column. The muscles that lie along the front of the spinal column in the abdominal region are attached by their lower ends to the bones of the thighs, and one of the exercises that is practised in strengthening them is to lie flat on the back and draw the legs up toward the body. Walking, running, and hill climbing also exercise and strengthen these muscles.

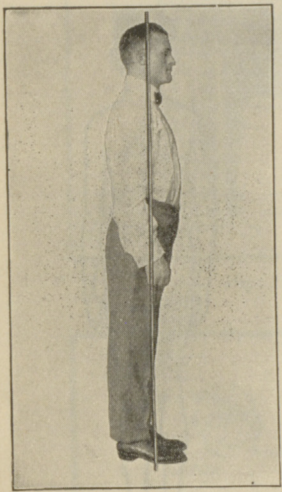


Fig. 23. The vertical line posture test.

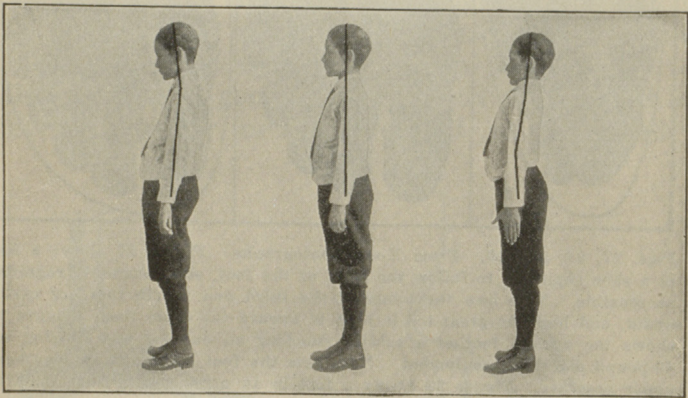
A third mistake often made is to try to bring the shoulders back by throwing the entire upper part of the body backward. The shoulders should be drawn back without moving any other part of the body, by pulling the scapulas flat down on the back.

The vertical line test of posture.—One test of posture that is in use in many schools is called the vertical line test. If a vertical line is dropped from in front of the ear to the forward part of the foot,[1] the long axis of the head, neck, and trunk will, in correct standing position, be parallel to it (Fig. 23). If the position is incorrect, the line through the axis of the body will be zigzag and not a

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

straight vertical line. The test can be made by holding a pole in the upright position, as is shown in Figure 23. The vertical line should pass just in front of the knee and in front of the shoulder.

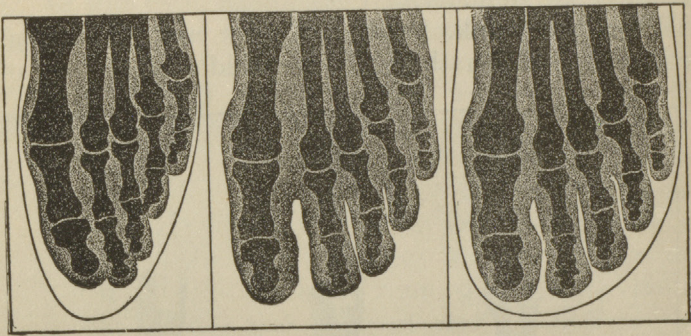
When the trunk, head, and neck are held upright, a vertical line drawn through the middle of the tip of the



Figs. 24, 25, and 26. The figure in the centre shows correct posture; the head, neck, and trunk form one continuous vertical line. On the left, the head is too far forward, which causes the spinal column to bend backward between the shoulders and forward at the waist. On the right, the shoulders have been drawn up, the back bent inward at the waist, and the whole upper part of the body thrown too far backward. In the figures on the left and right the head, neck, and trunk form a zigzag line.

shoulder should pass through the ear or behind the ear. If this line passes in front of the ear, the shoulder is too far forward.

The structure of the foot.—The skeleton of the foot is composed of 26 bones which are held together by muscles and ligaments. Lengthways from the heel to the ball of the foot, the bones are built together in the form of an arch. There is also a cross arch in the foot behind the toes, similar to the arch in the knuckles of a closed hand. In walking, the foot is moved by tendons that run down along the ankle from the muscles below the knee and are attached to the bones of the foot. The foot is also



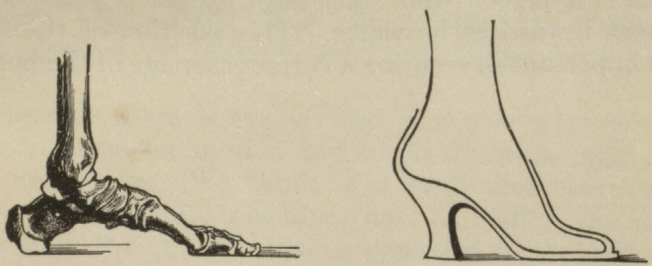
Figs. 27, 28, and 29. From X-ray photographs. Figure 27 shows a foot in a shoe supposed to follow the lines of the foot, and commonly regarded as sensible. Note how the bones of the third and fourth toes are curled under, and how the great toe is bent in toward the other toes. Figure 28 shows the unshod foot of a soldier standing on one leg and bearing his 40-pound marching equipment. Note how the foot expands and lengthens under pressure. Figure 29 shows a foot in an army shoe. Note the free play of the toes.

to a considerable extent supported and held from tipping over sideways by the pull of these tendons from the muscles of the leg.

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

A high-heeled shoe props the arch of the foot up on end, instead of allowing it to stand in its natural position. Shoes with heels that slant forward move the back point of support from the heel toward the middle of the foot and make walking very insecure and difficult. Shoes with pointed toes bend the great toe outward and interfere with the inner front point of support, causing the wearer to turn the toes out and tending to cause the arch of the foot to be turned over on its inner edge.[1] Tight shoes interfere with the outer point of support of the foot by keeping the bones back of the toes from springing down and spreading apart in a natural manner and thus throwing part of the weight on the outside of the foot. All this causes tired and painful feet, and makes walking difficult and fatiguing.

The points of a good shoe.—A good shoe should have a wide, low heel, or for a natural foot, no heel at all. It



Figs. 30 and 31. Showing the arch of the foot, and how a high-heeled shoe props it up on end.

should be straight along the inside, so that it will not bend the great toe around toward the other toes. It should be long enough not to cramp the toes, and it should have a box in it high enough not to press on the toes and cause corns and ingrowing nails. The sole should be flat across, only slightly turned up at the toe, and wide enough so that the outer border of the foot will not overhang it.

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

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

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

CHAPTER IV

FOODS AND WHY WE NEED THEM

From my window I can see a windmill standing with its arms outlined against the sky. A little while ago it was whirling rapidly about and pumping water into the tank that it keeps supplied. Now it is standing motionless in the sunshine, as if overcome by the morning heat. Is the windmill broken? Or has anything happened to it that will keep it from any longer pumping water for its owner? Not at all. The only trouble is that the wind which supplied the *power* to run the mill has, for the time, failed.

Wherever there is motion and whenever work is done, power to cause the motion and to do the work must come from somewhere. We think of a swift and heavy automobile as a powerful machine, but, in reality, the power comes from the gasoline that is exploded in the cylinders, and, when the supply of gasoline gives out, an automobile can no more move itself than can a stone. Every other machine, whether it be run by steam, gasoline, electricity, water, wind, or in any other way, must draw the power that runs it from some source outside itself. The windmill cannot run itself; it must stand and wait until the wind comes to give it motion and make it able to do its work.

Food as a source of power.—The human body has strength. It moves and does work. It cannot furnish itself with power, however, so we must have some source from which to draw the strength that is in our muscles. This source of power is the food that we eat. *Food is necessary to give strength to the body.* Without it the muscle cells cannot contract and cause the movements of the body parts.

Food as fuel.—A locomotive as it thunders past us glows with warmth. It gets its warmth from the fuel that is burned under its boiler. A stove with a fire in it gives off heat to all the room. This heat comes not from the stove itself, but from the fuel that is burned in the stove. Your own body is warm, as you know from feeling it. The heat of the body comes from the food that is burned within the cells. *Food is necessary to keep up the body heat.* Without it the temperature of the body would quickly fall to that of the air about it, and this would be fatal to the cells; for the cells can live and be in health only when the temperature of the body is close to 98 degrees.

Food as building material.—The human body is more wonderful than any machine made by man, in that it builds its own parts and keeps them in repair. The body starts as a single cell, which is composed of *protoplasm*, or living material. This cell builds more protoplasm, increases in size, and divides, and this process is kept up until the full-grown body is finally built of living cells which have come from the first cell. Even after the body is grown, new cells must be built; for, as long as life continues, the outer cells of the skin, the red blood corpuscles, and some of the other cells are dying and being replaced by new cells.

New protoplasm is also constantly needed to repair the cells; for, within all the cells the living protoplasm is constantly breaking down, and new protoplasm is being built to take its place. The material that is used in all this building of living matter comes from the food that we eat. *Food is necessary to furnish material for the growth and repair of the cells.*

Elements found in the body.—The living matter of the body is composed of at least five different elements, all built together into a material that is very different from any of them. The black solid called carbon makes up over one-half of the whole. The two gases of the air, oxygen and nitrogen, together with another very light and highly explosive gas called hydrogen, make up nearly all the remainder. In addition, some sulphur is built into protoplasm, and in the nucleus of the cell a little phosphorus is found. Among other elements that are present in the body are chlorine and five minerals—potassium, sodium, calcium, magnesium, and iron. It is not intended that you shall remember the names of all these elements, but it is intended that you shall understand that the body is made of perfectly definite materials, and that, if these materials are not supplied in our foods. the body must suffer.

The three classes of foods.—Foods are divided into three classes, according to the elements of which they are composed. These classes are the *proteins*, the *carbohydrates*, which include the starches and sugars, and the *fats*. Lean meats, eggs, milk, peas, beans, and all foods made from grains are rich in protein. Potatoes, turnips, cabbage, and other vegetables are valuable mainly for their starch. Grains also contain large amounts of starch. Fruits, sweet potatoes, honey, molasses, and milk contain sugar, and we add great quantities of sugar to our foods to make them more pleasant to the taste. Fats and oils we get in butter, lard, fat meat, eggs, cheese, chocolate, nuts, and olive and cottonseed oil. In general, we get proteins and fats from animals, while from plants we get proteins and carbohydrates.

Proteins the building foods.—All three classes of foods give heat and strength to the body. The proteins furnish building materials in addition. They contain the same five elements that are found in the living matter of the body,—carbon, hydrogen, oxygen, nitrogen, and sulphur. Since they are used for building up the cells, we should expect them to contain these elements; for we use leather to patch a leather shoe, steel to replace a worn-out part in a machine, and to repair the body, the materials of which the body is built must be used.

Minerals necessary to the body.—A man excretes from his body nearly an ounce of mineral salts daily,[1] and it is necessary that certain amounts of the different minerals found in the body be supplied to make good this loss. In our food we always get small quantities of these minerals, but little attention has been given to making sure that diets include a sufficient supply of them. Recent experiments show that this trusting to chance for the right amount of minerals is not always satisfactory. Not counting common salt, with which we all supply ourselves, the three minerals that may be lacking in our food are *iron*, *calcium* (lime), and *phosphorus*. We shall discuss the need for each of these separately.

Iron needed to build red blood corpuscles.—Iron is used in the body mainly in building *hemoglobin*, the substance in the red blood corpuscles that carries the oxygen. If the supply of iron falls too low, the person becomes pale and weak because of a lack of red corpuscles and because of a lack of hemoglobin in the corpuscles that he has. In cases of this kind the patient is given iron in liquid form as a medicine, and a little of this seems to be used by the body; but all physicians agree that for building hemoglobin the iron in food is far more valuable than iron in other forms.

[1] The greater part of this mineral matter is common salt, of which the average man uses daily from one-third to two-thirds of an ounce. This is more than is necessary for the health, for experiments indicate that one-tenth of this amount is sufficient to keep the body in good condition.

The green parts of vegetables, especially spinach, are rich in iron; and, in general, eggs, vegetables, and grains, when the outer portion of the grain is used, give a rich supply of this material. Milk is low in iron, and in animals that feed their young on milk a large surplus store of iron is laid up in the body before birth. It is estimated that fifteen milligrams of iron are needed daily by a healthy man, and that the average diet contains from twelve to nineteen milligrams.[1] This indicates that it would be very easy to select a diet that would be deficient in this important mineral.

Lime needed by the body.—Careful investigation has shown that growing animals require about 1.2 per cent as much calcium as they gain in weight. When this amount of calcium is not provided, the bones are frail and the teeth are soft and defective. There must also be a certain amount of calcium dissolved in the lymph to keep the cells in health, and, if the supply of lime be cut off entirely, life cannot continue. It is certainly true that many young children are not supplied with enough of this mineral. Adding a little limewater to artificial foods does not provide enough lime to be of much importance in building the skeleton and the teeth; for a pint of limewater as strong as it can be made contains slightly less lime than is contained in a pint of cow's milk. Milk, eggs, vegetables (especially leaf vegetables), and whole grains hold the first place among the foods that are rich in lime.

Lack of phosphorus in the body.—Experiments indicate that from 65 to 90 milligrams of phosphorus are needed daily in the body,—an amount greater than many diets will supply. The yolk of egg, the outer layer of grains, peas, beans, chocolate, and nuts are especially rich in

[1] An ounce of iron would furnish the body with 15 milligrams a day for five years.

phosphorus. Meats also supply considerable quantities of this element to the body. Larger amounts of phosphorus are needed during the growing period than in adult life, and if this is not supplied the bones are likely to become soft.

Foods rich in minerals.—It is perhaps worth while to call attention at this time to the fact that the foods on which young animals live while starting in the world supply to the body minerals as well as protein and energy-yielding substances. Milk has in it all the elements, except iron, that are necessary to nourish a young animal, and an egg has in it everything necessary to build a chick, including the iron for the blood corpuscles and the lime for the skeleton.

Foods which are rich in minerals ought to form a great part of our diet and be eaten by young people especially. Vegetables, also, because of the large quantities of them that can be eaten, furnish a rich supply of minerals to the body. In the body of an animal the lime is in the skeleton, and when we eat the meat we get little of this mineral.[1] In wheat the mineral matter is mainly near the surface of the grains and is not found in white flour.[2] A diet, therefore, that is composed chiefly of meat and white bread is low in the minerals needed by the body. Whole wheat bread, oatmeal, breakfast foods, and, in general, vegetables and fruits, are rich in minerals. Children who are fed too long on milk suffer because of a lack of iron, and a meat diet supplies less mineral to the body than a vegetable diet.

[1] When a wolf or a fox eats a bird or a hare, it makes sure of a supply of calcium for itself by eating the bones as well as the flesh. Puppies fed only on lean meat and fat meat showed weakness of the bones, while other puppies of the same litter that were given bones to gnaw, in addition to the meat, developed normally.

[2] The laxative effect of whole wheat bread is now believed to be due to the rich supply of phosphorus in it, and not to the irritating effects of the bran, as was formerly supposed.

The diet of children in particular needs care to make sure that the right minerals are contained in it, for there is a special need for mineral matter when the body is growing rapidly. Generally speaking, the mineral income of the body can be increased by cutting down the amounts of meat and white bread eaten and using milk and vegetables more freely.

Vitamines.—Within the last few years it has been discovered that certain substances called *vitamines* are necessary for health. We do not know exactly what vitamines are, but small amounts of them are found in our foods, and a good diet must contain them. They are destroyed by cooking with alkalis, and are therefore not found in corn bread or in biscuit made with soda.

We are not sure how many vitamines there are, but two are definitely known to exist. One is present in whole grains, in beans, peas, potatoes, turnips, and other vegetables and in milk and eggs. In this country almost every one secures enough of this vitamine, but the lack of it causes a disease of the nervous system called beriberi, which is responsible for many deaths among peoples who live chiefly on rice. The second vitamine is found in milk and butter, the yolks of eggs, and the green parts of vegetables. When animals are given a diet that contains none of this vitamine, growth does not take place, and there is soreness of the eyes; and when the supply of vitamine is low, growth is slow and the health is poor. Many persons in Canada do not get enough of this vitamine, and one of the chief reasons for the use of leaf vegetables and milk is to secure an abundant supply of it.

Selecting foods.—Of all the hygienic problems that confront mankind, that of selecting a proper diet is one of the most difficult. Since the health of the digestive organs must be kept in mind as well as the needs of the body for certain materials, the whole subject can be entered into more intelligently after the digestive system has been studied. In the next chapter, therefore, we shall discuss the digestive organs and their work, and shall then take up the more difficult subject of selecting a diet that will keep the human body in health.

CHAPTER V

THE DIGESTIVE ORGANS AND THEIR WORK

Robinson Crusoe on his island had plenty of goats, and from goat hair a fine waterproof cloth is woven that is used as a covering for the tops of automobiles. Yet, because Crusoe had no way of turning the hair of his goats into cloth, he was forced to wear clothes made of stiff, heavy skins and to carry an absurdly heavy and awkward skin umbrella. There were trees in abundance on the island, but it required much labor to convert them into baskets, furniture, and boats. There was clay from which all kinds of dishes and vessels could have been made, but he went for years without tasting soup or boiled food, and he counted it one of the happy hours of his life when he succeeded in making a rude vessel that would stand the fire. There were tons of sand to be had from which glass might easily have been manufactured, but he had no windows in his dwellings. All about Crusoe were materials from which a thousand articles could have been made that would have added to his comfort and enjoyment, but until these materials were worked over and changed, he could not put them to use.

The meats, grains, and vegetables that we eat contain the materials that are needed for the nourishment of our bodies, but the form of these foodstuffs must be changed before we can use them. As ice must be melted before the elements that are in it can be used by the body, so must our foods be *digested* before they can be taken into the blood and used by the cells. *Digestion is the process of breaking up and changing our foods into substances that* *can be dissolved and taken into the blood.* Until this is done, our solid food is as useless to us as were most of the materials on his island to Robinson Crusoe.

The digestive system.—The digestive system includes the *alimentary canal*, the *teeth*, the *salivary glands*, the *liver*, and the *pancreas*. The alimentary canal is the long passageway through the body into which the food is taken and in which it stays while it is being digested. It is lined with a smooth mucous membrane, and in its walls are muscles to force the food onward through the canal. The teeth are a mill set at the mouth of the alimentary canal to crush and grind the food into small pieces so that it will be easier to digest. The other digestive organs are glands that pour juices into the alimentary canal to assist in the digestion of the food. The whole process of preparing the food for the use of the body is a most important one, and the great set of organs that carry it on fill nearly the whole abdominal cavity.

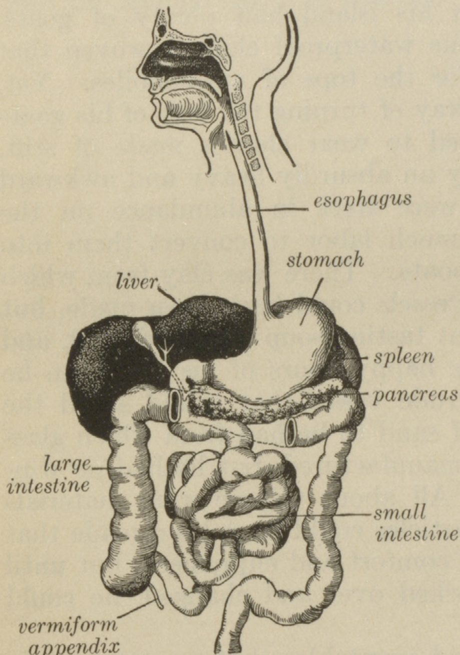


Fig. 32. The digestive system.

The digestive glands.—The digestive glands are formed by the folding of the mucous membrane that lines the alimentary canal into deep little pockets. The juices that digest the food flow out of the mouths of these glands. The liquid part of the juices is composed of water that passes through the walls of the glands from the lymph, as water passes into a sweat gland. Some glands are simple, like little wells sunk in the walls of the digestive tract. Others, like the salivary glands and the pancreas, are branched like a tree, and the juices that come from them are secreted by hundreds of little tubules, all of which flow into the main duct of the gland. The glands are said to *secrete* when the liquid flows from them, and the liquid itself is called the *secretion* of the gland.

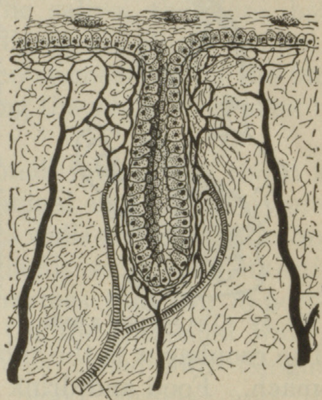


Fig. 33. Diagram of a simple gland.

The work of digestion done by enzymes.—Dissolved in the secretions of the digestive glands are certain substances called *enzymes*. These are built up by the cells that compose the walls of the glands and are dissolved by the liquid which passes through the cells when the glands secrete. *The work of digesting the foods is done by the enzymes.* An enzyme digests only one kind of food, so there are different enzymes secreted for breaking up the protein, fat, starch, and each of the different kinds of sugars that we eat. As we study the work of the different digestive juices, we shall speak of them as digesting the foods. You will understand, however, that it is the enzymes in these juices that do the actual work of digestion.

The salivary glands.—There are three pairs of salivary glands. One pair lies under the tongue; one pair is found under the corners of the lower jaw; and the other pair is found in front of and below the ears (Fig. 34). These glands secrete the saliva, which is carried to the mouth by ducts leading from the glands. The saliva moistens the food and makes it possible to swallow food like crackers, which in a dry state would become dust in the mouth. Dissolved in the saliva is an enzyme which begins the process of digestion by attacking the starch that is in the food and breaking it up into malt sugar.

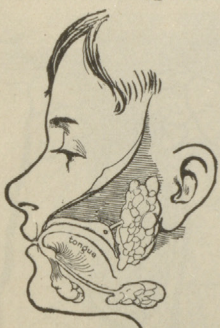


Fig. 34. The salivary glands.

The esophagus and stomach.—The esophagus is the tube connecting the throat and the stomach. Food and drink do not fall down the esophagus, but are forced down it by the contraction of the muscles in the walls of the esophagus. This you can prove by drinking with your head lower than your body.

The stomach stands almost on its end on the left side of the body close up under the diaphragm. It holds about three pints, and when full is about a foot long. When empty, its walls are drawn together, and it occupies little space. It has a double function—to serve as a storehouse for food so that enough can be eaten at one time to supply the body for several hours, and to secrete *gastric juice* for the digestion of the food.

The gastric juice.—From two and one-half to five quarts of gastric juice are secreted a day. It comes from the many hundreds of little glands which lie in the stomach wall and open into the stomach. The gastric juice contains an enzyme called *pepsin* that digests protein. It contains also an acid which kills many of the bacteria in the foods and so keeps these bacteria from causing trouble in the intestine. The acid in the gastric juice stops the action of the saliva on the starch, but in the upper part of the stomach the food may lie from one to two hours before the gastric juice works its way through it. The saliva, therefore, has a considerable time in which to digest the starch before the acid reaches it. The heat in the stomach melts the fat in the food, which assists in reducing the whole food mass to a liquid condition.

The small intestine.—The small intestine is coiled and folded upon itself in the abdominal cavity. It is about twenty-two feet in length, and its walls are lined with thousands of little glands. These glands secrete an intestinal juice which contains several enzymes that are important in the digestion of the food. On the intestinal wall are many little finger-like projections called *villi* (singular, *villus*). These contain many blood vessels, and they *absorb* the digested food; that is, they take it into the blood through the intestinal wall. So abundant are the villi that they give the entire inner surface of the intestinal wall the appearance of velvet.

The liver and the pancreas.—The liver weighs nearly four pounds and is the largest gland in the body. It lies on the right side of the body under the diaphragm. It secretes a greenish yellow liquid called *bile*, which is poured into the small intestine when food passes into the intestine for digestion. The bile assists in destroying acids that come from the stomach, in making more active the enzyme that digests the fats, and in dissolving the fatty foods. In the next chapter, we shall study other important functions of the liver.

The pancreas is a long, light-colored gland which lies along the lower border of the stomach. It secretes and empties into the small intestine great quantities of thin, watery *pancreatic juice.* This liquid contains enzymes for digesting the three most important foodstuffs,—proteins, starches, and fats. The pancreatic and intestinal juices, along with the bile, are thoroughly mixed with the food

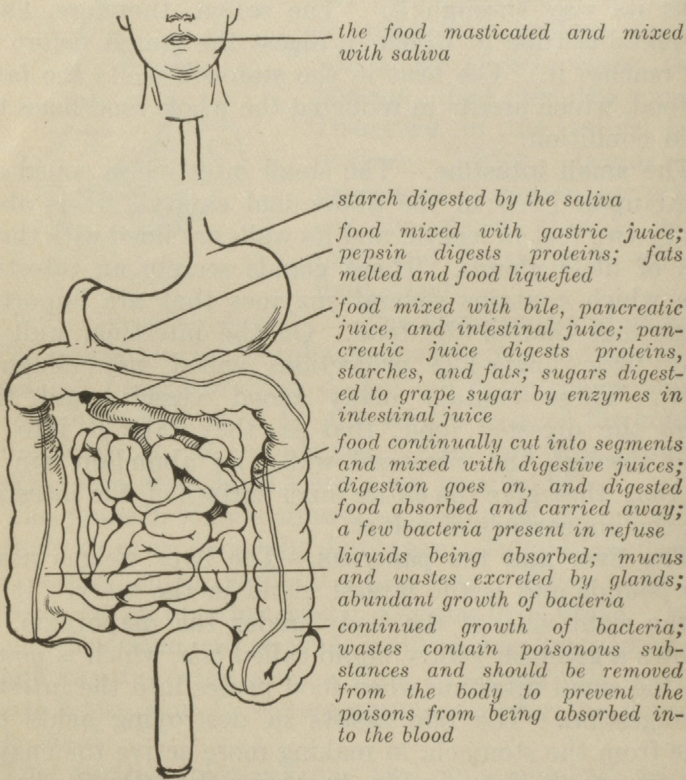


Fig. 35. A diagram illustrating the changes that take place in the food during its journey through the different parts of the alimentary canal.

in the small intestine, and they are even more important than the gastric juice in preparing the food to be carried to all parts of the body.

The large intestine.—The large intestine begins low down in the right side of the abdominal cavity, passes up the right side of the body, then across under the diaphragm, and down the left side of the body. Just below where the small intestine opens into it, there is a small, worm-like structure called the *vermiform appendix*. The walls of the vermiform appendix contain much loose spongy tissue of the same kind that is found in the tonsils, and just as tonsillitis is caused by germs growing in the tonsils, so appendicitis is caused by germs growing in the walls of the appendix.

The story of digestion.—Let us now trace the history of a meal by imagining that we can see the food after it has been eaten, and that we can watch it while it is being digested. In the mouth we find that the teeth slide over each other, crush the food into small pieces, and mix it with saliva. The enzyme in the saliva at once begins the process of digestion by attacking the starch that is in bread, potatoes, and many other of our foods, changing it to sugar.

After the food has been chewed, the tongue draws it back into the opening of the pharynx. The walls of the pharynx then grasp it and press it backward and downward into the esophagus, through which it is carried to the stomach. When the food reaches the stomach, the gastric juice trickles in on it from the glands in the walls all about, and the pepsin attacks the meats and other protein foods. Under the action of the gastric juice, the outer layer of the food mass dissolves and slides on into the lower part of the stomach, where the stomach walls contract on it and squeeze it about to mix the gastric juice thoroughly with it.

From time to time the ring of muscle that closes the gateway between the stomach and the intestine opens, and a portion of the food from the lower part of the stomach is forced on into the intestine in the form of a thick liquid.[1] Here a flood of digestive juices is poured in upon it. Greenish yellow bile comes from the liver; great quantities of juice, rich in enzymes for digesting proteins, starches, and fats, are secreted by the pancreas; and all along the small intestine, juices containing enzymes are poured out by the thousands of little glands that are in the wall. The circular muscles in the walls of the intestine keep contracting on the food and cutting it up into little sausage-like segments, which are continually being made, combined, remade, and moved about, thus mixing the digestive juices thoroughly with the food.[2] All the time the food is gradually being worked along the intestine, and the enzymes are bringing about the following changes in it:

The pancreatic juice attacks the protein and splits that which has escaped the pepsin of the stomach; it breaks up the starch and completes the digestion of this part of the food; and it digests the fat, changing it into glycerine and other substances that will dissolve in the intestine. The enzymes in the intestinal juice assist in digesting the protein and in changing all the different sugars into the one particular sugar (grape sugar) that the body can use.

And now as we follow the food in its course through the intestine, we notice that the liquid becomes less and less in amount; that only the solid wastes remain. As some desert rivers run out over the sand and lose themselves in their own channels, so the stream of liquid food in the intestine disappears. Where is it going? It is soaking into the wall of the intestine and passing into the millions of

[1] It should be understood that during stomach digestion the food is continuously being worked downward from the upper part of the stomach, and that from time to time it passes on into the intestine in rather small amounts. It takes about six hours for the stomach to be emptied after an ordinary meal.

[2] The segments into which the food is cut are about an inch long, and the contractions of the muscle rings come as often as thirty times a minute.

little capillaries that run in the wall. What will be done with it? It will be carried through all the body to furnish heat and strength, and to be built into bone and muscle and nerve; for, as the waterfall, even though it keep the same form, is made up of rapidly passing water, so our bodies, that seem to us to be the same year by year, are composed of materials that are ever shifting. The skin that we have to-day will, in a short while, be dead and gone, and the food that we eat to-day will be built into a new skin. The flesh and heart and brain of an ox are built of grass, and the human body is built of the food that we eat.

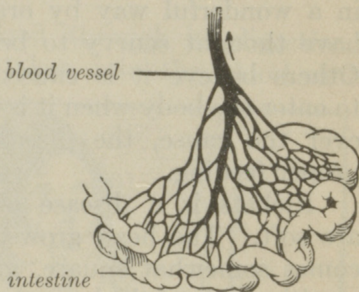


Fig. 36. Showing the vessels which carry the food from the small intestine.

The refuse matter in the large intestine.—In all food there is some indigestible material, like the woody, fibrous parts of potatoes and cabbages, the skins of fruits, and the tough fibres of meat. This matter passes from the small intestine into the large intestine, where its bulk is very considerably increased by mucus and other wastes that are secreted by the glands in the wall of the large intestine. In this waste material, millions of bacteria grow and cause decay, and in the process of decay poisonous substances are formed. Nothing is more important to the health than that this refuse material be cleared out of the intestine before the poisons are absorbed into the body. This question we shall discuss in the next chapter.

Scurvy and rickets.—The causes of these diseases are not definitely known, but they are in some way connected with the nutrition of the body.

Scurvy is a disease in which the joints are swollen and tender and there is bleeding of the gums. It is found in infants that have been improperly fed and among sailors and others who lack fresh food. It can be prevented by fresh meats and fresh vegetables and fruits, and is relieved in a wonderful way by orange juice. Some investigators have thought scurvy to be due to the lack of vitamines. Others believe it is caused by a bacterium that is able to enter the body when it is not properly nourished. Whatever the cause, the disease can easily be prevented by proper feeding.

Rickets is a disease of children in which the bones are soft. The head grows larger than is natural and becomes somewhat square, and there are knots on the ribs on either side of the breastbone where the bone and cartilage meet. It has been suggested that rickets is due to lack of vitamines or to a lack of calcium, but neither of these explanations seems to be correct. It is in some way connected with bad feeding and is prevented and benefited by a properly selected diet.

CHAPTER VI

THE FOODS WITHIN THE BODY

We have now traced the food through its digestion. We have explained how it is taken into the blood and carried to the cells. What do the cells do with it? What becomes of it after the cells have finished with it? Why, when we keep eating all the time, does not the body become so full of food that we cannot take in more? Perhaps it may start you to thinking about this subject in the right way if we go back for a few minutes to something else that you have seen.

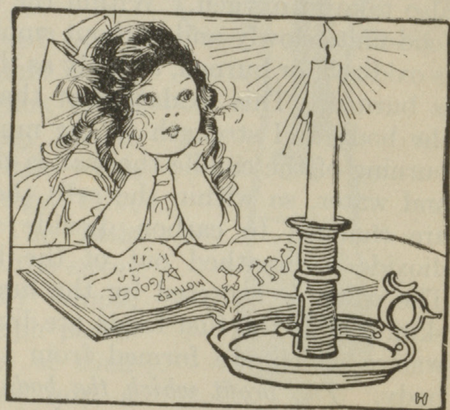


Fig. 37. When the candle burns the elements in it are not destroyed.

Long ago in your Mother Goose book you read:

> "Little Nanny Etticoat,
> In a white petticoat
> And a red nose.
> The longer she stands
> The shorter she grows."

Why does a lighted candle grow shorter the longer it stands? What becomes of the candle when it is burned? You must study chemistry before you will have a really clear idea of what happens in the process of burning. At present we can only explain to you that the oxygen of the air unites with the elements of which the wax is composed and forms carbon dioxide and water, which pass off into the air. The materials in the candle, therefore, *are not destroyed*. They are merely changed to vapor and gas.

The fate of the carbohydrates and the fats.—The cells of the body take in the sugar and fats of the foods. They also take in oxygen. Within the cells the oxygen and the food unite slowly and without smoke or flame, and the food is oxidized, or burned, as truly as the wax of a lighted candle is burned. This oxidation of the foods furnishes heat to the body and strength to the muscle cells, and, as in the burning of the candle the wax is changed to carbon dioxide and water, so within the cells the fats and carbohydrates are changed to carbon dioxide and water. The carbon dioxide is breathed out of the body through the lungs. The water is excreted by the lungs, the kidneys, and the skin. Thus the fuel foods are burned in the cells, and the wastes which are formed from them are cast out of the body. *The profit which the body receives from these foods is the heat and the power to do work, which are given to the body when they are burned.*

The fate of the protein foods in the body.—The living protoplasm of the body is continually breaking down and being oxidized. The protein food is used to build new protoplasm to take the place of that which is broken down.[1] In time this protoplasm will also be broken down and oxidized, so that the proteins are as truly burned in the body as are the carbohydrates and fats. The difference is that they are built into living material before the oxidation takes place. Carbon dioxide and water are among the waste products that come from the burning of the proteins, but

[1] It should be understood that only a part of protein food is built into living tissue.

there are other wastes also,—*uric acid* and other similar substances. These wastes are injurious to the cells, and the liver does a very important work in gathering up and converting a great part of them into *urea*, which is excreted from the body.[1] We shall now describe the organs that eliminate the protein wastes.

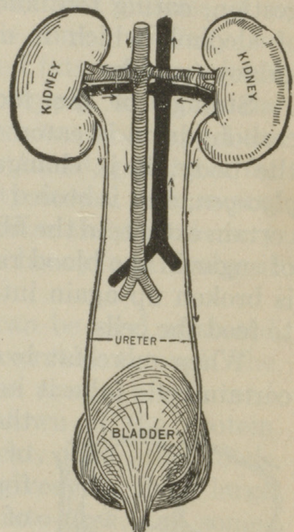


Fig. 38. The kidneys and the bladder seen from behind.

The kidneys.—Fastened to the back wall of the abdominal cavity are two bean-shaped organs, called the *kidneys*. Each kidney has in it many thousands of little tubes which all drain into a larger tube, the *ureter* (Fig. 38). The little tubes in the kidneys, like the sweat glands, are surrounded by lymph, and the water of the lymph passes into them and flows out of their mouths, as water passes into a sweat gland and flows out on the skin. The urea and other protein wastes are dissolved in the lymph, and they leave the body by passing with the water through the kidney tubes into the ureter and draining off to the bladder. *The function of the kidneys is to excrete water, salts, and protein wastes.*

Keeping the kidneys in health.—The kidneys have to remove the body wastes and are best cared for by caring for the whole body. There are, however, some things

[1] About 92.5 per cent of all the protein wastes excreted by the kidneys is in the form of urea. About 2 per cent of the whole is excreted in the form of uric acid, and it is estimated that an equal amount of uric acid is converted into urea by the liver. The uric acid part of the wastes comes from the nuclei of the cells and from the muscle cells when they work.

that should be avoided if possible. Among the things that are especially likely to injure the kidneys may be mentioned heavy lifting, exposure to cold and wet, indigestion, eating too much meat, and especially the drinking of alcohol, which is one of the most common causes of kidney trouble.

Storage of the foods within the body.—When more carbohydrate is eaten than is needed for immediate use in the body, it is changed to a starch-like substance called *glycogen*, and is stored within the cells of the liver and, to a certain extent, in the fibres of the muscles. When the supply of sugar in the blood runs low, this reserve store of glycogen is broken up again into sugar and given off into the blood to feed the cells.

When more fat is eaten than can be used in the body, certain cells take it in and store it within themselves until they become little more than bags of oil. These cells, massed together form the fat that you see in the body of an animal. When a person is sick and does not eat, the body uses this fat for food.

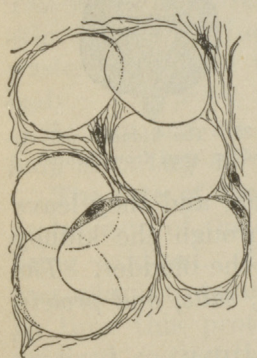


Fig. 39. Fat cells. They are little more than bags of oil.

A small amount of protein is dissolved in the blood, but the great storehouse of the protein in the body is the muscles. The muscles are built up when we eat a diet that is rich in protein, and when for any reason we are deprived of food, the muscle fibres are broken down and used to nourish the cells of the heart, the brain, and other vital organs. Famine sufferers and persons who have come through long sicknesses are little more than skeletons because their muscles have been used to sustain the organs necessary for life, and the fat has been used to give the body heat and strength.

Surplus food in the body.—When we eat more carbohydrate than can be stored in the liver and muscles, it is converted into fat and stored in this form. Usually we lose our appetite for carbohydrates and fats when we have had enough to furnish a reasonable supply of fat in the body. We can, therefore, in most cases trust our appetites to tell us when we have had enough bread, potatoes, fat meat, butter, or other starchy or fatty foods. There are, however, a few persons whose cells oxidize these foods very slowly, and such persons become too heavy and fleshy if they eat freely of foods of this kind.

When more protein is eaten than can be used or stored in the body, it is broken up and excreted through the kidneys.[1] From this protein the same wastes are formed that are formed from the breaking down of the protein of the body cells. A heavy diet of meat, or of other foods that are high in protein, therefore, gives the liver large amounts of protein wastes to change into urea, and sometimes more of these wastes are thrown into the blood than the kidneys can excrete. This subject we shall discuss in more detail in the next chapter.

Alcohol as food.—Alcohol in small quantities can be used to furnish strength to the muscles. In quantities up to two ounces a day it is oxidized within the cells and gives heat to the body. Because it can be used in these ways, it is often stated that it is a food. The modern idea of a food, however, is that it must not only furnish

[1] In the breaking up of the excess protein, the carbon and hydrogen in it are converted into either sugar or fat and used to give the body heat and strength. It is not to be understood, therefore, that surplus proteins are entirely useless to the body. The point is that they yield only energy, and this can be obtained much more cheaply from carbohydrates and fats without filling the body with poisonous wastes.

building material or energy to the body, but that *it must also be harmless when it is broken up within the cells.* This definition of a food is, we think, a correct one; for certainly the toxin of the tetanus or the diphtheria germ is not a food, opium is not a food, and strychnine is not a food.[1] Yet all these poisons are taken into the cells and are broken up in them, and they must furnish a small amount of heat to the cells.

We cannot, therefore, say that alcohol is a food because it is used by the cells, but, before making our decision on this point, we must know whether, in being broken up within the cells, it injures them—whether it interferes with those wonderful processes that keep the protoplasm alive. When we view the question in this light, we must decide that alcohol acts as a drug rather than as a food; for, as a drunken man shows, the action of the mind is dulled and made very uncertain by alcohol; under its influence the muscles are weakened, and their control is lost; and its whole effect on the body is that of a drug and not of an ordinary food. Even in small amounts,—amounts far too small to produce signs of intoxication,—there is good reason to believe that alcohol interferes with the enzymes that break up the food within the cells and throws the life processes of the protoplasm out of their natural course.

[1] Alcohol is composed of carbon, hydrogen, and oxygen. It is made from sugar, has in it the same elements that are found in sugar, and it would seem reasonable to expect it to act as a food toward the cells. We must, however, recognize that not only what elements are in foods and drugs, but also the way they are built together, is important; for carbolic acid is built of the same materials and is closely related to sugar and alcohol, and strychnine and cocaine are composed of carbon, hydrogen, oxygen, and nitrogen,—the same elements that are most abundant in protein foods. Just why substances that are composed of the same elements should affect cells so differently is hard to explain, but it is one of the facts of chemistry that we must accept.

CHAPTER VII

FOODS AND HEALTH

How shall we know what foods we ought to eat and how much of each is best for us? Occasionally the idea is advanced that in selecting a diet the best plan is to follow the appetite,—that the lower animals keep in health by eating the food they like, and that when the body calls for anything it does so because it needs it. It would be fortunate for us if by following this simple rule we could always be sure of keeping our digestive organs in order and of supplying our bodies with the materials that they need. But as a matter of fact this is not the case. Young rats that were allowed to eat freely of 23 different grains and vegetable foods failed to grow to more than half normal size, while other rats, compelled to live entirely on a mixture of rolled oats and dry alfalfa leaves, reached their full size. Certainly many persons crave foods that they know will be injurious to them, and in the selection of foods, rules and principles must be followed, as well as the appetite, if the diet is to be adapted to the body's needs. The amount of protein needed by the body has, in the past, been one of the most disputed of all the questions pertaining to diet, and we shall begin this chapter by a discussion of that question.

Quantity of protein needed by the body.—When men are given an abundance of food and are allowed to select the kinds that they like, it is found that the average man consumes daily from four to four and one-half ounces of dry protein. Some individuals eat far more and a few persons take much less than this amount, but a little over four ounces is the quantity of protein eaten by the average prosperous Canadian, American, or European.

But many persons keep in health when eating much less than this amount of protein, and recent investigations have shown that proteins differ from each other and that the amount of protein needed by the body depends upon the one that is taken. In digestion the proteins are split into *amino-acids*. These are absorbed into the blood and are used as the building stones with which the body repairs its wastes and grows. Nearly twenty amino-acids are now known, which different proteins yield in different amounts; some proteins lack certain amino-acids altogether, while others they furnish only in small amounts. For its building purposes the body picks out from the blood as much of each of the different amino-acids as it needs, using the remainder for fuel as it uses sugar and fats.

Figs. 40 and 41. A Roman and a Japanese soldier. They made their reputations as fighters on a low-protein diet.

Meat, fish, milk, and egg proteins are complete; they supply in large amounts all the amino-acids that the body needs. The proteins of grains, beans, and peas are low in certain amino-acids and must be eaten in large amounts if they are the sole source of protein supply. Potato protein seems to be of good quality, although it is supplied in only small amounts. When a number of different kinds of foods are eaten, the amino-acids lacking in one food may be furnished by another, and thus all the needs of the body will be met. All the protein needs of the body can be met with vegetables, but including meat, milk, or eggs makes it much easier to plan a satisfactory diet. The proteins of beans and of peanuts are of better quality than most vegetable proteins. Gelatine is a protein of very low grade.

The muscular endurance of low-protein subjects.—All vegeterians live on a low-protein diet. That it is possible to maintain the body in health and strength on such a diet is shown by the muscular endurance of vegeterians. In one seven-day walking race of 372 miles, two vegetarians won first and second places, beating the fastest flesh-eater by 22 hours. In another great walking race of 124½ miles, in which there were thirty-two competitors, the first six men who arrived were vegetarians, the seventh and eighth were meat-eaters, and the ninth, tenth, eleventh, and twelfth were vegetarians. In January, 1912, the Edinburgh Marathon race (25 miles) was won by the Finnish runner, Kolehmainen, who is a vegetarian. This same man in the 1912 Olympic games at Stockholm went to the post on six successive days against the best runners of all the world, and six times he defeated them all so easily that he is declared to be "the greatest of all Olympic heroes—the best long distance runner who ever wore spiked shoes."

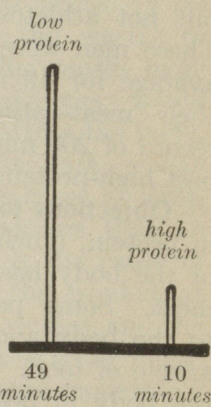


Fig. 42. The low-protein subjects held their arms extended for 49 minutes on an average; the high-protein subjects for 10 minutes.

Many other athletic contests have been won, and are being won, by vegetarians, but, since in all cases of this kind much depends upon the individual, we shall give some average endurance tests that have been tried on a number of individuals at the same time. Professor Irving Fisher of Yale University selected fifteen athletes who were living on a high-protein diet and tested their endurance. He found that on the average they were able to hold their arms extended for ten minutes. One man, who was a baseball pitcher and had powerful shoulder muscles, was able to hold his arm extended for 22 minutes. The endurance of thirty-two young men, vegetarians and low-protein subjects, but not athletes, was then tested by the same method. These men were able to keep their arms extended on an average for 49 minutes, practically five times as long as their meat-eating competitors. One of them made a record of 200 minutes, more than nine times as long as the best high-protein athlete.

Objections to a heavy meat diet.—Because meat is rich in protein, much of the discussion as to the protein needs of the body has centred about the advisability of eating meat. Some persons have insisted that it is injurious to the body and that it should not be used at all as an article of food. As we have shown, it is possible to keep the body in health with a vegetable diet, provided milk is also used, but there is no proof that a moderate amount of meat is harmful to the average person. But because meats are pleasant to the taste, very large amounts of them are sometimes eaten. This is objectionable because:

(1) *Meat does not supply the minerals and the vitamines that the body needs.* If large amounts of meat are eaten, small quantities of other foods will be taken, and some of the needs of the body may not be supplied.

(2) *Large amounts of meat in the diet cause poisonous substances to be formed in the intestine.*[1] When more protein

[1] Individuals differ enormously in the kinds of bacteria that grow in the intestines and in the amount of poison formed by them, and these substances are often abundant in the intestines of animals that live on a vegetable diet, as well as in the intestines of meat-eating animals. Nevertheless, it is true that in the average person a diet of vegetables and milk causes small quantities of the poisons to be formed, and a diet of meat and eggs causes an increased quantity to be formed.

is eaten than the pepsin and trypsin can digest in a reasonable time, part of it passes undigested into the large intestine. Here bacteria cause it to decay, and in the process of decay poisonous substances are formed. These poisons are then absorbed into the body, and they cause headaches and other disturbances by poisoning the cells.

(3) *Meat does not supply the bulk that is needed in the diet.* The lack of bulky material causes the wastes to lie for a long time in the intestine, and this causes more of the poisons to be absorbed from these wastes than would be absorbed if they were promptly removed from the body.

(4) *A heavy meat diet loads the system with protein wastes.* This is probably injurious, in some cases at least. It has long been believed by many physicians that an excess of substances of the uric acid class is the cause of gout and other serious ailments. Part of the trouble, at least, seems to lie somewhere in the protein wastes, and the patients are benefited by cutting the protein to a low point.

Because of these facts it is wise to eat only moderately of meats and to use other articles of food more liberally than they are used when meat is taken in large amounts.

The energy needs of the body.—*The body must have enough food to provide it with heat and with strength for the work that it does.* A certain amount of food is burned in the body, even when the body is completely at rest. After eating, the amount of food burned by the cells is greater. When work is done by the muscles, the amount of food used is increased,—enormously increased if hard work is done.[1] Exposure to cold causes the muscles to have a greater tension, and thus increases the amount of food

[1] The energy content of food is measured by the heat it yields when burned. The unit of measurement is the calorie, which is the amount of heat required to raise a litre of water one degree Centigrade. Roughly, it is the amount of heat required to raise one quart of water two degrees Fahrenheit. The body gets the equivalent of about 4 calories of heat for each gram of dry carbohydrate or protein

burned in the body and the amount of heat released. Cold also causes a person to move about more and to swing the arms and stamp the feet, which increases the heat production of the body; it may cause shivering, which brings still other muscles into use. In young persons the food is burned very rapidly in the cells, a boy or girl of ten or twelve years requiring as much food as a man or woman, and young persons of 16 and 17 years much more than middle-aged persons. Women require somewhat less food than men, and in old persons the food is not used so rapidly by the cells.

Effects of a diet that does not yield enough energy.—A group of young men placed on a diet that yielded insufficient energy continued to grow thinner until they had lost a little more than 10 per cent of their weight. After that their bodies burned less food, and they continued to live on this low level without further loss of weight. They did not become ill, but they lacked vigor, and when they attempted severe muscular exercise they found that they lacked strength for it.

During the recent war many millions of persons were forced to live on this low plane, and at all times great numbers of persons in all countries are undernourished. This is especially true of children; among both the rich and the poor great numbers of boys and girls are underfed. Sometimes this is because not enough food is provided.

eater, and about 9 calories from each gram of fat. An average-sized man needs enough food each day to yield the following numbers of calories:

Absolute rest in bed without food	1680 calories
Absolute rest in bed with food	1840 calories
Office work or other light work, about	2500 calories
Light muscular work	2700 calories
Moderately active muscular work, as work of farmer or mechanic	3400 calories
Hard muscular work	4000 calories
Very hard muscular work	6000 calories

In a boys' school where most of the pupils were from 13½ to 16 years of age, the food used had a value of almost 5000 calories for each pupil.

More often it is because the child is not hungry and eats only certain of the articles of food that are placed on the table.[1] Such children are in a low state of vigor, they do not grow fast enough, and it is believed that they have less resistance to infections than they would have if they were well nourished. The best indication as to whether enough food is being provided is the weight.

Food for energy.—Bread, grains, potatoes, butter, sugar, and fat meats are the foods on which we mainly depend for our energy. The body can use for fuel purposes any protein that is not needed for building material; but proteins are expensive foods, and, as we have seen above, it is not wise to eat too heavily of them. The thing to do, therefore, is to eat the proteins that we need for building material and then take enough fats, starches, and sugars to give us plenty of heat and strength. Usually we can trust our appetites to tell us when we have had enough of these foods. Taking food into the body increases the amount that is burned in the cells, and the amount of body heat produced. Carbohydrates increase the heat production least, fats increase it more, and proteins increase it most of all. A winter diet, therefore, should be higher in fats and protein than a summer diet. Meat helps to keep up the body heat in winter, and a diet consisting largely of fruits and vegetables is advisable on hot summer days.

The mineral supply of the body.—This subject has already been discussed. In general, eating large amounts of meat and sugar causes a lack of minerals, and a diet of vegetables and milk supplies minerals. Of all the minerals,

[1] The sensation of hunger is due to the contraction of the muscles of the stomach, and these muscles do not necessarily contract when the body needs food. It is generally supposed that children overeat, but far more of them do not eat enough. The trouble comes from the fact that they eat too much of sweets or other foods that gratify the appetite and refuse many articles of ordinary food.

the one most commonly lacking is calcium, which can be supplied by the free use of leaf vegetables and milk.

The vitamine supply.—Whole grains, peas, beans, and vegetables contain abundant supplies of the vitamine that prevents beriberi. Milk is moderately rich in this substance. Practically all of our population have enough of this material. The other vitamine is found in the leaves of plants, in the yolks of eggs, and in milk and butter. An animal like the cow or rabbit can eat enough grass or leaves to supply it with this vitamine, but a human being cannot do this. Milk and butter should therefore be used. The livers and kidneys of animals supply this second vitamine (it is found in cod-liver oil), and it is reported to be present in the fat of fish.

General dietary principles.—The seeds of plants are our chief source of food; wheat and corn bread, breakfast foods, oatmeal, rice, macaroni, peas, beans, and nuts make up the greater part of the diet of the people in temperate climates. Fruits and vegetables like potatoes, turnips, and carrots, furnish about the same elements to the body as grains. A diet composed of these foods is likely to lack certain of the needed amino-acids, calcium, and the vitamine found in leaf vegetables, eggs, and milk. Meat will make good the lack in the protein, but it will not supply the calcium or the vitamine, and to make the diet complete eggs or milk or leaf vegetables must be used. As we have already seen, it is difficult for man to eat enough green vegetables to supply the lacking substances, and for this reason eggs and milk, especially milk, should be used. Grains, vegetables like the potato, fruits, and meat do not make a complete diet. Leaf vegetables, milk, or eggs also are necessary.

The importance of milk in the diet.—All who understand the food needs of the body are agreed that it is a great misfortune that many families are using less milk than formerly because of an increase in its price. Milk is still one of the cheapest of our foods; a quart of it contains almost as much energy as a pound of steak, and it contains minerals and vitamines that can be supplied in an ordinary diet by nothing else. A certain organization that has long been at work to improve the diets of poor persons says that a quart of milk should be provided each day for a child and a pint for an adult. A noted authority on foods has stated that good milk is worth whatever it costs to produce it, and that no meat should be bought until each member of the family has been provided with a pint of milk. Another authority on foods reports that in his own family from 25 to 30 per cent of all the money expended for food is used in the purchase of milk. The most serious mistake made by our people in the purchase of food is in not buying enough milk.

Large quantities of sugar injurious to the digestive organs.—In his wild state man secured most of his sugar by eating starchy foods and digesting them to malt sugar. Now he prepares great quantities of sugar and uses it in his food, but the sugar that comes from cane and beets is cane sugar and not malt sugar. This sugar, when taken in large quantities, is very irritating to the stomach, and because in large amounts it is not a natural food for man we have but a small quantity of the enzyme that digests it. When a large amount of sugar is eaten, therefore, it may remain for a long time undigested in the small intestine, and when this occurs the sugar is likely to be fermented by bacteria and injurious acids formed from it. Sugar should be taken in moderate quantities, and it should be mixed with other foods and not eaten at a time when it will form a thick, syrupy solution in an otherwise empty stomach. A moderate quantity of candy eaten at the close of a meal has a very different effect on the digestive system from that of a large quantity taken before a meal.

Fats.—Fats hinder stomach digestion, and except in very cold weather few persons can take a daily ration of more than three and a half ounces of fat without bad results. Persons who suffer from acid stomach are advised to eat liberally of fatty foods, and about two ounces of fat should be included in the average daily diet. Certain individuals who refuse to eat butter, fat meat, olive oil, or other fatty foods, live on very small quantities of fat, and get their energy almost entirely from carbohydrates. This throws a heavy task on the starch-digesting enzymes, and it is not so likely to give a well-ordered digestion as a mixed diet. It is also believed that the cells of the body keep in better health when part of their nourishment is supplied in the form of fat; that persons who eat little fat are more subject to germ diseases, especially tuberculosis, than are those who eat reasonable quantities of fatty foods.[1] During the war more hardship seems to have been caused by a lack of fats than by a shortage of any other class of foods.

Eating vegetables beneficial to the health.—Coarse vegetable foods like string beans, cabbage, cauliflower, carrots, turnips, potatoes, beets, radishes, asparagus, lettuce, celery, and spinach are very necessary to the health. They furnish minerals to the body and after they are digested there remains much bulky refuse matter that causes the wastes to be moved rapidly along the intestine.

[1] Fat is considered the most important part of the diet in tuberculosis. Outdoor life in this disease is more beneficial in cold climates than in warm climates and more beneficial in winter than in summer. Some physicians think that this is because in winter the exposure to the cold increases the appetite for fat. Milk and eggs have always been used as a source of much of the fat in the treatment of tuberculosis, and it is possible that a part of the benefits that are supposed to come from the fats in the diet is due to an abundant supply of the vitamine that is found in these foods.

These are the foods that are least palatable to most persons, and they are the ones that are most frequently left out of the diet. One difficulty in getting enough of these vegetables into the diet is that in the country the family garden is often neglected, and a sufficient variety of them is not produced. Another difficulty is that in towns and cities these vegetables are often needlessly allowed to wilt in stores and markets, and their tenderness is lost before they are cooked. The chief difficulty, however, is that only a few persons understand how to cook vegetables so that they will come to the table with the attractive flavors and odors that an expert vegetable cook can bring out. Because it is a difficult art to do this, many housewives give their attention to the easier and simpler tasks of cooking meats and of making pies, cakes, and desserts, and serve on their tables vegetables cooked in an unappetizing way. It is very important that the proper attention be given to the raising and preparation of these foods, and every young person should learn to eat all the different kinds of vegetables that are served in his home.

A plan for getting a proper diet.—Since the very life of the body centres around the food from which the cells build their living substances and from which they get their energy, it is easy to understand that the question of diet is the most important problem of all hygiene. It is not possible to give any simple rules that will always be a complete guide in eating, but the following suggestions may be helpful:

(1) *Eat enough food.* Only the energy needs of the body are increased by work, and laborers who eat large quantities of food are not nearly so likely to suffer from a lack of protein, minerals, and vitamines as those who take little exercise and eat only small amounts of food.

(2) *Eat many different kinds of foods.* As far as it is possible to do so, make it a rule to eat at each meal one food rich in protein, like lean meat, eggs, beans, or cheese; one or more starchy foods like breakfast foods, bread, macaroni, or potatoes; some fatty food like butter, fat meat, or nuts; some coarse vegetable food like cabbage, asparagus, turnips, or beets; a moderate amount of some sweet food like sugar, syrup, preserves, jelly, honey, cake, or a sweet dessert. Follow this plan, and you will probably not be tempted to eat too heavily of any one kind of food and will supply your body with all the different materials that it needs.

(3) *Include milk and butter in the diet.* If this third rule is followed in connection with the two rules previously given, the food needs of the body will be met.

It is very important to follow some plan that will cause enough food to be eaten and all the different materials that are needed to be supplied; for experience has proved that persons who simply follow their appetites or eat the foods that can be most conveniently secured frequently fail to supply their bodies with some of the materials that they need.

Constipation a deadly enemy to health.—No matter what diet is eaten, unless the wastes are rapidly moved along the intestine and promptly cleared out of the body, ill-smelling gases and poisons will be formed in the refuse matter in the large intestine. These will be absorbed into the blood and cause bad breath, headaches, and other evil consequences. In selecting a diet, enough coarse food should be chosen to give large amounts of bulky refuse matter. This will assist in causing the wastes to be moved rapidly along the intestine.

Other important points in the prevention and cure of constipation are vigorous exercise, especially bendings of the body and movements of the legs that will press the digestive organs about and help the circulation of the blood through them; massage of the abdomen, which also helps the circulation of the blood through the stomach, liver, and intestines; a daily cool or cold bath; attending to emptying the bowels regularly at a certain hour each day;[1] eating foods like fruits, corn meal, and graham flour, which have a natural laxative effect; drinking large quantities of water, especially at bedtime; and keeping the nervous system in good condition so that the digestive organs will be properly regulated. A few physicians now understand how to treat successfully patients suffering from constipation, and any one who suffers ill-health month after month because of poisons produced in his own body should, if possible, put himself in charge of a physician who is especially qualified to treat this trouble.

The cost of food.—The object of eating is to supply the body with building material, heat, and strength. To make sure that all the needs of the body are supplied, we must eat foods of different kinds; we cannot live on corn meal and beans, no matter how cheap they may be. It is often possible, however, to supply the needs of the body either with high-priced foods or with other foods that may be purchased at a much lower rate. For example, the same amount of energy that can be purchased in wheat flour for four cents costs ninety-five cents in oysters, and protein costs nine times as much in canned corn as in corn meal.

[1] An X-ray examination of animals shows that before the bowels are emptied the part of the large intestine which runs across the body is raised up partially on end and the part which runs up the right side of the body is dragged across to take the place of the transverse portion. It takes about 20 minutes for these changes in the position of the large intestine to be brought about. It is possible to train the nerves that control the intestine until they will set the muscles of the intestine in action at regular times, and it is exceedingly important to do this.

The average family is not wealthy, and according to the best statistics available it is slightly undernourished. We cannot go into the question of food costs further than to point out that in our country millions of dollars might be saved each year and the health of our people greatly improved, if the persons purchasing the food supplies of families understood how to secure the most nourishment for the money that they have to expend.

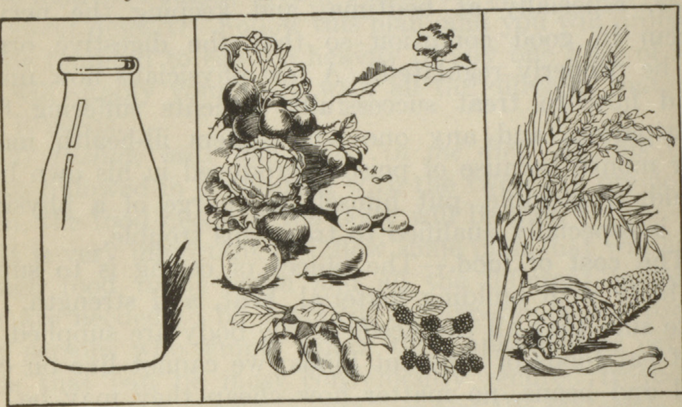


Fig. 43. Milk is especially valuable for its lime and the vitamine in its cream. Vegetables and fruits are rich in minerals and vitamines. Grains are used the world over to supply the body with heat and strength.

How to select foods.—During a strike in one of our large cities a poor woman spent her last ten cents for lettuce to feed her hungry family. She did not know that lettuce is nineteen-twentieths water, and that a pound of corn meal will furnish the body with as much heat and strength as will twenty-two pounds of lettuce. One who buys food for a family, where the income is not large, must watch the markets and learn to pick articles that are not high priced. At the same time the buyer must secure such a variety of foods that they will give the body enough of all the substances that it needs. To do this requires a knowledge of the needs of the body and of the materials that are in the different foodstuffs.

Hard-working people and growing children need a great deal of the heating and strengthening foods, and these may form three-fourths of all that they eat. Of such foods, the grains and products made from them, like flour, corn meal, rice, and oatmeal, are the cheapest. Next in low price and in heat- and strength-giving value are white and sweet potatoes, which are cheap whenever they are plentiful. Sugar, molasses, and corn syrup furnish us with heat and strength at a little higher price than do the grains. Dried fruits contain sugar in a more expensive form than sugar and syrups. Fat meat, salt pork, bacon, butter, and cottonseed oil are all heat- and strength-giving, but cost more according to their food value than the grains and potatoes. Therefore, when we are buying our heating and strengthening foods, we shall do well to choose mostly grains and potatoes, with just enough fat- or sugar-containing foods to give them flavor.

As the building foods cost more than the heating and strengthening foods, it is well to remember that we do not need nearly so much of them. We can also buy the cheapest of these foods, knowing that they furnish as much food value as the others. For example, a pound of round steak is more nourishing than a pound of porterhouse steak, and it is cheaper. Dried beans, which cost much less than meat, are rich in building material and may be substituted in part for meat, without injury to the health. Other meat substitutes which allow a saving in money are peas, beans, cream cheese, and peanut butter. If we have to choose between meat and milk, we should choose milk, as it is more nearly a perfect food than meat. Even at eighteen cents a quart, milk is no more expensive than meat at thirty-five cents a pound. When eggs are expensive, we can use the same substitutes for them that we do for meat. When they are cheap, they are an economical building food, since they give nourishment almost without waste.

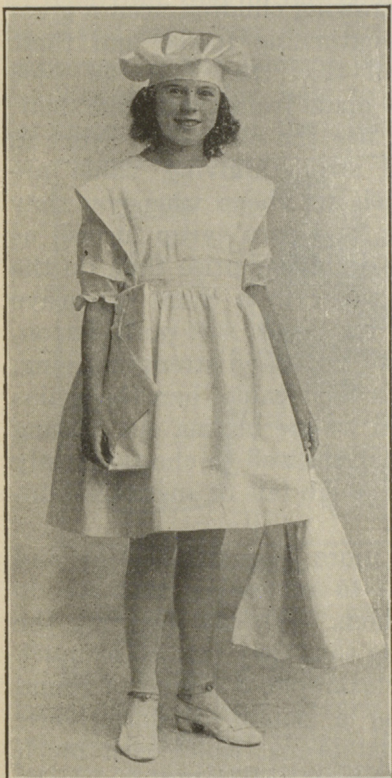


Fig. 44. A little home-maker.

Besides the heating and strengthening and building foods, we must have foods which contain mineral salts and *the different vitamines that are found necessary to growth and health.* If we are using substitutes for meat, or if leafy vegetables are expensive, we should buy more milk in order to get enough of these health-preserving substances.

The importance of well-cooked food.—It would be hard to think of an article of food more pleasant to the taste and more certain to agree with the digestion than warm, crisp, brown toast. It would be hard to think of an article of food more disagreeable to the taste and more ruinous to the health than rolls baked only until the outer part is slightly browned, while the inner part of each roll is still a sticky, doughy mass. Yet the toast and the rolls are made from the same materials. The difference is in the way they are cooked.

It has been said that the greatest difference between the food of the rich and the food of the poor is in the cooking. There is much truth in this, for to a very considerable extent we all live on the same foods. It would take a whole book to discuss fully the subject of cooking, and we cannot attempt to do this here. There are, however, two points in regard to cooking that are so important that every one should understand them.

The cooking of starchy foods.—Raw starch is in little hard grains that are digested very slowly. When placed in hot water, these grains swell up into a soft mass. This softened starch can then be easily digested. Oatmeal or corn meal that has been cooked for only a short time is very difficult to digest, but if these foods are placed in a double boiler and cooked for several hours they are very easy to digest. Thoroughly baked bread is the "staff of life," and every healthy person can digest it. But half-baked bread, with the starch grains in it almost as hard as little bits of wood, is ruinous to the digestion of any one who is forced to eat it.

The use of fats in cooking.—Fat is a most valuable heating and strengthening food, but, like every other food, it may injure the body if it is taken in a wrong way or in too large amounts. When fat has been made very hot, as often happens when food is fried, acids that injure the stomach are formed in it. Also, when foods are coated with fat, the digestive juices cannot get at them, and they are digested very slowly. For this reason many foods are much harder to digest when fried than when cooked in other ways. Greasy crullers, pancakes, fried pies, and other fried foods are injuring the digestive organs of many people, and the health of many families would improve at once if their frying pans were thrown away.

The importance of pleasing the taste.—The human body is not a mere furnace or engine, and giving it certain quantities of food materials does not necessarily mean that it will be properly nourished. The importance of pleasing the taste, of serving food attractively, and of pleasant and cheerful conditions while eating must always be kept in mind.

Another important reason for preparing food in an attractive manner is to tempt the appetite so that a sufficient amount will be eaten. Many measurements and weighings indicate that a boy or girl of a given age and height ought to have about a certain weight, and that large numbers of boys and girls do not get enough food because they refuse to eat many things that are placed on the table. Sometimes the trouble comes from eating little or nothing at breakfast time, or from eating something before mealtime so that little dinner or supper is taken. If you are thinner than you ought to be, be sure that you eat a full meal three times a day.

Spoiling of food caused by bacteria.—If a piece of meat is left in a warm room, it will soon spoil. But if it is thoroughly cooked and tightly sealed up in a can, it will keep for years. Or if it is placed where it will remain frozen, it will not decay. Every fisherman or farmer knows that salt helps to keep fish or meat from spoiling, and the housekeeper puts sugar in her fruits to keep them from souring, or to "preserve" them.

What is it that causes food to spoil? Why is it that food will keep if it is canned, or frozen, or heavily salted, or preserved in sugar? What must we do with our foods when we want to keep them from spoiling and becoming unfit for use?

Spoiling and souring of food are caused by *bacteria.* These are plants so very small that we can see them only with a microscope. Some kinds of bacteria are able to grow in our bodies and cause sickness. These kinds we call disease germs. Many kinds of bacteria that do not cause disease can grow in our foods and cause the foods to spoil so that they become unfit for use. *The important thing in the care of foods is to keep bacteria from growing in them.*

Keeping bacteria out of food by cleanliness.—We give bacteria a chance to get into food by allowing dust to blow into it; by allowing flies to crawl over it; by allowing mice, rats, and roaches to run about in pantries; by keeping the food in dirty vessels; by washing it with dirty water; by handling it with unclean hands; and in general by failing to keep it clean. *Cleanliness is the first great point in caring for food, since it keeps bacteria from getting into the food.*

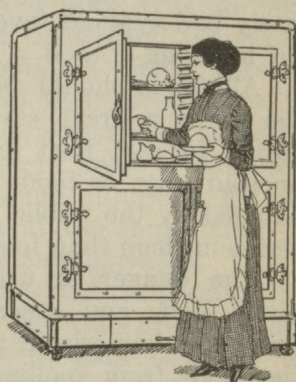


Fig. 45. Food should be kept in a refrigerator, and there should always be enough ice in the refrigerator to keep the food cold.

Keeping bacteria from growing in foods by cold.—Bacteria grow very slowly in foods that are kept cold, and by keeping foods cold we can do much to keep them from spoiling. Do not leave in a warm kitchen milk, meats, cooked fruits, or other foods that will spoil, but put them at once into a refrigerator with plenty of ice. If ice cannot be obtained, food should be bought or cooked only as it can be used, for spoiled food is unfit for use. *Cold is the second great point in the care of food, since it keeps bacteria from growing in the food.*

Killing the bacteria in food with heat.—Cooking food kills the bacteria in it and for a time keeps the food from spoiling. Milk vessels and other vessels in which food is kept should be scalded with hot water before they are used. If this is not done, great numbers of bacteria will get into the food from the vessels and will quickly cause it to spoil.

Keeping disease germs out of foods.—Persons who are sick and persons who are caring for the sick often have dangerous disease germs on their hands. It is never safe for these persons to handle food, for if the germs get from their hands into the food, other people are likely to catch the disease. No one who has consumption or who has lately had typhoid fever should have anything to do with the handling of food.

All foods should be carefully guarded from flies, for the fly is a great carrier of dangerous germs. It need hardly be said that foods that have been handled in an unclean way, or foods that have been fingered over and handled by the public, are far more likely to have disease germs in them than foods that have been kept clean.

The danger in using food preservatives.—There are many acids and other substances that will prevent the growth of bacteria in milk and other foods, and will keep the foods from spoiling. Some of these are sold in drug stores or by agents and are used by housekeepers, especially in canning fruits. Though some of these substances are harmless, it has been proved that others are poisonous, and their use in foods is unnecessary and unwise.

CHAPTER VIII

THE TEETH

The teeth are composed of the hardest tissues in the body, but decay of the teeth is the most common bacterial disease of man. Unlike many other infections, this disease runs on and on, and can be checked only by a surgical operation that removes the infected tissues and the germs that are in them. We have therefore a whole class of surgeons (dental surgeons) who give their entire time to the treatment and prevention of infections of the teeth and their surrounding parts. In recent years it has been proved that defective teeth are more injurious to the health than had been suspected, and the importance of keeping the teeth sound can hardly be exaggerated.

How bad teeth injure the health.—Bad teeth cause the food to be swallowed in large pieces and thus greatly delay digestion. They also allow germs to gain entrance to the bones of the jaw and establish centres of infection in these parts. These germs are usually slow-growing races of streptococci that live in the bones for years, and often the health is greatly injured by the toxins that are absorbed from them. Frequently the germs are carried from the teeth to other parts of the body and by growing in these parts cause rheumatism, heart disease, kidney disease, and other ailments.

The structure of a tooth.—A tooth is composed of a *crown*, a *neck*, and one or more *roots*. The main bulk of the tooth is composed of *dentine*, or ivory, a substance harder than the most compact bone. The crown is covered by a coat of *enamel.* This substance is very hard, but brittle like glass. The enamel can easily be broken by biting on hard objects, and it may be cracked by very hot food or drink taken into the mouth. If it is once broken off it is never replaced, and without the covering of enamel over it the dentine soon decays. The roots of the teeth stand in sockets in the jaw-bones and are covered by a layer of bone-like cement. Lining the socket in which the root stands is a layer of connective tissue that fastens together the root and the bone of the jaw. In the centre of the tooth is the *pulp cavity*, a little chamber containing nerves and blood vessels. Break open the tooth of an animal, and you will easily find the enamel, the dentine, the pulp cavity, and the little root canals through which the nerves and blood vessels enter from the jaw-bone.

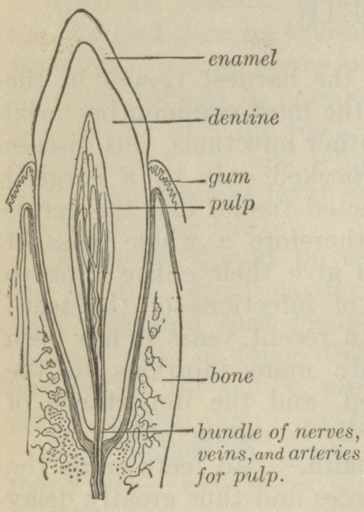


Fig. 46. A section through a tooth, showing its structure and how it is fastened into the jaw-bone.

Why a tooth decays.—Decay of the teeth is caused by bacteria that grow in the materials that stick to the teeth and lodge between them. It is thought that the bacteria start the decay by forming acids that eat away the enamel. Then other kinds of bacteria enter the cavity and destroy the dentine. If the decay is allowed to go on until the pulp is reached, this is killed, and the germs not only grow in the dead pulp but enter the jaw-bone through the root canal and set up their growth about the end of the root. When the decay is reaching the pulp, but when the nerve endings in the pulp are not yet dead, the tooth may ache. A gum boil is due to infection at the root of a tooth.

The teeth preserved by keeping them clean.—The way to preserve the teeth is to keep them clean, so that bacteria cannot find a home around them. The teeth should be brushed both inside and outside after each meal, and food that is lodged between them should be carefully removed. This point is important because decay nearly always begins between the teeth. Some dentists recommend that the food be removed with dental floss, but in the hands of the average person a toothpick is more effective. A quill pick is less likely to injure the gums than a wooden or metal one. Rinsing water about vigorously in the mouth and driving it between the teeth removes many small food particles, and this should always be done after the teeth have been brushed.

A good tooth powder or paste is an aid in cleaning the teeth. Prepared powders or pastes may be used, or a good powder made of precipitated chalk and powdered orris root, which may be purchased from any druggist. Charcoal, pumice stone, or other gritty substances should not be used, as they scratch the teeth and leave little grooves in the surface where food and bacteria collect. A curved brush with the bristles longer at the ends cleans the teeth better than a straight brush; a medium-sized brush with moderately stiff bristles should be used.

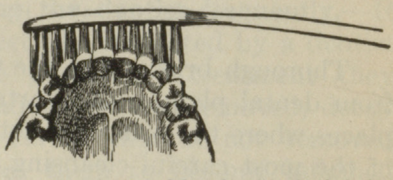


Fig. 47. A curved brush with the bristles longer at the ends cleans the teeth better than a straight brush.

Deposits on the teeth.—The mucus of the saliva forms a film over the teeth, and in many mouths patches of gummy material collect on the teeth where they are not cleaned in chewing the food and by brushing. These deposits are called *dental plaques*, and they are filled with living bacteria that produce acid and start decay beneath the plaques. *Tartar* is a hard mineral deposit that usually forms most abundantly along the edge of the gums. It is often stained brown by the escape of blood into it and may become bluish, green, or almost black from changes in the coloring matter of the blood in it.

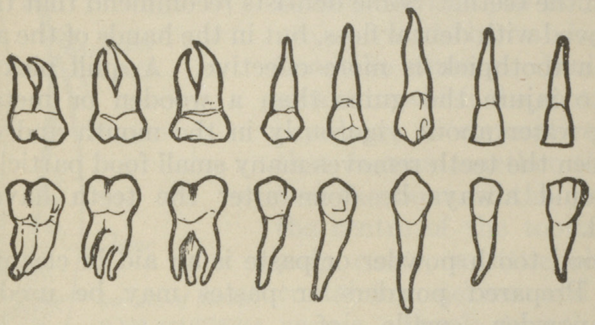


Fig. 48. One half of the permanent set of teeth.

Thorough brushing of the teeth helps to keep them free from dental plaques and tartar, but these may appear on places where the brush cannot reach them or even, in spite of the most careful cleansing, where the brush does reach. It is important, therefore, to visit a dentist from time to time to have any deposits on the teeth removed.

The care of the gums.—In many persons the gums are slightly inflamed along the margins and bleed easily when they are brushed. To keep them in health it is very important that tartar on the teeth be removed, for the tartar irritates the gums and causes them to shrink, leaving the roots of the teeth bare. This inflammation and receding of the gums may allow germs to work down about the roots of the teeth and form pus about them, thus causing them to become loose in their sockets. When the teeth are cleaned, the gums should also be thoroughly brushed with a light, quick stroke that will stimulate the circulation in them but will not injure them. One dental authority states that inflamed gums can surely be restored to health if the gums and teeth are brushed in the proper manner for two minutes four times a day. Some writers advise that in cleaning the back teeth the brush be given a twisting movement, and that the brushing be always from the gums toward the crowns of the teeth. Others believe that the outer surfaces of the back teeth can best be cleansed by giving the brush a circular or rotatory motion. All authorities are agreed that the brushing should not be crossways on the teeth. The purpose of brushing is to prevent cavities from forming in the teeth and to keep the gums in health, and the brushing should be frequent enough and thorough enough to accomplish this purpose. It is best to have two tooth brushes, as a brush becomes soft when too frequently used.

The importance of visiting the dentist frequently.—It is very important that the teeth be inspected by a dentist at regular intervals and be given any treatment they may need. If the dental plaques are not removed, decay may start beneath them. Tartar that is not removed irritates the gums and causes them to become inflamed and to shrink. A most necessary part of the care of the teeth, therefore, is to have any deposits on them removed promptly, and a dentist should examine the teeth every three months to see if this needs to be done.

It is also important that cavities be filled while they are yet small, both because this plan preserves the teeth and because it is more economical and less painful than waiting until the cavities have enlarged and a great part of the tooth has been eaten away. All over the land people are suffering with toothaches and paying for expensive X-ray work, root fillings, and crown and bridge work, when they could have preserved their teeth by spending a mere fraction of the same money at an earlier date for small fillings. If the pulp of the tooth dies and the germs gain entrance into the bones of the jaw, it is exceedingly difficult to eradicate them, and sometimes it is impossible to do so. It is not considered safe to fill a dead tooth unless the X-ray is used to make sure that the filling extends to the end of the root canals; even after the roots are filled it is considered advisable to put a temporary filling in the tooth, and after a time to examine it again with the X-ray to make sure that no infection has developed in the bone at the tips of the roots. Dental work of this kind is very expensive, and it is much more satisfactory to have the teeth attended to when only cleaning and small fillings are required. Unless decayed teeth can be so treated that they will be free from germs, it is better to have them extracted, and there are not a few dentists who believe that a dead tooth is better out of the mouth than in it.

The temporary teeth.—The jaws are too small in childhood to hold the large teeth that we need in later life. In early life we have, therefore, a set of twenty small *temporary teeth.* This set is composed of four *incisors,* two *canines,* and four *molars* in each jaw (Fig. 50). The incisors are flat and chisel-like for biting off the food. The canines are more round and pointed, and in the dog and other carnivorous animals they are used as weapons and for tearing flesh. The molars are broad, square teeth with square *cusps,* or points, and wide surfaces for crushing and grinding the food. About the sixth year the temporary teeth begin to drop out, and by the twelfth or fourteenth year they have all been replaced by permanent teeth.

The permanent teeth.—There are thirty-two permanent teeth. In each jaw there are four incisors and two canines that replace the incisors and canines of the temporary teeth; four *bicuspids* in place of the temporary molars; and six molars that come in behind the space occupied by the temporary teeth. The first permanent molars appear about the sixth year. The third molars, or wisdom teeth, usually appear from the sixteenth to the twenty-first year, but in some persons these teeth never make their way through the gums.[1]

Fig. 49. The tooth on the right decayed, the roots were not absorbed, and the tooth had to be pulled to make room for the permanent tooth. The tooth in the middle shows the roots partly absorbed. The roots of the tooth on the left have been completely absorbed and the tooth has dropped out.

The importance of caring for the temporary teeth.—The first reason for caring for the temporary teeth is that they themselves are necessary for the health; for, if they are allowed to decay, the child will form the habit of bolting his food; the digestion will be deranged by the germs that are swallowed; and the nervous system and the disposition will be damaged by the pain from the toothache that the child will be compelled to endure. For the sake of the health during the years of childhood and to prevent the forming of wrong eating habits, the temporary teeth should have the best of care.

[1] Sometimes when the wisdom teeth or other teeth fail to appear at the normal time it is because they have turned sideways in the jaw or have become tightly wedged among the roots of the other teeth. Teeth that are lodged in the jaw in this way are called *impacted* teeth, and there are many cases on record of persons who suffered greatly from nervous troubles because of the pressure such teeth were exerting. If the teeth do not appear at the proper time and there is any trouble with the health, impacted teeth should be looked for. The X-ray is used in making the examination.

The second reason for caring for the temporary teeth is to prevent the permanent teeth from coming in irregularly. The permanent teeth begin to form long before birth at the roots of the temporary teeth, and by the end of the third year even the wisdom teeth are formed in the jaws. These teeth then gradually grow and harden, and the roots of the temporary teeth disappear before them (Fig. 49). Finally, the roots of the temporary teeth are entirely absorbed and the first teeth drop out, leaving to the permanent teeth the places they occupied.

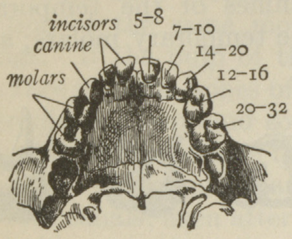


Fig. 50. The upper temporary teeth of a child about three years old with the average time of eruption given in months. The lower teeth usually appear a few weeks earlier than the upper. The first permanent molars, which at this time are being formed in the jaws, are shown behind the temporary teeth.

If the temporary teeth are allowed to decay, their roots are not absorbed before the permanent teeth appear. The second teeth, therefore, either remain buried in the jaws or appear in an irregular line, some inside and some outside of the line of the first teeth. Another difficulty caused by decay and loss of the temporary molars is that when the first permanent molars come in they move forward and take positions that belong to the bicuspids, and there is then not enough room for the permanent bicuspids. For

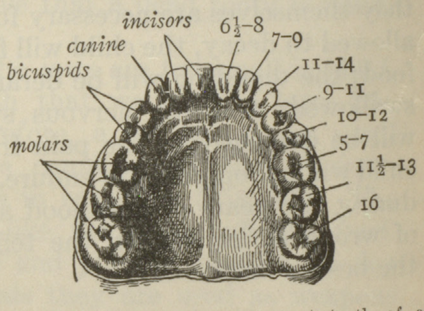


Fig. 51. The upper permanent teeth of a man twenty-six years old, with the average time of eruption given in years. The lower teeth usually appear two or three months earlier than the corresponding upper ones.

the sake of the permanent teeth, therefore, the temporary set should have the best dental care, and if for any reason they have been allowed to decay, a dentist should be consulted when it is time for the second teeth to appear. Permanent fillings, and not cement fillings, should be used in the temporary teeth, for some of these teeth remain in the mouth until the child is 10 or 12 years of age.

The importance of caring for the first permanent molars.—The first permanent teeth, which come in about the sixth year, behind the temporary molars, are often mistaken for temporary teeth. These molars have deep grooves in their surfaces in which the food lodges, and they come into the mouths of many children before the habit of washing the teeth has been formed. They are therefore especially liable to decay. They should be filled at once if cavities appear in them, because they are not replaced when lost, and without them the jaws do not grow in length as they should. Count the double teeth in the mouth of a six- or seven-year-old child, and if there are three of them on one side of the jaw, the back one is a permanent molar.

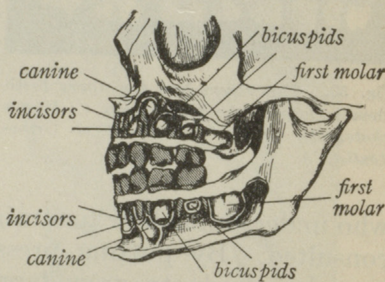


Fig. 52. The jaws of a child four years old. The jaw-bones have been cut away to show the permanent teeth growing at the roots of the temporary set.

Other points in the care of the teeth.—Sticky foods like oatmeal and mashed potatoes cling to the teeth and cause them to decay. Hard foods like apples, cornbread, and bacon clean the teeth and give the gums the exercise that is needed to keep up the circulation through them. Every diet, therefore, should contain some tough, solid material into which the eater can set his teeth. Sugar left among the teeth ferments easily and causes decay. For this reason eating candy at all hours of the day, so that the crevices among the teeth are kept filled with it, is almost sure to cause decay.

Straightening irregular teeth.—Often the permanent teeth come in irregularly and are turned forward in front because the temporary teeth have been allowed to decay, or because adenoids or nasal growths have kept the bones of the jaws and of the roof of the mouth from growing enough to make room for the teeth. When for these or any other reasons the teeth are irregular, a dentist who understands how to straighten them should at once be consulted. By putting pressure on the teeth the bones may be made to grow larger and the arch of the jaw expanded until the teeth have sufficient room.

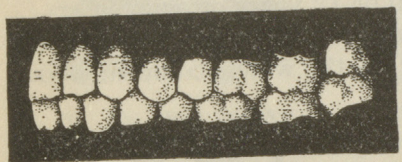


Fig. 53. This shows how the upper teeth should close on the lower teeth. (*After a photograph from "The Practical Orthodontist."*)

Figure 54 gives an idea of the changes that a good dentist can make in the appearance of a person whose mouth is spoiled by irregular or protruding teeth. The work of straightening the permanent teeth ought to be begun as soon as they appear, and not delayed until all of them are in the mouth, as is often advised. A tooth that has been crowded out of line ought not to be pulled, but the circle of the teeth should be widened until there is room for all.

Defective teeth due to illness and to lack of calcium in the diet.—A tooth is first built up by the growth of a "bud," or little group of cells of the mucous membrane which covers the jaw. It is then hardened by having calcium deposited in it. This hardening of the teeth is going on all through childhood, and severe cases of scarlet fever, measles, diphtheria, and other illnesses may interfere with the deposition of lime and cause the teeth to be soft and ill-formed when they come through the gums months or years later.

Defective teeth may also be caused by lack of calcium in the diet. It is therefore especially important to the teeth that children be guarded from disease and that an

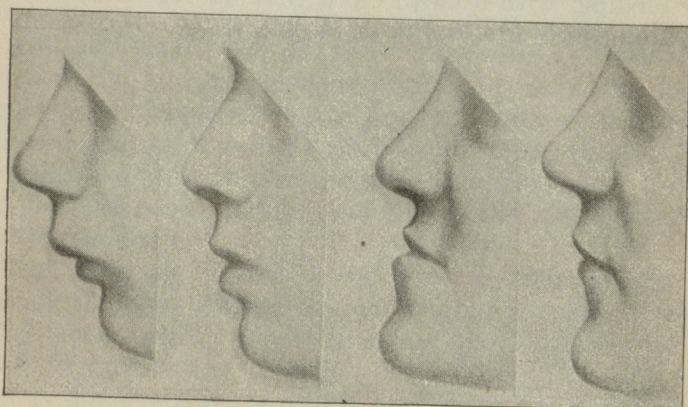


Fig. 54. Two cases in which the teeth needed and received the care of a good dentist. (*After a photograph from "The Practical Orthodontist."*)

abundance of lime be supplied in the food during the early years of life. The question of lime in the diet should be given special care when babies are brought up on any food other than milk.

Care of the mouth of an infant.—Little babies often suffer from sore mouth. This disease is caused by germs and is usually brought on by lack of cleanliness. It should be promptly attended to by a physician, because it not only causes suffering and nervousness in the child but also fills the alimentary canal with germs and ruins the digestion.

When the teeth are making their way through the gums, the mouth should be examined to see that there are no little ulcers on the gums when the teeth are cutting through. If these are found a physician or a dentist should be consulted; for it is very unwise to allow a child to go on swallowing the many thousands of pus-forming germs that come from the ulcers. One of the best means of preventing trouble in the mouth of a baby is to wipe out the mouth, after feeding, with a clean cloth that has been dipped in a saturated solution of borax or boric acid.

CHAPTER IX

THE HEART AND THE CIRCULATION OF THE BLOOD

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

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

Arteries and veins.—The blood in its movement, or *circulation,* through the body flows through the same channels again and again, always returning to the starting point, the heart. We have, therefore, two sets of blood vessels in the body,—the *arteries,* which carry the blood *from* the heart, and the *veins,* which bring the blood *to* the heart. The large arteries which leave the heart send

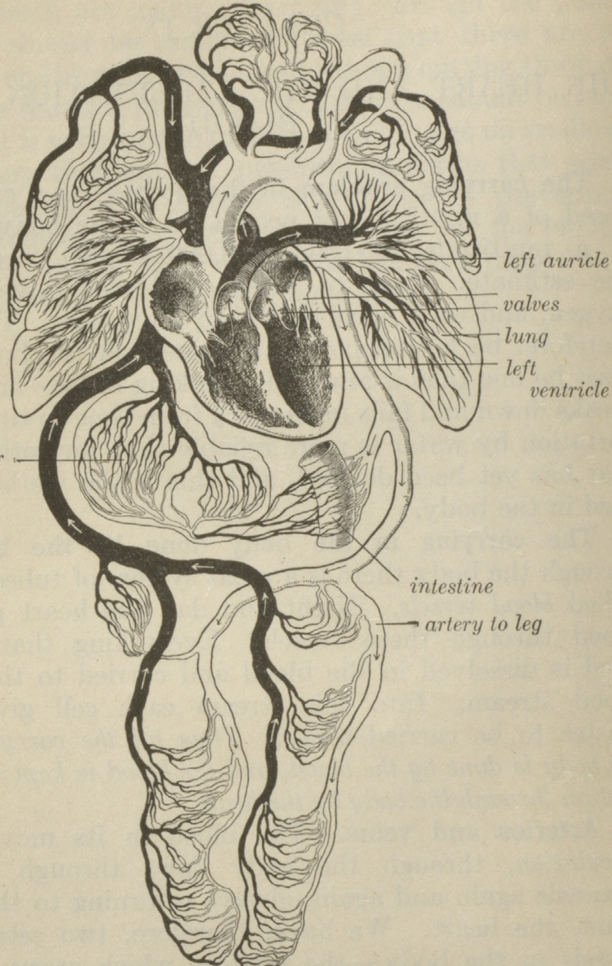


Fig. 55. Diagram showing the circulation of the blood. Note the valves between the auricles and ventricles and at the mouths of the great arteries that open out of the ventricles.

branches to the different parts of the body. These branches divide into finer and finer branches, called *capillaries*, which run in among all the cells. Then the capillaries unite into small veins. The veins, like the creeks that form a river, keep coming together, until finally all of them are united into the great veins which carry the blood back to the heart.

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

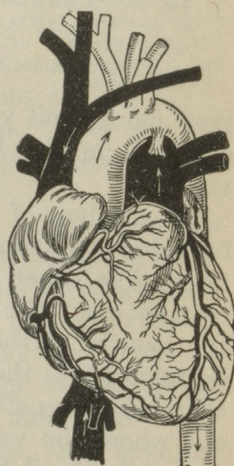


Fig. 56. The heart.

The heart.—The heart lies in the chest with its point to the left of the centre. Its walls are made of strong muscles, and within the heart are four chambers, or cavities, two on each side. The two upper cavities are called *auricles*; the two lower cavities are called *ventricles*.

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

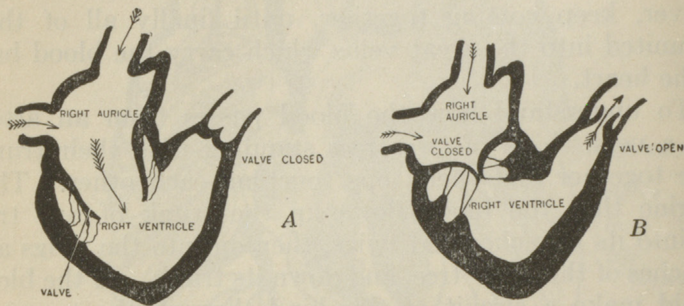


Fig. 57. A diagram of the right side of the heart showing the working of the valves. When the blood flows into the auricles and the ventricles relax, the valves of the heart are shown in *A*. When the ventricles contract and the blood flows out into the arteries, the valves are shown in *B*.

your chest, and you will feel your heart move as its walls close in on the blood and force it onward through the vessels.

The valves of the heart.—In every pump there must be valves to keep the liquid from flowing backward. The heart, like other pumps, is provided with these valves,—two between the auricles and the ventricles, and two at the mouths of the arteries to keep the blood from flowing backward into the ventricles when their walls relax and the chambers open after each beat. In Figure 55 you can study out where the valves are placed, and from Figure 57 you can understand how they prevent a backward flow of the blood in the vessels and in the heart.

Tracing the circulation of the blood.—Trace the circulation of the blood in Figure 55, and you will see that the heart is a double organ; that the right side sends the blood on a short journey through the lungs and back to the left side; and that the left side drives the blood into the arteries for a long journey through all the body and back again to the right side of the heart. The blood flows through the vessels very swiftly, making the journey through the lungs in about fifteen seconds, and the long journey through the body in less than a minute.

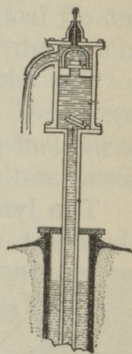


Fig. 58. A diagram of a pump. Locate the valves and explain how they work.

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

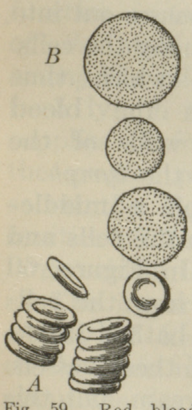


Fig. 59. Red blood corpuscles (*A*) and white blood corpuscles (*B*).

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

The white corpuscles are larger than the red ones and are fewer in number. *Their work is to kill the disease germs that get into the body.* They literally seize upon the germs and swallow them.

The lymph.—The blood capillaries are so small and so abundant among the cells that you cannot stick a pin into your tissues anywhere without breaking many of them and letting the blood escape. The capillaries have very thin walls, and as the blood flows through them some of the plasma escapes and passes out into the spaces among the cells. The plasma which thus escapes from the blood through the walls of the capillaries is the *lymph.*

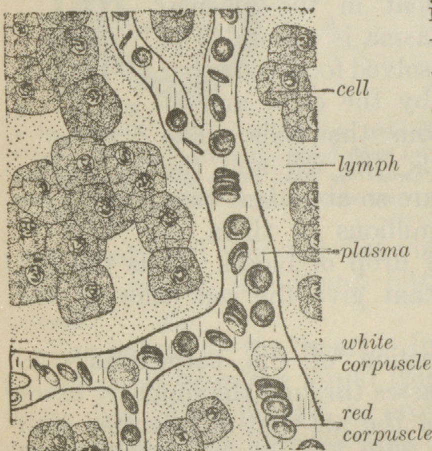


Fig. 60. The cells are bathed in lymph, which is plasma that escapes through the thin walls of the small blood vessels. (Diagrammatic.)

The lymph a middleman between the cells and the blood.—In Figure 60 you can see how the cells lie among the capillaries, and how they are bathed in the lymph that escapes through the thin walls of these vessels. The cells, therefore, are not in the blood stream, but this stream, so to speak, merely passes by the house, and the cells must find some way of getting their supplies from the stream into the house. This is done through the lymph. As the red corpuscles pass along in the capillaries, the oxygen breaks loose from the corpuscles, passes out through the walls of the vessels into the lymph, and so reaches the cells. In the same way, the foods that are dissolved in the plasma make their way out into the lymph that surrounds the cells, and the wastes that the cells give off pass through the lymph into the blood and are carried away. *The lymph acts as a middleman between the cells and the blood, passing the oxygen and food from the blood to the cells, and the wastes from the cells to the blood.*

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

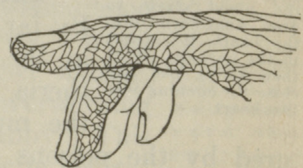


Fig. 61. Lymphatic vessels in the fingers.

The importance of caring for the heart.—The responsibility of keeping the whole transportation system of the body in operation falls on the heart, which is usually about the size of the fist of the person to whom it belongs.

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

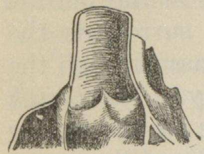


Fig. 62. Valves in an artery where it leaves the heart. There are three valves attached like loose pockets to the wall of the artery. When the blood starts to flow backward into the heart, it catches in the pockets, which then swing out and close the opening into the heart.

The heart injured by disease germs. By far the most common cause of trouble in the heart is disease germs. In diphtheria and scarlet fever the nerves and the muscle cells of the heart are so injured by the poisons produced by the germs, that even in the mildest cases of these diseases, physicians frequently forbid the patient to sit up in bed, because they fear the effect of the strain on the heart. Furthermore, the heart is often so poisoned by an attack of one of these diseases that the nerves and muscle cells never recover, and the heart is left weak for life. In other diseases, such as pneumonia, rheumatism, and influenza, the germs themselves attack the valves and cause them to shrivel and harden, so that they allow the blood to leak backward, and again the heart is injured for life. As much as possible, therefore, we ought to avoid all these germ diseases,—the catching diseases which are so common, and which people often carelessly give to each other. After an attack of one of these diseases, hard exercise should be avoided until the heart has had time to regain its strength.

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

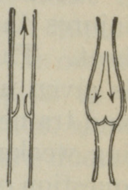


Fig. 63. A valve in a vein. The veins have valves in them to prevent the blood from flowing backward when pressure comes on the veins. Run your finger down a vein on your forearm, and little knots will stand out on the vein at the points where the valves are located.

There is danger, therefore, of overworking the heart, especially at that time of life when the boy or girl is entering manhood or womanhood and the body rapidly increases in size. When overworked, the heart, like any other muscle, at first enlarges, and then, if the overworking is kept up, becomes weak and flabby. This condition of the heart is called "athletic heart." If a person whose heart has been injured by over-exercise takes a long rest, going to bed, if necessary, his heart usually recovers. He ought, however, to take care not to force his heart into this condition.

Proper and improper exercise.—Do not keep on at any heavy work or hard game until you are exhausted. Do not play tennis all day. Do not spend a whole Saturday afternoon playing football. Remember that a baseball pitcher needs a stout heart as well as a strong arm, and that, for the sake of both your arm and your heart, you should not stay in the pitcher's box a whole half-day at a time. Do not enter long Marathon races that are intended for men and not for boys, and do not get on your bicycle and ride at a fast pace, hour after hour, up hill and down. You should understand, however, that it is only *overwork* that you are being cautioned against, and that both moderate exercise and severe exercise taken for short periods, are beneficial to the heart, as well as to other parts of the body.

Tobacco injurious to the heart.—Tobacco sometimes injures the heart until it has a quick, weak, and fluttery beat. This is a serious ailment, but usually, if the tobacco is given up, the heart seems in time to recover. Coaches and trainers will not allow athletes to smoke, because smoking weakens both the heart and the other muscles. The question of the effects of tobacco on the body we shall discuss in more detail in a later chapter.

The heart injured by headache remedies.—A number of drugs commonly used (among them phenacetine, acetanilide, and antipyrine) will check a headache. The practice of taking these drugs for headaches and colds is dangerous; for they all weaken the action of the heart, and their continued use will bring on heart disease. They should be taken only when prescribed by a physician, and no good physician will prescribe them often for the same person; for treating a headache in this way is not finding and removing the cause of the trouble, but drugging the body so that the pain will not be felt.

The effects of alcohol on the heart and blood vessels. Alcohol causes the walls of the blood vessels to become weak and brittle. For this reason, apoplexy, which is caused by the bursting of a blood vessel in the brain, is more common among users of alcohol than among abstainers. Alcohol often weakens the heart by causing its muscle cells to change to fat. In many beer drinkers there is the additional trouble that the working cells of the heart are buried in a great mass of fat that must be lifted and moved every time the heart beats. When one realizes that in germ diseases everything depends on the heart's keeping at work until the body has had time to overcome the germs that are attacking it, the disastrous effects of alcohol are more easily understood. In pneumonia, especially, when it is a great task for the heart to drive the blood through the congested lungs, and in diseases in which the heart is weakened by the poisons from the germs, it is most important that the full power of this organ be saved for the ordeal which it must undergo. Statistics from a hospital in a city where excessive beer drinking was very common, show that 16 per cent of all deaths in the hospital were due to "beer-drinker's heart."

Digestive troubles and the heart.—When the digestive organs are out of order, the stomach sometimes becomes filled with gas and presses on the heart, causing a most uncomfortable feeling and a pounding and irregular beating. The digestive system, of course, should be given proper treatment in cases of this kind, but if this is done, there need be no alarm about the heart itself.

How to stop bleeding from a wound.—If the blood flows from a wound in spurts, the cut blood vessel is an artery. The bleeding can be stopped by twisting a cord or a knotted handkerchief above the wound, as shown in Figure 64. If the blood flows in a steady stream, the cut vessel is a vein; in this case the bandage should be placed below the wound. The injured part of the body should be kept raised. If the cut vessel is a large one, it is necessary to act very quickly, and someone should press on the part to stop the bleeding until the bandage can be made ready. If the wound is on the head or body, a thick cloth should be

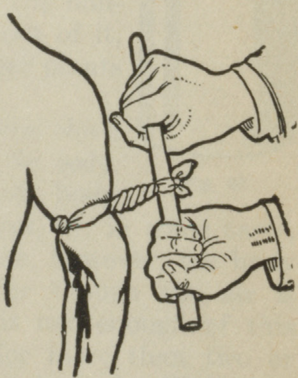


Fig. 64. Checking bleeding from a wound.

pressed firmly down upon it. A physician should be called as quickly as possible.

Bleeding from the nose.—Bleeding from the nose may often be stopped by simply pressing the upper lip against the teeth, or against a small ball of paper or some other object placed between the teeth and the lip. Bathing the neck in cold water may also help to check the bleeding. The head should be held erect in nose-bleeding, so that as little blood as possible will run to the nose. Do not blow the nose, for this will often start the bleeding afresh.

CHAPTER X

RESPIRATION

Fill a bottle with boiled water and one with unboiled water, and arrange growing beans in them, as is shown in Figure 65. The bean with its roots in unboiled water will grow for a considerable time—as long as the mineral matter in the water will provide it with food materials. The roots of the plant in the boiled water will quickly die, and the whole plant will then wither, because the roots no longer send the water up to the leaves.

Fig. 65

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

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

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

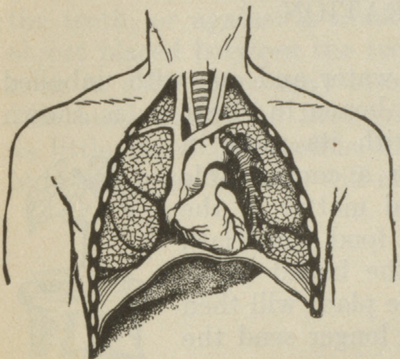


Fig. 66. The chest, showing the position of the heart and lungs.

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

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

The changes in the air in the lungs.—The walls of the air sacs are very thin, and great numbers of small blood streams constantly flow through the capillaries in them.

The oxygen of the air that we take into the lungs passes into the blood through the walls of the sacs, and the carbon dioxide that is in the blood passes out into the air that is in the sacs, and is then breathed out of the lungs. *The air*

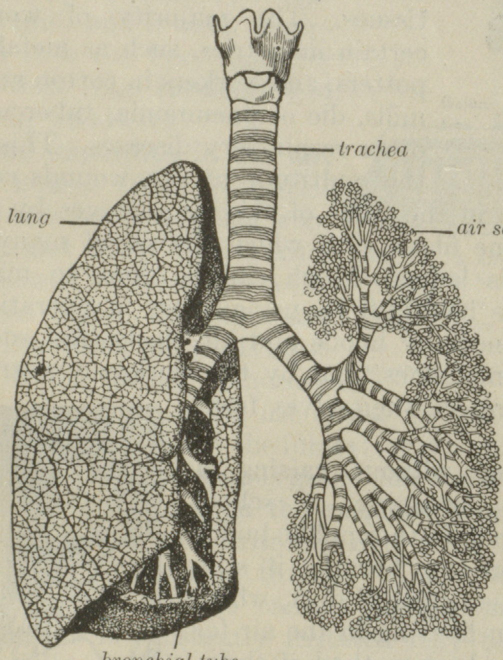


Fig. 67. The lungs.

in the lungs, therefore, loses oxygen and gains carbon dioxide, and the blood takes in oxygen and gives up its carbon dioxide.

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

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

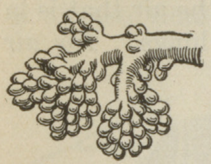


Fig. 68. A small bronchial tube and the air sacs in which it ends.

Sweeping without raising a dust.—Dry sweeping of school buildings and of other public buildings is injurious, because it stirs up great quantities of dust, which then remain floating in the air for hours. The best method of cleaning public buildings, as well as private homes, is the vacuum process. When this cannot be used, wet sawdust, a sweeping compound, or something else effective should be employed to keep down the dust. One device that is sometimes used is a can attached to the handle of a broom and so arranged that it

Fig. 69. A workman wearing a mouthpiece to protect himself from dust.

keeps the broom moist with kerosene or water. The floor brush shown in Figure 70 is very satisfactory for sweeping, and paraffin oil is extensively used in making up floor dressings and sweeping compounds. Sawdust moistened with it makes a very satisfactory sweeping compound, and a cloth dampened with it is the best thing for removing dust from furniture and for cleaning woodwork.

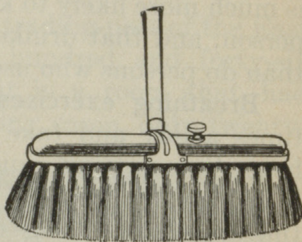


Fig. 70. A dustless brush. The back of the brush is hollow and is filled with kerosene, which slowly trickles down and keeps the bristles moist while the sweeping is being done.

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

The effect of tobacco on the respiratory organs.—Tobacco smoke is hot and irritating and often causes sore tongue and "smoker's sore throat." Undoubtedly these diseases sometimes lead to cancer, because any part of the tissues that is constantly irritated may develop into a cancer. When the smoke is inhaled into the lungs a sooty deposit which must certainly be injurious is left on the walls of the bronchial tubes. When smoke is exhaled through the nose it has a tendency to cause catarrh and injures the sense of smell. The nicotine that is taken into the blood, either by partially paralyzing the nerve centres that control the breathing muscles, or by its effect on the muscles themselves, causes the shortness of breath with which every smoker is familiar.

The effect of alcohol on the lungs.—The chief injury to the lungs and air passages caused by alcohol is that it makes them more easily attacked by germ diseases. It has long been known by physicians that pneumonia is much more likely to kill a user of alcohol than a temperate person, and that drinkers suffer far more from tuberculosis than do persons who use no alcohol.

Breathing exercises.—You should stand erect several times a day and take a few long, deep breaths. If you have been sitting quietly at your work for some time, it will make your tired muscles more comfortable to stretch the arms and swing them about. A half-dozen breaths of cool, fresh air, taken at an open window, will do wonders toward waking you up when you have become tired and sleepy at your work. It is good for the whole body to have the carbon dioxide emptied out of the lungs, a fresh supply of oxygen taken in, and the heart made to send the blood more quickly on its way. Vigorous breathing exercises, however, should not be practised by persons who are sick or weak, and they are very injurious to consumptives. No one should practise breathing exercises long enough to make himself dizzy.

CHAPTER XI

VENTILATION

In 1758, during an attack on the trading-post of the East India Company at Calcutta, one hundred and forty-six Englishmen were shut up overnight in a room that had but a single window. When morning came, only twenty-

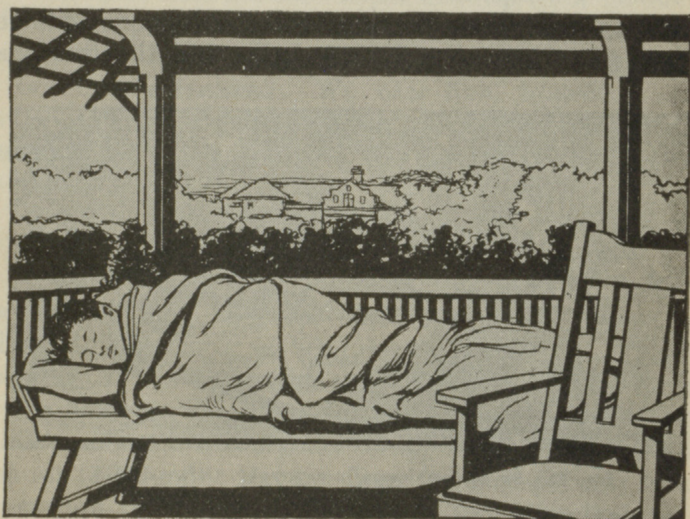


Fig. 71. Move your bed out into the open air if it is possible for you to do so.

three of them remained alive. After the battle of Austerlitz, three hundred prisoners were crowded into a cavern. In a few hours two-thirds of them were dead. Many other instances are on record of people who have perished when shut up in closets, vaults, or the holds of ships. Most persons have read of some of these instances, and practically every one takes care to keep out of places where he is likely to perish because his supply of air fails.

It would seem, however, that many persons are like the kind-hearted old gentleman who could not bring himself to cut off his dog's tail all at once, and so cut off an inch each morning until the tail was gone; for while these people object most decidedly to killing their bodies all at once with bad air, they do not seem to mind killing them a little at a time. Perhaps they do not realize what they are really doing, but the damage is constantly being done, nevertheless; for they go to churches, lecture halls, and theatres where

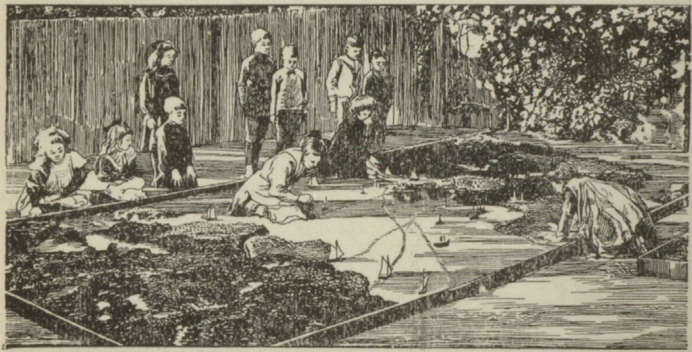


Fig. 72. An outdoor lesson in geography. (*After Ayres.*)

the air is so foul that it gives them headaches; many persons sleep in rooms with windows and doors so tightly closed that the sleepers must breathe the same air again and again; children often cover their heads with the bedclothes and do not get a breath of fresh air all night long; and many schools and factories are so badly ventilated that the health and the working power of those in them are continually being undermined. The whole subject of ventilation is, therefore, of the very greatest importance, and in this chapter we shall take up the study of why we need fresh air and how to get it.

Enough oxygen usually in the air.—About one-fifth (21 per cent) of the air is oxygen, and the remainder is nearly all nitrogen. The nitrogen is not used in the body, but is simply breathed into the lungs and breathed out again unchanged. The oxygen is taken into the blood and carried through the body to the cells. Air that has been breathed once has lost about one-fourth of its oxygen, and, where people are crowded together as the victims were in the "Black Hole of Calcutta," the oxygen in the air becomes exhausted. We can live, however, on 15 or even on 12 per cent of oxygen, and under any ordinary conditions the trouble with the air we breathe is not with the amount of oxygen in it.

The carbon dioxide problem.—Carbon dioxide is given off into the air from the lungs, and too much of it in the air is poisonous to us. It was long supposed that this was the chief trouble with indoor air,—that the paleness and lack of strength noticed in those who lived without good ventilation were due to carbon dioxide poisoning. All our rules for ventilating buildings have been laid down with the idea that we must bring in large quantities of fresh air (3000 cubic feet per hour for each person) to keep the carbon dioxide from becoming too abundant in the air that we breathe. This is still a good rule to follow; for it has not yet been proved that breathing large amounts of carbon dioxide week after week is not injurious to the health. Recently, however, it has been proved that in ventilation other questions besides the amount of carbon dioxide in the air must be considered.

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

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

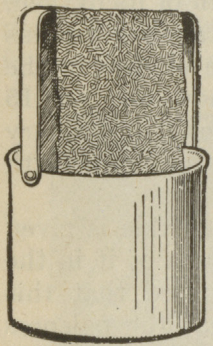


Fig. 73. A home-made humidifier—a pail with a strip of cloth arranged for feeding the water up and letting it evaporate into the air.

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

The necessity for motion in the air.—In hot weather, and in warm and wet indoor atmospheres, it is most important that there be air currents to break up and blow away the hot, moist air blankets that surround us. How important such air currents are is shown by an experiment that was carried out in England. In this experiment, a group

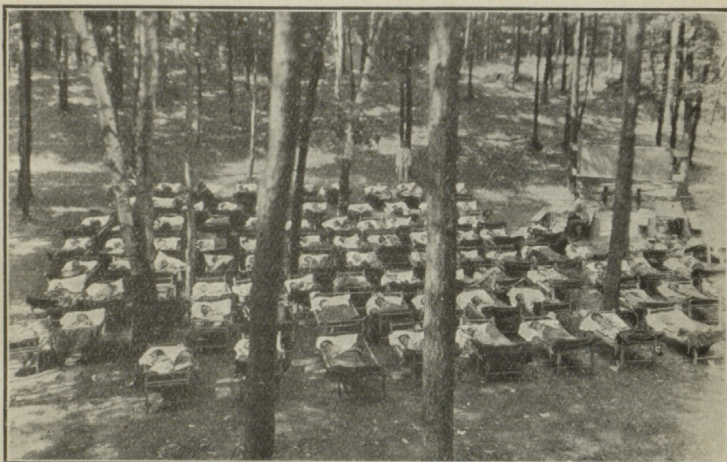


Fig. 74. The pupils at Victoria Park Forest School, Toronto, having their noonday rest under the trees.

of students were closed in a small room and watched through a glass in the door. At first they were laughing and joking, but soon they began to show signs of distress. Formerly it would have been concluded that they were suffering from a lack of oxygen or were being poisoned by carbon dioxide. The real trouble, however, was the overheating and the moisture in the air, as was proved by the fact that when an electric fan was started in the room, the students became comfortable again without the introduction of fresh air.

Disagreeable odors in crowded rooms.—In crowded and heated rooms, odors always arise that cause headache and a feeling of faintness in persons who are sensitive to them. A low temperature makes these odors much less noticeable, and a current of fresh air through the room not only sweeps away the odors themselves, but also refreshes

Fig. 75. The only building at Victoria Park Forest School, Toronto. There the pupils have their noon-day meal, and there also, in bad weather, their school work is done. When it is fine their desks and seats are outside under the trees.

the people and destroys the effects of the odors on them. Persons who are troubled with symptoms of illness when they attend public meetings can sometimes escape the difficulty by arranging for a seat near a ventilator or window, or where a current of air from an open doorway will blow across them. It is probable that "crowd poisoning" is nothing but the effect of the overheating and of the odors that are usual in buildings where many people are assembled.

Open-air schools.—In many places open-air schools have been established for under-nourished children, with the idea of nursing them back to health rather than of advancing them in their school work. In these schools the pupils are fed and have long rest periods, and only light school work is done. Experience has shown, however,

Fig. 76. The pupils at the Victoria Park Forest School, Toronto, having their noon-day meal.

that in the open air the children throw themselves into the work so eagerly and their minds are so clear that even in outdoor schools that give only half the usual time to study, the pupils advance as rapidly as they do in an indoor school where they spend the whole day over their books. Why, then, should not boys and girls who are in good health, as well as those who are sick, be in schools where they can master their work with the greatest ease and at the same time build up their bodies by breathing outdoor air? The time has come when each community must answer this question. In mild climates and in warm weather, there is certainly no reason for going to the great expense of trying to get the right kind of air indoors, when nature has filled all outdoors with exactly the kind of invigorating air that we need.

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

CHAPTER XII

ADENOIDS AND COLDS

Among the most common of all the ailments that afflict the inhabitants of the temperate and frigid regions of the earth are colds and certain other troubles of the nose and throat. These maladies, of course, are not so severe as many other diseases, but certainly they cause more inconvenience than all our other lesser sicknesses combined. It is true, also, that they often weaken the

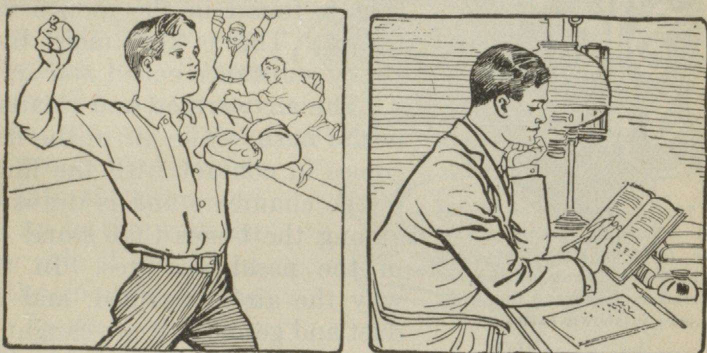


Fig. 77. Adenoids sap the strength so that any one who is suffering from them has very little chance of being the best athlete in the school; they dull the mind so that the victim of them rarely stands at the head of his class.

body and lay the foundations for other serious difficulties. People lack the general understanding of these diseases that they ought to have, and in this chapter we shall therefore make a study of them. In order that we may do so more intelligently, we shall first consider the structure of the nose and throat.

The chambers of the nose.—The air passes through the nostrils into the *nasal chambers.* These long, narrow passages are about three-quarters of an inch wide; they extend up into the head about as high as the level of the eyes, and they run back and open into the throat behind the mouth. They are separated from each other by a very thin, bony partition. On the outer wall of each chamber are three curved and rolled-up bones that stand out in the pathway of the air (Fig. 78). The whole interior of the nasal chambers is lined by the same skin-like *mucous membrane* that is found in the mouth and throat. This is kept moist by a sticky substance called *mucus.*

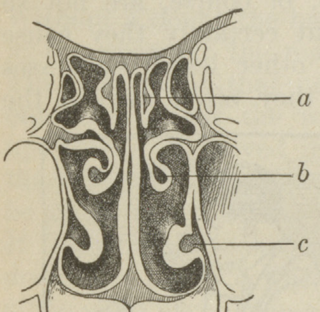


Fig. 78. A cross-section of the nasal chambers, showing the bones (*a*, *b*, and *c*) that stand out in the pathway of the air. The mucous membrane lining the chambers is shown in white.

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

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

The throat.—The throat is a funnel-shaped cavity which curves backward and downward around the base of the tongue. At its bottom are two openings, one leading to the stomach and one leading to the lungs. In front, a little flap-like structure, the *soft palate,* hangs down from above and partly separates the throat from the mouth. Above and behind the soft palate are two openings which lead into the nose, and high up in the walls on either side of the throat are the mouths of the two *Eustachian tubes,* which are small passageways that lead to the middle ears (Fig. 79). In the walls of the throat are four *tonsils,* which we shall describe in some detail.

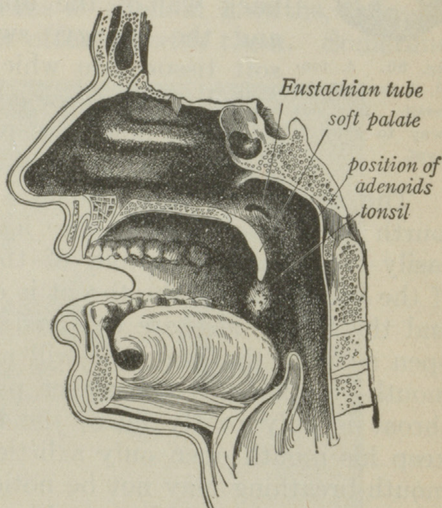


Fig. 79. The nasal passages, mouth, and throat.

The tonsils.—One small tonsil lies in the back of the tongue; one is high up in the back wall of the throat; and the other two lie in the side walls of the throat. These structures are composed of loose, spongy tissue, and leading down into them are small openings, or *crypts,* which are formed by folding the mucous membrane down into deep little pockets (Fig. 80). Germs grow in these pockets and cause tonsillitis,—a disease in which the tonsils are swollen and have matter in them like that found in boils. In many persons the tonsils are always infected with germs and become so swollen and enlarged that they block the throat and interfere with the breathing. The tonsil which is most commonly enlarged is the one in the back wall of the upper part of the throat, and the spongy, swollen, whitish mass of soft tissue into which this tonsil changes is called *adenoids*, or *adenoid growths*. Usually, when adenoids are present, the other tonsils also are enlarged, but this is not always the case.

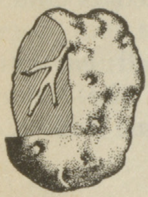


Fig. 80. A tonsil. A part of the tonsil is cut away to show a crypt.

The symptoms of adenoids.—In moist climates one-fourth of all the children may have adenoids. The most easily recognized symptom of them is mouth-breathing. If the upper part of the throat is entirely blocked by them and the tonsils also are enlarged, the mouth will be kept open so wide that any one will notice that the child is a mouth-breather. If the upper part of the throat is only partly filled, the child may keep his mouth open only a little, and the mouth-breathing may not be noticed at all, except when the child has a cold or is asleep. After the adenoids have been growing for some time, the upper teeth begin to turn forward; the face is puffed out under the eyes; the eyes have a strained look and are drawn down at the inner corners; the lips thicken; the upper lip shortens and is turned out; there is often a white line running down from the corner of the nose marking off the division between the cheek and the lip; and the whole face has a dull, stupid look.

Fig. 81. Adenoid growth that has been removed. One-half natural size. (*After Wingrave.*)

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

Besides these symptoms of adenoid growths, there are certain other effects that often go with them. Sometimes

Fig. 82. Typical adenoid faces.

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

The remedy for adenoid growths and infected tonsils. The only thing to do for adenoids and infected tonsils is to have them out at once. When performed by a skilled surgeon this operation is not severe, and in thousands of cases it has resulted in an improvement in the condition of the child that is almost miraculous. One sixteen-year-old boy gained fourteen pounds in three weeks after having his adenoids and tonsils removed; and it is a common thing for a child whose adenoid growths have been taken out to make a sudden increase in height and weight and to renew his interest in his school work.

The evil consequences of waiting to outgrow adenoids. Usually, but not always, adenoids disappear by the time a person is grown.[1] It must not be thought, however, that their evil effects disappear with them; for if the nostrils are not used in breathing, the nasal chambers and the upper part of the face do not grow as they should, and the person is left with narrow air passages, protruding upper teeth, a short, thick upper lip, and often with catarrh and a swollen condition of the nasal mucous membrane that will remain with him for life. Neglected adenoids spoil the beauty of the face for all time, and it is estimated that three-fourths of all deafness is due to them. Any one who advises waiting to outgrow adenoids is giving the

[1] A case of adenoids has been reported in a child six weeks old and one in a man of seventy years. They are by no means to be thought of as a disease of children only, for many cases are found in persons up to forty years of age.

worst advice possible. They ought to be removed, and this ought to be done before they interfere with the growth of the bones of the nose and face.

Colds.—Colds are caused by germs that live on the mucous membrane of the nose and throat. They may be divided into two classes,—*epidemic colds* and *chronic colds*. Epidemic colds are caused by germs of a particularly virulent strain that are handed from one person to another until the disease sweeps the community. Most of us must either endure these colds or find a way to escape the germs that cause them—no easy thing to do when people who have colds insist on shaking hands with us and leaving with us a few millions of the germs with which they are so bountifully supplied.

Spraying the nose with something that will kill the germs often helps to check a cold in its early stages. A hot foot bath cannot kill the germs in the nasal passages, but it helps to draw the blood away from the congested parts and assists in correcting the disturbances of the circulation that accompany a cold. It may also relieve to some extent the headache from which the victim of a violent cold suffers. A hot bath taken before going to bed is even better than a foot bath for drawing the blood away from the congested parts.

In chronic colds, the germs remain with the person all the time, growing only a little when he is in good health and offers a vigorous resistance to them, and springing into greater activity whenever the person gets his feet wet, becomes chilled, loses sleep, or does anything else that weakens his body and lowers its resistance to germs. A person with a cold of this kind is like a country invaded, but not conquered, by an enemy. At one time the inhabitants of the country drive back the foe and give themselves a breathing spell; at another time the advantage is with those who make the attack. The patient's only hope of victory over his germ enemies is to build up his health until his body has sufficient fighting powers to drive them out completely. The following practices have been found important in giving the body strength for this work:

Clearing out the nose and throat.—Adenoids, enlarged tonsils, bent and enlarged bones in the nose, and anything else that prevents a free passage of the air through the nose and a free drainage of the mucus from it, turn the nasal chambers into splendid homes for countless germs. The battle against colds is a battle against germs, and we cannot hope to succeed if the enemy is intrenched behind fortifications.

Getting enough fresh air.—Experience with both consumptives and well persons shows that no one thing is so important as fresh air in giving the body the power to kill germs. Many persons suffer continually from colds, because they live and work in buildings where the air is dry and overheated, and any one who wishes to free himself from a chronic cold must include fresh air in his plans.

Keeping the bowels open.—When refuse matter does not pass promptly through the intestines, it putrefies and produces poisons that break down the health of the whole body. These poisons destroy the power of the body to resist germs, and they injure the nervous system so that the blood vessels are not properly controlled. The feet of persons who are in this condition are therefore often cold while other parts of the body are congested with blood, and the circulation in general is not regulated as it should be. This disturbance of the circulation is in itself favorable to the growth of germs and makes the cure of a cold difficult. The remedy is to get the digestive system into good working order, and many persons recover from chronic colds when they do this.

Taking cold baths.—The practice of taking cold baths helps to give freedom from colds. Probably one way that it does this is by bringing out the white blood corpuscles that kill germs; for it is found that the white corpuscles are more abundant in the blood after a cold bath than before it. Another way that a cold bath helps is by teaching the blood vessels in the skin to open and close promptly. When cold strikes the body, these vessels ought to close and thus keep the blood in the inner parts, where the heat of the body will not be lost. Then, when the cold is removed from the skin, the vessels ought to open and allow the blood to come to the surface of the body. In some persons who are in bad health, the nervous system, which governs these vessels, does not control them properly, and the vessels in the skin may not close promptly enough to prevent the escape of the heat from the body; or, at the slightest feeling of cold on the skin, the blood vessels may shut up tight and gorge the inner parts of the body with hot blood, while the skin is left cold and shivering.[1] Cold baths help to train the vessels of the skin to open and close properly, and to keep the right amount of heat within the body. In beginning to take baths of this kind, intelligence and care are necessary; otherwise much harm may be done.

Drafts and colds.—People are sometimes advised to pay no attention to drafts and to open the windows, no matter how cold the weather may be, because it is germs and not drafts that cause colds. Yet many persons know from their own experience that sitting in a cold draft does cause them to sneeze, to feel chilly, and often to become actually sick. How can the idea that it is beneficial to the

[1] It should be understood that in chills, such as we have at the onset of grip or pneumonia, the difficulty is that the blood has been driven to the inner parts of the body, and the skin, where our sense of feeling is, no longer is warmed by the blood flowing through it. There is no lack of heat in the body, for often a person has several degrees of fever at the same time that he is having a chill.

health to sleep where the wind will blow over you be reconciled with the idea that a draft of cold air is dangerous? If motion in the air is desirable, why not have as much of it as possible?

In the first place, it must be understood that drafts of cold air take the heat out of the skin, and that a person who is exposed to them should have sufficient extra clothing to enable him to keep up his body heat. This keeping up of the body temperature is fundamental in the preservation of the health, for the resistance of the body to germs is weakened at once by the loss of too much heat. Much damage may be done by compelling school children who have been accustomed to hot rooms to sit in their ordinary clothing with the windows wide open on a cold day.

In the second place, it must be recognized that persons who have chronic colds—those who are carrying a host of germs just ready to break through their resistance and put them to bed—are already sick. It must also be recognized that what is safe for a well person or for one accustomed to it may be neither safe nor wise for a sick person or for one not accustomed to it. When cold air strikes a person who is in a half-sick condition, the vessels in the skin close more than they should. The result is that the blood is driven inward, so that in a few minutes the person can feel the mucous membrane in his nose swelling from the great supply of blood in it. This gorging of the membrane of the nose with blood causes a great quantity of lymph to escape among the cells, and it weakens the resistance of the mucous membrane so that the germs on it multiply more rapidly.

Cold drafts may thus cause a cold in a person who is in ill-health by disturbing the circulation and the distribution of the blood; or perhaps it is better to say that cold drafts make a chronic cold worse in this way. It is not advisable, therefore, for a person who is weak or half-sick to expose himself suddenly to severe conditions.

Training the body to endure ordinary exposure.—A person who suffers from chronic colds needs to build up the strength of the body gradually; to accustom the vessels of the skin to cold baths gradually so that they will act properly instead of throwing him into a chill when a blast of cold air is felt; to clear the nasal passages and the throat of obstructions; to stop the poisoning of the body by decaying intestinal wastes; and, in general, by degrees to bring the body back to where it will be able to stand ordinary exposure without injury and to kill the germs that are causing the cold. Any one who is always having colds ought, therefore, to begin to build up his health, and if he is wise he will have a good physician guide him in this task.

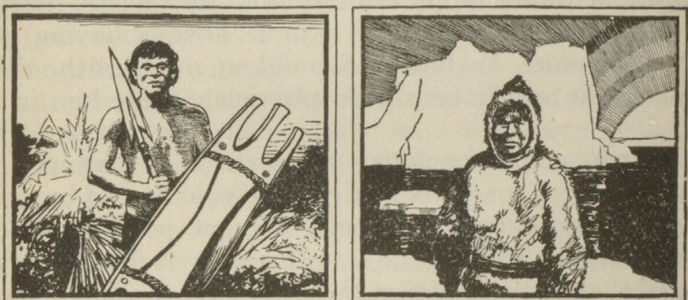
Catarrh and bronchitis.—Catarrh is a chronic cold in the head. Bronchitis is a chronic cold in the bronchial tubes. In both cases the body is kept poisoned by the germs that are growing in it. Recently it has been discovered that in most cases of these diseases, the germs spread from permanent breeding places in the tonsils or the nasal sinuses,[1] and that treatment is useless until the homes of the germs are broken up. There is often no swelling or pain in the infected parts, and many persons who are greatly in need of medical attention go for years without it. Since infections of these kinds are believed to cause many cases of rheumatism, heart and kidney disease, and other serious ailments, they should be given prompt medical care.

[1] The nasal sinuses are cavities in the bones that open off the chambers of the nose.

CHAPTER XIII

CLOTHING AND THE BODY HEAT

A man in the cold arctics loses much more heat than does a man in the warm tropics. Yet the temperature of the human body all over the world is the same. A man who is exercising violently produces five or six times as much heat as a resting man produces. Yet the temperature of the human body during exercise and rest is practically



Figs. 83 and 84. The object of clothing is to keep up the body heat.

the same. Cold-blooded animals become warm or cold according to the temperature of their surroundings, but the warm-blooded animals, including man, keep their heat near a certain point whether the weather is hot or cold. In health the temperature of the human body varies from 98.8 degrees to about one and one-half degrees below this point.

The object of clothing.—We take our clothing so much as a matter of course, that we often forget that the one great purpose in wearing it is to protect us from cold. It is true that it protects the body from wounds also, and we pay great attention to it because of its effect on our appearance; but yet the fact that the inhabitants of the frigid regions are clad from head to foot in furs, while those who live in the tropics are often very scantily clad, shows that man put on clothing, just as he built houses, to protect himself from the weather. We ought not, therefore, to become so interested in the colors and the appearance of our clothing that we forget the real reason why it is worn.

The necessity for a regulator of the body heat.—To a certain extent we can regulate the heat of the body by wearing heavy clothes in winter and lighter clothing when the weather is hot. Yet we cannot regulate the loss of heat from the body by clothing alone; for the temperature of the body must be kept constantly at one point, while the thermometer often runs up and down 20 or 30 degrees in a single day. There must, therefore, be some delicate regulator that will govern the loss of heat from the body according to the changes in the temperature of the air. This work is done by the skin.

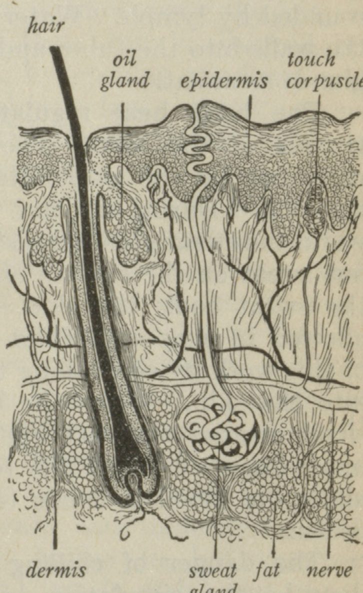


Fig. 85. A section of the skin.

The structure of the skin. The skin is composed of a tough outer layer called the *epidermis*, and of a deeper layer of connective tissue called the *dermis*. The outer cells of the epidermis are dead and are continually scaling off, but the cells in the lower part multiply and grow to take the places of those that are lost. The dermis contains the nerves of touch and great numbers of small blood vessels. Below the dermis is a layer of loose connective tissue in which a considerable quantity of fat is stored. This layer of fat helps to retain the body heat.

Hair follicles and sweat glands.—At certain points the epidermis is folded down into deep pockets called *hair follicles,* from the bottom of which the hairs grow. At other points *sweat glands* run down from the outer surface of the epidermis and lie coiled in the dermis. The sweat glands are hollow tubes, the lower ends of which are surrounded by lymph. Water from the lymph soaks through the walls into the tubes and flows out of the mouths of the glands as sweat.

The body heat regulated by the sweat glands and vessels of the skin.—The temperature of the body is regulated by the sweat glands and the small arteries of the skin. During the hot weather and when we do hard work, the sweat glands assist in cooling the body by pouring out sweat on the surface of the skin. The evaporation of the sweat cools the skin, just as alcohol cools it when allowed to evaporate from it. The arteries do their part of this work by controlling the amount of blood that comes into the skin. When the body is exposed to cold, these small arteries contract and keep the blood in the warm inner organs. When the body is heated, they relax and allow the blood to come to the surface, where it will be cooled.

The danger of chilling the body.—Chilling the body disturbs the circulation by driving the blood from the skin and congesting the inner parts of the body. This makes us especially liable to be attacked by the germs of pneumonia, influenza, and colds,—all of them germs that are often in the air passages waiting for a favorable opportunity to set up their growth. Wet footwear takes the heat out of the feet, thus causing the mucous membrane of the air passages and lungs to be gorged with the blood that ought to be in the lower limbs, and interfering with the germ-killing function of the white corpuscles. The wearing of rubbers when they are needed to keep the feet dry is a most important precaution in guarding against colds.

Danger of overheating the body.—Working in a hot, moist atmosphere is very exhausting, and it is almost impossible to keep up the health during the summer months, unless we can have air currents to blow away the hot air from about the body. Often these can be secured by sleeping and working outdoors, by opening windows, and by the use of ventilators and electric fans. Some persons do not yet realize that, from the standpoint of health, it is as important to keep cool in summer as to keep warm in winter. Accordingly, they are willing to pay large sums to heat the rooms in which they live and work in winter, but are not willing to spend a small sum for ventilators and electric fans to be used during the heat of the summer. Just as being chilled in winter makes us liable to attacks of influenza and pneumonia, so overheating in summer lowers our resistance to germs and makes us liable to attacks of diarrhoea, dysentery, and other summer diseases.

Suiting the clothing to the weather.—Men who are brought into hospitals suffering with sunstroke are often found to be wearing heavy coats and undershirts, and thick woollen trousers. Little babies in hot summer weather are often covered with "nettle rash" and "heat rash," because they are dressed in such heavy clothing that the skin is kept in an overheated condition. On the other hand, we often see people going without wraps and overcoats when the weather is so cold that the body heat can scarcely be kept up with the heaviest clothing. What we need to remember is that the object of dress is to keep the proper amount of heat in the body. In the spring and fall, especially when the weather is changeable, it is important that the weight of the clothing should correspond to the needs of the body.

Fig. 86. A Philippina wearing a costume that is attractive and well suited to a warm climate. The material of which the clothing is made is thin, and the large sleeves and open neck allow the heated air to escape from around the body.

Bathing.—One object of bathing is to cleanse the body. This we need not discuss. Bathing as it relates to health is mainly a question of the temperature of the water. Cold baths educate the vessels of the skin, so that they learn to open and close quickly and thus regulate the body heat properly. The importance of having the blood vessels trained to do this is better appreciated when we remember that animals in the natural state must adapt themselves only to changes in the weather, while man often passes in a few seconds from an artificially heated building into an outdoor atmosphere that is 30 or 40 degrees colder. When these quick changes from warm to cold air are made, the vessels ought to contract promptly and shut the blood off from the skin before too much heat is lost from the body.

The training of the blood vessels through cold baths is, of course, mainly a work of training the nervous system which controls the vessels, and if a person is weak and out of condition, a cold bath may have about the same effect on his nervous system that a long race would have on the muscles of a person not accustomed to taking exercise. In beginning to take cold baths, therefore, we must use care. They ought to be begun with water that is only cool, the bath should be short, and after the bath the skin should be rubbed briskly with a rough towel. Colder water may be used as the skin becomes accustomed to it, but in no case should the water be so cold or the bath so prolonged that the reaction fails to come promptly; for, when this is the case, the blood congests the inner organs and a headache is the usual result.

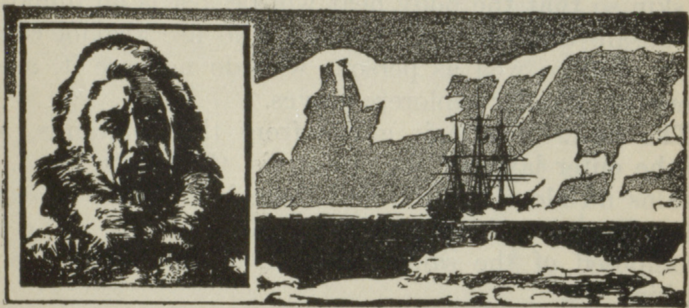


Fig. 87. Captain Roald Amundsen, who discovered the South Pole. Because alcohol lessens both the endurance of the muscles and the power of the body to resist cold, none of it was used on the Amundsen expedition.

It is the opinion of some physicians that certain delicate persons are never able to take cold baths without injury; that baths of this kind are injurious to any one who is in poor health or in a nervous condition, and that only those who are strong and in robust health can bear the shock of such a bath without injury. Others think that any one can train himself to take them with safety. This question we must leave to the physicians to decide.

Alcohol and the body heat.—In cold weather, taking alcohol causes a feeling of warmth, and men often take a drink to enable them better to endure cold. The feeling of warmth that is given by alcohol is deceptive. We feel cold when the blood has been shut off from the skin and warm when the hot blood from the inner parts of the body is flowing through the skin. Alcohol temporarily paralyzes the arteries of the skin and leaves them expanded. This allows the skin to become flushed with blood, and causes a sensation of warmth, but at the same time it allows the blood to be cooled and the body heat to be lost. When we are exposed to cold, the vessels ought to be contracted, and we ought to feel cold. Hence, to bring the blood into the skin so that the body heat will be lost is an unnatural and unsafe thing to do. Persons who use alcohol cannot endure cold so well as persons who do not use it, as the experience of polar explorers proves.

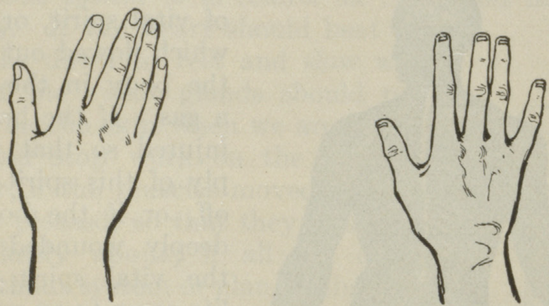
The hair.—The hair grows from the epidermis, and, like the outer layer of the epidermis, the hair is dead. It contains no blood vessels, and there is no sense of feeling in it. The growth of the hair is at the root. The hair is composed of the same material as the outer layer of the skin.

Each hair stands in a little pocket of the epidermis that is folded down deep into the dermis. Opening into this small pocket are little glands that pour out oil around the root of the hair. Brush your hair thoroughly, and it will become smooth and glossy from the oil that you work out from around the roots. Fine hairs are found all over the body, and the oil that comes from the glands at the roots of these hairs keeps the skin from becoming dry.

The care of the hair.—In the care of the hair nothing is so important as thoroughly brushing it. This brings the blood into the scalp and spreads the oil along the hair. The hair should not be wet every time it is combed, for the oil will be washed off, making the hair too dry. The head should be washed occasionally with good soap to cleanse the hair and remove scales and dirt from the scalp.

Dandruff is caused by germs growing in the oil glands and in the little pockets about the hairs. One person can get this disease from another, and for this reason public combs and brushes should not be used.

The nails and their care.—A nail is a portion of the outer layer of the epidermis that is very much thickened and hardened. Its growth is at the base. When a nail is lost a new one will grow in its place, if the bed on



Figs. 88 and 89. Well kept finger nails and finger nails that have been bitten off.

which the nails rests is not destroyed; but, if this bed has been destroyed, the nail will not grow again.

The nails should not be bitten off, nor should they be trimmed "to the quick," for this will spoil their shape and their appearance. They should be allowed to grow long enough to protect the ends of the fingers, and the space beneath the ends of the nails should be kept free from dirt. This is more a question of common cleanliness than it is of health; although it is a fact that bacteria multiply in the dirt under the finger nails, and inflammation sometimes is started in the skin by scratching with dirty finger nails.

CHAPTER XIV

THE NERVOUS SYSTEM

The work of the nervous system has always been a mystery to mankind. The ancient Greeks thought that the brain distilled some kind of vital spirit, or essence, which flowed out through the body in the form of a gas. If the brain were injured so that the supply of this spirit was cut off, or if the body were deeply wounded so that the vital spirit escaped, life came to an end.

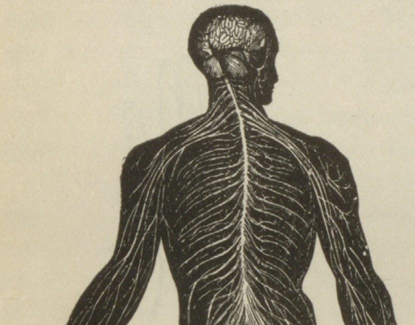


Fig. 90. The nervous system.

To-day we know a great deal more than the Greeks knew about the nervous system, but our knowledge of it is yet far from complete. We know enough, however, to help us greatly in the care of the body, and in this chapter we shall take up some of the facts concerning the nervous system that it is most important for us to understand.

The parts of the nervous system.—The nervous system is composed mainly of the *brain*, the *spinal cord*, and *forty-three pairs of nerves* that run out from the brain and the spinal cord to all parts of the body. It includes also many little masses of gray tissue, called *ganglia* (singular, *ganglion*), that are found among the inner organs of the body, and a great network of nerve fibres that run among these organs.

The function of the nervous system.—*The first function of the nervous system is to control all the organs and parts of the body.* If the heart should beat fast when we lie down to rest and slow when we run; if the sweat glands should pour out water on the skin when we are already freezing and stop work on the hot days of summer; if the muscles moved how and when they pleased, so that they jerked the body aimlessly about; if all the organs worked without system or plan, so that each part of the body carried on its activities without regard to the rest of the body, we should not have a working machine at all, but only a collection of organs and parts. A ruler must, therefore, be set over the whole body to keep all the parts working together properly. This ruler is the nervous system.

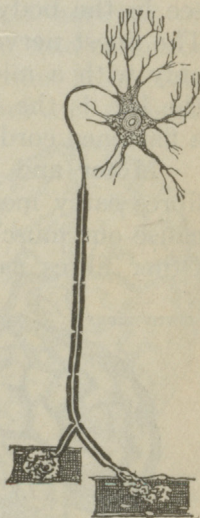


Fig. 91. A nerve cell and nerve fibre. At the lower end the attachment of the fibre to the muscle cells is shown.

The second function of the nervous system is to act as the organ of the mind. This function we shall discuss when we take up the study of the brain.

The nervous system composed of cells and fibres.—The nervous system is made up of *nerve cells* and of *nerve fibres.* The nerve cells are larger than most of the body cells, and have a gray color. Most of the nerve cells are found in the brain and spinal cord, but a few of them are found in the ganglia, which are little balls of nerve cells.

The nerve fibres connect the nerve cells with the other parts of the body. They have a glistening white color, but each fibre has a gray central part which carries messages to and from the spinal cord and brain. This gray core of the fibre is a branch of a nerve cell, and we may think of the nerve fibres as long branches of the cells which run out to all parts of the body. The white nerves that we see in the body of an animal are bundles of nerve fibres. The finest nerves contain but a few fibres and can be seen only with a microscope. The *sciatic nerve*, which runs to the leg, is the largest nerve in the human body. This is a flattened cord three-fourths of an inch across.

Motor and sensory nerve fibres.—Some of the nerve fibres carry messages from the brain and spinal cord that cause our muscles to move. These are called *motor* fibres. Other fibres carry messages from the skin, the eye, the ear, and other parts of the body to the brain. These messages cause us to feel, to see, to hear, and to understand the condition of all the parts of the body. They cause sensations in the brain, and the fibres over which they pass to reach the brain are called *sensory* fibres.

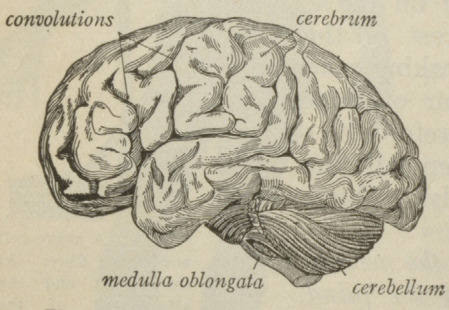


Fig. 92. The brain seen from the side showing the three principal divisions.

The brain.—The brain is a mass of very soft tissue weighing about fifty ounces and filling the cavity of the cranium (Fig. 3). It has three principal divisions, the *cerebrum*, the *cerebellum*, and the *medulla oblongata*. A general idea of the appearance of the different parts of the brain may be gained from Figure 92.

The cerebrum.—The cerebrum makes up more than three-fourths of the entire brain. It is divided by a deep groove into right and left *hemispheres*. The outside layer of the cerebrum is composed of nerve cells and, therefore, has a gray color. To make more room for these cells the whole surface of the cerebrum is thrown into folds, or wrinkles, that are called *convolutions*.

From the cells of the cerebrum a great network of fibres runs in all directions through the brain, and connects all its different parts with each other. Other fibres run down through the medulla into the spinal cord and connect the cerebrum with all parts of the body. Most of the motor fibres from the cerebrum are crossed in the medulla, so that the right side of the cerebrum is connected with the muscles of the left side of the body, and the left side of the cerebrum is connected with the muscles of the right side of the body.

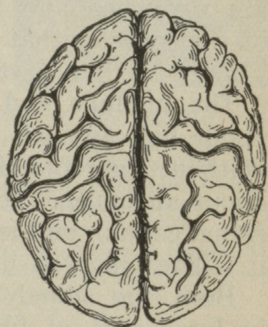


Fig. 93. The cerebrum seen from above, showing the hemispheres.

The function of the cerebrum.—*The gray outer layer of the cerebrum is the seat of all intelligence.* Without it all sensations of light, sound, taste, smell, touch, heat, and hunger are lost. When it is removed, all power of moving the voluntary muscles is gone. The cerebrum, therefore, is the part of the brain that thinks and feels. It is the part that causes us to remember and to know, to love and to hate, to be glad and to be sad. The cerebrum decides what we shall do; it sends out the messages to the muscles when we wish to move; and it governs the whole body. Without its cerebrum an animal can live, but all its intelligence is gone. It still breathes, and its heart continues to beat, but it is only a machine.

The cerebellum.—The cerebellum lies under the back lobes of the cerebrum. *Its function is to cause all the muscles to keep the proper tension and to assist in governing the muscles of locomotion.* In walking, more than two hundred muscles are used in holding the body upright and in moving the different parts that are brought into action Each of these muscles must contract with exactly the right force and at exactly the right time, or they will work against each other, and the right movements will not be made. When the cerebellum is injured, all the muscles are weakened and relaxed, and the person loses control of the muscles that support the body and move the legs. This causes him to stagger and reel like a drunken man.

The medulla and the spinal cord.—The spinal cord is about half an inch in diameter and eighteen inches long. Without the roots of the nerves that rise from it, it weighs about an ounce. It lies in the canal in the centre of the spinal column and is securely protected by the bones about it. The enlarged upper end of the cord is the medulla.

Both the spinal cord and the medulla are composed in large part of fibres that connect the brain with the different body parts. Some of these are sensory fibres, through which messages from the body are passed up to the brain. Others are motor fibres, over which commands from the brain pass down on their way to the different parts of the body. In addition, *the medulla contains the centres which govern the heart and lungs.* When the cerebrum of an animal is removed, the intelligence is lost; when the cerebellum is injured, control of the muscles is lost; but when the medulla is injured, life at once ceases, because the beating of the heart and the breathing stop.

Reflex action.—Much of the governing of the body by the nervous system is done without thought. The messages, or nerve impulses, pass through the sensory nerve fibres into the nerve cells, pass on through the branches of these cells into other cells that are touching them, and come out again by way of a motor nerve. An action that is caused in this way is called a *reflex action*, and it can best be explained by an example.

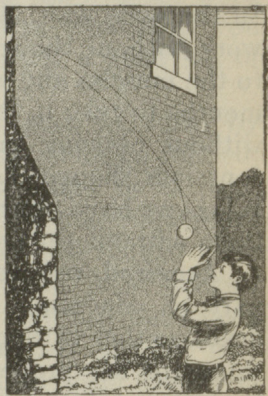


Fig. 94. The ball starts from the hand and comes back to it again. The impulse that causes a reflex action starts from the *outer end* of a sensory nerve and comes back to the muscle or gland that is thrown into action. *It does not start from the brain.*

Cross your legs, and strike yourself just below the kneecap with the edge of your hand. If you strike the right place, you will start messages to the spinal cord. These, without any thought whatsoever on your part, will pass into the motor nerves and down into the muscles of the leg. The muscles of the leg will then contract and cause the foot to jerk. *A reflex action is an involuntary action caused by an impulse that starts in a sensory nerve.* It is very different from the voluntary actions that are caused by impulses which start in the cerebrum and pass out to the muscles when we wish to move some part of the body. Practically all the governing of the internal organs of the body is carried on by reflexes.

Reflexes acquired through practice.—The reflexes that we have been discussing are natural reflexes; we are born with them. There is another set of reflexes that comes to us through practice. The skilled swimmer does not think how he shall move his arms and legs; in boxing, the hands move without thought and almost faster than the eye can follow; the telegrapher does not think about the combination of dots and dashes that spell out a word; he reads the message he is sending, and his hand does the rest. In the same way, all of us every day do a great part of our work without thought. We walk without giving attention to the muscles and parts which we must move; we open our mouths to take in food without thinking; we chew our food without noticing that we are chewing; we write without conscious thought as to the shape of the letters. All these things we have repeated so often that we have learned to do them without thought.

Acquired reflexes and education.—A very important part of education consists in establishing the right reflexes, so that without thought we shall do the more common things of life properly. A young person who is learning to write ought to learn to hold his pen in the right way and to shape the letters correctly, so that the right reflexes will be formed and the writing question settled for life. He ought to learn to group his words properly and to give the right inflection in reading, so that these matters will attend to themselves thereafter. He ought to take great care to say "please" and "thank you;" to modulate his voice so that it will not become loud and strident when he is talking eagerly; to take off his hat and to rise to his feet when he should do so; and to do all the other things that go to make up pleasant manners; for no one will ever have good manners who has not established reflexes that will make him able to do what he ought to do naturally and without thought of his actions.

When you are learning to do anything, the great thing is to do it right, so that you will form a reflex action of the right kind. Then, as long as you live, the part of your conduct and work that depends on this reflex will take care of itself, and you will be free to expend your energy on the new problems that arise day by day. The object of the training that you are receiving at home and in school is to make for you a set of tools with which to carry on the work of your life. If you wish to be a good workman, you must, first of all, manufacture for yourself a good set of tools.

Habits.—Habits are really reflexes that we form by repeating acts, and just as physical habits can be formed, so can moral habits and habits of the mind be formed. All kinds of habits are formed most readily in youth, and it is seldom that long-established habits are broken after the age of twenty-five or thirty. Indeed, it is difficult at any time of life to break a habit that has once been thoroughly established. It is because this is true that young people are so constantly urged to form habits of honesty, neatness, accuracy, and cleanliness. An investigation at Harvard University has shown that the students who do high-grade work in the schools of law, medicine, and engineering are students who did their work well before entering these schools; that it makes little difference what subjects they have studied previously, but that it makes a great deal of difference whether they have formed the habit of learning their lessons regularly and thoroughly, or of going through them in a lazy and careless way. The trifler in the lower grades of school is usually a trifler still in the high school, and very few high school drones ever become capable and industrious college students.

Just what it is that makes the nervous system want to keep on doing things in the same way, we shall not attempt to explain, but it is a well-known fact that what a man does in youth determines very largely what kind of person he will be in later life. If in youth he forms habits of dishonesty and laziness, he is almost certain to develop into an unreliable and unsuccessful man. If in youth he forms habits of honesty, industry, and promptness, he will probably become a trusted and a successful man. Rip Van Winkle was always intending to stop drinking, but when a glass was offered him, he would say: "We won't count this time"; so the time to begin his new life never came. There are many persons who have good intentions and are meaning to get down to work in the future, but their habits keep them loitering on in the same old ways. The importance, therefore, of forming correct habits in youth can hardly be over-estimated.

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.

Seven hygienic habits that you ought to form.—

1. Keep your teeth clean.
2. Eat moderately and chew your food thoroughly.
3. Breathe pure air whenever it is possible to do so.
4. Go to bed regularly at a reasonable hour.
5. Take proper exercise and hold yourself erect.

6. Learn to rest and to keep yourself calm.

7. Guard yourself, so far as you can, from disease germs.

Form these seven habits, and they will do more than all the medicines in the land to keep you in health.

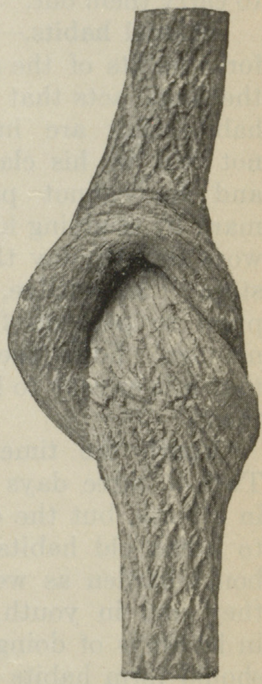


Fig. 95. Thirty-five years ago a young man tied this hickory tree in a knot. Now all the men in the world could not untie it. The habits that we form in youth are knots that we cannot untie in later years.

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 too much or by swallowing his food without chewing it. You will think it strange that any one should live in a thick, stuffy atmosphere, when there is pure air only the thickness of a window-pane away. 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 potters around when he ought to go to bed; and you will be amused when you see some one get excited over nothing and run around like 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.

Mental habits.—As we form habits of the body, so we form habits of the mind. And as it is the habits and not the single acts that are important to the body, so it is the habits that are important to the mind. A boy does not fail in his class because he misses school one day, and he cannot pass his examinations with a high mark by studying his lessons for one day. It is the steady work day by day that gives the training of the mind, the store of knowledge, and the habits of work that enable a pupil to pass up from grade to grade in a satisfactory manner. Form the habit of studying, and you will find that it is as easy to learn your lessons as it is to fail to learn them.

Youth the time when lasting habits are 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 bones harden as we become older, with whatever shapes they had in youth, so the nervous system becomes set in its ways of doing things as we advance in years. You should form habits that will carry you on in the road to health, and to respected, truthful, successful manhood and womanhood.

The habit of cheerfulness.—Cheerfulness improves the digestion, quickens the blood, and gives tone and vigor to the whole body. Care and discontent have exactly the opposite effects. It is most important, therefore, that we form the habit of meeting the world with a brave heart; that we learn to appreciate the sunshine of life, and to dismiss vexatious trifles and useless worry from our minds. The poet Robert Browning gave us both a beautiful song and a splendid philosophy when he wrote in his *Pippa Passes*:

"The year's at the spring
And day's at the morn;
Morning's at seven;
The hill-side's dewpearled;
The lark's on the wing;
The snail's on the thorn:
God's in His heaven—
All's right with the world."

CHAPTER XV

THE CARE OF THE NERVOUS SYSTEM

Suppose that you decide to raise your hand. The hand comes up. Can you explain exactly what makes it rise? It is in reality a very complicated action, and to make sure that you understand it, we will go through the different steps in it with you.

First of all, you decided to raise your hand. This was an act of the mind. Then nerve impulses, whatever they may be, were started out from the brain. These impulses travelled down through the medulla and spinal cord, passed out into the nerves of the arm, and finally entered the muscle cells. This caused the muscle cells to contract and lift the arm. The muscle did the work, but the nervous system decided what was to be done and caused the muscle to do it.

In all our other activities we find that the nervous system plays a guiding and controlling part. The regulation of the body heat; the secretion of the digestive juices; the excretion of the wastes; all these processes, as well as every movement that we make, are under the control of the nervous system. We must, therefore, keep the nervous system in health; for when it goes wrong in its work, the whole body suffers. Fortunately for us, our nervous systems are splendidly built, and, on the whole, they do their work faithfully and well. There are, however, certain points in the care of them in which many persons fail, and we ought to have an understanding of these points.

Sleep necessary for the nervous system.—The cells of the nervous system must have sleep to build themselves up for further work, and, so far as we know, they are the only part of the body that needs sleep. The amount of sleep needed varies greatly in different persons and in persons of different ages. A little baby may sleep as much as twenty-two out of the twenty-four hours. At six months of age he sleeps about sixteen hours. At seven years of age a child should sleep eleven or twelve hours; at ten or twelve years of age, at least ten hours. Older persons should take the amount of sleep that they find best for them. Occasionally a person is found who keeps in good health on four, five, or six hours of sleep. Other persons must have eleven or twelve hours. Each one should go to bed early enough not to feel sleepy when getting-up time comes; for there is no truth in the idea that one can have too much healthy sleep.[1]

Fig. 96. There is no truth in the idea that a person can have too much natural sleep.

Are you still tired and sleepy when you waken in the morning? Are you pale and languid and do you drag yourself through your work? If you are, it may be because you are cutting your sleep short; for there are thousands of people who are starving for sleep as truly as other people are starving for food and fresh air. If you have fallen

[1] Illness and poisons absorbed from the intestines cause drowsiness. When a person is sleepy from one of these causes, the condition is, of course, an unnatural one.

into a habit of staying up late in the evenings, break this habit and go to bed early. A runner or a baseball team that has been losing sleep has not the slightest chance of winning from others of equal ability who have had a sufficient amount of it. This is because the nervous system, when it lacks sleep, is out of condition and cannot control the muscles as it should.

Rest necessary to the health of the nervous system. A great amount of nervous energy is required to drive the more than five hundred muscles of the body, and when we study or do other brain work, it is the nervous system that is called into action. In either physical or mental work, therefore, we tire the nervous system, and we ought not to continue either until our cells are poisoned with the "fatigue toxins" that appear in the body in cases of exhaustion.

Factory workers who are forced to speed themselves up to machines, and little children in schools where the recitation periods and the school days are too long, suffer from fatigue and cannot do their best work. Many earnest, ambitious individuals who are trying to do the very best work of which they are capable, injure themselves and lower their working power by keeping their nervous systems exhausted.[1] In general, it has been found best to work hard during regular working hours, and then to have rest periods when something entirely different is done. In schools there should, therefore, be rest and play periods for young children, and older persons ought to work certain hours every day and then for a time have a different kind of occupation.

[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.

Fresh air helpful in resting the nervous system.—A nerve fibre from a frog will carry impulses all day without fatigue if it is exposed to the air so that it can take in the oxygen that it needs. If the supply of oxygen be cut off from it, however, it soon becomes exhausted. Undoubtedly children in open-air schools can do more work without becoming tired than can children in indoor schools, and it is the belief of those who sleep in the open air that they need about an hour's less sleep than they require if they sleep indoors. These facts indicate that fresh air is an aid in preventing exhaustion, and that tired nerve cells are more quickly rested and built up when the body is given plenty of outdoor air.

A peaceful mind necessary for health.—In our study of the nervous system we must always keep in mind that it has the double function of governing the body and of acting as the organ of the mind. It is perhaps economical to have these two different kinds of work done by the same system, but this plan has its drawbacks as well as its advantages; for the condition of the mind greatly affects and sometimes interferes with the proper regulation of the body.

Good news or bad news may greatly change the beating of the heart. A toy that pleases a child will cause his whole body to tingle with pleasure, and will cause impulses to pass out to his muscles that will make him laugh and clap his hands. Food that is pleasing to the taste, or even the sight or smell of food, will cause the "mouth to water," which is another way of saying that it causes the digestive juice to flow from the salivary glands. Experiments on a dog have shown that the sight and smell of food, even though the food does not reach the stomach at all, causes an abundant flow of the digestive juices in the stomach; while in a dog that was made angry by having a cat placed near it when it was eating, the flow of the juice in the stomach was interfered with for two whole days. All these facts show that anger, sorrow, and worry interfere with the proper action of the body; that the mind greatly affects the body; and that a cheerful, quiet, hopeful mind is necessary for health.

At the same time, we must realize that sickness is a real thing, and that when it comes upon us we cannot depend upon the mind alone to restore us to health. When a child has diphtheria, only antitoxin will save its heart from being poisoned, and when tuberculosis attacks the lungs, good food, fresh air, and rest, as well as cheerfulness and hope, are needed if the body is to make a winning fight against the germs. When the kidneys have been poisoned by scarlet fever or by the use of alcoholic drinks, nothing that we can think about them will make them able to throw the wastes out of the body as a pair of sound kidneys are able to do. The mind cannot take poisons out of the body; it cannot kill germs that get into the body. These things the body must do for itself, and all that the mind and the nervous system can do is to help to keep each organ of the body at work at its particular task.

Nevertheless, it is true that the nervous system rules the whole body; that when the nervous system goes wrong, the whole body goes wrong; and that just as food, fresh air, exercise, and rest are necessary to the health of the body, so a peaceful, hopeful mind is necessary in order that the nervous system may remain in health and regulate all the body parts properly.

CHAPTER XVI

THE EYE

Many of the messages which travel up the nerves to the brain are started within the body itself, and cause sensations that tell us about the condition of the body. Examples of sensations of this kind are sleepiness, fatigue, weakness, faintness, hunger, thirst, and nausea.

Others of the messages that come to the brain are started in the nerves by things that are outside the body, and these messages bring us information about the outside world. The nerves that carry these messages are the nerves of *sight*, *hearing*, *touch*, *taste*, and *smell*. Seeing, hearing, touching, tasting, and smelling are the five special senses, and the eye, the ear, the nose, the mucous membrane of the mouth, and the skin are the special sense organs.

The brain dependent on the sense organs for information. Through the special sense organs we learn all that we know of the world about us, and when anything interferes with the proper working of these organs, much information that ought to come to the brain fails to reach it. Many children who are thought to be stupid are dull, not because they have slow brains, but because their eyes and their ears are not quick in gathering the information that is necessary to make them intelligent. We must learn to care for our sense organs, especially for our eyes and ears, for without them the brain sits in idleness, and is no more certain of what is the right thing to be done than is the commander of an army whose scouts bring him no news of the enemy's movements.

The nerves in the eye stimulated by light.—Light is waves in the ether which fills all space, and the eye is an instrument so constructed that, when light enters it, the nerves of sight are stimulated, and messages are started to the brain. These messages give us a series of pictures of the world about us, from which we learn about the color and the form of objects, about their movements and their nearness to us. From these pictures much of our knowledge comes. Much of the pleasure also that we have in the world comes from them; for, just as music starts messages from the ear that give pleasure to the mind, so beautiful objects start messages from the eye that are pleasing to us. Years ago, a great man of science suggested that we should have concerts of beautiful colors for the eyes as well as concerts of music for the ears. Such concerts have already been attempted.

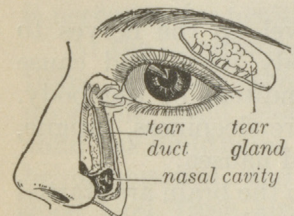


Fig. 97. The tear gland and the duct that carries the tears to the nose.

The protection of the eyes.—The eyes are protected from blows by the deep sockets in which they lie, and by cushions of fat on which they rest and turn. They are protected from dust and sweat, and screened from light, by the eyelids, the eyelashes, and the eyebrows. In the outer corner of each of the upper eyelids is a small gland which secretes the tears. These flow across the eyes to the inner corners, and run down a little duct into the nose. In their passage across the eye, the tears wash away dust and germs. In the eyelids are glands, very similar to the glands that oil the hair, which pour out oil along the edges of the eyelids. Sometimes these glands become diseased, and the secretion from them dries and forms scales around the roots of the eyelashes. The trouble in cases of this kind is that germs are growing in the gland. Dropping a solution of boracic acid (as much as will dissolve in water) into the eyes will help to kill the germs.

The muscles of the eye.—The eye is moved about by six muscles. The back ends of these muscles are attached to the eye sockets. The front ends are attached to the ball of the eye. These muscles can turn the eye in, out, up, or down. It is not necessary always to turn the head toward an object which we wish to see; for the eye muscles can turn the eye toward it while the head is at rest.

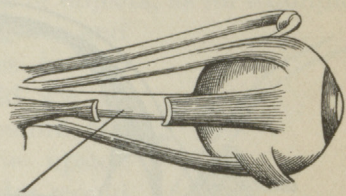


Fig. 98. The muscles that move the eye.

In some persons from birth the sight of one eye is better than that of the other eye. Such a person may fall into the habit of using only his good eye, and the muscles of the weak eye will not turn it toward the objects that he looks at. A person whose eyes behave in this way is said to squint, or to be cross-eyed. Usually the trouble can be remedied if it is taken in time, but if it is not attended to in very early life the sight of the defective eye will be lost. A little child with this trouble should, therefore, have proper treatment at the earliest possible date.

The structure of the eye.—The eye has a tough, white outer coat called the *sclerotic* coat; a dark middle coat called the *choroid* coat; and lining the back two-thirds of the eye, a delicate inner coat called the *retina*. The front part of the sclerotic coat, which is called the *cornea*, is transparent like glass, and we look out, or rather the light comes in, through a little window that is like a small round watch crystal on the front of the eye.

Inside the eye is found a circular, clear structure called the *lens*, which is fastened by ligaments to the choroid coat. The lens and the ligaments that support it divide the eye into a small front chamber and a large back chamber. The front chamber is filled with a watery liquid, called the *aqueous humor*. The back chamber contains a clear jelly-

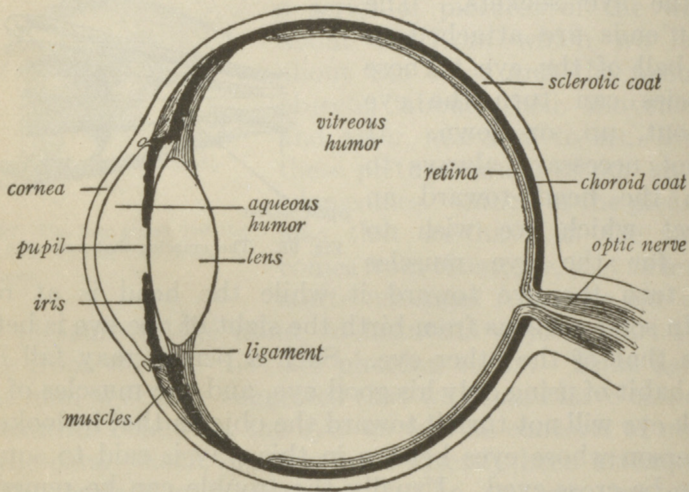


Fig. 99. A diagram showing the structure of the eye.

like substance called the *vitreous humor*. The nerves of sight enter at the back of the eye and spread out in the retina. The light reaches these nerves and starts messages in them by passing in through the cornea, the aqueous humor, the lens, and the vitreous humor, and striking against the retina.

The iris and the pupil.—The front part of the choroid coat is called the *iris*. This shows through the clear cornea, and the person is black-eyed, brown-eyed, or blue-eyed according to the color of his iris. In the centre of the iris is a circular opening called the *pupil*. Through this the light passes into the eye. Muscles in the iris regulate the size of the pupil according to the brightness of the light. Examine your own eyes after being in a bright light and again after being in a weak light, and you will have no trouble in seeing the difference in the size of the pupils.

The image formed by the lens on the retina.—If you were to focus a camera on a group of objects, as for example a house with trees surrounding it, and then look at the ground glass in the back of the camera, you would see an image of the scene that lies before the camera. The image would be upside down, and the right and left sides would be reversed, but the house and the trees would be there, each with its own colors, and each in the right position in the group. The lens in the front of the camera forms this image by gathering up all the light that comes into the camera from each of the objects, and bringing the rays together so as to form a picture of all the objects.

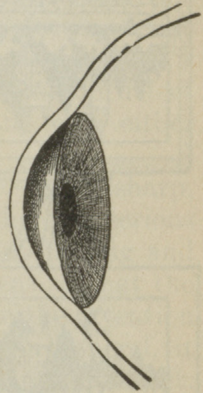


Fig. 100. The iris and the pupil.

In the same way, the lens of the eye forms on the retina images of the objects that we see. In the eye, as in the camera, the images are upside down, but they are there in their proper colors, and the different objects have the right sizes and the right positions in regard to each other. This picture of whatever we are looking at starts impulses in the nerves of sight to the brain, and when these messages are received by the brain, we form judgments about the size, color, and form of the objects, and say that we see the objects. By means of the images in the eyes we can judge also of the distances of objects from us, of their movements, and of their smoothness or roughness.

The shape of the lens changed in looking at far and near

objects.—In looking at a near object the lens of the eye must be rounded up, and in looking at a far object it must be flattened. This rounding and flattening of the lens is done by little muscles in the eye which loosen and tighten the ligament that supports the lens. If you should fill a small sack with water and then pull on the ends of the sack, you would flatten it; and if you should then stop pulling on the ends of the sack, the sack would of itself round up. So in the eye, when the ligament is loosened, the lens becomes rounder. This change in the shape of the lens is called the *accommodation* of the eye, because by it the eye is accommodated to the nearness or farness of the object.

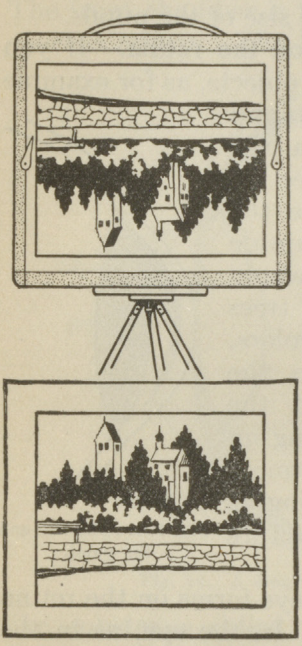


Fig. 101. The lens in the camera forms inverted images on the ground glass in the back of the camera.

Near-sightedness, far-sightedness, and astigmatism.—In a camera, if you move the lens too far forward or backward, the image becomes blurred. So in the eye the image will not be clear and the vision will not be distinct, unless the lens is the right distance from the retina.

The eyes of some persons are too long from front to back. In such eyes the lens is too far from the retina, and the image is indistinct. These persons see near objects better than far objects, and they are therefore said to be near-sighted. Any one who bends over his book in reading, or who holds his book less than twelve inches from his eyes, is near-sighted.

The far-sighted eye, on the other hand, is too short from front to back, and the lens is too close to the retina.[1] Persons with eyes of this kind see distant objects best, and they are said, therefore, to be far-sighted.

In other eyes, the curvature of the cornea is not the same in all its parts; that is, some parts of it are flatter than other parts. Rays of light that pass through this uneven cornea cannot all be brought to a focus at one point, and a clear image is impossible in such an eye. This trouble is called *astigmatism*. It is a very common defect in the eye and may be found alone, or along with either near-sightedness or far-sightedness.

Necessity for a clear image in the eye.—If a sharp, clear image is not formed on the retina of the eye, serious troubles follow. The muscles in the eye keep pulling and working to try to change the shape of the lens so that the vision will be clear; in reading it is a strain on the attention to tell what letters are in the words, and, in general, it makes all work that requires close attention more difficult. This overworks and deranges the nervous system, and soon the health of the whole body is injured. Two of the most common symptoms of eye-strain are headache and trouble with the digestion, often accompanied by dizziness and vomiting.

The importance of spectacles.—It is often said that the great amount of close work that people now do injures their eyes, and it is insisted that the eyes of school children in particular are damaged by the work that they are required to do. There is doubtless some truth in this statement, but it is also true that many eyes are naturally defective.

There should be in every class room in Canada a Snellen's Eye Test Card, and teachers in training in the

[1] In some cases of near-sightedness and far-sightedness the trouble may be in the shape or the refracting power of the lens.

Normal Schools should be taught how to use it. Teachers will then be able to advise their pupils as to whether it is necessary for them to consult an oculist regarding their vision. The great value of properly adjusted glasses to pupils who have defective vision can scarcely be estimated. They not only give clearer vision and relieve eye-strain, but they also relieve a strain on the entire nervous system.

Eye trouble among school children.—Do you hold a book close to your eyes when you are reading? Are you falling behind in your school work because you cannot see what is written on the blackboard? Do your eyes smart and ache after you have been studying for some time? Are they red and inflamed? Do you have headache or stomach trouble? If so, try to have your eyes examined and to get glasses if you need them. It is a mistake to think that going without glasses will help a person to outgrow eye trouble. It should be understood, however, that the fitting of the eye with glasses is a skilled task, and that it is a mistake to buy glasses from a store or to go for them to any one who is not an expert in correcting the defects of the eye.

Fig. 102. This boy carries his head on one side because of eye trouble. He needs to be examined by some one who is skilled in treating the defects of the eye. (*After Gould.*)

The eyes injured by disease germs.—In measles, scarlet fever, and smallpox, the germs grow in the eyes. During the progress of these diseases the eyes should be rested and shielded from a bright light, and when the eyes have been severely attacked, they should not be used until recovery is complete. "Pink-eye" is a highly infectious disease that often leaves the eyes red and inflamed for life. It is spread by germs that are passed from one person to another, and a child with "pink-eye" ought not to be in school. *Trachoma* is another germ disease of the eyes that is greatly to be feared. It is infectious, and it is unsafe to be around a person who is suffering from it. Do not wash your eyes in a public wash-basin; do not touch a public towel; do not touch your eyes with dirty hands; and do not touch the hands, the pencil, or the books of any person who has sore eyes.

Figs. 103 and 104. Before and after being fitted with glasses.

Importance of a good light while working.—To read or to work by a dim light is very injurious to the eyes. Too bright a light also is injurious, especially if one faces it, and a flickering light of any kind is bad. In writing one ought to sit so that the light comes over the left shoulder; for then the shadow of the hand will not interfere with the work. Facing a window in the daytime, or a lamp at night, is hard on the eyes. Reading on into the twilight is a great strain on the eyesight, and one ought not to seat himself carelessly too far from the light when doing close work at night.

One difficulty when the light is too dim is that the work is kept so close to the eyes that there is a great strain on the muscles that turn the eyes inward; for the closer an object is to the eyes, the more must the eyes be turned inward to focus both of them on it at the same time. Keeping the work close to the eyes is especially injurious in the case of little children; for their eyes are soft and easily pulled out of shape, and the muscles tugging at the eyes to turn them inward spoil the shape of the globe of the eye and cause astigmatism. To prevent this, school books for

Fig. 105. A good light while reading is important.

young children ought to be printed in type large enough so that the children will not have to keep the books close to their eyes while studying, and school rooms should be well lighted. The rule in erecting modern school buildings is to allow from one-sixth to one-fourth as much space for windows as there is floor space in the room. Ribbed glass used in the upper sashes assists very greatly in spreading the light evenly over the room.

Resting the eyes helpful and overtaxing them injurious. When we have been reading or doing other close work for some time, it benefits the eyes greatly to stop for a few moments and look at a distant object, or to gaze into the distance without looking at anything in particular. Reading on a moving train or a street car quickly tires the eyes, because the distance between the book and the eye is constantly changing, and the muscles in the eye are kept busy changing the shape of the lens. Reading while lying down is also hard on the eyes, because the book or paper is often held in such a position that the eyes must be strained to see it. If you read while travelling or while lying down, rest your eyes occasionally, and stop the reading before the eyes have become fatigued.

Foreign bodies in the eye.—When a particle of dust or other foreign body gets into the eye, *the eye should not be rubbed.* Sometimes the body can be washed out with clean water; or if the upper eyelashes are taken between the finger and the thumb and the eyelid drawn down and out, the position of the body may be changed until it can easily be removed. Some persons are skilful enough to turn the eyelids wrong side out and wipe the particle off with a cloth or a tuft of cotton. When this is done, the fingers, the cloth, and everything that touches the eye should be absolutely clean, for it is an easy matter to get into the eye germs that will cause great trouble. Sharp pieces of metal ought to be removed by a physician or an oculist before they cut deep into the eye and start inflammation.

CHAPTER XVII

THE EAR

Doubtless you have seen a flash of lightning fall from the sky, and have stood and waited until the rolling of the thunder came to your ears. What was it that came to your eyes and caused you to see the lightning? It was waves in the ether.[1] What was it that came to your ears and caused you to hear the thunder? It was waves in the air. Why can you not see the thunder? It is because the eye is not affected by waves in the air; only ether waves can stimulate the nerves of sight. Why is it that you do not hear the lightning? It is because ether waves do not affect the ear; only air waves stimulate the nerves of hearing.

Through the ear the confusion of air waves that comes from the instruments of an orchestra is transformed into music; through it we are able to understand the thoughts of a friend when he, by speaking, sends a series of air waves to us across a room. In the whole body there is nothing more wonderful than this instrument that has been given us to catch the waves in the air and carry their motion to the nerves of hearing, which lie deep in the bones of the skull. There are three main divisions of this organ,—the *outer*, the *middle*, and the *inner* ear.

The outer ear.—The outer ear is composed of cartilage covered with skin. It catches the sound waves and turns

[1] Ether is an invisible, elastic fluid that fills all space. Light, the electric waves that are used in wireless telegraphy, and the X-ray are waves in the ether. They run with almost incredible speed, light travelling at the rate of 186,000 miles a second. Air waves are very much slower than ether waves, sound waves travelling only about 1120 feet a second.

them down a winding canal to the middle ear. When a dog, a horse, or a rabbit is listening, it holds up its ears to catch the sound waves, and a man sometimes puts his hand behind his ear to help in catching the sound and turning it into the ear.

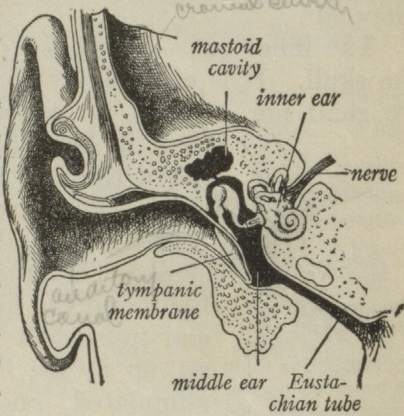


Fig. 106. Diagram of the ear.

The middle ear.—The middle ear is a little drum-shaped cavity in the bone of the skull. It is filled with air, and is connected with the throat by the Eustachian tube. At the inner end of the canal that leads inward from the outer ear is a little membrane called the *tympanic membrane*. This stretches like a thin skin across the bottom of the canal and separates the outer ear from the middle ear.

The bone of the skull behind the middle ear is spongy and has a cavity in it which is called the *mastoid cavity*. This opens out, like a little chamber, from the middle ear, and when germs infect the middle ear they often reach the mastoid cavity also. This trouble is called *mastoiditis*. In cases of this disease there is always danger that the germs will find their way to the brain and cause meningitis.

The bones of the ear.—Across the middle ear a chain of three small bones stretches from the tympanic membrane to the inner ear. These bones are called from their shapes the *malleus* (hammer), the *incus* (anvil), and the *stapes* (stirrup). The malleus is fastened to the tympanic membrane; the stapes fits into an opening that leads into the inner ear; and the incus is between the malleus and the stapes (Fig. 107). After we have studied the plan of the whole ear, we shall learn how these bones carry the motion of the sound waves from the tympanic membrane to the inner ear.

The inner ear.—The inner ear lies deep in the bone of the skull. It is exceedingly complicated in structure, and we shall not attempt to explain it further than to say that it has three parts,—a central part called the *vestibule*, a coiled part called the *cochlea*, and three *semicircular canals* at the back that wind through the bone of the skull. The entire inner ear is filled with a fluid, and the fibres of the nerve of hearing end in such a way that when waves are set up in the fluid, the nerve endings are stimulated, and messages are started in them to the brain.

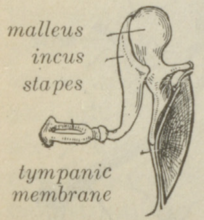


Fig. 107. The chain of bones of the ear connecting with the tympanic membrane.

How a sound wave starts a message to the brain. When a sound wave strikes the outer ear, it is turned down the canal leading to the inner ear; it then strikes against the tympanic membrane and starts it to swinging out and in. This puts the malleus, the incus, and the stapes in motion, and the stapes is pushed in against the liquid in the inner ear. This sets up waves in the liquid, and the beating of these waves stimulates the nerves of hearing and starts messages to the brain. When these messages reach the brain, we hear the sound.

If the waves in the air are large and strike violently against the tympanic membrane, so that large waves are set up in the fluid in the ear, we say that the sound is loud. If the waves are small, so that the tympanic membrane and the chain of bones swing gently to and fro, the nerves are stimulated only a little, and the sound is soft. Within the inner ear is a wonderful mechanism which is so arranged that a sound having one pitch will start messages in one set of nerves, and a sound having a different pitch will start messages in another set of nerves. By this arrangement the brain is able to tell the pitch of the different sounds that come to it.

Earache and running ear.—Practically all ear troubles are in the middle ear and are caused by germs. These germs work their way from the throat into the ear through the Eustachian tube, and they grow in the lining of the middle ear and about the little bones, much as they grow in the nose when we have catarrh. Frequently, in diseases like colds, grip, scarlet fever, measles, and diphtheria, the ears become infected, and in these cases it is most important that a physician give them early and proper care. Often it is adenoids that start ear trouble, and in chronic cases of earache or running ears, adenoids should be looked for.

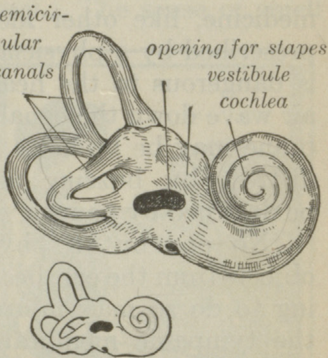


Fig. 108. The inner ear. The lower figure shows the natural size of the inner ear.

It is not right to allow children to suffer needless pain from ear troubles, and they ought not to be left to outgrow them; for a running ear already has a hole through the tympanic membrane, and the hearing is in danger of being lost. Nearly all deafness in older persons is due to the fact that, when these persons were children, germs were allowed to grow in the ears until they injured the tympanic membrane or the bones that carry the motion of the sound waves to the inner ear. Sometimes the membrane or the chain of bones is broken down or destroyed. Sometimes the trouble is that the membrane is thickened and stiffened, or the chain of bones is stiffened at the joints until the movement in it is wholly or partly lost. Among grown persons about one-third have the hearing affected in one or both ears. This could be prevented by attending to the ears at the proper time.

Other points in the care of the ear.—Quinine, if taken for a considerable time, may cause deafness, and this medicine, like other medicines, should be used only when prescribed by a physician. A blow on the side of the head is dangerous to the hearing; for it may send so strong an air wave down the canal of the ear that the tympanic membrane may be broken. Live insects in the ear cause great distress by buzzing and moving about. They should be drowned by pouring warm oil into the ear.

No one but a physician should attempt to remove objects from the ear, because an unskilled person in attempting to do so may injure the lining of the canal, or break the tympanic membrane. In the canal of the ear there is a bitter wax secreted to protect the ear from insects. Children sometimes form a habit of picking at their ears with the head of a pin or other object. This causes the lining to become inflamed and the wax to be secreted too abundantly. One physician has said, "You should never thrust anything smaller than your elbow into your ear," and another has added, "Before you thrust your elbow into your ear you should wrap your coat around it." If wax accumulates until it becomes troublesome, a physician should be consulted.

CHAPTER XVIII

THE ORGANS OF TOUCH, TASTE, AND SMELL

The sight and the hearing are especially important because they give us knowledge not only of near objects, but also of objects that are far away. The sense of smell may also give us information of an object when it is at a distance; but, in the main, this sense, as well as the sense of taste and the sense of touch, is valuable because it enables us to judge of objects that are near at hand.

Fig. 109. A blind girl reading by sense of touch.

There is not much that we can learn about any of these senses that is important from the standpoint of health. It is interesting, however, to know something of the way in which the messages that cause the sensations of touch, taste, and smell are started in the nerves, and to understand something of what we learn through these senses. In this chapter we shall, therefore, study the organs of touch, taste, and smell.

Touch.—The sense of touch is the most widely distributed of all the senses, for we can feel through the skin on every part of the body. Through the sense of touch, even better than through the eye, we can learn the form of objects; through it we can tell whether objects are smooth or rough, whether they are hot or cold. Blind persons learn to read by passing the finger tips over raised letters, and persons who are both blind and deaf gain through the touch much of the information that comes to others of us through the eye and the ear. The touch, therefore, is a sense that is not only at all times highly useful to us, but one that can be further educated and in time of need called into use to take the place of other senses.

The endings of the nerves of touch in the skin.—The dermis, or lower layer of the skin, is thrown up into little peaks called *papillae* (singular, *papilla*), that stand up under the epidermis. Some papillae contain a great network of little blood vessels. Others contain a *touch corpuscle*, which is a little group of cells with a nerve fibre winding about through it and ending in it (Fig. 85). Other fibres of the nerve of touch divide at the outer end into many little branches which end freely among the lower cells of the epidermis, or spread out into little saucer-like structures around the bases of some of these cells (Fig. 86).

Fig. 110. A nerve fibre ending around the bases of the cells in the epidermis.

The nerves of touch are especially abundant in the fingers, lips, tongue, and tip of the nose, and in these places the sense of feeling is most acute.

Messages started by pressure in the nerves of touch. When we touch anything, the epidermis is pressed down on the ends of the nerves of touch. This starts impulses to the brain, and when these impulses arrive in the brain they cause us to feel. If all the nerve endings that are being stimulated have the same amount of pressure on them, we know that we are feeling a smooth surface.

If some of them are being pressed harder than others, we know that the surface is rough. When we are touching an object, we know where the object is, because we know from what part of the body the messages are coming. We know whether the object is large or small by the extent of skin surface that is touching it, and by the distance that we must move our hands to pass them over it. If you lay your hand against the wall, messages come in from the whole front of the hand, and you judge that you are touching one large object. If you feel two objects, like the points of two pencils, you know that there are two of them because the messages come from two places in the skin with a space between them in which the nerves are not being stimulated.

Mistaken judgments concerning objects that we touch. The mind can make mistakes in judging of the messages that come in through the nerves of touch as well as in forming judgments from the messages that come in through the eye. Cross your fingers and rub them across the tip of your nose so that the nose is between the two fingers. Can you explain why you seem to feel two noses?

Taste.—The nerves of taste are in the mucous membrane of the tongue and of the back part of the mouth. Before anything can be tasted, it must first be dissolved. Then it works its way down among the cells and starts impulses in the nerves of taste. When these impulses reach the brain, we learn whether the object has a sweet, sour, bitter, or salt taste. Many of the supposed tastes of foods are in reality odors; and when, because of a cold or for other reasons, the sense of smell is dull, many foods are practically tasteless. The continual use of tobacco, alcoholic drinks, and strong condiments, like pepper and tabasco sauce, permanently diminishes the sense of taste.

biting sauce made from a variety of mexican pepper.

The sense of smell.—The sense of smell is probably the keenest of all our senses. It is likely that it is of use chiefly to judge whether or not our food is in proper condition to be eaten, and to tell whether air is fit to be breathed. Lower animals, like the dog, have this sense so highly developed that they can follow the track of a man or other animal many hours after the trail has been made. Among men, individuals differ greatly in the sharpness of their sense of smell.

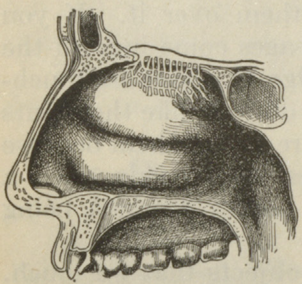


Fig. 111. The nerve of smell ending in the mucous membrane of the nasal chamber.

The nerve of smell stimulated by particles in the air.—What we call an odor, or a smell, is, in reality, little particles of matter floating in the air. These particles come from a rose, from our food, or from anything that we smell, and are drawn up into the nasal chambers with the air. In the mucous membrane that lines the upper part of these chambers are found the *olfactory cells*, from which nerve fibres run to the brain. When odors come in contact with the olfactory cells, impulses are started that cause the sensation of smell.

Care of the organ of smell.—When the delicate olfactory cells are destroyed, they are not renewed, and the sense of smell is permanently lost. They may be destroyed by inflammation, which is often brought on by inhaling dust or by working among the fumes of acids or other chemicals. Exhaling cigarette smoke through the nose is also very injurious to the cells, and many cigarette smokers have little or no sense of smell. Another common cause of the loss of the sense of smell is catarrh, which ought always to be treated by a good physician and not allowed to run on from year to year. When the throat is blocked by adenoids, the odors of foods cannot enter the nose as they should, and the pleasure of eating is to a considerable extent lost. The sense of smell is valuable to us both because of the pleasure that we receive from agreeable odors and because of the warnings that come to us in the way of disagreeable odors, and we ought to try to keep it in as good working condition as possible.

CHAPTER XIX

TOBACCO

When Columbus returned from the West Indies, he reported that the natives carried with them to kindle fires a brand made by rolling in corn husks the leaves of a certain herb which they cultivated. He also reported that they perfumed themselves with the leaves of this herb, and that no treaty of peace could be ratified among the Indians without smoking the herb in a pipe, because they believed that when the smoke of its burning ascended to heaven the Great Spirit smelled a sweet savor and was pleased.

Fig. 112. The peace pipe.

The use of this Indian herb became popular in England through the influence of Sir Walter Raleigh, and the custom of using it spread rapidly through Europe in the seventeenth century. At first it was thought to have medicinal value, but in a short time men of intelligence and high position came to think of it as a dangerous drug and became alarmed as to the consequences that would follow its widespread use.[1] A great movement against the new

[1] During the seventeenth century the plague, or "Black Death," ravaged Europe, and it was generally believed that smoking was a safeguard against this disease. It is possible that there was some foundation for this belief; for the plague is spread by fleas that come from plague-infected rats, and it may be that fleas dislike the odor of tobacco that is present on the clothes and skin of tobacco users.

custom then sprang up over all the known world. In Turkey the pipes of smokers were thrust through their noses; in Russia the noses of smokers were cut off, and those who repeated the offense were put to death; the church threatened the users of the weed with excommunication; and King James of England issued a protest against its use, in which he declared it to be "a custom loathsome to the eye, hateful to the nose, harmful to the brain, dangerous to the lungs, and in the black, stinking fume thereof nearest resembling the horrible Stygian smoke of the pit that is bottomless".

Why the habit of using tobacco is so widespread.—In spite of all the opposition that has been offered to it, tobacco is now used over practically the whole world. Of course, if people spend their money in this way, it means that they will be compelled to go without food, clothing, furniture, books, music, and other things that for their health, comfort, and richness of life they ought to have. In India all ages and both sexes are constant smokers, and in China many of the workmen carry with them as their constant companions a supply of tobacco and a pipe. Yet in India and in China the great mass of the people toil for a miserable wage that will hardly keep them alive, and in years of crop-failure hundreds of thousands of them actually perish for lack of food.

Why do men put this extra burden on themselves? Why did the Indians that Columbus saw perfume themselves with the odor of tobacco? Why do men now engage in the seemingly foolish custom of drawing smoke into the mouth and puffing it out again? Let us search out the answer to this problem.

Nicotine.—There are certain drugs that produce such pleasurable effects on the mind that people form the habit of taking them to experience these effects. Among these drugs may be mentioned hasheesh, which comes from Indian hemp and is used by the people of India. It produces a kind of intoxication and fills the mind with the most brilliant ideas of grandeur and power, causing the most pitiful specimen of humanity to feel himself a very king among men. Alcohol has something of this same effect, for it deadens the judgment and the critical powers of the mind and causes a person to regard his own efforts as brilliant, even when there is no ground for a high opinion of what he has done. Opium deadens the sensibilities to pain and produces sensations of delicious ease and luxury. Cocaine, chloral, and a few other drugs produce effects that are pleasant to the mind, and men fall into the habit of taking them. The most widely used of all these drugs, however, is nicotine, which is present in tobacco. The sensations produced by it will be discussed in a later paragraph.

Nicotine a narcotic.—Physicians speak of certain drugs as *stimulants* and of certain others as *narcotics*. Stimulants quicken the action of the protoplasm of the cells; they make the muscles contract more strongly and cause the nervous system to conduct impulses better and to control the body with a firmer hand. Narcotics deaden the nervous system and weaken its action; they slacken the muscles and lessen their strength. Strychnine is a good example of a stimulant. It is given by physicians when the heart action flags and when there is general weakness and collapse. Opium is an example of a narcotic. It is given by physicians to dull the senses to pain and to quiet those whose nervous systems have been overwrought. The nicotine that is in tobacco is a narcotic, and it is so strong that a few drops of it introduced into the mouth will paralyze the nervous system and stop the beating of the heart.[1] We

[1] Tobacco is from 1 to 4 per cent nicotine. In chewing, only a small part of the nicotine in the tobacco is absorbed into the body, and in smoking, most of the

shall now discuss some of the more important effects of nicotine on the body.

The effect of tobacco upon the heart.—Tobacco contains a poison called nicotine, which is highly injurious to the heart. In those who use tobacco to excess, the heart beats more rapidly than it should, while the force of its beat is greatly lessened. When the habit has been continued for a long time, the heart's action sometimes becomes very irregular, at one time beating too rapidly, at another too slowly, and occasionally missing a beat. This is known as tobacco heart. Though a serious condition, it usually disappears when the use of tobacco is stopped.

The effect of tobacco upon the digestive organs.—The worst effects of tobacco upon digestion are due to the fact that the heart is weakened, and the digestive organs do not get a sufficient supply of blood. The digestive juices are lessened in amount, so that the food cannot be promptly digested. This trouble comes on slowly and often is not noticed by the person himself. Even when it becomes serious, the tobacco user often believes that his indigestion is due to some other cause. When such a person gives up the tobacco habit, he is usually surprised to find that there is great improvement in his powers of digestion and in his general health.

The influence of tobacco on growth.—There are many indications that the processes within the cells that cause growth differ from the processes that go on during the repair of the protoplasm. That is, in cells and in young people that are growing, there are processes going on that

nicotine is broken into other compounds. It is probable that these other compounds produce a large part of the effect that follows smoking. That men smoke to obtain the drug effects of nicotine and of the compounds that come from the nicotine, and not for the physical and mental pleasure of the smoking, is shown by the fact that a smoker is not satisfied with tobacco from which the nicotine has been extracted.

are not going on in cells and in persons that have reached their full size.[1] Tobacco seems to have an especially evil effect on the processes of growth; for without doubt it is most injurious to the young. Two young guinea pigs that were made to inhale tobacco smoke from the fourth day after birth, on the forty-fourth day weighed 174 and 169 grams respectively instead of 330 grams, which is the normal weight for a guinea pig of this age. One of them died on the forty-fourth day, and the other was not subjected to further inhalations. At the end of the third month this animal weighed only 295 grams. The normal weight at that age is 485 grams, so the animal was still stunted and far below its normal size.

So generally is it known that cigarette smoking interferes with the processes of growth and stunts the young that we have laws forbidding the sale of cigarettes to boys below a certain age. In 1889 the Japanese government became alarmed because of the small size of some of its citizens, and, after an investigation of the effects of tobacco, passed a law which was worded thus: "Smoking of tobacco by persons under the age of twenty is prohibited." Professor Seaver of Yale University found that of the young men entering Yale during a period of ten years, the smokers averaged 15 months older than the non-smokers, and that, notwithstanding their greater age, they were one-third of an inch shorter and had slightly less lung capacity. The boy who wishes to become large and strong should let cigarettes alone during his growing years, for there is every reason to believe that young smokers fail to reach their full development either of body or of mind.

The effect of tobacco on the nervous system.—The

[1] By experiments on animals it has been found possible to feed them in a way that will keep them alive, but will not cause growth in them. This indicates that the processes of growth and of maintenance are different.

most serious effects of tobacco are on the nervous system. It interferes with the control of the muscles, and it injures the mind, as we should expect a narcotic to do. The trembling that may be seen in the hands of almost any one who smokes cigarettes to excess shows in a very marked way how tobacco interferes with the control of the muscles. Because of this effect, tobacco users are not good marksmen with the rifle, and many of them are unable to do delicate work. The following statement by Luther Burbank, the great plant breeder and nurseryman of California, illustrates this point:

"To assist me in my work of budding—work that is as accurate and exacting as watch-making—I have a force of some twenty men. I discharge men from this force at the first show of incompetency. Some time ago my foreman asked me if I took pains to inquire into the habits of my men. On being answered in the negative, he surprised me by saying that the men I found unable to do the delicate work of budding invariably turned out to be smokers and drinkers. These men, while able to do the rough work of farming, call budding and other delicate work 'puttering' and have to give it up, owing to inability to concentrate their nerve force. Even men who smoke one cigar a day I cannot intrust with some of my delicate work."

How tobacco affects the mind.—Tobacco undoubtedly injures the mind, so that the person using it learns less rapidly and thinks less clearly. Those who have used it for some time have a tendency to become nervous, restless, unable to remain still for any length of time, and unable to keep their minds concentrated on any one subject. As one writer expresses it, "The mind of a tobacco user seems to lose its grasp of things." It is probable, however, that the main reason why tobacco users fall behind other men in intellectual work is that nicotine steals away ambition. Its first effect on the mind is to lull it to rest; to make one contented with himself and his achievements; to make one satisfied to sit and watch the smoke curl upward while other things take care of themselves. This feeling of ease, comfort, and freedom from responsibility is very pleasurable, and the tobacco habit is the most common of all the drug habits to which man is addicted. In summing up the good or the evil which comes from a habit of this kind, however, we must always remember that the world's work must be done, and that when a drug for any reason interferes with the working powers of a man, some one else will probably be compelled to do the work which he ought to have done. We must also remember in connection with all drug habits that it is important to know whether we are to be forced to pay with the health of our cells for the pleasurable sensation that the drug gives.

Tobacco and scholarship.—The worst effects of tobacco upon the nervous system are its effects upon the mind. Wherever smokers and non-smokers have been compared, it has been found that non-smokers are much better students. They not only prepare their lessons more easily and more quickly, but they also retain what they have learned longer than the smokers. Of 2,336 smokers in the public schools of one city, only 320 were able to keep up with their classes, while only 16 were reported as "bright" or "better than average" students. Most of the backward boys in the schools are recruits from the ranks of tobacco users.

Other effects of tobacco on the body.—Dyspepsia is very common among tobacco chewers who swallow small quantities of the juice and among those who injure their nervous systems by excessive smoking. Another effect of the continued use of tobacco is to raise the blood pressure, which greatly increases the work of the heart.

Smoking also has a bad effect on the air passages; for the hot ammonia and other compounds in the smoke frequently cause "smoker's sore throat", and cancer of the tongue and throat is more common among smokers than among non-smokers. Besides all these effects on separate organs of the body, the nicotine has a depressing and weakening effect on the body as a whole, just as it has an enfeebling and quieting effect on the mind.

The effect of a moderate use of tobacco.—In reading this chapter you must bear in mind that not all the evil effects of tobacco that have been described come at once, nor is it possible to observe all of them in every person who is a tobacco user. Small doses of any drug produce proportionately smaller effects than do larger doses, so persons who use tobacco moderately suffer less from it than do persons who use large amounts.

These are the effects of tobacco when used to excess or when used by the young, and persons who have experience with cases of this kind naturally regard tobacco as one of the worst enemies of mankind. Others who see men all about them smoking and yet attending to their work day by day often take the view that, after all, the tobacco habit is of little consequence. The truth is that some men are born with more health, strength, ambition, and intelligence than others, and that one of these strong men, even after using tobacco for a long time, may still have more strength and brain power than the man who lacked these qualities from his birth.

The question is not, however, whether the strongest tobacco user has more strength than the weakest man who does not use tobacco. The question is whether the strong man is able to use tobacco and at the same time realize the full strength of his body and of his mind. Everything that we know about the effect of nicotine indicates that it is not possible to do this; that it is a violent poison to the cells; that if taken into the body in large amounts, it will cause death; that if constantly taken during the growing years, it has a very disastrous effect on development; that in any amount whatsoever, it has a narcotic effect on the muscles and on the delicate cells of the brain; and that any one who uses it will be injured by it.

Why a boy should not use tobacco.—"Your first duty in life is toward your *afterself*—the man you *ought* to be. So live that he in his time may be possible and actual.

"Far away in the years he is waiting his turn. His body, his brain, his soul are in your boyish hands. He cannot help himself.

"What will you leave for him?

"Will it be a brain unspoiled by lust or dissipation, a mind trained to think and act, a nervous system true as a dial in its response to the truth about you? Will you, Boy, let him come as a man among men in his time? Or will you throw away his inheritance before he has had the chance to touch it? Will you turn over to him a brain distorted, a mind diseased, a will untrained to action?

"Will you let him come, taking your place, gaining through your experiences, hallowed through your joys; building on them his own?

"Or will you fling away his hope, decreeing wanton-like that the man you might have been shall never be?

"This is your problem in life; the problem of more importance to you than any or all others. How will you meet it, as a man or as a fool?

"When you answer this, we shall know what use the world can make of you."—DAVID STARR JORDAN.

CHAPTER XX

ALCOHOL

A standard text on hygiene, that was used in many of our medical colleges as late as 1890, taught that malaria was due to miasma from swamps; that typhoid fever was connected with the rise and fall of ground water; that cholera seemed to be related to the temperature of the soil from four to six feet below the surface; that erysipelas was due to impurities in the air; that diphtheria was caused by sewer gas; and that yellow fever was an air-borne disease.

These ideas seem strange to us to-day, but the fact that they were current so recently, even among medical men, emphasizes the fact that, in the past, men have looked upon disease as something that comes upon us from without; that they have thought of the causes of sickness as lying in the world about us. Now we have come to understand that the causes of ill-health are to be sought for, not in the swamps and forests and changes of weather, but within the body itself; that it is what goes into the body, rather than the distant outside world, that is important in hygiene. We have learned that the great secret of health is to keep the lymph in which the cells are bathed free from poisons and impurities and to allow the cells to live their own lives in a natural way.

Along with this new knowledge, there has come a truer understanding of the uses of medicines and a greater care about taking into the lymph strong drugs whose effects on the delicate cells are not fully understood. The best physicians now realize that all medicines are foreign and unnatural substances in the lymph, which ought to be given only when there is good reason to believe that the body will be benefited by them; and they are continually amazed at the reckless and ignorant way people pour patent medicines and other strong drugs in upon their cells. In this chapter we shall study the effects on the body of the use of alcohol, a powerful drug that is extensively used by the people of our country.

Where alcohol comes from.— *Yeast* is a small plant that lives on the skins of fruits and in very rich earth, and that often blows about in the air. The favorite food of this small plant is sugar, and when it falls into a liquid that contains sugar, it grows and multiplies very rapidly. In doing this it uses the sugar for food and breaks it up into water, carbon dioxide, and alcohol. This process is called *fermentation*. The alcohol in all the different kinds of intoxicating drinks that are used by man comes from the fermentation of sugar by yeast.

Different kinds of alcoholic drinks.—The natives of the tropics cut off the flower clusters of palm trees and collect the juice that pours out from the cut ends. This contains much sugar, and after it has been fermented it contains great quantities of alcohol. The Mexicans collect the juice of the *agave*, or century plant, in the same way and manufacture an intoxicating drink from it. Fruit juices are rich in sugar, and in temperate countries the people make wine by allowing them to ferment. Grapes, apples, currants, and blackberries are the fruits that are most commonly used for this purpose. In the manufacture of beer, grain is soaked in water until it sprouts, and the starch in it is digested to sugar and dissolved out in water. Yeast is then allowed to change the sugar in the liquid to alcohol. Rum is made by fermenting molasses and distilling off the alcohol; whisky is made by distilling the fermented liquid from sprouting grains; and brandy is made by distilling fermented fruit juice.[1] Alcoholic drinks have different tastes, according to the substances from which they are made, and some are stronger than others, but in all of them it is the alcohol itself that is the important thing.

The use of alcohol injurious to the body.—Is alcohol injurious to the body? In the past there has been a division of opinion on this point. To-day we have come into an age of science, and we are substituting knowledge for guesswork in all fields of human thought. What are the facts in this case? Does taking alcohol among the cells cause the body machine to run a longer or a shorter time, and is it laid up for repairs more days or fewer days in a year when alcohol is used? The following statistics will give us some information on the question.

The effect of alcohol on health and length of life.—In Australia the workmen have benefit societies that pay wages for time lost on account of sickness. The records of these societies show that the members of societies that admit only abstainers lose but little over half as much time on account of illness as do the members of societies that admit drinkers. This indicates that the use of alcohol increases sickness. A number of life insurance companies have kept records of the deaths of the abstainers and drinkers among their policy holders separately. When these records are examined, the results are always the same,—the death rate among the drinkers is higher than it is among the abstainers. We can therefore decide that alcohol used as men ordinarily use it causes sickness and shortens life; and, since this is true, it must also be true that it is injurious to the cells.

[1] In distilling liquors, the liquid (the fruit juice or the water in which the grain has been soaked) that contains the fermented sugar is heated, and the vapor that comes from it is caught and condensed. The alcohol in the liquid is changed to vapor more easily than water, and the liquors that are manufactured in this way are strong in alcohol.

The effects of alcohol on the structure of the cells. Alcohol causes *fatty degeneration* and *fibroid degeneration* of certain of the tissues.[1] In fatty degeneration little droplets of oil begin to collect within the cell, and gradually the living protoplasm of the cell is replaced by fat, until sometimes the cells become mere bags of oil. When the cells of the gastric glands are changed in this way, they lose their power to secrete; when the muscle cells of the heart are changed to fat they lose their strength; when the walls of the arteries are affected, they are, of course, weakened; and when there is fatty degeneration of the liver, kidneys, or nerve fibres, we must expect these organs to fail in their work.

The tissues most commonly affected by fibroid degeneration are those of the liver, kidneys, arteries, heart, and brain. In this kind of degeneration there is an overgrowth of the connective tissue elements, while the working cells degenerate and die. Often in the arteries the elastic muscle coat is not only changed to connective tissue, but lime is deposited in the walls. These changes make "pipe-stem" arteries, which are brittle and often have the opening in them narrowed until it is with great difficulty that the blood makes its way through them.

Some diseases that may be caused by alcohol.—Prominent among the causes of death that are connected with the use of alcohol are: hardening of the liver, in which the liver turns to connective tissue and shrinks into a small, hard organ utterly incapable of doing the work which it is supposed to do; diseases of the kidneys, in which these organs degenerate and fail in their work of excreting the poisonous wastes; heart disease, which may take many

[1] As we have already explained there is good reason to believe that in some of these changes in the tissues it is intestinal toxins rather than the alcohol that really causes the trouble, but since it is the drinking of the alcohol that causes the toxins to be formed, the fault in the end goes back to the alcohol.

forms; hardening of the arteries; apoplexy and paralysis, which are due to the bursting of blood vessels in the brain; insanity and other diseases of the nervous system; tuberculosis, pneumonia, and other germ diseases, to which the user of alcohol falls a victim because he has weakened the defenses of his body; and accidents that would never have occurred had not some one been under the influence of drink.

It will be noticed that the chief effects of alcohol, aside from those on the nervous system, are on the heart, blood vessels, lungs, stomach, liver, and kidneys,—the great internal organs that supply the body with food and oxygen and dispose of its wastes. When we remember how the life of the whole body requires that the work of these organs be efficiently performed, it is easy for us to understand that anything that injures them is of first importance in the realm of health.

The effects of a continued moderate use of alcohol. It should be understood that, except for certain effects on the brain, we are discussing in this chapter the effects on the body of what is called moderate drinking; for, when alcohol is used day after day, even though it be used very moderately, there is a piling up of its effects on the tissues. Indeed, the cells of the man who drinks a moderate amount of beer or wine daily are never free from the influence of alcohol. Beer drinkers suffer most of all from fatty degeneration of the tissues, and one need never become intoxicated to experience the evil effects from alcohol that have been described above.[1] The shortening of life is in moderate

[1] "Alcoholic diseases are certainly not limited to persons recognized as drunkards. Instances have been recorded in increasing numbers in recent years of the occurrences of diseases of the circulatory, renal, and nervous systems, reasonably or positively attributable to the use of alcoholic liquors in persons who never became really intoxicated and were regarded by themselves and others as 'moderate drinkers.' "

—Dr. William Welch.

drinkers and not in drunkards; for the death-rate among those who habitually drink to intoxication is so high that no insurance company will accept them.[1]

Alcohol not a brain stimulant.—It is well known that alcohol in large quantities is a cause of delirium tremens, paralysis, and insanity. The effect of small amounts of alcohol on the nervous system is not so well understood, and many persons still believe that a glass of beer or wine stimulates the brain and increases the working power of the mind and body. This idea is a mistake. Some typesetters were given an ounce (two tablespoonfuls) of alcohol on certain days, and a record was kept of their work. They did nearly one-tenth less work and made one-fourth more mistakes on the days when they used alcohol than they did on days when they had no alcohol, and the effects of the alcohol lasted through the second day. A man who took three ounces of alcohol each day for twelve days could add figures only three-fifths as fast as when he took no alcohol, while it took him more than three times as long to memorize a certain number of lines of poetry. These facts show that the power to do mental work is lessened by alcohol, even when taken in small amounts. This effect lasts for at least forty-eight hours after a medium dose, and for this reason the person who drinks alcohol daily is never able to do his full day's work. *Alcohol is not a brain stimulant.*

The effect of alcohol on the strength and control of the muscles.—The man who has taken alcohol always feels that he is stronger and has more endurance because of it. In this case, again, the alcohol user is mistaken as to his real condition, as facts like the following prove:

[1] A few of those classed as drinkers may have become heavy drinkers after they were insured, but insurance companies reject not only drunkards, but also those who seem likely to become drunkards. The comparison is, therefore, in the main between abstainers and moderate drinkers.

About sixteen years ago, Professor Durig, a chemist and an expert mountain climber, carried on a series of experiments by repeatedly climbing a peak in the Alps. On certain days he drank alcohol equal to the amount in two glasses of beer; on other days no alcohol was taken. He was accustomed to use moderate amounts of alcohol, and he felt that he worked more easily on alcohol days, but to his surprise he found that on those days he expended 15 per cent more energy and required more than one-fifth longer to climb the mountain. Other tests carried on for ten days in the laboratory showed that two glasses of beer taken at dinner reduced the working power of the muscles 10 per cent. "Alcohol gives, not strength, but only a feeling of strength, to the muscles." It deadens the ability to feel fatigue, but does not relieve fatigue.

It is probable that the weakening effect of alcohol on the muscles is mainly due to its interference with their control by the nervous system. The movements are made awkwardly, and the muscles work against each other, and thus much of their power is lost. This lack of fineness of control in alcohol users is shown at once in a baseball pitcher, a bowler, a rifleman, or any one who does work that requires each muscle to work exactly the right amount and at exactly the right moment.

The resistance of the body to germs weakened by alcohol.—Persons who use alcohol are more easily attacked by germ diseases than are those who do not use alcohol, and the drinkers suffer more severely when they are attacked. In pneumonia the death rate among drinkers is nearly twice as high as it is among non-drinkers, and in one epidemic of cholera in Glasgow the death rate among the alcohol users attacked was nearly five times as high as it was among the sober men who took the disease. Many of the foremost medical men are now convinced that the giving of alcohol to a patient who is suffering from pneumonia, diphtheria, cholera, typhoid fever, or other germ disease is not only useless but positively harmful.

Alcohol an ally of tuberculosis.—In 1905 medical men who were interested in the study of tuberculosis met in a convention in Paris, to discuss means for preventing the spread of this disease. In this convention the following resolution was adopted: "*In view of the close connection between alcoholism and tuberculosis, this Congress strongly emphasizes the necessity and importance of combining the fight against tuberculosis with the struggle against alcohol.*" These men believe that the use of alcohol is responsible for a great deal of tuberculosis, and they are able to give good reasons for their belief.

Other effects of alcohol.—The drunkard is not the only person who suffers from the results of his habits. A vast number of persons live in need of food, clothing, and shelter because the money that should have supplied these things has been spent for drink. Among such persons there has been an untold amount of disease and suffering and wretchedness. Drink has been responsible for a vast amount of crime. Almost one-third of all persons supported by charity, and nearly one-half of all homeless and friendless children in children's homes, have owed their condition to some one's intemperance. "The worst feature of the poverty caused by alcohol is not the fact that the drunkard himself suffers, but the fact that innocent persons suffer far more than he."

What employers think of the use of alcohol.—Some years ago 6,976 business men employing 1,745,823 men answered inquiries concerning their employment of drinking men. Of these, 5,363 said they preferred men who were known to be abstainers, and 1,613 said they made no effort to learn the habits of their men. Most of the great railroads strictly enforce rules against drinking while on duty, and many of them will not employ a drinking man.

Alcohol and the Great War.—During the Great War, the principal nations of the world passed laws to limit or prohibit the manufacture and use of alcohol. They realized that they could not fight the foreign enemy so effectively, while this other enemy, alcohol, remained unchecked at home.

What medical men think of the use of alcohol.—The attitude of the great majority of medical men has been so well expressed by a recent writer that we repeat the substance of his statement. "So I am bound to believe, on the evidence, that if you take alcohol habitually in any quantity whatever, it is to some extent a menace to you. I am bound to believe, in the light of what science has revealed, (1) that you are threatening the physical structure of your stomach, your liver, your kidneys, your heart, your blood vessels, your nerves, your brain; (2) that you are unquestionably lessening your power to work in any field, be it physical, intellectual, or artistic; (3) that you are in some measure lowering the grade of your mind, dulling your higher sense, and taking the edge off your morals; (4) that you are distinctly lessening your chances of maintaining your health and of living to old age; (5) that you are adding yourself to the number of those whose habits cause more suffering and misery, disease and death, than do all other causes combined." To these conclusions we might add (6) that you are fastening upon yourself a habit that will lead many business men to refuse to employ you.

CHAPTER XXI

ACCIDENTS

In every school there should be a small First Aid Box. This box contains the necessary articles to deal with the ordinary school accidents.

FAINTING

Fainting is one of the most common accidents. It is the result of a reduced flow of blood to the brain. The most common causes are the onset of a contagious disease, bad ventilation, constipation and indigestion, decaying teeth, and coming to school without any breakfast. Repeated cases of fainting are probably due to heart disease.

You can tell when a child is about to faint by the ashy color of the face. When you see a child in this state, immediately lower his head until it is between his knees. To do this, hold the head firmly with one hand across the brow, and the other at the back of his neck. This causes a rush of blood to the head, and, if done in time, will prevent fainting. If the clothing around his neck is at all tight, this should be loosened. Have some one open all the windows, and as soon as possible give him a drink of cold water.

If the child has fainted and fallen, before you noticed what was happening, leave him lying flat on the floor for the time being. Do not place anything under his head for a pillow. If, with the help of an adult or of several children, the child can be lifted by the feet until only the head and shoulders rest on the floor, consciousness will quickly be restored. If this is not possible, flick the face with a towel wrung out of ice-water or very cold water, and hold a piece of cotton wool saturated with spirits ammonia aromat to his nose. When he begins to revive, give him a drink of very cold water. You might add to the water a quarter of a teaspoonful of the spirits ammonia aromat. A bottle of this mixture, well corked, should always be kept in the First Aid Box.

For some time after fainting, the child should remain lying down. He should be made as comfortable as possible and should be warmly covered. Fainting is always followed by a feeling of chilliness. When the child has sufficiently recovered, he should be sent home, as he is not able to do the ordinary school work for the rest of the day.

NOSE-BLEED

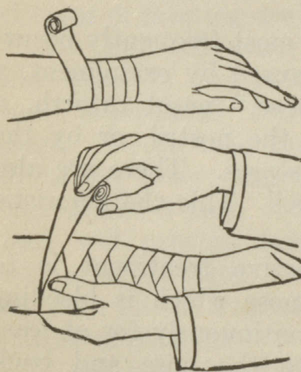
Nose-bleed is probably the next most frequently occurring school accident. It may be caused by excitement, a blow on the nose, "picking the nose," nasal catarrh, a foreign body in the nose, ulcer of the nostril, or by the onset of some of the contagious diseases. There are also rare cases of what we call "bleeders." This characteristic of bleeding very easily is inherited.

The simplest and usually effective treatment is to compress the lip and side of the nose which is bleeding with the index finger, gently but continuously for at least five minutes. Cold applications to the nose and back of the neck are frequently quite effective. Have the child seated with head held erect and breathing deeply and regularly through the mouth. Too often one sees a child with nose-bleed holding his head down over a basin. This position of course is exactly the wrong one. The child should be warned not to blow his nose, so that the forming blood clot will not be disturbed.

There are some cases of nose-bleed so severe that these simple measures do not suffice. In that case, a physician should be sent for. If some time is likely to elapse before his arrival, the nostrils should be packed. To do this, boil scissors and forceps and carefully scrub your hands with a brush and soap. Cut off a few inches of the narrow sterilized gauze in the First Aid Box, and with the forceps, gently introduce it into the bleeding nostril. Force it straight back—not upward—and keep on inserting it, until the nostril is completely packed. This method will usually stop the severest nose-bleed.

WOUNDS

The ordinary wound should be swabbed at once with tincture of iodine. Never use water on a wound unless it has been boiled. If the area around the wound is dirty, carefully cover the wound itself with a piece of sterilized gauze and hold it in place while cleaning the surrounding area. Scrub away from the wound, not toward it; otherwise, you will be sure to introduce dirt into the wound. After having swabbed the wound with tincture of iodine, place on it several layers of dry sterilized gauze and bandage it in place.



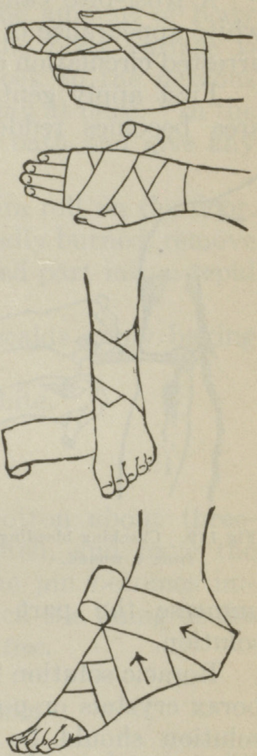
Figs. 113 and 114. Showing a circular bandage and the method of reversing a bandage.

Before attempting to dress a wound, you should carefully scrub your hands with hot water and soap, using a nail brush.

Wounds, however, may continue to bleed. In that case we call them *hemorrhages*. These may be divided into three groups,—capillary, venous, and arterial.

A capillary hemorrhage is characterized by oozing of the blood. It is practically always controlled by a dry sterilized dressing and snug bandage.

Where a vein is injured you will see a steady flow of dark red blood. If this is not controlled by a snug bandage, press with the thumb on the side of the wound farther from the heart, since the blood in the veins is flowing toward the heart.



Figs. 115, 116, 117, and 118. A reversed bandage and a figure-of-eight bandage on the hand; a figure-of-eight bandage and a reversed bandage on the foot.

The most serious hemorrhage is that resulting from a cut artery. In this case, you see regular jets of bright red blood spurting from the wound. Send for a physician at once. In the meantime, elevate the part and apply pressure on the side of the wound nearer the heart. If the wound is in an arm or leg, apply a tourniquet. You will find a triangular shaped piece of cotton in your First Aid Box for this purpose. A fairly large handkerchief may be used by knotting it loosely around the arm; then insert a lead pencil lengthways between the arm and the handkerchief, and keep turning the pencil about until it tightens the bandage sufficiently to stop the bleeding. Do not leave a tourniquet on longer than is necessary to stop the bleeding. After 20 minutes release it gradually and leave it loosely around the limb, so that it may again be tightened if bleeding recommences. If a tourniquet is left on too long it may cause gangrene.

FROST-BITE

A frost-bite can easily be detected by the completely white appearance of definite skin areas. This is due to the arrested circulation of blood to the part.

First apply gentle friction to the part until the white area becomes reddened, showing returned circulation of blood. If the frost-bite is slight, apply vaseline and dressing, and keep the part elevated for an hour or so afterwards. If blisters form, sterilize a needle or pair of scissors by boiling for five minutes, and prick the lower edge of the blister. Gently squeeze out the fluid and then apply boracic compresses. These must be changed frequently enough to keep them always moist. If it is a frost-bite on the hand or foot, the best treatment is to immerse the part in a basin containing warm boracic solution.

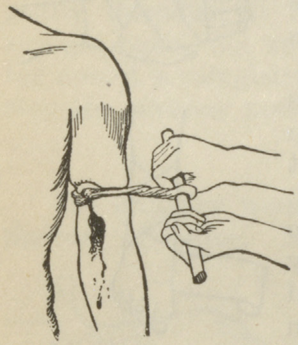


Fig 119. Checking bleeding from a wound.

Boracic solution is made by dissolving a tablespoonful of borax crystals or powder in a pint of boiling water. This solution should be allowed to become just comfortably warm before using it for the purpose indicated above. A compress is made by dipping into the solution several layers of gauze cut the right size for the part affected, and squeezing it out sufficiently so that the solution will not drip from it when it is applied. If a piece of oiled silk is placed over the compress and then a thick pad of absorbent cotton over that, the compress will stay moist for about two hours or possibly longer.

BURNS AND SCALDS

The deaths from burns and scalds depend, not on the depth of the burns or scalds, but on the amount of body surface affected. If over a third of the body surface is burned, death is apt to result from shock to the nervous system. In that case, send for a physician at once. In the meantime, get the patient into a tepid bath and give any safe stimulant you have at hand.

If a child's clothes take fire, have him roll on the floor. This will smother the flames. If he is badly burned, remove the clothes by cutting and get the injured part into a tepid bath.

For the ordinary small burns and scalds apply baking soda and moist dressing.

When blisters form, treat as in frost-bite.

SWALLOWING A PIN

Roll up little balls of absorbent cotton about three-quarters of an inch in diameter, moisten, and have the child swallow about half a dozen. The pin becomes imbedded in these and will then not scratch the lining of the alimentary canal. *Do not give a purgative.*

FOREIGN BODY IN THE EAR

Leave it alone unless it is in plain sight and can easily be removed with forceps or by touching it lightly with the end of a match coated with seccotine or liquid glue. Leave the match in contact with the foreign body until the glue sets, and then gently withdraw it attached to the foreign body. You should not attempt to probe inside the ear, because of the danger of injuring the delicate membrane of the ear-drum. If an insect gets into the ear, a little warm sweet oil should be dropped in. This will kill the insect, and it can then be easily removed. Sometimes in washing the ear a little water will remain in the canal and cause a painful buzzing. To remove the water, turn the head so that the affected ear hangs downward, and have the patient hop about the floor to shake out the water.

FOREIGN BODY IN THE NOSE

Have the child blow his nose as hard as possible. An attempt should be made to remove the foreign body by very gently inserting forceps straight back through the nostril. Never direct the forceps upward. If the tip of the nose is tilted upward it will be easier to see inside.

FOREIGN BODY IN THE EYE

The most frequent source of trouble in this respect is a small cinder becoming imbedded on the inner side of the upper lid. Turn the upper lid inside out, and remove the foreign body with a wisp of absorbent cotton wrapped around the end of a tooth pick or a match. If an acid of any kind gets into the eye, immediately pour water into the eye. Pour one pitcherful after another into it, until it is thoroughly flushed out. Call a physician at once.

CHOKING

Hold the child head downward and slap him on the back.

APPARENT DROWNING

(1) *Drain* the *water from* the patient's *lungs* by catching him *under the waist* and holding him for a few seconds with the *head hanging down.*

(2) Then lay the patient *face downward* as shown in Figure 120, with one *arm extended* directly overhead, the other arm bent at the elbow, and the face resting on the hand or forearm, so that the nose and mouth are free for breathing.

(3) *Kneel over the patient, straddling his hips* as shown in Figure 120. Place the *palms* of the hands on the *small of*

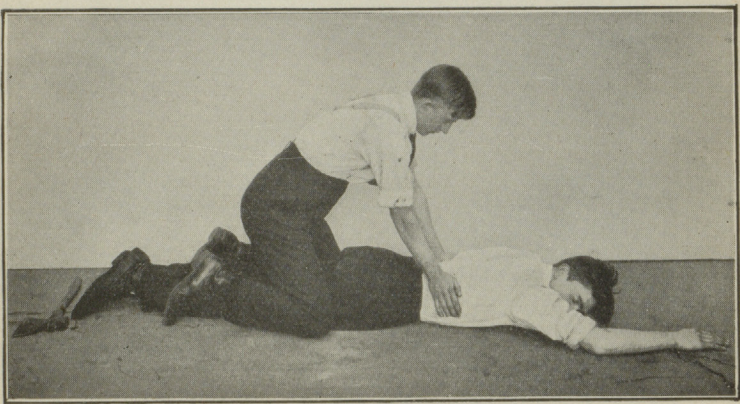


Fig. 120.

the back with fingers resting on the ribs, the *little finger* just *touching* the *lowest rib*, the thumb along side of the fingers, the tips of the fingers just out of sight.

(4) With *arms* held *straight*, *swing forward* slowly so that the weight of your body is gradually brought to bear upon the patient as in Figure 121. The lower part of the chest and also the abdomen are thus compressed, the air is forced out of the lungs, the diaphragm is kept in natural motion, and the circulation of the blood is increased.

(5) Now immediately *swing backward* so as to completely remove the pressure, thus returning to the position

shown in Figure 122. The chest walls expand, and, the pressure being removed, the diaphragm descends, and the lungs are supplied with fresh air.

(6) *After two seconds swing forward again.* Then *repeat twelve to fifteen times a minute* the double movement of compression and release. If a watch or a clock is not

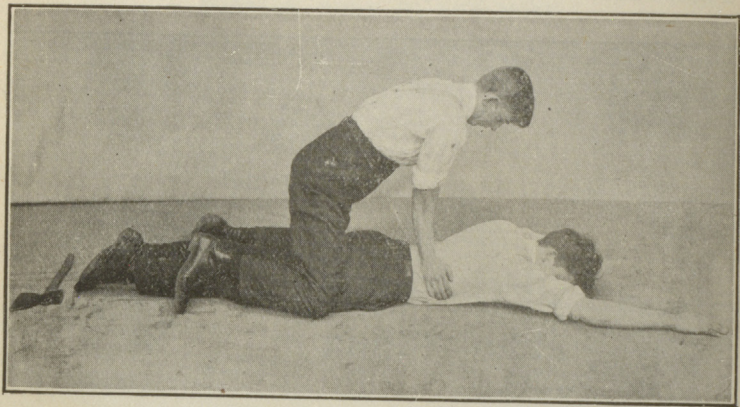


Fig. 121.

visible, *follow* the natural rate of your own *breathing.* The proper rate may be determined by counting—swinging forward with each expiration and backward with each inspiration.

(7) While this is being done, *some one else should loosen* any *tight clothing* about the *patient's neck, chest, or waist.* Try to *keep* the *patient warm* by having someone cover him with a blanket and by placing hot water bottles near his body but outside the blanket to prevent burning him.

(8) *Continue* this *artificial respiration without interruption* until natural breathing is restored, if necessary for *four hours.*

(9) When the *patient* revives, he should be *kept lying down.* Give him a drink of hot ginger tea or coffee, or 15 drops of spirits of ammonia in a glass of hot water. *Always send for a doctor.*

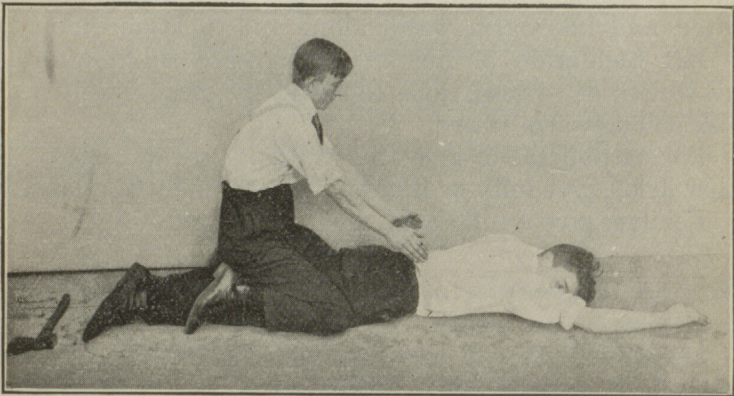


Fig. 122.

(10) Watch the patient until the doctor comes, and, if normal breathing stops, artificial respiration should be resumed at once.

SUFFOCATION

Suffocation may be produced by hanging, by choking, by gas or smoke poisoning, or by electric shock. Get the patient into the open air at once. Sprinkle cold water on the face; carry on artificial respiration as in cases of apparent drowning, and, when the person is able to swallow, give stimulants as directed above.

POISONING

Bottles that contain poisons should never be kept among medicines. When a poison is taken by accident, a physician should be called at once. If possible, have the messenger tell him what poison has been taken, so that the proper antidote may be brought.

In the meantime, if the poison is not an acid, give an emetic. Good emetics are mustard and water, salt and water, and lukewarm water alone and in large quantities.

For bichloride of mercury (corrosive sublimate) give the whites of several eggs, followed by large quantities of milk or lukewarm water.

For carbolic acid, give the whites of several eggs. For other acids, give milk or lukewarm water in large quantities.

For lye, give a mild acid, such as vinegar.

POISON IVY

Ivy poisoning can usually be prevented if the parts touched by the ivy are washed thoroughly with yellow kitchen soap and water. This preventive treatment is good only if carried out shortly after exposure, before any signs of inflammation appear. If the rash has come out, do not use soap and water, but let out any blisters and apply a wet dressing of either boracic acid or one part of sugar of lead in eight parts of water.

SPRAINS

A joint is sprained when, due to a wrenching or twisting of the part, the ligaments which guard the joint become stretched or torn. This injury is most commonly found at the wrist or ankle, and the swelling which accompanies it is due to bleeding from the torn blood vessels of the ligament affected. The pain and swelling which rapidly ensue make it difficult at times to distinguish between sprains, dislocations, and fractures; a little care taken to compare the affected part with its opposite mate, however, will usually indicate the difference.

In all cases the primary treatment is the same. To prevent the swelling, with its accompanying pain and tension, and to arrest bleeding, elevate the part and apply ice or cold water. Then apply a snug bandage and place the joint at rest in the most comfortable position. After the acute stage has passed and the swelling has diminished, hot compresses may be applied and the part gently massaged toward the body. At this stage some movement of the part should be begun to avoid stiffness.

DISLOCATIONS

A dislocation of a joint is an injury by which one of the bones which enter into it becomes forced out of relation to the other, and is the result of direct or indirect violence or muscular exertion. Since more or less rupture of the ligaments of the affected joint always takes place, the signs and symptoms are similar to those accompanying sprains, viz.: pain, swelling, loss of motion, with the added sign of joint deformity. This injury is usually found in the upper extremity, involving shoulder, elbow, wrist, or fingers. In all cases, with the probable exception of the latter, a surgeon's skill will be required, but meantime, treatment the same as that given for sprains should be applied.

FRACTURES

A fracture or broken bone may be simple, compound, or comminuted. A fracture is said to be compound when a sharp end of bone has punctured the skin, thus permitting infection to gain access to the injured part. When the bone is shattered at one point, it is said to be comminuted. A fracture is incomplete when it does not sever the bone, as is commonly seen in the "green-stick" fractures of children, and is complete when it consists in the entire separation of the fragments.

The signs and symptoms of fractures are pain, loss of function, a sensation of grating on movement, shortening of the part, and extensive swelling from bleeding about the part injured. The pain causes reflex spasm of the muscles attached to the bone injured and thus increases the suffering. If the part is not made steady by splints, the sharp ends of the bone may produce a compound fracture from a simple one. For this reason, any attempt at reduction must not be made, but the injured part should be kept as quiet as possible and the patient not moved by unskilled hands.

Temporary splints may be made from any material at hand, and these should be carefully tied or bandaged to the limb so as to include the joint above and below the fracture. When an injury is severe, it is better to assume that a fracture is present and avoid any manipulation which would make matters worse. It is always better to rip or cut off the clothing than to attempt to remove it in the usual way. If swelling is severe, ice cold compresses should be applied. In case of compound fracture, swab the wound with iodine and apply a dry dressing of sterilized gauze before adjusting the splints.

A Canadian Junior Red Cross Member

CHAPTER XXII

DISEASE GERMS

HOW THEY GET INTO THE BODY; THE STRUGGLE BETWEEN THE BODY AND THE GERMS

Disease germs are the greatest enemies of mankind. Every day they kill thousands of people, and they cause the loss of an untold amount of time and money. To get an idea of the amount of sickness, sorrow, and loss that is caused by them, imagine a land where no colds, catarrh, tuberculosis, influenza (grip), diphtheria, or pneumonia ever come; a land where boils, blood poisoning, and tetanus (lockjaw) are unknown; where there is no smallpox, measles, scarlet fever, whooping cough, or mumps; a land without malaria, cholera, leprosy, yellow fever, or plague; a land free from typhoid fever, and from many of the other diseases that afflict mankind. Picture to yourself a country and a people free from all these diseases, a country where many of the inhabitants pass from childhood to old age without sickness or disease, and you will have an idea of what a land without disease germs would be like.[1]

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

[1] It is within the power of man to cause all parasitic diseases to disappear from the world.—PASTEUR.

protozoön). Disease germs are bacteria and protozoa that grow in the body and poison the cells.

Where disease germs come from.—At this point you should get it firmly fixed in your mind that disease germs are living plants and animals; and that just as a pine tree can come only from the seed of a pine tree, or as a chicken can come only from the egg of a chicken, so a disease germ can come only from another germ of the same kind. It is a common idea that germs spring from unclean and decaying matter—that "filth breeds disease germs"—but this idea is not correct. They are often found in unclean matter, and such matter is dangerous because germs may remain alive in it for a long time. But germs can no more originate in such matter than a cow can come from the grass in the pasture, or a stalk of corn can spring up where no grain of corn has been planted in the earth. *Nearly all the germs that attack us are spread from the bodies of persons who are sick with germ diseases.*

The world not swarming with disease germs.—From the very beginning of your study of this subject you should clearly understand that the world is not filled with disease germs that are lying in wait to attack us. It is true that bacteria and protozoa are abundant in water, that bacteria are swarming in the soil, and that they are constantly being blown about in the air. But of all the many hundreds of kinds of bacteria and protozoa that are in the world, only a few cause disease. The others are harmless, and even when they get into our bodies, it is not we, but the bacteria and protozoa, that suffer. The germs of most diseases quickly die outside the human body. It is a mistake to think that every breath of air is dangerous, and that all food and water contain disease germs. The winds that blow over the meadows, the rain that falls from the clouds, the trees of the forest, the grass in the pasture, and, in general, the great outdoor world, are practically free from germs. In the bodies of persons who are sick from germ diseases, in the houses where sick people live, and wherever the wastes from the bodies of the sick go, there, and in most cases there only, are disease germs to be found.

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

Fig. 123. The germs that attack us come from the bodies of the sick.

How germs enter the body.—Except in a few cases which we shall discuss later, germs do not pass through the unbroken skin, but *nearly all germs that enter the body get into it through wounds, or through the mouth or nose.* In later chapters we shall learn what germs get into the body through cuts and sores; we shall study about biting insects (mosquitoes, flies, ticks, fleas, and bedbugs) that pierce our germ-proof armor (the skin) and place germs directly in the wounds that they make. We shall read of other germs that enter the body by way of the nose, and we shall learn how very dangerous germs may reach the mouth from flies, from the hands, from drinking cups, in food and water, and in many other ways. Here we wish only to call your attention to the fact that wounds (many of them made by insects), the nose, and the mouth are the gateways through which disease germs get into the body.

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

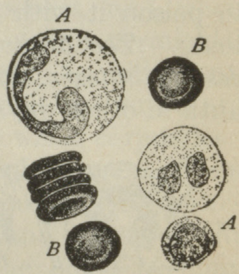


Fig. 124. *A* shows the white and *B* the red corpuscles of the blood as they appear under a microscope.

How germs cause sickness.—In spite of the greatest care that we can take, all of us are certain at times to get disease germs into our bodies. Between these germs and the body there is then war. The germs attack the body. They try to grow in it and use it for food. To defend itself the body kills the germs. In this chapter we shall learn how the body resists its small foes.

The germs of some diseases (diphtheria, tetanus) produce poisons that are called *toxins*. These toxins are carried through the body in the blood, and cause sickness by poisoning the cells. A little group of tetanus germs in a small wound, or a small patch of diphtheria germs growing in the throat, may produce enough toxin to poison and kill the whole body.

The germs of other diseases (typhoid fever, pneumonia) produce no free toxins; but when the germs are killed and broken up, toxins that have been produced within them are set free, and the materials of which the germs themselves are made act as poisons to the cells. In these diseases the end of the illness comes when the germs have all been killed, but the faster they are destroyed the more severe for the time will the disease be.

How the body destroys toxins.—One way in which the body protects itself against germs is by producing *antitoxins.* When disease germs grow in the body and begin to poison it with toxin, the body begins to produce antitoxin. *The antitoxin does not kill the germs, but it does destroy the toxin,* and thus saves the cells from being poisoned until in other ways the body can kill the germs.[1]

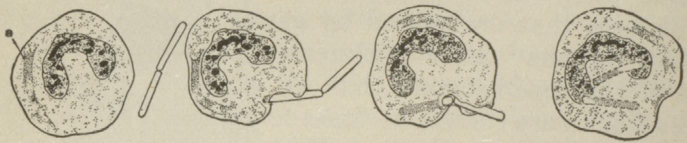


Fig. 125. A white corpuscle taking in a bacterium.

How the body kills germs.—If you should examine a drop of blood with a microscope, you would find a very great number of cells floating in the liquid part of the blood (Fig. 124). These cells are of two kinds. Most of them are red in color, and these are called *red corpuscles.* Their work is to carry oxygen through the body. The other kind of cells in the blood are the *white corpuscles.* These are the soldiers of the body, and *their work is to kill disease germs.*

[1] There is a different toxin and antitoxin in each different germ disease. The toxin and antitoxin of diphtheria, for example, are different from the toxin and antitoxin of tetanus or of typhoid fever.

A white corpuscle approaches a germ and flows about it, or swallows it, as you see in Figure 76. Then the corpuscle tries to digest and kill the germ, while the germ tries to grow in the corpuscle and use it for food. When the corpuscles are victorious, the germs are destroyed and the disease is stopped. But if the germs are too numerous and too powerful, the corpuscles are killed, and the disease goes on until the body dies.

Besides the white corpuscles, there is another great defender of the body, the *germicidal* ("germ-killing") substance of the blood. There is always some of this substance in the blood of a healthy person, and when disease germs attack the body, more of the germicidal substance appears in the blood and helps to kill them. In our fight against the germs this germicidal substance is perhaps even more important than the white corpuscles.[1]

Why we have certain diseases only once.—When germs attack us, the body manufactures more of its germicidal substances to kill them. More and more of the germicidal substances is formed, and the blood becomes stronger and stronger in its power to kill germs. Finally, if the body is successful in its struggle with its enemies, the germicidal substance and the white corpuscles get the upper hand of the germs and recovery begins. After a patient recovers from some diseases (for example, smallpox, measles, and whooping cough), a large amount of germicidal substance remains in the blood for years, or even for life. Any germs of these diseases that get into the blood are therefore promptly killed, and a person is seldom attacked by one of these diseases more than

[1] The body produces different germicidal substances in killing the germs of different diseases, just as different toxins and antitoxins are produced in different diseases. A person therefore may have a great power of killing the germs of one disease, as, for example, smallpox, and at the same time fall an easy victim to some other disease, as tuberculosis.

once. Cases of infantile paralysis, pneumonia, smallpox, and many other infectious diseases are treated with blood from a person who has recovered from the disease. Why could such blood be expected to kill the germs?

Keeping up the resistance of the body to germs.—Through all your study of germ diseases you should bear in mind the importance of keeping up the germicidal power of the body. All of us, without knowing it, take into our bodies the germs of deadly diseases. As the seeds of plants lie in the cold earth waiting for the warmth

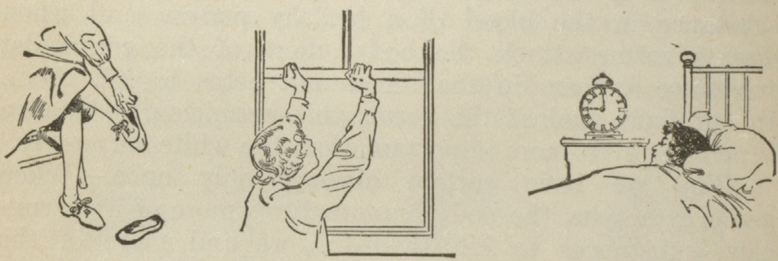


Fig. 126. Dry feet, fresh air, and plenty of sleep help to keep up the power of the body to kill germs.

of spring to come, so these germs often lie in the body waiting for a chance to grow. The only safe way, therefore, is to keep the body always in health, so that it will be able to kill any disease germs that may enter it. Overwork, exposure to cold, wet feet, hunger, fatigue, worry, lack of fresh air, lack of sleep, alcohol—all of these things injure the body and lower its germicidal power. It is the duty of every one to keep himself in health—to care for his body intelligently and carefully—and to fail to do this is no more sensible than it would be sensible for the soldiers in a fort to open the gates and lie down to sleep in the midst of their enemies.

Alcohol and resistance to germs.—Many physicians have long believed that drinkers suffer far more from many germ diseases than do those who use no alcohol. A spell of drinking often brings on an attack of pneumonia, and the death rate from pneumonia is very high among drinkers. Wounds heal less rapidly in users of alcohol than in abstainers, and the inflammation is more likely to run on into blood poisoning in a drinker. So in cholera and typhoid fever it is the drinkers who suffer most, and there is every reason to believe that this is the case in all germ diseases. Drink no alcohol if you wish to keep up the power of your body to resist germs, for users of alcohol are attacked by germ diseases more frequently than abstainers, and many of them die of these diseases when they are attacked.

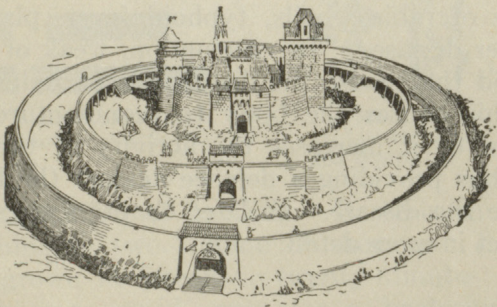


Fig. 127. The Castle of Health. Read the three rules for the prevention of germ diseases, and tell what the two outer defenses of the castle, and the walls of the castle itself, represent.

The third great rule for the prevention of germ diseases.—The third great rule for the prevention of germ diseases is: *keep the body in health, so that it will be able to kill disease germs.* A general does not risk the fate of his army on a single battle line, but behind the first line of soldiers he places a second line, and behind the second line he has still a third line of defence in case the enemy should break through the first and second lines. So, in our warfare with the germs, we should not depend on any single line of defence. We should try to keep germs from being spread about, we should guard the gateways by which they enter the body, and within the body we should have the defenders at their posts. For, sooner or later, just when we cannot tell, our unsleeping enemies will pass through the first and second lines of our defence, and if at that time the health of the body is low and the defenders of the body are weak, it will be the worse for us.

Increase the defences of the body by vaccination.— Vaccination has been employed as a protection against smallpox for more than a century, and of recent years it has been used to increase the resistance of the body to the germs of rabies, boils, typhoid fever, plague, and of many other diseases. In vaccination, weak or dead germs of the kind that cause the disease are introduced into the body. This causes the body to manufacture germicidal substances, or it increases the activity of the white corpuscles, thus providing a defence against the living germs that cause the disease. In later chapters we shall discuss this subject in more detail.

CHAPTER XXIII

BACTERIA

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

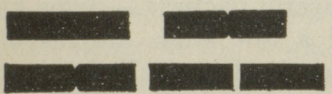


Fig. 128. A diagram showing the way a bacterium multiplies by pinching in two.

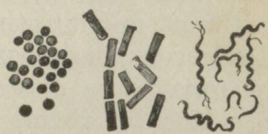


Fig. 129. The three shapes of bacteria,—cocci, bacilli, and spirilla.

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

The shapes of bacteria.—Bacteria are cylindrical, spherical, or spiral—shaped like a fire-cracker, a marble, or a corkscrew. The cylindrical bacteria are called *bacilli* (singular, *bacillus*). The spherical bacteria are called *cocci* (singular, *coccus*), and the spiral forms are called *spirilla* (singular, *spirillum*). The shapes of bacteria have nothing to do with the diseases which they cause, but often give a convenient way of distinguishing between different kinds.

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

Dangerous, harmless, and useful bacteria.—Some kinds of bacteria cause disease, and a few kinds are useful to man. Most of them, however, lead their little lives in the soil, in water, or even in our own bodies, and neither help nor harm us. Among useful bacteria are those that take a part in butter and cheese making, and those that help to increase the fertility of the land. The bacteria of decay, although they destroy much of our food, are also, on the whole, useful to us. Imagine what the world would be like if all the animals and plants that have lived and died in it were lying about us, and you will be convinced that the bacteria of decay are our friends and not our enemies.

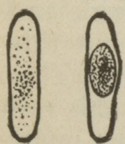


Fig. 130. The right-hand figure shows a spore of a bacterium.

The spores of bacteria.—Certain kinds of bacteria produce *spores* when hard times come upon them. A spore is formed by the living matter of a bacterium gathering itself into a little, hard ball that rests like a little seed, until food, moisture, and other good conditions for growth return. Then it grows again into an ordinary bacterium, which goes on growing and multiplying as before. So very difficult are bacterial spores to kill, that some of them have been found alive after they had been dried for ten years, and others are not killed by boiling them for several hours. Fortunately for us, the germs of none of our most common diseases produce spores, and these germs may be killed by a very moderate amount of heat.

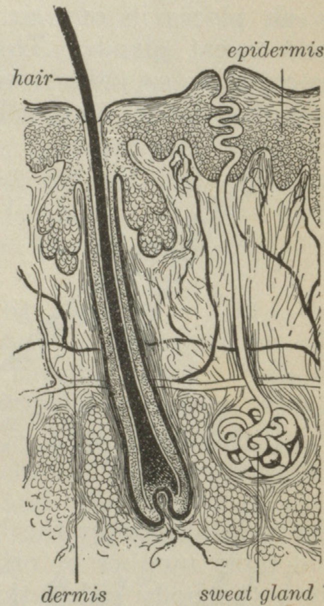


Fig. 131. A section of the skin.

The skin.—Without the skin to protect us, it is probable that bacteria would swarm into our bodies in such numbers that in a week there would not be a living human being in the world. We know that this is true, because most of the bacteria that attack us enter the body by way of two small openings (the mouth and the nose), and because when even a single cut or tear is made in the skin, the body is sometimes hardly able to hold back the germs. If the inhabitants of a besieged city were hard pressed to defend a single open gate of the city, we should not think that they stood much chance of holding back the enemy if the whole city wall were thrown down. So if the body is hardly able to defend itself when there is only one wound in the skin, we should not expect it to keep up the fight long if the covering behind which it is sheltered were removed.

The skin is composed of an inner layer called the *dermis*, and an outer layer called the *epidermis*. The hairs stand in deep narrow pockets that are called *hair follicles*. Through the epidermis, the sweat glands open on the surface of the skin by little pores or openings.

Bacteria that enter the body through the skin.—The weak places in our armor of skin are the hair follicles and sweat glands. Through these weak points certain bacteria do sometimes work down and cause inflammation, pimples, boils, carbuncles, and erysipelas. These same

Figs. 132 and 133. If bacteria were large enough for us to see them without a micscrope, a pencil that had been in some one's mouth would appear something like this, and the legs of a fly would be seen to be loaded with germs.

bacteria also enter the body through wounds, and a considerable number of other disease-producing bacteria get into the body either through wounds or by the bites of insects.

Bacteria real living plants.—In this chapter we shall discuss the bacteria that enter the body through the skin. During your study of this chapter, as well as during your study of later chapters, it will help you greatly if you can get a clear picture in your mind of what bacteria are really like. Remember that the moss which clings to the bark of a tree is on the tree, even though you cannot see it from a distance. So if you could only see them with your unaided eyes, there are, as it were, great forests of bacteria growing on your skin, and clusters of bacteria hanging to particles of dirt and to the legs of flies. Whether we see them or not, bacteria are real living plants, and you should be able to call up pictures of these little plants in your mind.

You can help yourself to get clear and correct ideas in regard to bacteria by asking your teacher about the points that you do not understand, and you can learn much about them from a physician. For physicians know many things about bacteria that are not found in a little book of this kind; they can tell you many things that a teacher cannot be expected to know; and sometimes they allow boys and girls to look at bacteria through their microscopes.

Diseases caused by pus-forming bacteria. — The pus-forming germs are among the most wide-spread of all the germs that are capable of causing disease. They are found in the soil around the dwellings of men and of animals, they are common in unclean water, and they always occur in great numbers on the human skin, where they feed on the dead cells and other matter on the skin. There are several different kinds of these bacteria, but they all cause inflammation and form pus, the thick, creamy, liquid matter that is found in boils and infected wounds.

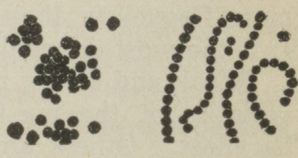


Fig. 134. The two most common pus-forming germs.

The pus-forming bacteria may grow in almost any part of the body and cause inflammation of the part that is attacked. In wounds they cause pus to be formed. In the skin they cause pimples, boils, carbuncles, and erysipelas. Very commonly they attack the walls of the throat or intestine and cause tonsillitis, sore throat, inflammation of the bowels, or appendicitis. Occasionally they attack the membranes around the brain and cause meningitis, or set up their growth in the lungs and cause pneumonia. In like manner they may grow in the lining of the heart, or they may spread through all the body and cause blood poisoning.

The different kinds of pus-forming bacteria. — The most common of the pus-forming bacteria is a small coccus (*Staphylococcus*)[1] that grows in bunches or clusters (Fig. 134). This coccus is the usual cause of pus in small wounds, of pimples, boils, and carbuncles, and of inflammation and ulcers in the bones. It may also cause blood poisoning, and is sometimes found in other cases of inflammation.

Another common pus-forming bacterium is a coccus (*Streptococcus*)[2] that grows in chains (Fig. 134). This germ causes erysipelas by making a wide-spreading growth in the skin. It is sometimes found in small sores and boils, but it more commonly attacks the inner parts of the body. It is often the cause of tonsillitis, appendicitis, and blood poisoning. More commonly than any other germ it is found in inflammation of the middle ear,[3] and it causes meningitis and pneumonia more frequently than do the other pus-forming bacteria. It is the most dangerous of all the pus-forming germs.


Fig. 135. A pus-forming bacillus.

Weak and strong races of pus-forming bacteria.—Some varieties of the pus-forming germs seem to be entirely harmless. Others are exceedingly dangerous and, whenever they have the opportunity, produce the most violent cases of inflammation and blood poisoning. None of them

[1] Pronounced staf-il-o-kok-kus. [2] Pronounced strep-to-kok-kus.

[3] The running ears that are common among children should receive prompt medical attention, both because there is danger of injury to the hearing, and because there is danger that germs will reach the brain and cause meningitis or a brain abscess.

should be allowed to enter the body when it can be prevented; but germs from a carbuncle, an old abscess, a case of erysipelas, or a case of blood poisoning are far more to be feared than germs of the same race from the skin or from some other source outside the body. It is a common thing for a person with a boil to scratch the germs into the skin with his fingernails, and cause a whole crop of boils in different parts of the body.

Care of wounds —For our protection against pus-forming germs it is very important to know how to care for small wounds. If the wound has been made by a clean instrument and bleeds freely, the blood will wash the germs outward, and by its germicidal power will probably kill any bacteria remaining in the wound. In such a case, the best thing to do is to tie up the wound "in the blood," and not open it until it is healed, unless inflammation sets in. A good plan is to wrap the wounded part in a thin, clean, inner cloth, and outside of this tie a second cloth. The outer cloth can be changed from time to time when it becomes soiled, while the inner cloth is left undisturbed to keep germs from getting into the wound. Wounds on the feet and hands, where dust and earth are likely to get into them, should have especially careful attention.

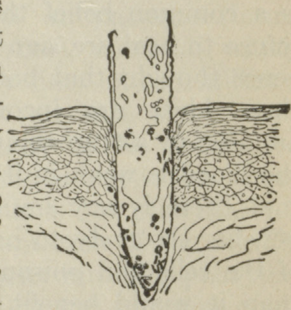


Fig. 136. If a nail or other instrument is driven through the skin, it will carry germs down and leave them among the cells.

A wound that has been made with anything unclean should be carefully washed in pure water. Where there is dirt in a wound, the wound should be washed with a disinfectant, as a five per cent solution of iodine in alcohol or ether.

After a wound has been bandaged, it should be carefully watched, and if pain, redness, or swelling shows that germs are growing in it, the wound should be opened and disinfected. A salve, such as borated vaseline, that contains boric acid, is often very useful in treating small infected wounds, and peroxide of hydrogen is used to flush out larger wounds and boils and to kill the germs in them. Peroxide of hydrogen must be used with care, however, or the tissues will be injured by it.

The pus-forming bacteria injurious to the body.—It is a common belief that boils, pimples, and wounds that refuse to heal are signs of "impure blood," and it is sometimes thought that boils are beneficial to the body. Both these ideas are incorrect. When pus-forming bacteria are able to set up their growth in the body, it means that the blood is weak in its power to kill these germs, and not that there is any impurity in the blood; and it no more benefits the body to have pus-forming bacteria kill groups of the cells and poison the whole system with their toxins than it would benefit it to be attacked by the germs of typhoid fever, pneumonia, or diphtheria.

Vaccination against pus-forming bacteria.—Vaccination with dead germs is now a common treatment for boils and for any long-continued infection with either of the more common pus-forming bacteria. A serum prepared from the blood of the horse is also used in severe infections of one of these germs (streptococcus). This serum is similar to diphtheria antitoxin, but it is prepared by repeatedly vaccinating the horse with dead germs and, instead of antitoxin, it contains a substance for increasing the activity of the white corpuscles.

CHAPTER XXIV

COMMUNICABLE DISEASES OF THE AIR PASSAGES AND THE LUNGS

The air passages consist of the *nasal chambers* (nose), the *pharynx* (throat), the *larynx* (voice box), and the *trachea* (windpipe) and its branches (bronchial *tubes*). The lungs are composed chiefly of air passages (bronchial tubes), some of which are very fine, and of millions of little air sacs that lie at their ends. The tonsils are two rounded elevations in the side walls of the pharynx. A tube from each of the middle ears opens into the pharynx.

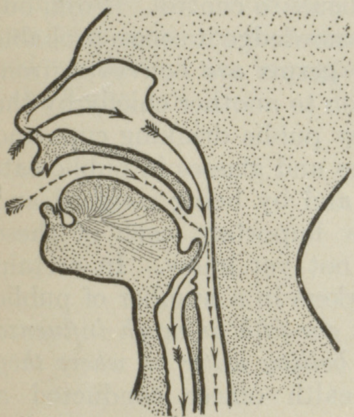


Fig. 137. The solid arrows show the path of the air to the lungs; the dotted arrows show the path of the food to the stomach.

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

How the germs of respiratory diseases are spread.—The germs of respiratory diseases enter the body and leave the body through the mouth and nose. They reach the hands more easily than the germs of other diseases and pass more readily from one person to another, and in the army camps during the Great War they were the diseases that were most difficult to control. From our present knowledge it seems probable that the germs are conveyed from one person to another chiefly by the hands; by public drinking cups and the dishes and glasses in public eating places and soda fountains; and by being coughed and sneezed out into the air. How important each of these methods of infection is we do not yet know. In certain army camps and among the workers in a number of public eating places *there was less than one-fifth as much influenza where the dishes were washed in boiling water as where they were washed by hand.* One health officer conducted a campaign based on the two simple ideas of smothering coughs and sneezes and of keeping the hands away from the face, and he believes that by this campaign he reduced the respiratory infections in his district by 30 per cent.

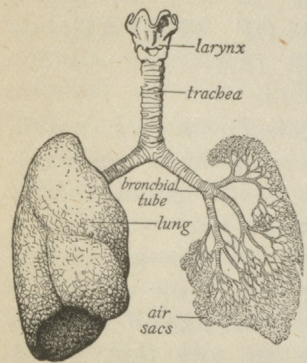


Fig. 138. The lungs.

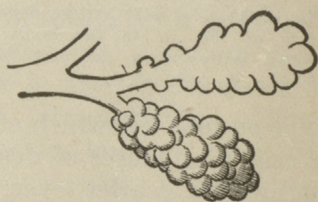


Fig. 139. Air sacs that lie at the ends of the small bronchial tubes in the lungs.

Preventing respiratory diseases.—Patients suffering from respiratory diseases must be isolated to prevent the spread of the germs, and coughs and sneezes should be covered. To avoid these diseases a person should not touch objects that have been touched by others; he should not shake hands unless it is necessary; he should avoid public drinking cups and public eating and drinking places where the dishes are not sterilized; he should keep his hands away from his face and should wash them thoroughly with soap before eating; he should avoid crowds if possible; and he should keep himself in the best possible health, so that his resistance to the germs will not be lowered. Experiments prove that fresh air increases the resistance of animals to germs, and all experience indicates that outdoor life, outdoor sleeping, and good ventilation are important in building up the defences of the body.

CHAPTER XXV

DIPHTHERIA

Some cases of diphtheria are so severe that death comes in a day or two. Other cases are so light that they are mistaken for colds in the head or for simple sore throats. The disease is most common in children, and there is always an increase in the number of cases when the children come together in school after the long vacation. The incubation period is usually from two to eight days, but may be less.

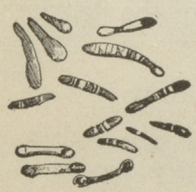


Fig. 140. The bacillus of diphtheria.

The germ of diphtheria.—The diphtheria germ is a bacillus. It grows most frequently in the throat, but often it is found in the mouth, nose, and larynx.[1] It may grow also on the lips, on the lining of the eyelids, and in other parts of the body.

The diphtheria bacillus does not usually grow outside the human body, except when it gets into milk. In most cases it is killed by drying, but when it is protected by matter about it, the bacillus can live for some time. On slate pencils that had touched the lips of children who were in the early stages of diphtheria, the germs were found to be alive after several days, and in dried "membranes" from the throats of diphtheria patients it is known that the germs can live for months.

How diphtheria germs get into the body.—Diphtheria germs enter the body by way of either the mouth or the nose. They are passed from one person to another in various ways. They may be coughed out into the air

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

and inhaled,[1] or by spitting they may be spread about in a most dangerous manner. They are almost certain to be on the handkerchiefs of the persons who are carrying these germs, and they can easily get on doorknobs, books, or furniture. They have been found on public drinking cups, and they may be on pencils, chewing gum, pieces of candy, toys, or any of the other objects that are handled and passed around by children. A number of diphtheria epidemics have been caused by milk, and flies may carry the germs about and leave them where they will reach the mouth and throat. Cats suffer from diphtheria and spread the disease, and other domestic animals probably do the same.

Fig. 141. Diphtheria germs have been found on pencils.

Difficulties in controlling diphtheria.—Diphtheria caused the death of over 2,000 Canadians in 1921. This large number was nearly double the number of deaths from measles, whooping cough, or scarlet fever. One-half of all the deaths from diphtheria occur in children under the age of five years. The chief difficulty in stamping it out is that the germs often linger in the throat for four or five weeks, and occasionally for several months, after recovery from an attack of diphtheria. The germ is

[1] In coughing, sneezing, laughing, and to a certain extent in talking, small droplets of liquid are sent out into the air. They may fly to a distance of several feet (three to nine), and some of them are so very fine that they are said to float in the air for as long as twenty minutes. When a person is suffering from a disease like diphtheria, pneumonia, or tuberculosis, these droplets are, of course, filled with the germs of the disease. One should not stand near a person who is coughing, and a sick person should hold a handkerchief or a paper napkin before his face when he coughs.

found also in the throats of a considerable number of healthy persons[1] (often in those who have been in contact with cases of the disease), and in the noses and throats of persons who seem to be suffering only from ordinary colds or from light cases of sore throat. As a fire sometimes bursts forth into flames again after it seems to be dead, so diphtheria, after it seems to have disappeared often breaks forth anew from these germ carriers. For at any time one of these persons may pass on to others germs that will cause the most severe cases of the disease; or, if his resistance to the germs runs low, he himself may be overcome by them.

Quarantining in cases of diphtheria.—To control diphtheria, every one who is carrying virulent diphtheria germs must be shut up in quarantine, whether he be sick or well. It should be understood that in doubtful cases it is not possible for a physician to tell by looking at the throat whether or not it is free from diphtheria bacilli. To determine this, a microscopical examination for the germs must be made.

Diphtheria toxin.—The diphtheria germ occasionally produces death by causing the throat to close, but the usual cause of death in diphtheria is the very powerful toxin. So poisonous is this toxin that a patch of diphtheria germs the size of the thumbnail growing on the tonsil may produce toxin enough to cause death. The toxin attacks especially the nervous system, the kidneys, and the heart.

[1] Investigations indicate that when diphtheria is in a place from three to five healthy persons in every thousand carry virulent diphtheria germs in their throats. In these persons the body is holding the germs in check, so that they cannot multiply enough to produce the disease, but it is not able to destroy them.

Chronic carriers of diphtheria germs usually have diseased tonsils, and removal of the tonsils causes such persons to become free from the germs. Infected tonsils seem also to make one more liable to the disease.

The antitoxin treatment for diphtheria.—In Chapter XXII we learned that when disease germs produce toxin in the body, the body works up an antitoxin to destroy the toxin and save itself from being poisoned. Working in accordance with this principle, scientists have learned how to get a diphtheria antitoxin from the blood of the horse.[1] When a person is attacked by diphtheria, some of the antitoxin from the horse is injected into the body. This does not kill the diphtheria germs, but destroys their toxin and saves the cells from poisoning until the body can kill out the germs.

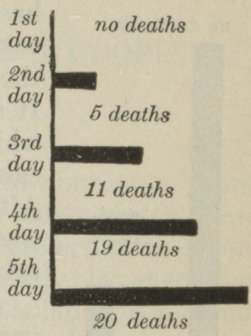


Fig. 142. Showing the number of deaths in 100 cases of diphtheria, when antitoxin is used on the first, second, third, fourth, and fifth days. The sooner antitoxin can be used in this disease, the better. The figures are taken from the experience of the London hospitals.

It is very important that the antitoxin be given in the early stages of diphtheria, for after the toxin has poisoned the cells of the nervous system, kidneys, and heart, great damage has been done, and it is not possible to undo it. Antitoxin is useful in all stages of the disease, however, and should always be used. It is also very useful in preventing diphtheria, and when a person has been exposed to the germs, a dose of antitoxin is often given to prevent the development of the disease.

[1] The antitoxin is prepared in the following manner: Diphtheria germs are placed in beef broth, where they multiply and produce great amounts of toxin. A little of this toxin is then injected into the blood of a horse, and the horse begins to work up antitoxin to destroy it. A larger dose of toxin is then given to the horse, and still more antitoxin appears in the blood. More and more of the toxin is injected, until the blood of the horse is made as strong in antitoxin as possible. Then the horse is bled and the blood allowed to clot. The thin yellow liquid (serum) that appears around the clot contains the antitoxin. After being freed from certain impurities, this serum is sealed up in glass containers and sold as antitoxin.

The results of the antitoxin treatment.—From the very beginning of its use in the treatment of diphtheria, antitoxin has been a great success. Indeed, when antitoxin is given in the very early stages of the disease, there are almost no deaths. It should be understood that the paralysis which sometimes follows diphtheria is not caused by antitoxin, but by the disease. After an attack of diphtheria the heart is weak, and violent exercise should not be taken.

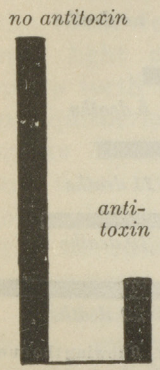


Fig. 143. When no antitoxin is used in the treatment of diphtheria, about forty-four patients in a hundred die. When antitoxin is used, there are only one-fourth as many deaths (eleven in a hundred).

The Schick test.—A few years ago a very simple test was discovered to tell whether a person could or could not catch diphtheria. This is known as the Schick test. It consists in injecting a few drops of a prepared diphtheria toxin into the skin and then watching whether a characteristic red spot appears where the injection was made. If such a spot does not appear within two or three days it shows that the person cannot catch diphtheria.

Lasting protection by diphtheria vaccination.—For those in whom the characteristic redness appears, and who are therefore known to be liable to catch diphtheria, doctors now advise a course of protective injections similar to those which have proven so successful against typhoid fever. This protective treatment consists of three small injections, a week apart. There is no sore, as there is in smallpox vaccination, and the injections are harmless. The protection lasts for years, and perhaps even for life.

CHAPTER XXVI

PNEUMONIA; INFLUENZA; AND WHOOPING COUGH

PNEUMONIA

The character of the disease.—Up to about ten years ago tuberculosis caused more deaths in this country than any other germ disease. Now a better understanding and knowledge of the disease has considerably lessened the death rate from it. In some parts of Canada pneumonia now claims more victims than any other of our microbe enemies. It is much more common in cities than it is in the country, probably because in a city, where the people are crowded together, the germ is more easily passed from one person to another, and because fresh air is less abundant in the city than it is in the country.

Pneumonia usually begins with a chill (often a very severe one), cough, fever, pain in the side, and rapid breathing. The sputum has a rusty color caused by blood from the air sacs of the lungs. The disease runs a swift and severe course, the crisis coming usually in from three to eight days. In rare cases death is caused by the closing of the air sacs in so great a portion of the lungs that the patient cannot breathe, but more commonly the heart is overwhelmed by the toxin that is carried from the diseased lungs by the blood. Pneumonia attacks particularly children under five years of age, aged persons, and those who for any reason are weak or sick. Users of alcohol are especially liable to pneumonia, and all physicians know that drinkers fare badly when attacked by this disease.

The germ of pneumonia.—Pneumonia may be caused by a number of different germs, but in most cases a small coccus[1] is the invader. This germ grows not only in the lungs but also in the nose, mouth, throat, and air passages; in children it is a very common cause of inflammation in the middle ear, and it is sometimes the cause of meningitis. The pneumonia germ attacks many animals, and it is possible for man to get the disease from animals.

How pneumonia germs enter the body.—Pneumonia, like diphtheria, is an infectious disease. The germs are in the sputum and often in the discharges from the nose of a pneumonia patient; they are passed from one person to another in all the ways that diphtheria germs are spread abroad; and they enter the body through the mouth or nose. The germs are killed by drying, and outside of the body they quickly die.

Preventing the spread of the germs.—Pneumonia, like diphtheria, is a communicable disease. No one should go about a pneumonia patient except those who are waiting on him, and the sputum of the patient should be destroyed.[2] The avoidance of crowding is also important in preventing pneumonia.

Preventing pneumonia by keeping up the health.—The pneumonia germ is one of the most widespread of disease germs, and it is not always possible, try as we may, to avoid it. During pneumonia epidemics, therefore, it is advisable to make a special effort to keep up the general health, so that the body may be able to kill any pneumonia

[1] *Pneumococcus* (neu-mo-kok′-kus). In the army during the Great War, the streptococcus was also a common cause of pneumonia.

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

germs that may reach the lungs. To keep up the health a person should avoid all exposure to wet and should wear sufficient clothing to protect himself from cold. He should avoid alcoholic drinks, for the man whose power to resist germs is lessened by drink falls into the hands of a terrible foe when the pneumonia germ attacks him. A person should also eat good food, take plenty of sleep and exercise, and should spend as much time as possible in the open air. Anything that builds up the general health is a safeguard against pneumonia, and anything that weakens the body may bring on pneumonia. In some of the army camps during the Great War it was noticed that respiratory diseases increased when the ground thawed and the men's feet became wet.

Fig. 144. Kiss the baby on the cheek, not on the mouth. If it isn't your own baby, do not kiss it at all.

The importance of fresh air.—There is little doubt that the resistance of the body to pneumonia germs is often weakened by a lack of fresh air. By many it is believed that the large number of pneumonia cases in February and March is to be accounted for on the theory that we have been weakened by living indoors all winter, often in houses that are not sufficiently ventilated. Physicians and boards of health are more and more recommending fresh air as a means of keeping up the health, and in treating pneumonia some of the most successful physicians put the patient outdoors even in the coldest weather, as is done in the treatment of tuberculosis. Baths and other necessary treatments, however, are always given indoors.

Any one who wishes to keep up his resistance to the pneumonia germ cannot afford to neglect the fresh air factor.

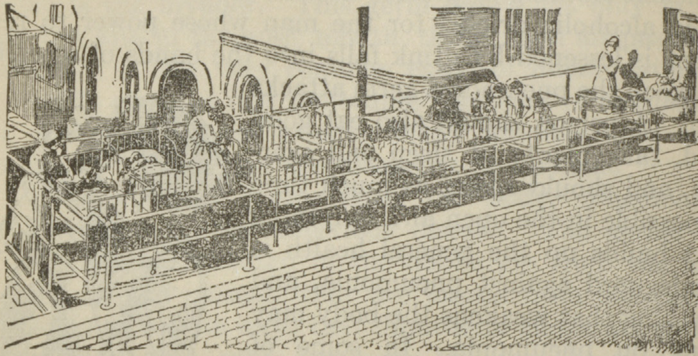


Fig. 145. Pneumonia patients being treated in the open air.

INFLUENZA

The germ of influenza.—Influenza (grip) was little known until 1889-1890. Then a great epidemic swept over the country, and the disease has been common with us ever since. It is, however, an ancient disease, and epidemics of it were common in Europe in the Middle Ages.

Influenza is probably caused by a filtrable virus. The germs are in the sputum and the discharges from the nose, and it is probable that the disease is communicable only in the early stages. The incubation period is very short, and it is the most catching disease known.

Influenza a serious disease.—The influenza germ produces a powerful toxin that has a profound effect upon the whole body. It does not poison the body so acutely as does the toxin of the diphtheria germ, but it causes a depression and weakness that often last for months. Another bad feature of the disease is that other troubles, such as pneumonia, tuberculosis, eye and ear diseases, bronchitis, and colds, often follow it, and it may leave a part of the body, as the stomach, the kidneys, or the nervous system, in a weakened condition. Because it is so widespread, and because its after-effects are so serious, influenza is a much-dreaded disease. The most important point in the treatment of the disease is for the patient to go to bed at once and remain in bed until the danger is over.

Guarding against influenza.—Influenza is so infectious that only a most careful quarantine of first cases will control it. Masks have proved helpful in some hospitals in protecting nurses and physicians from respiratory diseases, but most health officials seem to think that the public will not wear them in a way to make them of much use in influenza time. To be effective, masks must be made of closely woven material, they must be changed frequently, and they must not be turned wrong side out after being worn. To protect a person from germs coughed out by others a mask should cover the eyes as well as the mouth and nose. Good health is no protection against the disease. In the great 1918 epidemic the well and those in the prime of life were especially attacked.

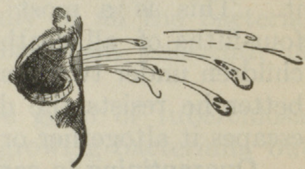


Fig. 146. In droplets that are coughed out into the air the germs of influenza, colds, and other respiratory diseases are found. See footnote, page 223.

WHOOPING COUGH

Whooping cough dangerous to children.—The incubation period of whooping cough is usually from four to fourteen days, but it may be as long as three weeks, and the "whoop" may not show itself for some time after the commencement of the attack. It is especially infectious in the very early stages. A child may be permitted to return to school in five weeks after the beginning of the whoop, provided the severe coughing spells have ceased.

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

Quarantining in cases of whooping cough.—To children under five years of age, whooping cough is a very dangerous disease, and cases of it ought not to be allowed to run unchecked with the idea that every one must have it. During quarantine the patient need not be shut up indoors, but he ought to keep away from others who might become infected with the germs. A vaccine is now prepared that will often prevent the disease. It will also shorten and lessen the severity of the attack if used promptly when the first symptoms appear. Dogs and cats suffer from whooping cough, and during epidemics they may be a means of spreading the germs.

CHAPTER XXVII

TUBERCULOSIS

Probably from the earliest times, mankind has been afflicted with tuberculosis, for a great Greek physician named Hippocrates wrote a treatise on tuberculosis in 400 B.C., and in the lungs of Egyptian mummies the marks of tuberculosis have been found. At the present time *Bacillus tuberculosis*, or the *tubercle bacillus*, as it is sometimes called, is the most deadly of all the bacterial enemies of man. In Canada, more than one-tenth of all deaths are caused by this germ.

The germ of tuberculosis.—The germ of tuberculosis is a slender bacillus. It is a slow-growing bacterium, but it is a very hardy one, and often it resists all attempts of the body to kill it and grows steadily on until it causes death. Outside the bodies of men and animals it does not grow naturally, and light and drying gradually kill it. Away from the habitations of men and animals the tubercle bacillus is not found, but it is often present in the earth and refuse about places where cattle are kept and in the rooms of careless consumptives.[1]

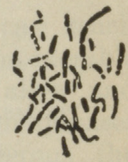


Fig. 147. The bacillus of tuberculosis.

Different forms of tuberculosis.—The tubercle bacillus may grow in almost any part of the body and cause tuberculosis of the part attacked. Tuberculosis of the lungs, is the best-known form of the disease, and causes by far the most deaths. Tuberculosis of the bones is also a

[1] A consumptive is a person who is suffering from tuberculosis of the lungs.

common trouble, and most of the lame and crippled people that we see have been deformed by tuberculosis of the spinal column, or of the bones of the hips, legs, or feet. Tuberculosis of the bones is especially common among children, as is also scrofula, or tuberculosis of the lymphatic glands. Tuberculous meningitis, which causes more deaths than any other form except tuberculosis of the lungs, is more common among children than among older persons.

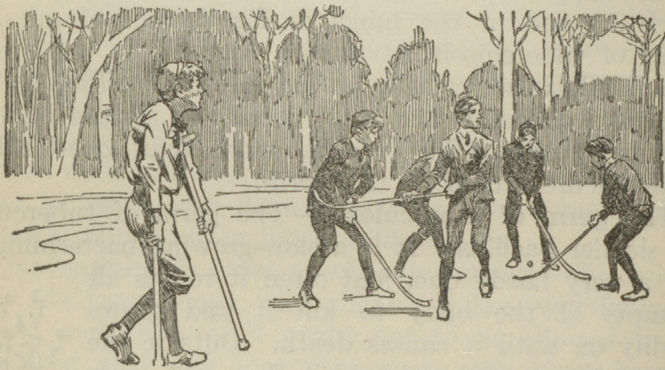


Fig. 148. Many of the lame and crippled people that we see have been deformed by tuberculosis of the bones.

The skin, kidneys, intestine, larynx, and other parts of the body also may be attacked by this germ: and when the tubercle bacillus is growing anywhere in the body, it is always possible for it to be carried by the blood to the lungs.

How the tuberculosis germs enter the body.—It is not possible in most cases of tuberculosis to tell how the germ got into the body. There is no doubt, however, that some cases come from breathing in germs from dried sputum and from droplets that have been coughed out by consumptives, and that many other cases come from germs that have been swallowed and that have passed through the walls of the intestine into the blood. It is probable that the germ gets into the body by way of the mouth more commonly than was formerly supposed.

How tuberculosis germs are scattered.—In tuberculosis of the lungs, the germs may be coughed out into the air in droplets of saliva, they may be carried by flies if all sputum is not carefully destroyed at once, and they may be spread abroad in all the ways that pneumonia and diphtheria germs are scattered. Dishes that have been used by a consumptive are a source of danger unless they are disinfected, and food that a consumptive has prepared or touched may contain the germs. The tuberculosis germs may also be in milk or water, they may be carried on the feet from sidewalks and other places where people spit, and in almost countless other ways these germs can reach the mouth and nose. They can withstand considerable drying, and in dried sputum they remain alive and virulent after the germs of most other common diseases would be dead. This makes especially dangerous the habit of spitting that some careless consumptives have, for in the advanced stages of the disease several billion germs are thrown off daily from the lungs. Indeed, it is not right for any one to spit in public places, for it is probable that more than one-half of the people in our country who have tuberculosis do not know that they are afflicted with the disease.

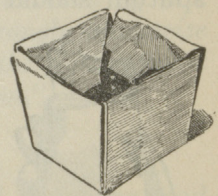


Fig. 149. A waterproof pasteboard sputum cup. These are very cheap, and they should be burned after being used.

Disinfecting sputum.—The importance of destroying the sputum of consumptives cannot be too strongly insisted upon. It should be received either in pasteboard cups that can be burned, or in a vessel that contains a disinfectant.

Carbolic acid is a good disinfectant to use for this purpose, but lysol is better, for it dissolves the mucus of the sputum and allows the disinfectant to get quickly to the germs. When the consumptive is travelling, the sputum may be received in waterproof envelopes or pocket sputum cups that are made for the purpose, or on pieces of cloth that may be carried in a paper bag until a fire is reached. The sputum should not be swallowed, for if this is done, the germs may set up intestinal tuberculosis, or they may pass through the intestinal wall, be carried away in the blood, and start the disease in some part of the body that has not yet become infected. Under no circumstances should the sputum be allowed to dry, for in the dry condition it is impossible to keep the germs from being scattered about.

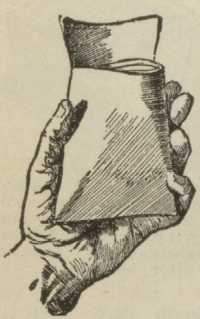


Fig. 150. A pocket sputum cup, to be burned after being used.

Other precautions to be taken.—A consumptive should hold a paper napkin or a handkerchief before his face when he coughs, and these napkins or handkerchiefs should be burned, or placed in a disinfectant, or kept in water until they can be boiled. A consumptive should learn to keep his hands away from his face and mouth, and should occasionally wash his hands in a disinfectant. He should have his own dishes, and these should never be washed with other dishes, nor allowed to come in contact with them until after being boiled for at least five minutes. His bed clothes, clothing, and furniture ought occasionally to be disinfected, or at least exposed to the bright sunshine as much as possible, and his clothing should be boiled before it is washed with other clothes. A consumptive should have a sleeping room to himself, and this room should be kept bright and well ventilated, to help kill any germs that may be free in it.

Alcoholism and tuberculosis.—In Chapter XX it was stated that alcohol lessens the power of the body to kill germs; also that the person who uses alcohol makes himself more liable to tuberculosis. So closely connected are the use of alcoholic drinks and tuberculosis that we must again draw attention to the resolution adopted in 1905 by the International Tuberculosis Congress: "*We strongly emphasize the necessity and importance of combining the fight against tuberculosis with the struggle against alcoholism.*"

TUBERCULOSIS IN ANIMALS

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

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

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

THE TREATMENT OF TUBERCULOSIS

The steady manner in which tuberculosis often runs on and on has caused many persons to think that it is an incurable disease. This is a great mistake. In very many persons who become infected in early life the germs are walled off and held dormant in the lymphatic glands or other parts of the body. It is a very common occurrence for the tubercle bacillus to start its growth in the lungs and to be checked by the body without the person who is being attacked ever knowing what is happening. If tuberculosis is taken in hand before the germs have gained a secure foothold, it yields to treatment much more readily than many other bacterial diseases.

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

Important factors in treatment.—In the successful treatment of tuberculosis, the following are the more important factors:

Rest. If a consumptive can be kept quiet, much of the toxin that is produced by the germs will be thrown off in the sputum. Anything that causes the breathing to be quickened and deepened causes more of the toxin to be carried from the lungs through the body, and increases the fever.

A consumptive should therefore have rest. If he has fever, he should have absolute rest, not even walking about his room. Laughing and loud talking should be avoided, and coughing should be refrained from as much as possible. When there is no fever, a little exercise may be taken, but it should be taken with care.

Food. A consumptive should have an abundance of nourishing food, especially of fatty food. Meat, eggs, milk, and any other good foods that he can eat and digest

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

should be taken. Lunches should be eaten between meals and on retiring. The foods must be well prepared and served in different ways, or the patient will become tired of them. "Stuffing" a patient, however, may cause indigestion, and the diet of a consumptive should be looked after carefully.

Outdoor life. Nothing in the treatment of tuberculosis is more important than fresh air, and the disease has been most successfully treated when the patients have lived and slept in the open air, summer and winter. Often an upper porch can be arranged as a sleeping place. In outdoor sleeping in winter, it is necessary to have warm clothing and to wear some kind of hood to protect the head and neck, and in many places in summer it is necessary to screen the patient from mosquitoes.

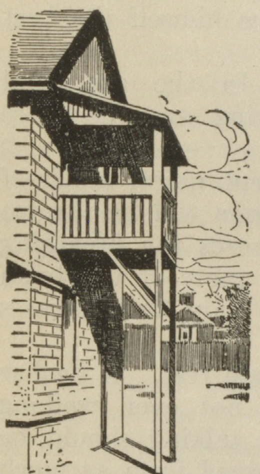


Fig. 151. An outdoor sleeping place, of a kind that most consumptives can have.

Other important points. Warm and dry clothing is of course important. Sunlight on the skin increases the number of white corpuscles in the blood and is used in the treatment of tuberculosis, but too much exposure to light is injurious, and the advice of a physician is needed in taking the light treatment. A consumptive should not remain in a damp house.

Finally, every consumptive should have a skilled physician to watch over and guide him in his treatment of himself, and he should secure some of the many books and circulars that have been written on tuberculosis and its treatment, and learn how to live in a way that will give the best possible chance for recovery. He should always think of the safety of others and should take care not to endanger those about him. He should be cheerful and hopeful, for if he takes his disease in time he has every reason to expect recovery.

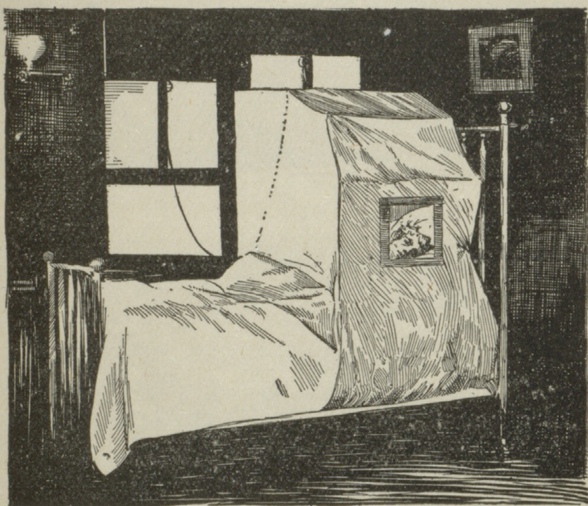


Fig. 152. Window tents can be bought that allow a consumptive to obtain fresh air through an open window while his body remains in bed in a warm room.

The effect of climate on tuberculosis.—It was formerly supposed that climate was very important in the treatment of tuberculosis, but in all climates consumptives are now being cured, and it has been found in treating this disease that rest, food, and fresh air are of much more importance than climate. Unless a consumptive has money enough to support himself without work and to give himself proper care, he should not leave his home for a distant place. For in many places consumptives are not welcomed, and it is better to be at home and have

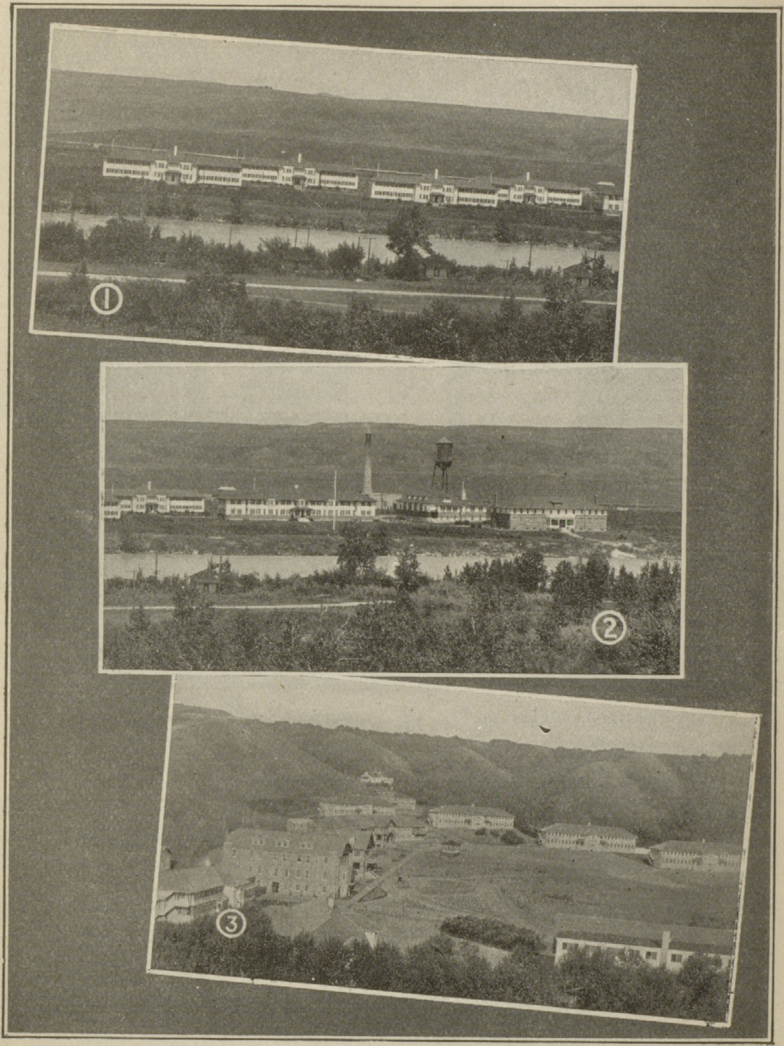


Fig. 153. 1 and 2. The Central Alberta Sanatorium at Keith, Alberta.
3. The Saskatchewan Sanatorium at Fort Qu'Appelle, Saskatchewan.

the proper care than to be without money or friends in the best climate in the world. In general, a cold, dry climate is best for consumptives, and they should avoid hot, moist climates and high elevations.

Sanatoria for consumptives.—All our provinces have established sanatoria to which consumptives can go and, at a slight expense, remain until they recover from the disease. This is sensible, for in a sanatorium a consumptive can have proper food and care at much less expense than he can have them at home, and in sanatoria the spread of the disease is stopped. In checking the spread of tuberculosis, sanatoria have been a wonderful help—perhaps a greater help than any other one thing.

Inheritance and tuberculosis.—Tuberculosis is often spoken of as an inherited disease, and it is true that some families are more afflicted by it than are other families. This does not mean that children in these families are born with tuberculosis germs in their bodies, but it means that they are born with less power of killing these germs than most people have. *People who come of tuberculous families cannot have tuberculosis unless they get tubercle bacilli into their lungs*, and if infection can be avoided, particularly in very early childhood, they may be as well and strong as any one.

Hygiene and tuberculosis.—A quick disease like measles or smallpox cannot be prevented by hygienic living; the germs attack so rapidly that the disease is on in full force before the body has time to manufacture substances to kill them. In tuberculosis the situation is very different. The body has plenty of time to work up its defences, and even where the germs have begun to grow in the body they are checked and held in a harmless condition in the great majority of cases. It follows, therefore, that *right habits of living and improving the conditions under which* *we live are most important in the fight against the disease.* From 15 to 30 are the years when tuberculosis is most common, and during this time of life special care should be used to *keep the resistance of the body high.* One important fact to remember is that after attacks of diseases like measles or typhoid fever the body needs special care until health and strength have returned in full.

Fig. 154. Little girls making their beds on one of the sleeping porches of the Preventorium of the Imperial Order of the Daughters of the Empire at Toronto. A Preventorium is an institution for caring for boys and girls who have been exposed to tuberculosis and who are not in good health.

Progress in the prevention of tuberculosis.—As we have seen, no germ has so spread itself through all society and has so extended its ravages to all parts of the world as has the tubercle bacillus. Yet the world is not full of tubercle bacilli. The air of the fields and woods, the streams of the forests and mountains, and the soil of the fields are free from them. The millions of people who in the past have died of tuberculosis germs got these germs from either sick cattle or sick men. Practically all the millions of people now living who are carrying these germs in their bodies were infected either by human sputum or by milk. Some persons, some cities, and some nations have to a greater or less degree known these facts for some

Fig. 155. These patients at the Queen Mary Hospital are carrying out the treatment of "Play in the open air."

years, and in many places a warfare on the Great White Plague is now being waged. This warfare has been most successful. "Tuberculosis is communicable, preventable, and curable," is the battle cry of the anti-tuberculosis host. Much of the work that is being done has as yet hardly begun to show its effects, but the results prove clearly that it is not necessary for people to die of tuberculosis as they are dying now.

CHAPTER XXVIII

DISEASES OF THE ALIMENTARY CANAL

The alimentary canal is a long passageway through the body. Its principal divisions are the mouth, throat, esophagus, stomach, small intestine, and large intestine. Like the air passages, the alimentary canal opens to the outside world, and germs, therefore, easily enter it. The juices of the stomach contain an acid that keeps most bacteria from growing in that part of the alimentary canal, but in the long reaches of the small intestine a number of germs grow and cause disease.

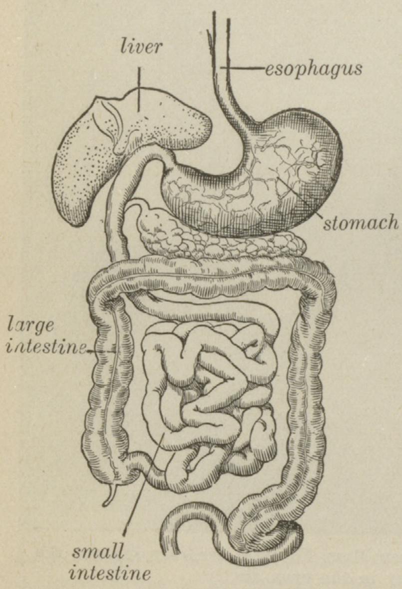


Fig. 156. The alimentary canal.

Bacterial diseases of the intestine.—Among bacterial diseases of the intestine are typhoid fever, cholera, dysentery, diarrhoea, and meat poisoning. It should be understood that intestinal diseases are much more easily prevented than are respiratory diseases, for the germs in most cases leave the body only in the intestinal wastes.

Food poisoning.—Food poisoning is sometimes caused by bacteria of the typhoid group, but in our country it is usually due to a soil bacillus that is a relative of the tetanus germ. It gets into meat, fish, and canned vegetables and fruits, and, since it forms spores that are not killed except by considerable steam pressure, fruits and vegetables canned after being merely boiled may still be infected by it. It produces a most violent toxin, and it is the toxin that has been formed in the food before it is eaten, and not the germs, that does the damage. The toxin is destroyed by boiling, and any canned food that seems spoiled in the least should be cooked before it is even tasted, for death has followed tasting a spoonful of spoiled corn or "nibbling" a spoiled bean pod. Symptoms of the poisoning do not usually appear for from one to four days. Among the symptoms are great weakness, blurred vision, and paralysis of the throat.

TYPHOID FEVER

Typhoid fever is found in all climates and in all countries where man dwells. It is usually a severe disease, but during some cases ("walking typhoid") the patient is hardly ill enough to go to bed. It is rapidly decreasing, but it still causes quite a number of deaths each year. The incubation period is from seven to twenty-one days.

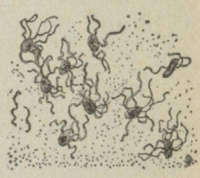


Fig. 157. The typhoid germ.

Typhoid fever an important disease.— The importance of typhoid fever is not shown by the number of deaths that it causes. For every person who dies from typhoid fever there are six or seven others who must be watched over through the anxious weeks of an attack, and of these a considerable number rise from their sickness with weakened kidneys, lame backs, crippled limbs, or other injuries that last through life.

The typhoid germ.—The germ of typhoid fever is a plump bacillus. It is fitted to live in a liquid, and swims freely. It enters the body through the mouth and attacks especially the walls of the small intestine, but in cases of typhoid the germ is found in the blood and all through the body. Meningitis, pneumonia, and ulcers in the bones are caused by this germ, and the "rose spots" that appear on the abdomen in most cases of typhoid fever are caused by the germs growing in the skin. The germs leave the body in the discharges from the bowels and kidneys, and occasionally in matter vomited by a typhoid patient. They may be in the perspiration, and if they are growing in the lungs, they will be found in the sputum.

The typhoid germ outside the body.—The typhoid germ is not known to attack animals. It can live in water for several weeks, and in the soil it is thought that it lives for several months. It multiplies rapidly in milk. Drying quickly kills it, and in general, typhoid germs usually die soon after they leave the human body. Typhoid victims are therefore persons who have taken into their mouths typhoid germs that not long before left the body of some one else.

How typhoid fever is contracted.—Persons in the same house with a typhoid patient may get the germ on their hands by handling bedding or in a hundred other ways. Flies will carry the germs in great numbers if all wastes from a typhoid patient are not carefully destroyed. Occasionally the germs are in oysters that have been grown in polluted waters, and for this reason cooked oysters are safer than raw ones. In a large number of cases, the typhoid germ has been carried in milk where some one having the disease has handled the milk, or where the milk vessels have been washed in water containing the germs. In many other cases typhoid is contracted from water. In a later chapter we shall discuss the subject of disease germs in drinking water.

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

The prevention of typhoid fever.—The great preventives of typhoid fever are pure water, pure milk, a safe method of disposing of human sewage, destroying carefully the germs that come from the bodies of typhoid fever patients and others who are carrying typhoid germs, removal of the breeding places of flies, and vaccination. In rural districts, well-water polluted with human discharges carrying the germs of typhoid is the chief means of spreading the disease. Vaccination against typhoid fever is now extensively practised in armies, hospitals, communities where the disease is usually prevalent, and among those who for any reason may run an unusual risk of being exposed to the disease. By vaccination the disease can be almost entirely prevented, and some health officers advise anti-typhoid vaccination for the whole population.

DISEASES CAUSED BY RELATIVES OF THE TYPHOID GERM

The causes of some of the germ diseases of the intestine are not well understood, as so many different bacteria are found growing in the intestine that it is sometimes impossible to be sure which one is causing the trouble. Among the germs frequently found in the intestine are several that are closely related to the typhoid bacillus. In this chapter we shall study some of the more important and best-known of these germs.

The colon bacillus.—The colon bacillus is very much like the typhoid bacillus. It is always found in the intestine of man and of all the higher animals. Usually it feeds on the contents of the intestines and does no harm, but when the body is weakened (as by hot weather), or perhaps when a more powerful race of the germs gets into the intestine, the colon bacillus seems to be a cause of diarrhoea and other troubles.

The bacillus of dysentery.—*Chronic* dysentery is caused by a protozoön; this disease we shall study in a later chapter. The sudden attacks of *acute* dysentery, which sometimes run in epidemics, are caused by a bacillus that differs very little from the typhoid bacillus. This is a severe disease, and one that is greatly feared by armies. In different parts of Canada there are epidemics of it every summer. The germs are scattered in the same ways that typhoid germs are scattered, and because the disease is a very dangerous one, all discharges from a dysentery patient should be carefully destroyed.

Illness from germs of the typhoid group in foods.—One form of meat poisoning is due to a bacillus of the typhoid group that causes illness in cattle, horses, hogs, and goats. The germ is in the flesh before the animal is killed, and the flesh of sick animals should not be used as food. Meat infected with this germ has no odor and does not appear to be spoiled.

Many of the sudden outbreaks of diarrhoea and intestinal trouble that are due to foods are believed to be due to other relatives of the typhoid germ. Sometimes they get into the food from people, but it is known that animals like the dog, cat, rat, and mouse carry germs of this group, and it is believed that food is sometimes infected by these animals.

Rats in particular are unclean, destructive, and unsanitary animals, and they should not be allowed about human habitations or where human foodstuffs are kept.

OTHER BACTERIAL DISEASES OF THE INTESTINES

Diarrhoea and inflammation of the intestine are important causes of death, especially among young children. They are most to be feared in the summer, the time when children are weakened by the heat, and the time when germs multiply most rapidly in water and in foods. The germs enter the body in water, milk, and other foods. Flies are especially responsible for the spread of these diseases.

Germs that cause diarrhoea.—It seems probable that any one of several different kinds of bacteria may cause diarrhoea and inflammation of the intestine. In some cases pus-forming bacteria seem to be the guilty germs. In other cases it is probably the colon bacillus. Probably mild attacks of typhoid fever and dysentery are sometimes mistaken for simple diarrhoea. The disease is infectious, and germs from a sick person should be destroyed.

Weak and strong races of intestinal germs.—It is probable that among the germs that commonly grow in the intestine there are different races, some more powerful than others. It is also probable that new races of these germs give us more trouble than those to which we are accustomed; for water that does not seem to trouble those who use it daily will often start intestinal disturbances in visitors and travellers. This is probably because those who drink the water from day to day become accustomed to the germs in it, and their systems learn to resist them, while a stranger is not prepared to overcome germs of these particular races.

Cholera infantum, or summer complaint, in children.— It has not been possible to prove that any one germ is the cause of cholera infantum. In a number of epidemics the bacillus of dysentery has been discovered, but in many cases other germs appear to be the cause. The trouble seems to be that in summer babies are weakened by the heat until they have little resistance to germs, and at the same time the milk which is fed to babies is kept warm until it swarms with multitudes of bacteria of many different kinds. *To prevent cholera infantum the milk must be kept clean and cold,* and it should be used as fresh as possible. The milk vessels and the bottles should be thoroughly washed and scalded to kill germs that are on them, and no impure water that is likely to contain germs capable of causing diarrhoea should ever be given to a little child.

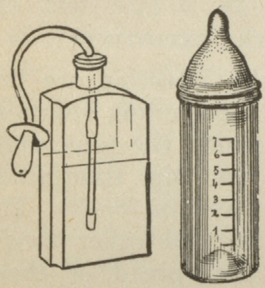


Fig. 158. The wrong kind of nursing bottle and the right kind. The bottle with the long, slender tube and the narrow mouth is hard to keep clean; the bottle with the wide mouth may be cleansed easily.

Indigestible foods that will lie in the intestine and form a breeding place for germs should not be given to young children. The general health of children should be built up in every way, so that they will be able to resist germs. *It should be remembered that cholera infantum is infectious, and any person who is caring for a little baby should keep the baby away from the disease.* Isolating the patient and disinfecting the body wastes has proved one of the most effective methods of checking the spread of the disease.

CHAPTER XXIX

DISEASE GERMS IN WATER

The disease germs that are most common in water are the germs of intestinal diseases. We should therefore consider the question of a pure water supply. The importance of this subject is often not appreciated, for many people neither realize the great number of deaths that are due to impure water nor understand that it is possible to prevent most of these deaths.

The importance of a pure water supply.—By filtering their water supplies through beds of sand, many cities have saved two-thirds of the people who would have died of typhoid fever, if they had continued drinking impure water. Niagara Falls installed a water-purifying plant, and five years later its death rate from typhoid was only one-eighth of what it had been when polluted river water was used.

Germ diseases that are contracted from water.—The diseases that are most frequently contracted from water are cholera, typhoid, dysentery, and diarrhoea. The germs of these diseases come from the bodies of human beings, reach water that is used for drinking purposes, and get back to the human mouth. In Canada, typhoid fever is the most important of the water-borne diseases.

Not only are the deaths from typhoid and other intestinal diseases reduced by using pure water, but for some reason a marked decrease in the number of deaths from pneumonia, tuberculosis, and several other diseases seems to follow changing from impure to pure water. The reason for this decrease is not yet fully understood. It is known, however, that in pneumonia, influenza, diphtheria, and tuberculosis the germs are practically always in the wastes from the alimentary canal, and tubercle bacilli have been found in the water of a stream that received the drainage of a tuberculosis sanatorium. It seems probable that the germs of respiratory diseases live in water and that many persons contract these diseases through impure drinking water.

How disease germs get into drinking water.—Usually, disease germs either get into water from sewage or are washed into the water from soils that have been polluted with wastes from the human body. They may get into a well or cistern, if a person who has germs on his hands works around the pump or handles the water buckets; a stream may be polluted by washing clothes from a diseased person in it, or by a diseased person bathing in it; but, in general, disease germs are washed out into waters from polluted soil. The following history of the typhoid epidemic that occurred in Plymouth, Pennsylvania, in 1885, shows how the water supply of a town may be infected with germs. During the winter of 1884-85, a man living on the bank of a stream that flowed into the town reservoir was stricken with typhoid fever. The wastes were thrown out on the snow, and in the spring the waters from the melting snows and the rains washed these germs into the water supply of the town, and typhoid fever suddenly broke out. The city had a population of about 8000, and during the height of the epidemic from 50 to 200 persons a day were attacked. Altogether there were 1104 cases and 114 deaths. People who drank from wells escaped, and there is no doubt that the germs came from the public water supply.

Epidemics like the one in Plymouth are, of course, uncommon, but if you will investigate you will probably find that in the town or community in which you live, several persons die each year from diseases that are mainly due to water.

Dangerous waters.—Any water that comes from the surface of the ground is likely to contain disease germs. Shallow wells, springs, and small streams are the most dangerous of all waters. It is not safe to use water from these sources, no matter how clear and pure it may seem; for in the country, where people drink chiefly from wells, typhoid fever is more common than it is in our most crowded cities; and in the mountain regions, where the people drink from the most beautiful clear springs and streams, typhoid is a great scourge. Experience shows that intestinal diseases follow the drinking of surface water, and it is not the part of wisdom to fail to profit by the experience of those who have lived before us.

Safe waters.—In general, waters that do not come from the surface of the ground are safe. Deep artesian wells (except in rare instances in mountain regions) furnish water that is absolutely safe. Rain water that is caught and stored away in tanks above the ground is safe also. There is a common idea that dangerous germs may be blown up on a roof in dust, but the germs of intestinal diseases die if they are thoroughly dried, and are not found in rain water that has been kept from touching the ground. Underground cisterns that are thoroughly cemented are much safer than wells. Yet there is danger of ground water getting into a cistern around the top, or if part of the pipe that carries the water from the roof is underground, germs may easily get into the cistern through this pipe. There is also danger of germs falling into an underground cistern from the platform above. Distilled water is perfectly safe, but some bottled spring waters contain bacteria.

Keeping germs out of wells.—In country regions, wells will probably be the principal source of drinking water for many years, and it is important that they be made as safe as possible. In guarding a well from dangerous germs, the following are the chief precautions to be taken:

Keeping surface water out of wells. Very few bacteria live deeper than three or four feet in the ground, and water, as it comes from the ground into a well that is as much

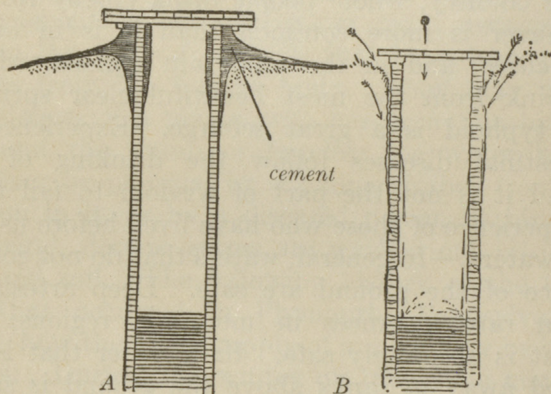
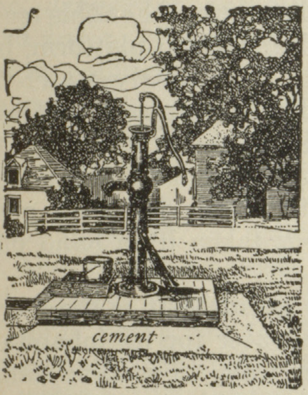
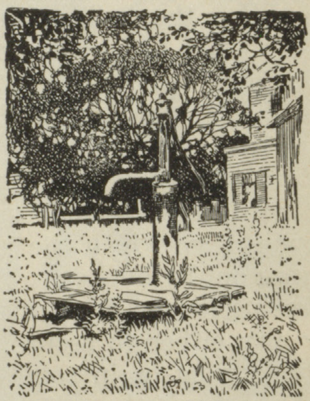


Fig. 159. *A* shows a well so arranged that surface water and germs are kept out of it. *B* shows how surface water and germs get into a well.

as twenty feet deep, is usually free from germs. In most cases the pollution of the water in such a well comes from the surface water getting into the well when it rains and carrying with it germs from the upper layers of the soil.

To keep a well free from dangerous bacteria, it should first of all be located on high ground and away from all pigpens, stables, or other outbuildings. In no circumstances should any puddles of water be allowed near it. Around the mouth of the well a tough clay should be spread and packed in thoroughly, to form a water-tight layer over the soil. This should slope so as to carry all water away from the well. The whole task is to keep surface water out, and this can be done still better by cementing the upper part of the wall and laying a circle of cement over the surface of the soil, as is shown in Figure 159. The platform should be wide enough to keep any surface water whatever from running down in behind the wall and getting into the well.





Figs. 160 and 161. From which well would it be safe to drink the water?

The foregoing precautions will do much to keep out of a well not only bacteria that are in the soil, but also matter on which bacteria can feed and multiply. Yet if the earth about a well is polluted (as it is in thickly settled regions where there are many dry closets), some germs are certain to find their way into the water. For this reason it has often been necessary in towns and cities to fill up wells, and where there is reason to think that a well has been the cause of disease, the use of water from it should certainly be stopped.

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

Freeing water from disease germs.—It is the duty of every city either to secure pure water for its inhabitants, or, by filtering or in some other way, to remove dangerous germs from the water that it sends to the homes of its people. Many cities fail to do this, however, and when one is compelled to use impure city water or water from an ordinary well or spring, the best plan is to boil it. Simply bringing it to the boiling point will kill all dangerous germs. Most house filters are almost useless, and some of them are worse than useless, for they catch and hold matter in which bacteria breed and multiply, and the bacteria pass through the pores in most of them. Very fine porcelain filters, if they are carefully cleaned and attended to, do strain out bacteria, but they work very slowly, it is a great deal of work to care for them, and it is easier to boil water than to look after one of them. Filtering through animal charcoal takes certain coloring matter out of the water and makes it look clear and bright, but it does not remove germs. It is always to be remembered that to use fruits, vegetable dishes, or milk vessels that have been washed in impure water may be as dangerous as to drink the water. Bringing water to the boil will make it safe for drinking purposes.

Fig. 162. Water like this is free from disease germs, unless it has been polluted by wastes from the bodies of the sick.

The danger of bathing in polluted water.—When a person bathes in polluted water he of course gets whatever germs are in the water on his hands and face and probably also in his mouth. For this reason it is not well to swim in polluted water, and swimming pools are a real danger when constant attention is not given to their cleanliness and the disinfection of the water. The water in a swimming pool is usually disinfected with chlorine or a compound of lime that contains chlorine.

Clear water not necessarily safe.—Because the water in a well is clear, or because people have been drinking it for a hundred years, does not mean that it is safe. Germs are so small that they cannot be seen by the unaided eye, and it is possible for a well to have been in good condition twenty-five years ago and to be receiving surface water now. It is possible, too, that many of the people who have drunk water from the well during the hundred years have died of diseases that they contracted from the water. Do not make the mistake of thinking that a well can be made safe by cleaning it out occasionally. Typhoid germs live longer in clean water than in dirty water, and a well can be made safe only by keeping disease germs out of it.

CHAPTER XXX

SMALLPOX

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

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

Some races of smallpox germs are weak and produce a type of the disease so mild that it is often mistaken for chicken pox. Other races are very virulent and cause smallpox of so malignant a type that numbers of the victims die, and many of those who recover lose their sight. In this disease, as in diphtheria and other infectious diseases, it would seem that weak races of germs may become strong, and that a mild type of the disease may at any time change to the malignant form. It is important, therefore, that mild cases of smallpox should be quarantined and not pronounced chicken pox; for from a mild case of the disease, germs may be spread abroad that will become virulent and bring many persons to their graves.

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

VACCINATION

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

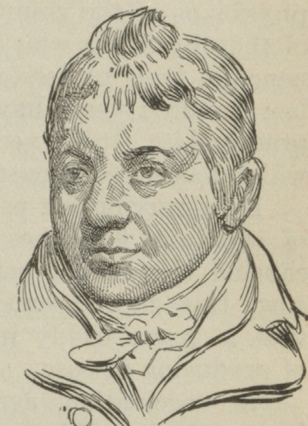


Fig. 163. Edward Jenner, who in 1797 discovered vaccination, the greatest medical discovery the world has ever known.

Vaccination an almost perfect protection against smallpox.—In April, 1912, nine cases of smallpox were reported in Niagara Falls, New York. There had been much opposition to vaccination among the people of this part of New York State, and little vaccination had been performed for twenty years. When the smallpox epidemic started, the local health officer was inactive, and the disease spread until in November, 1913, there were 66 cases, and in January, 1914, there were 204 cases. Effective measures were then taken for the control of the epidemic, and by March 6 more than 25,000 persons had been vaccinated, and the cases were put under strict quarantine. In February there were 121 cases, in March 10, in April 2, in May 1, and in the next five months none. Of the 550 cases reported during the epidemic, only 8 had been vaccinated within five years.

Many pages could be filled with similar statistics showing that vaccination almost surely prevents smallpox. Yet many persons seem never to have heard of these facts, for there are still in Canada societies that actively oppose vaccination. Some people think that among those who do not believe in vaccination are some of the prominent physicians of the country. This is a great error, for none of the physicians who oppose vaccination have any prominence in their profession. The leaders of medicine for the last hundred years have believed in vaccination and have practised it. It is a very serious matter to oppose a measure which has saved thousands from death or disfigurement.

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

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

How long vaccination protects against smallpox.—After vaccination, the germicidal substance in the blood becomes weaker and weaker, but seldom disappears entirely. Just when it becomes so weak that it is necessary to be vaccinated again, it is impossible to say. Sometimes it is fairly strong after seven, eight, nine, or ten years. In a very few persons it disappears so rapidly that in nine months it fails to protect against smallpox. The safest way is to be vaccinated every few years, and when there is danger of being exposed to smallpox, to be vaccinated again if more than nine months have passed since the last vaccination. There can be no mistake in this, for, if the germicidal substance is still strong in the blood, all the germs put in by vaccination will be killed, and the vaccination will not take. If the vaccination does take, it is a sure sign that the germicidal power of the body is beginning to run low and that another vaccination is needed.

Why every one should be vaccinated.—*Every one should be vaccinated to protect himself.* If smallpox germs do get to a person who has been successfully vaccinated, that person will in all probability kill the germs and suffer no harm. If he has not been vaccinated, he will probably suffer from an attack of smallpox, with a considerable risk of losing his life. Even if he recovers, he will be fortunate if he is not more or less scarred and pitted for life.

Every one should be vaccinated to protect others. Persons who have smallpox cause expensive quarantine, they interfere with business and with schools, and by scattering abroad smallpox germs they endanger the lives of others. A person who refuses or neglects to be vaccinated and then takes smallpox, makes a public nuisance of himself, and it is neither fair nor right to be a nuisance to one's friends and neighbors. In 1885 *one* man carried smallpox to Montreal and started an epidemic that cost over three thousand lives.

Little danger in vaccination.—Vaccination causes only a small sore, and there is practically no danger from it when it is properly done. The greatly swollen arms and running sores that sometimes follow vaccination are caused by pus-forming bacteria and are not a true part of vaccination at all. The pus-forming germs usually get into the wound in impure virus, from infected instruments (as from a lancet that has been used in opening a boil), from an unclean skin, or from dirt that gets into the wound. Only pure virus should be used,[1] the skin and instruments should be clean, and the wound (like any other wound) should be protected from pus-forming and tetanus germs. When one gets a great sore on the arm, it is not possible to tell whether the vaccination virus is working or not, and many persons who think they have been successfully vaccinated have only had a growth of pus-forming bacteria in their arms.

A point about germ diseases that should be understood.—It is a common idea that if the blood is "pure" we shall be protected from germ diseases, and if the blood is "impure" we shall suffer from these diseases. This idea is not correct. A person's blood may be as pure as any flowing in the veins of man, and yet that person will fall a victim to smallpox germs if he lacks in his blood the substance that kills those germs. His muscles may be like bands of steel and his nerves may be tingling with the joy and vigor of perfect health, and yet if in his blood there is not the particular substance that kills the tubercle bacillus, he had best beware of that germ. He may even, as we have already pointed out, have substances in his blood that will enable him to kill some kinds of germs and yet may fall an easy victim to germs of another kind. Resistance to germs is, therefore, not a question of pure blood, but a question of having in the blood particular substances that will kill particular germs.

[1] Only virus that has been carefully prepared and sealed in glass tubes should be used.

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

CHAPTER XXXI

THE HOUSEFLY

There is a belief among some people that flies are useful because they feed on wastes. No greater mistake could be made. Flies light on and walk over all manner of unclean matter, and then spread germs and uncleanness over dishes, food, and milk vessels. They may come to our faces straight from feeding on the sputum of a consumptive or the wastes of a typhoid patient. They may fly directly from some one who has sore eyes to our hands or faces or to the very eyes of a little baby that cannot defend itself from them. There is nothing more dangerous or more unclean than to live among a swarm of flies.

Kinds of germs carried by flies.—Almost any kind of germ may be carried by flies. Not only does a fly carry germs on its feet, but when it feeds on matter that contains disease germs, the germs are found in the matter that comes from its alimentary canal. In one speck left by a fly that had been captured on the face of a leper, 1115 leprosy germs were found. Tuberculosis germs and typhoid germs have also been found in fly specks, and there is no reason why a fly that walks over or feeds on matter containing the germs of any disease should not spread abroad those germs.[1]

Keeping germ-containing matter away from flies.—A fly may get germs on its feet by walking on the skin of a patient who has smallpox, measles, scarlet fever, or

[1] A study of 415 flies showed them to be carrying from 550 to 6,600,000 bacteria. The average was 1,250,000. Living typhoid bacilli have been found to remain in or on the bodies of flies for 23 days, and tubercle bacilli for 15 days.

erysipelas. It may easily take up dangerous germs from an open sore or ulcer. Flies are certain to become infected, if they are allowed to feed on the sputum of a consumptive, pneumonia, influenza, or diphtheria patient. The wastes

Fig. 164. This child is healthy and well, but flies may leave disease germs in his food.

from typhoid, dysentery, and cholera infantum patients must be absolutely destroyed, or flies may carry the germs all over the vicinity and may endanger the life of every one in the neighborhood. In general, it is unsafe to have flies about any person sick with an infectious disease, for there is always danger that by lighting on his hands or face or on some article in the room, they will take up germs.

Screening against flies.—From what you already know you will realize the importance of screening against flies, of freeing our houses as much as possible from them, and of covering all food and dishes from flies. When any flies at all are in a house, a young child should always be screened from them, for it is not right to leave a helpless little baby where it will not only be continually annoyed by flies crawling over it, but will have many different kinds of dangerous germs left on its face.

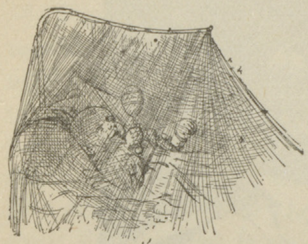


Fig. 165. A baby should be screened from flies.

Removing the breeding places of flies.—By far the most effective way of dealing with flies is to remove their breeding places. The egg of the housefly is laid in manure (chiefly in horse manure, and almost entirely in fresh manure) about stables, and to some extent in dry closets, garbage, and decaying vegetable matter. In a day or less the egg hatches into a small, white, footless maggot, which in nine or ten days from the time the egg was laid changes into the adult fly.

It is estimated that three hundred flies may hatch in a cubic inch of manure, and if the breeding places of the flies are left undisturbed, they will hatch faster than it is possible to kill them.[1] It is a simple matter, however, greatly to decrease their numbers by removing daily

[1] Floors of stables must be made of cement or other tight material; otherwise the flies will hatch in the crevices and in the earth that becomes soaked with the liquid manure. Usually eggs are laid in manure before it is removed from the stalls, and if it is stored these eggs will hatch unless they are killed by lime or some other substance.

all matter in which they breed, burying it, or spreading it on the fields where it will dry and the eggs and young of the fly will be killed. They can also be kept from breeding in manure by covering it with lime, or sprinkling it with borax or a solution of hellebore in water.

Killing adult flies.—It is important to destroy flies that are already hatched; for the same flies may remain about a house all summer unless they are trapped or killed. The giant flytraps that are now bought or made, fly paper, poisons, and the fly swatter, are all useful in ridding a house of these pests.[1]

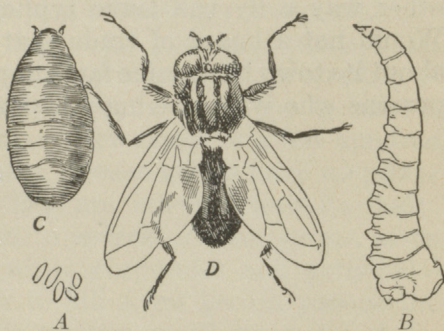


Fig. 166. The life history of the fly. *A* shows the eggs; *B*, the larva or maggot; *C*, the pupa; and *D*, the adult fly.

The economy of fighting flies and mosquitoes.—Under ordinary conditions it is not expensive to remove the breeding places of flies and mosquitoes in a town, and no money that a town can spend will pay better, either in dollars and cents or in the comfort that will come to the inhabitants, than money that is spent to free the town from these insects. In a small town one man can easily look out for all breeding places of mosquitoes. A cart

[1] The following hints may prove useful in the warfare on flies: Hang screen doors to open outward and rub them with a cloth dipped in kerosene or carbolic acid solution; make tops of traps of wire or glass so that the flies will come up to the light; use bananas or bread and milk for bait; take away water and food, so that the flies will come to traps or materials placed for them; mix finely ground black pepper with hard-boiled yolk of eggs or add two tablespoonfuls of formalin to a pint of milk and expose to flies. Neither the pepper nor the milk with the formalin in it is poisonous to children or animals. The milk placed on porches where flies gather is particularly effective on hot, dry days.

can remove weekly all the matter in which flies breed, and this matter can be sold for fertilizer for almost enough to pay for the expense of removing it. Boards of trade often try to improve and advertise their towns. Suppose a board of trade could say: "In our town you will not be bothered by mosquitoes. You will not be annoyed by flies, and you need not fear that while you are looking the other way a fly will leave typhoid germs on your plate." Would not a board of trade that could truthfully say this about its town have some facts to present that would interest persons who were seeking new homes?

CHAPTER XXXII

DISEASE GERMS IN FOOD

Foods (excepting milk) are not so likely as water to contain disease germs, but when foods become infected they are particularly dangerous, because germs can multiply in them. To appreciate this point you must understand that it is far more dangerous to take a large number of disease germs into the body than it would be to take a few germs of the same kind. A few dozen or a few hundred of almost any of the ordinary disease germs have no power to harm a rabbit when they are injected into its body, but if the dose is increased to several million germs, often the rabbit will die. Its white corpuscles and germicidal substances have the power to kill a few germs, just as the soldiers in a fort can drive away a small company of besiegers who are trying to break down the front gate of the fort. But when millions of germs attack the body at once, the defenders of the body cannot overcome them, just as the defenders of the fort would be unable to resist successfully a great multitude of attackers, who would not only try to enter through the front gate, but at the same time would break down all the other gates and swarm over the walls at every point. It is because in many foods a single germ can increase to a multitude that our foods especially need to be guarded against infection.

How germs get into foods.—Not only the germs of intestinal diseases, but also the germs of such diseases as tuberculosis, pneumonia, diphtheria, and scarlet fever, may reach the mouth in food. These germs get into the food from polluted soil, from flies, from washing in impure water the food or the vessels in which food is kept, from diseased animals, and most commonly of all from the hands of those who are carrying germs. Those who prepare food should pay special attention to the cleanliness of their hands, washing them often with soap and water; and no one who is sick with an infectious disease or who is just recovering from such a disease, should have anything to do with the handling or the preparation of foods.

Danger from spoiled food.—Besides the germs of special diseases, there are always present in foods the bacteria

Fig. 167. Food that has been handled by the public is likely to contain germs.

that cause fermentation and decay. These bacteria do not ordinarily cause sickness in man, but when taken into the alimentary canal in the prodigious numbers in which they are found in foods that are beginning to spoil, they cause fermentation in the intestine, diarrhoea, and other troubles. Tainted and soured foods are therefore unsafe and should never be eaten.

Buying foods.—The wise person buys his food in a store that is kept clean and where the food is protected from dust and flies. He never buys old and tainted meats or fish, or overripe or decaying fruits or vegetables, for these are swarming with bacteria and are already unfit for use. Above all, he will not buy any food that has been fingered over and handled by the public, for there is always danger that on such foods disease germs have been left from the fingers of some sick or germ-carrying person.

The care of foods.—In the care of foods two points are of special importance. These points are *cleanliness*, to prevent germs from getting into food, and *cold*, to keep germs that do get into the food from multiplying. The importance of cooking to kill any disease germs that may be in foods, as well as to kill certain worms that may be in meats, will of course be understood. It should also be understood that by thorough cooking all bacteria of every kind in food may be killed, and that food may be preserved in this way until a new supply of them has time to grow.

Dangers from milk.—Of all foods that are used by man, milk is the most dangerous, because without any cooking it furnishes a splendid place for the growth of almost all kinds of germs. Tuberculosis is sometimes contracted from milk, and it is known that typhoid fever, scarlet fever, and diphtheria may be spread by milk. Again and again it has been found that along the route of a certain milkman the people were suffering from one of these diseases, and on investigation it was proved that a case of the disease existed among those handling the milk or in their families; or that the bottles had been taken back from families where the disease was; or, in epidemics of typhoid fever, that the milk vessels had been washed in water from wells containing the typhoid germ. One article in a medical journal reported 330 epidemics traceable to milk, of which 195 were typhoid epidemics, 99 were epidemics of scarlet fever, and 36 were diphtheria epidemics. No person who has tuberculosis, or who has recently recovered from typhoid fever or other germ disease, should have anything to do with the milking of cows or the handling of milk. In general, the safest milk is that which is bottled at the dairy where it is produced. If possible, milk should be secured from a dairy that is known to collect and bottle its milk under sanitary conditions. It is difficult for a private citizen to guard against dangers from milk, and in all well-governed cities a health officer looks after the milk supply.

Milk and cholera infantum.—Most cases of cholera infantum are due to germs that are in milk.[1] Sometimes, as we have already learned, it does not seem to be any one special germ that is causing this disease, but the enormous number of many different kinds of bacteria that are in the milk in hot weather. Only pure milk is a fit food for babies, and milk that is filled with a multitude of bacteria and their poisonous toxins is unsafe. Especially in the months when babies are weakened by heat is a pure milk supply important.

Keeping milk free from germs.—All milk vessels and feeding bottles for babies should be thoroughly scalded before using, to kill the bacteria in the milk that adheres to them. Otherwise these bacteria will multiply in the new milk, and soon it will be filled with them. Milk vessels should never be rinsed in any but boiled water, the purest of rain water, or artesian water, for one dangerous germ that gets into the milk from the water remaining on the vessels may grow into a multitude. Milking should be done in a clean building that has fly screens on it, and everything possible should be done to keep dust and hairs out of the milk, for these are loaded with bacteria. The

[1] Of 1911 infants that died during one year in a large European city, only 844 were fed entirely on their mothers' milk.

milk should be cooled as quickly as possible, and kept cool to prevent the germs that do get into it from multiplying. It should be used before it becomes old, for milk that at first has only a moderate number of bacteria in it may soon be filled with countless myriads of them. It is also necessary for a medical officer to examine the cows from

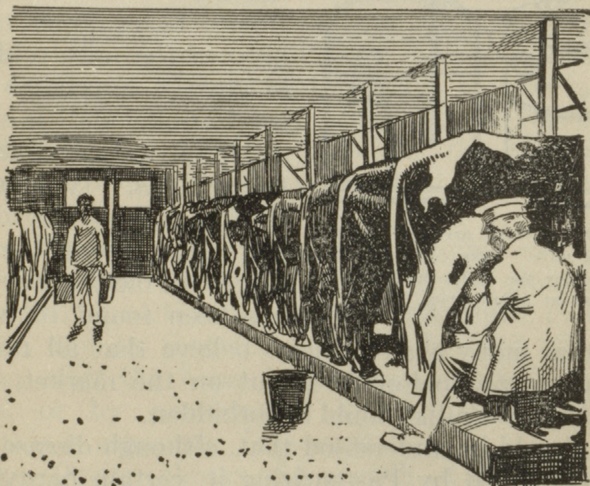


Fig. 168. Dairies should be models of cleanliness.

which the milk comes, or there will frequently be living tuberculosis germs in the milk.

Killing germs in milk.—When it is impossible to obtain pure milk, it is often best to "Pasteurize" the milk before it is used.[1] This is done by heating it to 145 degrees and holding it at this temperature for thirty minutes. This heating kills all disease germs and nearly all the other

[1] Recently many great epidemics of very severe sore throat (*septic sore throat*) have been traced to infected milk. The disease is caused by a streptococcus that causes inflammation in the udder of the cow. Cows probably get the infection from the hands of persons who have the disease.

bacteria in the milk, and the person who uses the milk has fewer germs to resist. A few children do not digest Pasteurized milk as well as they do raw milk, and Pasteurizing old milk that is already filled with acids and toxins from the bacteria that are swarming in it will not make this milk a fit food for a little child. In summer, however, most of the milk sold in cities is greatly improved by Pasteurization, and it is of no small advantage that all the tuberculosis, typhoid, diphtheria, and other dangerous germs that are in the milk are killed. In fact, so much disease has been found to be due to milk that many health officers believe that all milk should be Pasteurized before it is put on the market, and that the sale of raw milk should be forbidden.

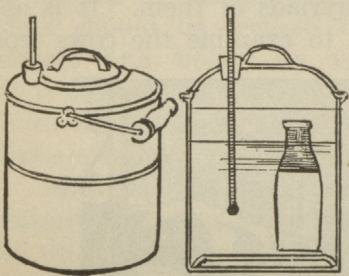


Fig. 169. A vessel arranged for Pasteurizing milk. Very convenient Pasteurizers for use in the home may be purchased at a low price.

It should be understood that, although disease germs in milk are killed by Pasteurizing it, certain hardy kinds of bacteria and many bacterial spores are not killed by the process. After milk is Pasteurized, it should be cooled at once, or these surviving forms will quickly multiply and cause it to spoil.

CHAPTER XXXIII

DISINFECTION

It cannot be too strongly emphasized that nearly all the germs that cause disease in man come from persons who have germ diseases, and that insects, water, and food are dangerous only when they have become infected with germs from some human being. In preventing the spread of infectious diseases, therefore, the most important point is to destroy the germs that come from the bodies of the sick.

Light.—Light is destructive to bacteria, and bright sunlight kills many kinds of germs in a few minutes. It is an excellent practice to expose bedclothes and rugs to the sun, and to throw up the shades and allow the sunlight to enter the house. In rooms occupied by consumptives, or by pneumonia, diphtheria, or influenza patients, this is especially important.

Drying.—Drying checks the growth of all germs, and most germs die if they are thoroughly dried. Damp houses keep alive the germs that are in them, and tuberculosis, pneumonia, and other diseases are more likely to develop in damp than in dry houses. Dirt and dust, mingled with sweat and oil from the skin, on doorknobs, banisters, and furniture, protect germs from light and keep them alive. For this reason the doorknobs and desks in schoolrooms should be cleansed occasionally with soap and hot water.

Heat.—Boiling water kills the germs of all common diseases, and handkerchiefs, dishes, and clothing that have become infected can be made safe again by thoroughly boiling them. Sputum and articles of little value may often be most conveniently disposed of by burning. The surfaces of dishes contain tiny crevices in which germs lodge, and in disinfecting dishes with hot water, it is necessary to leave them for a few minutes in water that is boiling, so that the heat will reach the germs in the crevices.

Chemical disinfection.—Certain chemicals are so poisonous to germs that they are extensively used in disinfecting. A physician should always be consulted as to which disinfectant is best for a particular purpose, and exactly how to use it, for some of them are better for one purpose than for another. Most disinfectants are very poisonous, and a little red ink or other coloring matter should be added to them so that they will not be mistaken for water. The following are some of the most common disinfectants:

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

Biniodide of mercury is more than twice as powerful as bichloride of mercury, and need be made only half as strong It is one of the best general disinfectants, and is especially useful in disinfecting the hands, since it does not injure the skin. It can be used on metals, and is useful for disinfecting instruments.

Carbolic acid, made up in a $2\frac{1}{2}$ per cent solution ($3\frac{1}{2}$ ounces of liquid carbolic acid to a gallon of water, or seven teaspoonfuls to a pint), is a good disinfectant. For disinfecting sputum and other discharges from the body it is well to use a 5 per cent solution.

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

Chloride of lime, used in the proportion of 4 ounces of chloride of lime to 3 gallons of water, is a cheap and powerful disinfectant. It may be purchased in grocery stores, put up in tin cans under the name of bleaching powder. It cannot be used on colored clothing, and the solution must be freshly made.

Milk of lime is a powerful disinfectant. To make the solution, add one part of freshly slaked lime by weight to four parts of water; or add the hard lumps of quicklime to the water and stir until a thick whitewash is formed. This is a cheap disinfectant, and for disinfecting the body wastes it is as good as anything that can be used. It should not be used in sinks, for it will cause trouble with the traps. Air-slaked lime (lime that has crumbled into fine powder from contact with the air) is worthless, and only quicklime should be used.

Special points in disinfecting.—In caring for a case of infectious disease it is well to understand the following special points in disinfection:

Disinfecting the hands. Any one who is caring for a person sick with an infectious disease should frequently sterilize his hands by holding them in a disinfectant. Washing the hands thoroughly in a soapy lather will almost free them from germs, and before eating they should be washed in this way and then disinfected. Keeping the nails trimmed and the skin smooth makes the hands much easier to disinfect. The hands of a person who is sick with a germ disease should frequently be washed with soap and water, and should be disinfected occasionally.

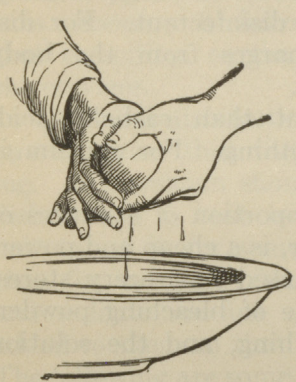


Fig. 170. Washing the hands thoroughly with soap and water helps to free them from germs.

Disinfecting body wastes. In typhoid fever and dysentery, the discharges from the intestines and kidneys should be received in vessels containing disinfectants. A strong solution of either chloride of lime or milk of lime is excellent for this purpose. It is necessary to see that the disinfectant is thoroughly mixed with the waste matter, and it should be allowed to stand for several hours to make sure that all germs are killed. Any matter that is vomited by the patient may contain the germs, and should be treated in the same way as the intestinal and kidney discharges, and all handkerchiefs that a patient may use should be put into hot water or a disinfectant. The wastes from the alimentary canal should be disinfected in tuberculosis and other respiratory diseases as well as in intestinal diseases. Even where there is water sewerage and these wastes can be thrown into the closet with little danger to the family of the sick person, still they ought to be disinfected; for the germs may reach the water supply of another town, and some one may suffer from them.

Disinfecting in diseases where germs are in the nose and mouth. In diphtheria, pneumonia, tuberculosis, influenza, measles, scarlet fever, and epidemic cerebro-spinal meningitis, the germs are in the discharges from the throat and nose. The instructions given on page 235 for disinfection in cases of tuberculosis apply in all these diseases.

Disinfecting buildings. Where a room or whole house is to be disinfected, it is usually done by fumigating. Formaldehyde is best for this purpose. Special directions are necessary for this work if it is to be done effectively. Quicklime is a good disinfectant for cellars and closets.

Mistaken ideas in regard to disinfection.—It is a common idea that there is some connection between the smell of a substance and its power as a germ-killer. Strong-smelling substances are sometimes burned in sick rooms, or a little carbolic acid is exposed in a saucer, so that it will scent the air of the room. It need hardly be pointed out that germs are not injured by anything of this kind.

The importance of disinfection.—Our second great law for the prevention of germ diseases was to keep germs from the bodies of the sick from being scattered abroad. This can be done only by disinfection, and if all families would learn the value of disinfection and practise it, perhaps the most important step in the prevention of germ diseases would be taken.

Isolating the sick.—People need to learn that sick persons should be kept away from those who are in health. This is best for both the sick and the well. It is possible to practise disinfection efficiently only when a sick person is kept in a room by himself, and the careless visiting in sick rooms which is allowed in colleges, boarding schools, and most families is a cause of much disease.

CHAPTER XXXIV

UNHYGIENIC HABITS

As we have said again and again in former chapters, nearly all disease germs leave the body by way of the mouth and nose, or in the wastes from the alimentary canal and kidneys, and most of them get into the body through the mouth and the nose, especially through the mouth. In their daily life, many persons have fallen into certain habits that make it easy for germs to get into the mouth and nose, and into other habits that scatter germs abroad where they are likely to do harm.

Fig. 171. It is never safe to use public drinking cups.

Putting objects into the mouth.—The habit of putting into the mouth, pencils, coins, candy, chewing gum, or any other object that has been in the mouth of another person, gives germs an opportunity to pass directly from one mouth to another. A public drinking cup on a train, at a public fountain, or in a school, is certain to be used by some one with disease germs in his mouth.[1] If another person then drinks from the cup, the germs have as good an opportunity as a germ could wish to pass into the mouth unweakened by drying. Each pupil in a school should have his own cup, and a private cup should always be carried when travelling; but if it is necessary to drink from a public cup, it is best to put both lips into the cup while drinking. This is because the germs are more likely to be sticking to the edge of the cup (in mucus from the lips of persons who have previously used the cup) than to be floating free in the water.

Putting the hands to the face.—Another habit that we would mention is that of allowing the fingers to touch the face, eyes, or lips. In many ways—from books, doorknobs, pencils, seats, and straps in street cars, and, from the hands of other persons—we get germs on our hands. It is advisable, therefore, to form the habit of keeping the hands away from the face. Special attention should be given to this point when sore eyes are prevalent. Before eating, the hands should be thoroughly washed with soap, for this is a very wonderful remover of germs.

Exchanging books in the schoolroom.—Where school-books are furnished by the town or province, they are sometimes given out each morning, and it is only by chance that a pupil receives the same book on two successive days. .This is not right, for the germs of diphtheria, pneumonia, scarlet fever, and of other dangerous diseases may be spread through a school by the books. Each child should keep the same books throughout the year,

[1] On a drinking glass that had been touched by the lips, 20,000 bacteria were found, and 5000 on a glass slip touched by a thumb moistened with saliva, as the leaves of a book are often touched with a moistened finger or thumb in turning them.

and passing books about from one pupil to another should be discouraged. It might be added that writing paper is more sanitary than the slates that are still in use in some places, for slates are often wet with saliva, and the sponges that are used on them are generally reeking with germs.

Drinking water to which one is not accustomed.—When one is away from home on a short journey it is often not possible to be sure whether the water that is provided for drinking purposes is safe or not. It is, therefore, the part of wisdom to take a supply of water from home, or to drink mineral water or boiled water, or even tea or coffee. By drinking water from various sources, while on their vacations, hundreds of people every summer contract typhoid fever. Strangers coming into a place that has an impure water supply are always far more liable to contract typhoid fever than the inhabitants of the place, who are accustomed to the water, and almost any strange water is likely to cause intestinal disturbances that may spoil all the pleasure of a short visit or excursion.

Spitting.—In previous chapters your attention has been repeatedly called to the fact that many germs may be in the mouth. That these germs are certainly scattered about by spitting, every one must understand. Tobacco spit is as bad as any other kind of spit, and every one must learn that to spit at all is not only an unclean and disgusting habit, but one that is very unsanitary. Many cities have laws against spitting in public places. These laws are founded on common sense and should be supported by all good citizens. Every one should, at least, have enough care for others to spit in the gutter and not on the sidewalk, for on the sidewalk the germs are almost certain to be carried on the feet of passers-by and on trailing skirts into the houses, stores, and offices.

Washing the teeth in wash-basins.—Cleaning the teeth in a wash-basin will leave any germs that may be in the mouth in the wash-basin, and you will readily understand how easy it would be for a few hundred thousand of these germs to get to the mouth of some one else who washes his face in the basin. A bathroom should have a sink over which the teeth may be cleaned, and in cars and public wash-rooms some place other than the wash-basins should be provided for cleaning the teeth. In a public wash-room the safest plan is to turn on the water and wash in the stream as it comes from the faucet.

Scattering the germs of intestinal diseases.—We come now to one of the most important and the most difficult of all the questions of sanitation, the question of how to prevent the spread of the germs of intestinal diseases. It is utterly amazing the way these germs now get scattered abroad, and the more we study the subject the more we realize how unclean a creature man really is; for we must remember that every one of the millions of cases of intestinal diseases that occur yearly are caused by germs that have escaped from the human body in the wastes from the alimentary canal and kidneys. In towns and in the country, where there is no water supply, the greatest care must be taken in disposing of these wastes, or disease will surely come from them. Where a city is supplied with water and has a sewer system, it is not difficult for a person or a family to know how to dispose of these wastes; but if the city disposes of its sewage by running it into the nearest stream, the people down the stream will probably suffer.

The danger of polluting soils.—In the last few years a very important discovery has been made. This discovery is that it is not an uncommon thing for healthy persons to carry very dangerous germs, and that the germs of all the infectious diseases of the intestine (cholera, typhoid, dysentery, and diarrhoea) may be carried by persons who are not themselves ill. So many cases of intestinal diseases come from well persons, that it is unsafe to allow the soil about a house to be polluted by the wastes of any human being, whether he be sick or well. If the soil does become infected with dangerous germs, these germs will be carried about by flies, they will be taken by the feet into houses and to well platforms, and sooner or later they will almost certainly reach the mouths of others. It is perfectly evident that no wastes from the human body should in any circumstances be allowed to touch the soil of dooryards. Closets where these wastes can be kept from becoming scattered and the germs in them can be destroyed, should be built.[1]

Allowing children to play in the dirt.—It is the children, more than any other persons, who suffer from germ diseases. One reason, and doubtless the main reason for this is that children have less resistance to these diseases than have those who have grown up. Another reason is that children crawl and play on the floor and earth where their elders spit, and where all kinds of dangerous germs are left by the feet of those who have walked on the streets or on polluted soil about the house. Babies should not be put down to play on dirty floors or in dirty yards, nor should they be allowed to put into their mouths objects that have been soiled by dropping them in such places. Little children need, more than any one else, to be guarded against germs, and for their sakes, especially, floors and yards should be kept as clean as possible.

[1] The discharges from the kidneys are dangerous as well as the intestinal discharges, for they very commonly contain streptococci, and they may contain the bacilli of typhoid fever.

CHAPTER XXXV

NEW DISCOVERIES IN REGARD TO GERM DISEASES

It is now only about forty years since the germ theory of disease came to be understood, and it is wonderful that we should have learned so much about these diseases in so short a time. Our knowledge of them is still incomplete, however, and scientists are constantly studying them and the germs that cause them, and each year new discoveries in sanitation are being made. Many of these discoveries prove most valuable in the warfare against germs, and each year we learn better how to bring communicable diseases under control. In this chapter we shall study some important facts in preventive medicine that have been discovered in the last few years.

Contact infection.—This study, like all the newer investigations of the subject, leads us to believe that it is not from air, dust, clothes, or furniture that germs usually reach us, but that they are passed in a rather direct way from one person to another on the hands, or on drinking cups, dishes, and other articles. This passing of germs from one person to another in large numbers and without giving them an opportunity to dry is called *contact infection,* and undoubtedly the great majority of cases of diseases like typhoid fever, pneumonia, influenza, diphtheria, whooping cough, scarlet fever, measles, and tuberculosis, originate in this way. So important indeed do some health officers now consider this method of infection, and so few cases of many diseases do they think come from houses, furniture, and clothes, that they have given up the disinfecting of houses after cases of diphtheria, measles, and scarlet fever, and are spending their energies in finding and isolating the persons who are carrying the germs. The theory on which this practice is based is that when mucus and other matter containing germs is dried on desks, doorknobs, or other articles, the great majority of the germs die at once; that the others are weakened by the drying; and that the small number of weakened germs that one would get from articles of this kind is not dangerous like the great numbers of fresh germs that one may receive direct from the patient himself, or from something he has just handled.

Two aids in preventing contact infection.—One of the most effective measures for preventing contact infection is health inspection of schools, because where this is practised, cases of infectious diseases are found in their early stages and removed before the germs spread to others. Another great aid in preventing contact infection is hospitals for isolating cases of typhoid fever, pneumonia, influenza, diphtheria, and other like diseases. These hospitals can give patients suffering with such diseases better care, better nursing, and better medical attention than they receive in their homes; they can at once cut off much sickness by stopping the spread of these diseases through families; and they ought to be established in every county and town in the land.

A safe disposal of human wastes.—Notwithstanding all the campaigns for sanitation that have been carried on in recent years, there are hundreds of thousands of farms in our land that are still without sanitary closets, and in villages, school grounds, church yards, and beside country homes, there are hundreds of thousands of open closets still in use. Any one who knows the habits of the housefly—how day after day it passes back and forth between these places and dining-rooms and kitchens—

knows that as long as such a condition continues, not even a beginning in sanitation and hardly a beginning in civilization has been made. It cannot be too strongly insisted upon that one of the most important of all sanitary measures is to provide a safe means of disposing of human wastes, and a sanitary toilet arrangement should be a part of every human habitation in the land.

Bad after-effects of infectious diseases.—Recently an investigation has been made by one of the large life insurance companies, of the death rate among 1574 of its policy holders who suffered from attacks of typhoid fever in 1911. Of these 1574 persons, 146 died of the disease, and 1428 survived; but during the next three years fifty-four of these survivors died of other diseases, twenty-one of them of tuberculosis. This gave a death rate more than twice as high as was to be expected among persons of this age. In the same way, bad after-effects follow measles, diphtheria, scarlet fever, influenza, pneumonia, and other germ diseases, and to take no account of these after-effects is like leaving out of account the wounded when one is reckoning the losses in war.

Raising the defences of the body by vaccination.—In the last few years the idea of preventing by vaccination certain diseases that are not well controlled by sanitation has gained great headway. Not only is this practised for the prevention of smallpox, rabies, and certain animal diseases, but vaccination against typhoid fever has now been proved to be a great success. The same methods have been employed to check epidemics of cholera, plague, meningitis, and whooping cough; and some individuals have themselves vaccinated against colds, influenza, pneumonia, and other diseases. The theory of all vaccination is the same,—weak or dead germs are introduced into the body, and this increases its germ-killing power.

HEIGHT AND WEIGHT TABLE FOR BOYS

Ht. Ins.	5 Yrs.	6 Yrs.	7 Yrs.	8 Yrs.	9 Yrs.	10 Yrs.	11 Yrs.	12 Yrs.	13 Yrs.	14 Yrs.	15 Yrs.	16 Yrs.	17 Yrs.	18 Yrs.
39	35	36	37											
40	37	38	39											
41	39	40	41											
42	41	42	43	44										
43	43	44	45	46										
44	45	46	46	47										
45	47	47	48	48	49									
46	48	49	50	50	51									
47	....	51	52	52	53	54								
48	....	53	54	55	55	56	57							
49	....	55	56	57	58	58	59							
50	....	....	58	59	60	60	61	62						
51	....	....	60	61	62	63	64	65						
52	....	....	62	63	64	65	67	68						
53	....	....	....	66	67	68	69	70	71					
54	....	....	....	69	70	71	72	73	74					
55	....	....	....	....	73	74	75	76	77	78				
56	....	....	....	....	77	78	79	80	81	82				
57	....	....	....	....	....	81	82	83	84	85	86			
58	....	....	....	....	....	84	85	86	87	88	90	91		
59	....	....	....	....	....	87	88	89	90	92	94	96	97	
60	....	....	....	....	....	91	92	93	94	97	99	101	102	
61	....	....	....	....	....	....	95	97	99	102	104	106	108	110
62	....	....	....	....	....	....	100	102	104	106	109	111	113	116
63	....	....	....	....	....	....	105	107	109	111	114	115	117	119
64	....	....	....	....	....	....	....	113	115	117	118	119	120	122
65	....	....	....	....	....	....	....	....	120	122	123	124	125	126
66	....	....	....	....	....	....	....	....	125	126	127	128	129	130
67	....	....	....	....	....	....	....	....	130	131	132	133	134	135
68	....	....	....	....	....	....	....	....	134	135	136	137	138	139
69	....	....	....	....	....	....	....	....	138	139	140	141	142	143
70	....	....	....	....	....	....	....	....	....	142	144	145	146	147
71	....	....	....	....	....	....	....	....	....	147	149	150	151	152
72	....	....	....	....	....	....	....	....	....	152	154	155	156	157
73	....	....	....	....	....	....	....	....	....	157	159	160	161	162
74	....	....	....	....	....	....	....	....	....	162	164	165	166	167
75	....	....	....	....	....	....	....	....	....	....	169	170	171	172
76	....	....	....	....	....	....	....	....	....	....	174	175	176	177

Prepared by Dr. Thomas D. Wood.

About What a BOY Should Gain Each Month

Age		Age	
5 to 8	6 oz.	12 to 16	16 oz.
8 to 12	8 oz.	16 to 18	8 oz.

HEIGHT AND WEIGHT TABLE FOR GIRLS

Ht. Ins.	5 Yrs.	6 Yrs.	7 Yrs.	8 Yrs.	9 Yrs.	10 Yrs.	11 Yrs.	12 Yrs.	13 Yrs.	14 Yrs.	15 Yrs.	16 Yrs.	17 Yrs.	18 Yrs.
39	34	35	36											
40	36	37	38											
41	38	39	40											
42	40	41	42	43										
43	42	42	43	44										
44	44	45	45	46										
45	46	47	47	48	49									
46	48	48	49	50	51									
47	....	49	50	51	52	53								
48	....	51	52	53	54	55	56							
49	....	53	54	55	56	57	58							
50	....	..	56	57	58	59	60	61						
51	....	....	59	60	61	62	63	64						
52	....	....	62	63	64	65	66	67						
53	....	....	....	66	67	68	68	69	70					
54	....	....	....	68	69	70	71	72	73					
55	....	....	....	....	72	73	74	75	76	77				
56	....	....	....	....	76	77	78	79	80	81				
57	....	....	....	....	....	81	82	83	84	85	86			
58	....	....	....	....	....	85	86	87	88	89	90	91		
59	....	....	....	....	....	89	90	91	93	94	95	96	98	
60	....	....	....	....	....	....	94	95	97	99	100	102	104	106
61	....	....	....	....	....	....	99	101	102	104	106	108	109	111
62	....	....	....	....	....	....	104	106	107	109	111	113	114	115
63	....	....	....	....	....	....	109	111	112	113	115	117	118	119
64	....	....	....	....	....	....	....	115	117	118	119	120	121	122
65	....	....	....	....	....	....	....	117	119	120	122	123	124	125
66	....	....	....	....	....	....	....	119	121	122	124	126	127	128
67	....	....	....	....	....	....	....	....	124	126	127	128	129	130
68	....	....	....	....	....	....	....	....	126	128	130	132	133	134
69	....	....	....	....	....	....	....	....	129	131	133	135	136	137
70	....	....	....	....	....	....	....	....	....	134	136	138	139	140
71	....	....	....	....	....	....	....	....	....	138	140	142	143	144
72	....	....	....	....	....	....	....	....	....	....	145	147	148	149

Prepared by Dr. Thomas D. Wood.

About What a GIRL Should Gain Each Month

Age		Age	
5 to 8	6 oz.	14 to 16	8 oz.
8 to 11	8 oz.	16 to 18	4 oz.
11 to 14	12 oz.		

Weight and measures should be taken without shoes and in only the usual indoor clothes.

PRONOUNCING GLOSSARY

abdomen (ab-dō′men).
abdominal (ab-dŏm′i-nal).
adenoid (ăd′en-oid).
agave (a-gah′vē̆).
ameba (a-mē′ba).
amylopsin (ă-mĭ-lŏp′sin).
appendicitis (ap-pĕn-dĭ-sī′tis).
aqueous (ā′quē-ŭs).
astigmatism (as-tĭg′mat-ism).
auricle (o′ri-kl).
bacillus (ba-sĭl′lŭs).
bacterium (băk-tē′ri-ŭm).
beriberi (bĕr′i-ber′i).
bronchial (brŏng′kē-al).
bronchitis (brŏng-kī′tis).
canine (ka-nīn′).
capillary (căp′il-lā-re).
carbon dioxide (kar′bon dī-ŏks′īd).
cerebellum (sĕr-e-bel′lŭm).
cerebro-spinal (sĕr′e-brō-spī′nal).
cerebrum (sĕr′e-brum).
chloral (klō′ral).
choroid (kō′roid).
cocaine (kō′kă-ĭn).
coccus (kŏk′kŭs).
coccyx (kŏk′six).
cochlea (kŏk′le-a).
communicable (kom-mū′ni-ka-ble).
cornea (kor′ne-a).
corpuscle (kor′pŭsl).
dengue (dĕn′gā)
dentine (dĕn′tĭn).
diaphragm (dī′a-frăm).
diphtheria (dif-thē′ri-a).
disinfectant (dis-in-fĕkt′ant).
dysentery (dĭs′en-tĕr-y).
enzyme (en′zīm).
epidemic (ĕp-ĭ-dĕm′ik).
esophagus (ē-sŏf′a-gŭs).
Eustachian (yu-stāk′ke-an).
femur (fē′mur).
fertilization (fer-til-īz-ā′shun).
fibula (fĭb′ū-la).
gangrene (găng′grēn).
germ (jerm).
germicidal (jer-mĭ-sī′dal).
glycogen (glī-kō-jen).
hasheesh (hash-ēsh′).
hemoglobin (hĕm-ō-glō′bĭn).
humerus (hyu′me-rus).
humidifier (hyu-mĭd′i-fī-er).
hygiene (hī′ji-ēn or hī′jēn).
hygienic (hī-je-ĕn′ik).
incisor (in-sī′sor).
infected (in-fĕkt′ed).
infectious (in-fĕk′shŭs).
larva (lar′va).
larynx (lăr′ĭnks).
lipase (lĭp′ās).
lymphatic (lim-făt′ik).
lysol (lī′sōl).
magnesium (mag-nē′zhe-um).
medulla oblongata (med-ŭl′la ŏb-lon-gah′ta).
meningitis (mĕn-ĭn-jī′tis).
miasma (mī-ăz′ma).
microbe (mī′krōb).
molar (mō′lar).

narcotic (nar-kŏt′ik).
nicotine (nĭk′o-tēn).
opsonin (ŏp′sō-nĭn).
oxygen (ŏk′sĭ-jĕn).
pancreas (păn′krē-as).
papilla (pap-il′ah).
patella (pa-tĕl′la).
pepsin (pĕp′sin).
permanganate (per-măn′gan-āt).
phalanges (fă-lăn′jēz).
pharynx (făr′ĭnks).
phosphorescent (fŏs-fo-rĕs′ent).
poliomyelitis (pŏl-ĭ-ō-mī-ĕ-lī′tĭs).
pollen (pŏl′len).
polyp (pŏl′ip).
protein (prō′te-in).
protoplasm (prō′tō-plasm).
protozoön (prō-tō-zō′ŏn).
ptomaine (tō′ma-ĭn).
ptyaline (tī′a-lin).
pupa (pū′pa).
pus (pŭs).
pyorrhea (pī-ō-rē′a).
rabies (rā′bĭ-ēz).
radius (rā′dē-ŭs).
respiratory (rĕs′pĭ-rā-tō-re)
retina (rĕt′i-na).
rheumatism (rōō′mă-tĭsm).
saliva (sal-ī′vah).
salivary (săl′i-vā-re).
sanatorium (săn-a-tō′ri-um).
sciatic (sī-ăt′ik).
sclerotic (skle-rŏt′ik).
sepal (sĕp′l).
serum (sē′rum).
spirillum (spī-rĭl′lum).
sputum (spū′tum).
stamen (stā′men).
stomoxys (stō-mŏk′sis).
strychnine (strĭk′nĭn).
tetanus (tĕt′a-nŭs).
tibia (tĭb′ē-a).
tonsillitis (tŏn-sĭl-lī′tis).
trachea (trā′kē-a).
trachoma (trā-kō′ma).
trypsin (trĭp′sin).
tuberculosis (tū-ber-kū-lō′sis).
tuberculous (tū-ber′kū-lus).
tympanic (tĭm-păn′ik).
tympanum (tĭm′pan-um).
ureter (yu-rē′ter).
villi (vĭl′lē).
virulent (vĭr′ū-lent).
virus (vī′rŭs).
vitamine (vī′tă-mĭn).
vitreous (vĭt′re-us).

INDEX