24. Dip a small piece of paper in alcohol and touch it with a match. It bursts into a flame at once, and develops great heat but no smoke. Notice that the paper does not burn until the alcohol is nearly used up. Explain that in the body alcohol seems to be easily oxidized, and uses oxygen which should go to the proper food of the body.

25. Hold a cold stone in the mouth of a teakettle or in the steam of a pan of water. Notice that the vapor condenses in drops upon the stone. This will illustrate distillation as well as a complicated apparatus of coils and running water. Explain that dew upon the grass is a distillation of water.

#### REVIEW TOPICS

1. Describe how alcohol and vinegar are commonly formed.
2. Describe the *yeast plant*.
3. Describe *mother of vinegar*.
4. Describe *fermentation*.
5. Tell how fermentation is applied to bread making.
6. Describe *malt liquors*.
7. Describe *wine*.
8. Describe *spirits* and the process by which they are made.
9. Describe *alcohol*.
10. Give the three main properties and effects of alcohol.
11. Tell what becomes of alcohol when taken into the body.
12. Tell why alcohol does not satisfy thirst.

## CHAPTER V

### DIGESTION OF FOOD IN THE MOUTH

**64. Food and digestion.** — Albumin, fat, and sugar are continually being oxidized in the body, and the products of oxidation, together with mineral matter and water, are being thrown off. In order to keep up the strength and form of the body a constant stream of new material must be supplied.

*Anything which, taken inside of the body, supplies it with weight, heat, or energy is food* (see pp. 64 and 89).

In preparation for the use of the body, food is reduced to a form which can be dissolved in water, and drawn through the walls of the blood tubes. The blood distributes it to all parts of the body. The process of producing a *chemical* change in food so that it can be taken up by the blood is *digestion*.

Man uses as food a combination of albumin, fat, sugar or starch, mineral matters, and water, which are identical with the proximate principles of the body. Of these water and mineral matters can enter the blood without being changed, while the albumin, fat, sugar, and starch require digestion. Albumin is changed to a form called *peptone*, which can easily diffuse through the walls of the blood tubes, and so become a part of the blood.

Sugar and starch are both changed to *glucose*, a form of sugar found in the grape. Fat is saponified and emulsified.

**65. Cooking.** — Digestion is begun by applying heat to food, either with or without water. Preparing food by heat is *cooking*. The heat of cooking coagulates the albumin. It also softens and dissolves the connective

tissue which binds together the cells of the food material, and thus makes meat and vegetables tender. It develops an agreeable flavor which stimulates the desire for food and promotes digestion. Cooking has no effect upon fat itself, but the tiny pockets of albumin in which it is stored in meat and vegetables are softened or dissolved away, and the fat is set free. In vegetables and flour, starch is in tiny grains, each of which seems to be made up of layers of starch separated by thin layers of a waterproof substance. Hot water causes the starch to swell and burst these envelopes, and the starch itself is then dissolved, thickening the water to a jellylike mass. Cooking has no effect upon the sugar and mineral matters of the food, except to mingle them thoroughly with the food.

Thorough cooking also destroys many poisons, and all the disease germs in tainted food. Yet cooking does not render tainted food fit for use.

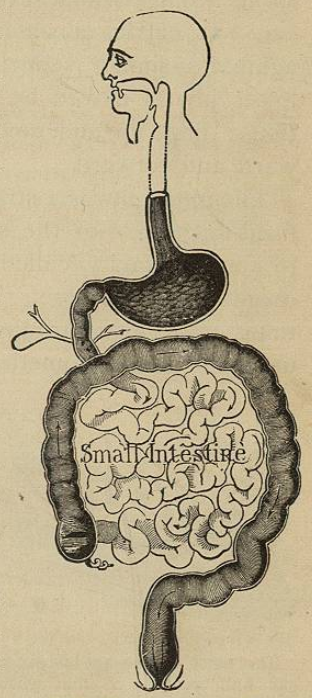
**66. Ways of cooking.** — Some foods are best cooked by being boiled or stewed. Other foods are best when roasted or broiled. The exact method is not so important as the skill of the one who does the cooking.

In all forms of cooking the principles are the same. If the solid food alone is to be eaten, as much of the juices as possible should be retained in the food by coagulating the albumin upon the outside at once so as to imprison the juices. This can be done by having the water boil before the food is placed in the kettle, or by placing the food in a hot oven. The film which forms upon the outside of the food effectually seals the juices within. If both the solid food and the liquid in which it is cooked are to be eaten, the flavors are better developed if the juices are diffused through the liquid. In this case the food should be placed in cold water or a cool oven, and heat applied gradually so as to avoid coagulating the exterior sooner than the interior. In most cases the food will be of better quality and taste if the cooking is done slowly. When the heat is continued after the food is thoroughly softened, its fibers are apt to become hard and dry.



As a general rule it is best to cook each kind of food separately. Each substance can then be cooked in its own peculiar manner. In roasting and broiling, the fat drips away. The outside of the meat, subjected to a high degree of heat, becomes hard, imprisoning the juices within. The inner part of the meat is protected from the heat and is cooked at a lower temperature than the outside. So its juices remain in a more natural state.

When food made from vegetables or grain is baked, a crust forms upon the outside. This consists of hardened albumin mixed with starch, which is partly changed by the heat to a kind of sugar. If the crust is not too much cooked and dried it is palatable and easily digested.



The alimentary canal.

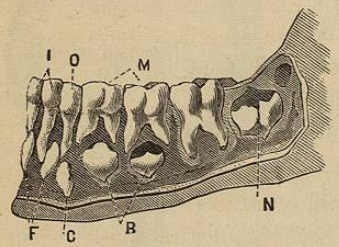
**67. The alimentary canal.** — Food is taken into the body and digested by means of a tube leading through the body. Beginning at the upper end, the parts of this tube, which is called the *alimentary canal*, are the mouth, pharynx, esophagus, stomach, and intestine.

**68. The mouth.** — The food is held in the mouth for a few seconds while it is mixed with the watery fluid called the *saliva*, and ground fine by the teeth. This grinding is *mastication*, and the mixture with saliva is *insalivation*. In these two processes, the teeth, tongue, cheeks, lips, and salivary organs all take part. The roof of the mouth is formed by the *bony palate* in front, and the *soft* movable palate behind. It is bounded on the sides and in front by the teeth, cheeks, and lips.

The floor is formed by the tongue and the lower jaw.

**69. The jaws.** — The lower jaw is a semicircular bone, whose hinder extremities are curved upwards. Each tip forms a hinge which turns in a socket just in front of the ear. It carries a semicircle of *teeth*, which exactly fit against a similar semicircle upon the upper jaw. The lower jaw is moved by powerful muscles in three directions: first, up and down; second, sidewise; third, backward and forward.

The upper jaw is a strong bone of irregular shape, firmly fixed to the rest of the skull. Its interior is hollowed out to form a cavity called the *antrum*, which has a small opening into the nose. The upper ends of the teeth sometimes project so far upward as to make slight elevations upon its floor. Sometimes an inflammation or abscess of a tooth may extend to the antrum, so that it becomes filled with pus, producing a very serious trouble.



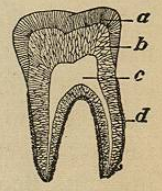

**The teeth at the age of six and one half years.** *I*, the incisors; *O*, the canine; *M*, the molars; the last molar is the first of the permanent teeth; *F*, sacs of the permanent incisors; *C*, of the canine; *B*, of the bicuspids; *N*, of the second molar; the sac of the third molar is empty. — MARSHALL.

**70. Teeth.** — The teeth are hard, bony pegs set deeply into the lower jawbone and in the edge of the hard palate. There are sixteen on each jaw. Counting from the middle of the front of each jaw, the first two on each side are like chisels, so as to bite or gnaw off the food, and are called the *incisors*. In a squirrel, they are long and sharp, so as to gnaw through wood. The third tooth is the *canine*. It is a round, firmly set tooth, which in animals is the *tusk*. The next two are larger, with flat surfaces; they are called *bicuspids*. The next three, the *grinders*, or molars, have large, flat surfaces, well adapted to grinding the food.



In a young child the two bicuspid teeth resemble the molar teeth in the adult, and the three molars are absent. At about the age of six, a whole new set of teeth begins to grow beneath the first teeth, and to press against their roots, cutting off their food supply. The blood takes away the substance of the old teeth as the new ones advance against them, until their projecting parts alone are left attached only by the gum. They finally drop out, while the new ones advance to take their places. The first teeth, like the permanent set, may decay and cause toothache, and should have as good care in filling and cleaning as is given to permanent teeth.

Sometimes when a baby's gums are being cut through by the growing first teeth, they are tender and swollen, making the child fretful. Yet teething seldom causes sickness in a healthy child.



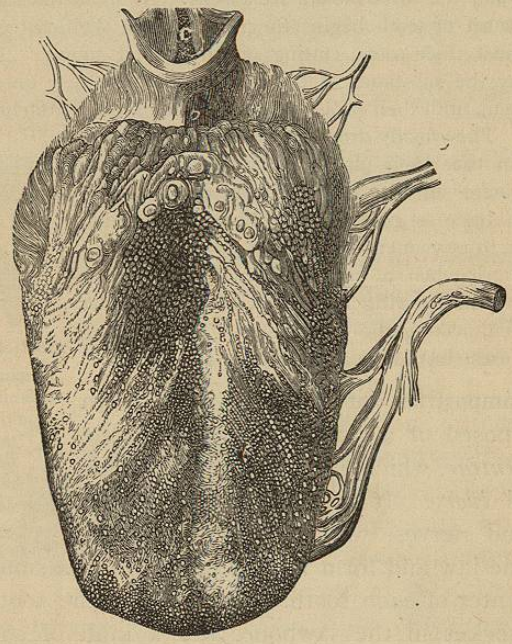

**Section of a tooth.**

*a* enamel.
*b* dentine.
*c* pulp cavity containing blood tubes and nerves.
*d* cement.

**71. Composition of teeth.** — The teeth are composed of a very hard kind of bone called *dentine*, which in some large animals is called *ivory*. It is nourished by blood tubes and nerves, which enter at the tip within the jaw and form a pulplike mass in a small cavity in the center of each tooth. The root of the tooth is set into a socket in the jawbone, and a kind of soft bone, called the *cement*, fixes it in place. The projecting part of each tooth, called the *crown*, is covered with a hard shell called the *enamel*.

**72. Care of teeth.** — When the enamel is too thin, or is worn or broken off, the dentine beneath it may decay. Then the tooth rapidly goes to pieces, often with much pain. Picking the teeth with pins and cracking nuts often break the enamel. Dirt and particles of food between the teeth are great promoters of decay. The saliva deposits a

brown substance called *tartar*, which may press the gum back from the root of the tooth, until a part of the tooth below the enamel is reached. Then the tooth may decay and break off at the gum, or the gum and bone may be forced back from the crown until the tooth becomes loose and drops out. Thoroughly brushing the teeth twice a day with a tooth brush and water is necessary for preserving the teeth. Particles



The tongue.

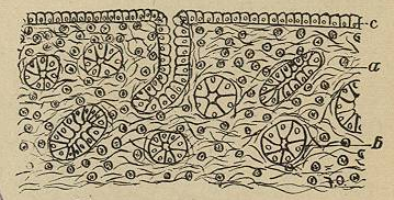
of food between the teeth should be removed, either by a soft wooden toothpick or else by passing a strong thread between the teeth. Still, with the best of care, some decayed cavities may develop, and these should be filled at once. With this care, almost any set of teeth should last a lifetime.

The *cheeks* and *lips* are thin layers of skin and muscles, which can be moved freely in all directions.



The *tongue* is a long, flat muscle, attached at its back end only, while its front part is capable of varied and precise movements in every direction.

**73. Mucous membrane.** — The cavity of the mouth is everywhere lined with a thin membrane, directly continuous with the outside skin. It consists of a loose network of cells carrying blood tubes and nerves. It is covered with a layer of flat cells, called *epithelium*. Into the loose tissue beneath the epithelium, there project pockets or tubes lined with cells directly continuous with the epithelial cells of the surface of the mouth. In health, the cells of each of the tubes and of the surface of the mouth produce just enough of a thin, clear liquid, called *mucus*, to moisten and lubricate the surface of the mouth. This membrane is called a *mucous membrane*. It is continued into the stomach and intestine, and into the windpipe and lungs.




**Mucous membrane** (× 200).

*a* cells and loosely woven fibers forming the main part of the membrane.
*b* mucous glands cut across.
*c* epithelium upon the surface.

Mucous membrane is modified skin turned in from the surface of the body to line the interior of all the cavities which communicate directly with the air. Every such surface is covered by an unbroken layer of epithelial cells. Wherever the epithelial cells are absent, the spot is raw and sore. The epithelial cells of the surface of the mucous membrane are designed mainly for protection; but those which reach into the tubes are set apart for the special work of producing mucus from material supplied by the blood.

**74. Gland and secretion.** — A collection of pockets or tubes lined with epithelium which forms a substance out

of the blood is a *gland*. The substance formed is called a *secretion*. The epithelium of the gland does all the work of secreting. All the mucous membranes of the body contain glands which secrete mucus, and in addition many contain glands which secrete other substances.

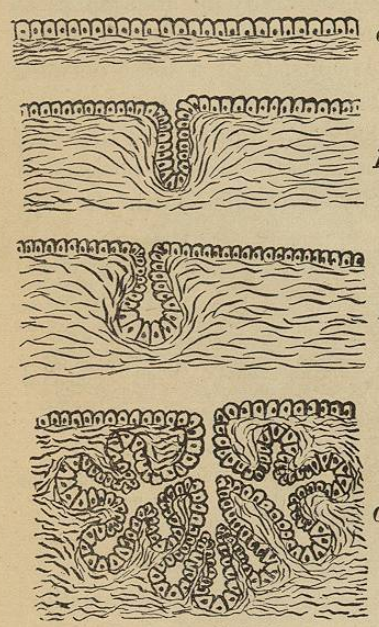


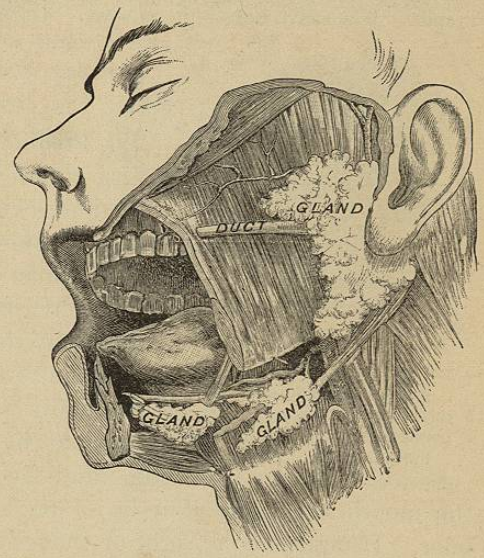

Diagram of glands.

*a* epithelium upon the surface of a mucous membrane.
*b* the epithelium continued into a simple tube.
*c* the epithelium continued into a simple pocket.
*d* the epithelium continued into a series of branching tubes and pockets.
*b*, *c*, and *d* are glands.

**75. Sore mouth.** — Babies sometimes suffer with a form of sore mouth in which white specks, like curdled milk, appear upon its mucous membrane. The spots are due to a kind of mold which grows in milk. Gently washing the mouth with clean, warm water several times a day will destroy the mold and remove the sores.

**76. Salivary glands.** — The mouth contains a fluid, called *saliva*, which enters it from three tubes on each side. Each salivary tube, after it has extended into the flesh on the face for an inch or so, abruptly divides again and again like the branches and twigs of a tree. At the end of the smallest divisions, there are minute pouches $\frac{1}{500}$ of an inch in diameter. All these tubes and pouches are rolled into a small mass with blood tubes and nerves. The whole collection is called a *salivary gland*. Each tube and pouch is lined with epithelial cells which make the saliva out of the fluid parts of the blood in which they are always bathed. The saliva flows out of the tubes into the mouth as fast as it is secreted. There is a salivary gland in front of each ear, called the *parotid* gland; one along each side of the lower jaw, called the *submaxillary* gland, and one just under each side of the front end of the tongue, called the *sublingual* gland.



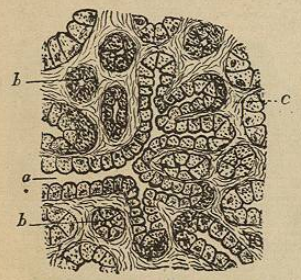



The salivary glands.

**77. Saliva.** — The saliva is a thin, colorless, alkaline mixture, which often contains air bubbles. About $\frac{1}{1000}$ part of the saliva is a white substance called *ptyalin*, which has the power to change starch to glucose while remaining unchanged itself. Hence, ptyalin is a *ferment*. It can act only in an alkaline fluid, and its action stops when the food is acted on by the stomach. It digests only a small amount of starch, and its value is due mainly to the water it contains.

**78. Use of the water in saliva.** — The water of the saliva has very important uses. The nerves of taste are covered by the epithelium of the mucous membrane, and some of the food must be carried through this epithelium to the nerves in order that it may be tasted. The water of the saliva dissolves the food and soaks through the epithelium, carrying a tiny amount of food to the nerves, and thus makes the sense of taste possible.

During digestion, food must be reduced to a fluid condition as thin as milk. The saliva begins the process. Enough saliva is mixed with food to form a pasty mass which the thin walled stomach can handle with ease.




**A salivary gland** (× 200).

*a* tube of epithelium forming the gland, cut lengthwise.
*b* tubes cut crosswise.
*c* connective tissue binding the tubes in place.

**79. Production of saliva.** — Saliva enters the mouth continually, but between meals only about an ounce an hour is produced, while during a meal the food increases in weight about one half by the addition of saliva. From one to three pints are produced daily. The flow of saliva is excited by the act of chewing, and by anything held in the mouth, especially if it be of an agreeable taste and odor. Hunger, or the sight or thought of agreeable food, "makes the mouth water." The longer food is chewed the more saliva is produced. This mixing and dissolving action of the saliva is greatly aided by the movements of the various parts of the mouth.

**80. Mastication.** — A morsel of food is pushed between the molar teeth, which crush and grind it by the three movements of the lower jaw. Between each movement of the jaw, the tongue and cheeks roll the morsel into a firm mass so that the teeth can act upon it to better advantage. The tongue has a delicate sensibility for the proper condition and position of the food, and its varied and precise movements, aided by the movements of the lips and cheeks, keep the food in the best position for the action of the teeth. In a few seconds, even hard and dry food becomes a thin and pasty mass. The tongue collects the mass into a ball in the back part of the mouth in preparation for its passage to the stomach. The process of sending food from the mouth to the stomach is *swallowing* or *deglutition*.



**81. The pharynx.** — Back of the tongue is a muscular bag about four and a half inches in length, lying against the spinal column and called the *pharynx*. It is lined with mucous membrane, which secretes far more mucus than that of the mouth. When the secretion of mucus is excessive it is called *catarrh*, but it is usually a harmless affection. The pharynx has seven openings; one into the esophagus or muscular tube leading to the stomach; one into the beginning of the windpipe; one into the mouth; two into the nose, and two into the middle ear. The openings to the nose and ears can be closed by raising the soft palate against the spinal column. The windpipe can be closed in three ways: first, by the root of the tongue arching itself backward over the windpipe; second, by a cover to the windpipe, called the *epiglottis*; third, by the *vocal cords* sliding

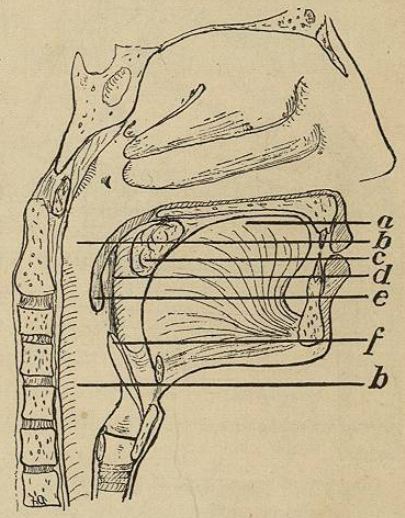



**Diagram of the beginning of swallowing.**

*a* top of tongue.
*b* pharynx.
*c* morsel of food.
*d* sliding door of the front of the pharynx.
*e* soft palate.
*f* epiglottis.

together in the middle. The opening to the mouth can be closed by two upright muscles which hang between the back part of the soft palate and the base of the tongue. These two muscles come together in the middle like sliding doors.

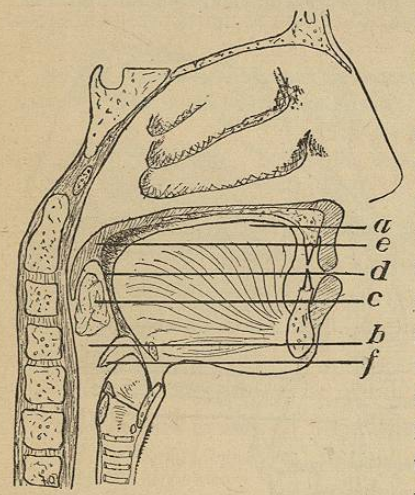



**Diagram of second part of swallowing.**

*a* top of tongue arched backward and upward.
*b* pharynx.
*c* morsel of food pushed into the pharynx by the back of the tongue.
*d* sliding doors of the pharynx which have come together in the middle.
*e* soft palate lifted upward to shut off the nose.
*f* epiglottis folded downward to close the larynx.

**82. Swallowing.** — By a conscious effort, the tongue quickly pushes the morsel of food backward towards the pharynx. The two upright muscles of the pharynx, gliding together over the surface of the tongue between it and the food, cut the food off from the mouth. During this movement the pharynx closes all its other openings, except the one to the esophagus. The food is now beyond the control of the will. The muscles of the pharynx itself now contract, forcing the food into the esophagus, the opening of which is the only one not closed.

**83. The esophagus.** — The esophagus is a muscular tube connecting the pharynx with the stomach. It is about nine inches in length. It is lined with mucous membrane and secretes only enough mucus to moisten its surface. When food reaches it, a ring of the muscular



tube contracts just above the morsel. This contraction runs down to the stomach, forcing the food before it as though a tight iron ring were slipped down over the esophagus. A contraction of a tube within the body in a regular manner, producing an onward movement of its contents, is called *peristalsis*. While a horse is drinking, the peristalsis of the esophagus may be plainly seen along its neck.

### SUMMARY

1. Anything which taken inside the body supplies it with weight or heat or energy is food.
2. All foods are composed of one or more of the five substances: water, albumin, fat, starch or sugar, and mineral matter.
3. Food must become liquid in form and enter the blood tubes before it can reach the cells of the body.
4. Cooking softens the food and develops its flavors. It also destroys many poisons in food.
5. In the mouth food is ground fine between the teeth and mixed with the saliva so as to form a thin paste.
6. Saliva contains a ferment which changes some of the starch of the food to sugar.
7. The tongue pushes the chewed food backward into the pharynx. The pharynx then closes all its openings except the one into the esophagus. The pharynx then squeezes the food into the esophagus, and the esophagus forces it into the stomach.
8. All cavities of the body which have an opening leading to the air are lined with a kind of soft skin called *mucous membrane*.
9. Mucous membrane is a network of cells and fibers covered with flat cells called *epithelium*.

10. Mucous membranes contain little pockets of epithelial cells, which produce a slippery fluid called *mucus*.
11. A collection of pockets or tubes, lined with epithelium, which separates a substance from the blood, is a *gland*.
12. The saliva is formed in three glands upon each side of the face.

### DEMONSTRATIONS

26. Notice the various movements of the teeth and tongue, lips and cheeks, in chewing. Have one of the pupils open his mouth wide. Show how the soft palate which forms the roof of the mouth can be raised and lowered. Show the sliding doors of the pharynx, which reach up to the soft palate and with it form an arch over the back part of the tongue. Notice the small projection which points downwards from the summit of the arch. This is called the *uvula*.

27. Have the pupils swallow slowly. Notice that the tongue, beginning at the tip, is applied to the roof of the mouth until its whole length touches the palate. Notice that when the back part of the throat begins to swallow, the food is beyond the control of the will. Notice that breathing is stopped, for both the nose and windpipe are closed.

28. Get a tooth and have it sawed in two lengthwise, so as to show the cavity in its interior. Get another, partly decayed, to show how the nerves of the interior are laid bare and exposed to injury.

29. Procure the lower jaw of a sheep or pig. With a hammer and chisel split open a part of the bone to show how the teeth are set into the bone.

30. Point out the difference between the skin and the mucous membrane of the lips. Notice that the two are directly continuous. Explain that the mucous membrane is really a modified skin, and that anything in the mouth and stomach is really outside the body proper just as it would be if it were held in the closed hand.

31. Examine a specimen of mucous membrane under the microscope, using a power of at least 200 diameters. Notice the layer of epithelial scales covering its outside. Notice the network of fine connective tissue which makes up the main part of the membrane. Notice the glands. They are tubes, but are cut across in the specimen



and appear as circles lined with large cells. Explain that the cells of the glands produce the mucus.

32. Have a boy open his mouth and raise his tongue upward and backward. With a handkerchief wipe dry the space between the tongue and teeth. In a moment a drop of water will collect between the small projections near the tongue. Move the tongue slightly, and notice that the liquid flows in a tiny stream. Explain that this is the saliva flowing from the sublingual gland.

33. Chew a piece of white bread. After a little, notice that it has a sweetish taste. Explain that the sweetness is due to the action of the ptyalin of the saliva in changing the starch to sugar.

34. While a horse or a cow is drinking, notice the peristalsis of the esophagus along its neck as it swallows each mouthful.

### REVIEW TOPICS

1. Define *food* and name the five classes.
2. Tell what change each must undergo in order to enter the body.
3. Tell what effect *cooking* has upon each class of food.
4. Discuss the different ways of cooking.
5. Give the parts of the alimentary canal.
6. Describe the *mouth*.
7. Describe the *jaws* and *teeth*.
8. Tell how the teeth are commonly injured, and how to preserve them.
9. Describe the *cheeks*, *lips*, and *tongue*.
10. Describe a *mucous membrane*.
11. Define a *gland*.
12. Describe a *salivary gland*.
13. Describe the use and appearance of *saliva*.
14. Describe *mastication*.
15. Describe the *pharynx*.
16. Describe *swallowing*.
17. Describe *peristalsis*.