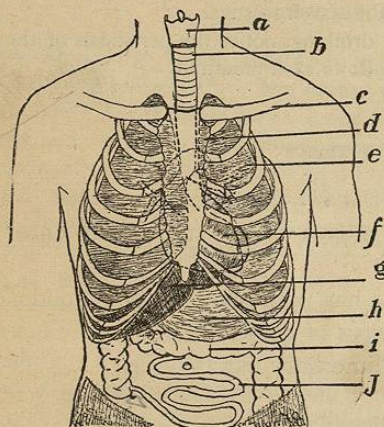


CHAPTER VI

STOMACH DIGESTION

84. Cavities of the body. — A muscular partition, curved sharply upward, divides the inside of the body into two



Organs of the chest and abdomen.

- a* larynx.
- b* trachea.
- c* clavicle, or collar bone.
- d* sternum, or breastbone.
- e* lung.
- f* heart.
- g* liver.
- h* stomach.
- i* large intestine.
- j* small intestine.

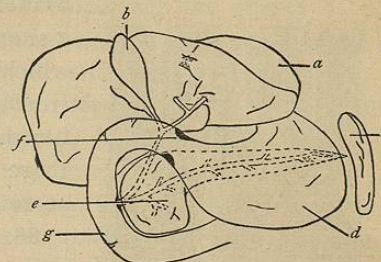
cavities, — an upper one, called the *chest* or *thorax*, which contains the *heart*, *lungs*, and the *esophagus*, and a lower one, called the *abdomen*, which contains the *stomach*, *intestine*, *liver*, *spleen*, and *kidneys*. This muscular partition is called the *diaphragm*.

85. The abdomen and peritoneum. — The abdomen is a closed cavity, bounded above by the diaphragm, on the sides partly by the ribs, and behind partly by the spinal column. The bones of the pelvis form its floor. The rest of its walls are formed by thick sheets of

muscles. It is lined with a very smooth membrane called the *peritoneum*.

The peritoneum also covers the outside of all the abdominal organs. Such a membrane, lining a cavity which is not in open communication with the air, is a *serous* membrane. The peritoneum is the largest and most important serous membrane. It is a thin, closely-woven network of interlacing cells covered by a single layer of flat cells, which give it a shiny appearance. It is moistened by a small quantity of watery fluid, which is not produced by glands, but is a part of the lymphatic circulation. Its smoothness permits easy movements among the organs of the abdomen.

86. The stomach. — The stomach is the first organ into which the food passes when it leaves the esophagus. It lies mostly on the left side of the abdomen half covered by the lower ribs. It is a conical enlargement of the alimentary canal, and is situated between the esophagus and the small intestine. It is about twelve inches in length and five inches

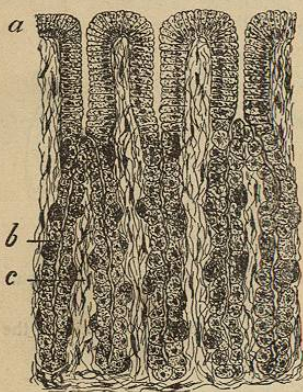


Organs in the upper part of the abdomen.

- a* liver, raised up.
- b* gall bladder upon the under surface of the liver.
- c* spleen.
- d* stomach.
- e* pancreas; the line passes through the common opening of its tube and that from the gall bladder.
- f* pylorus.
- g* duodenum.

in diameter. It is composed of a layer of muscle covered with peritoneum and lined with mucous membrane. Its walls are from $\frac{1}{16}$ to $\frac{1}{8}$ inch in thickness. It is hung in place by a short curtain of peritoneum, which is attached above to the under-surface of the liver and diaphragm. The esophagus opens into the stomach at its upper left side, called the *cardiac* extremity. The opening into the intestine is at the right and narrowest part, and is called the *pylorus*. The pylorus can be closed by a thick ring of muscle.

87. Glands of the stomach. — The mucous membrane of the stomach contains numerous glands which secrete a special digestive fluid called the *gastric juice*. The glands are short tubes each about $\frac{1}{250}$ of an inch in diameter, and $\frac{1}{40}$ of an inch in length. The tubes are set closely together and resemble pinpricks in the mucous membrane.



Gastric glands in the stomach
($\times 200$).

- a epithelium of the surface of the stomach.
b epithelium lining the tubes of the glands.
c connective tissue between the tubes.

Each tube is lined with a single layer of epithelial cells which produce the gastric juice from material supplied by the blood. Besides these glands there are many others which secrete only mucus.

88. Gastric juice. — The gastric juice is a yellowish fluid, and consists of water holding in solution *hydrochloric acid* and two ferments. These are the essential agents in stomach digestion. Hydrochloric acid is produced by the epithelium of the gastric tubes from the salt contained in the blood, and forms from $\frac{1}{5000}$ to $\frac{1}{500}$ of the gastric juice. The ferments are white, albuminous substances produced from the blood by the epithelium of the glands, and form about $\frac{1}{500}$ of the gastric juice. The flow of gastric juice is promoted by a slow, steady in-taking of food at about the temperature of the body. The saliva, which is slightly alkaline, an agreeable taste of the food, and a pleasant frame of mind also aid its flow. About three quarts enter the stomach each day.

89. Peristalsis of the stomach. — Anything taken into the stomach causes a continuous and regular movement of the organ, due to the alternate contraction and relaxation of its muscular fibers. This is an example of slow peristalsis. The food is thus caused to flow in a steady stream from the esophagus to the left, and then down to the right and back again, completing the circuit of the stomach in about three minutes. By this movement it is thoroughly mixed with the gastric juice.

90. Ferments of the gastric juice. — One of the ferments of the gastric juice, *rennin*, acts by coagulating milk. In the child this action is very important.

The other ferment, *pepsin*, softens the albumin of food and changes its character so that it will dissolve in water and diffuse through the walls of the blood tubes to become a part of the blood. This form of albumin is called *peptone*.

A quarter of a grain of pepsin can render a whole white of an egg soluble. It acts best at the temperature of the body, and there must be an acid present. The surface of the food particles are acted upon first, and the products of its action are rubbed off by the peristalsis of the stomach, and the next layer is acted upon in the same manner. Some of the gastric juice penetrates between the particles of food, and slowly eats its way into the food mass, thus dissolving apart the separate cells which compose the food. Its action is confined solely to the albumin. In fat meat the albuminous pockets are eaten away, and the fat is set free. Starch is not acted upon, except to be freed from its albuminous envelopes.

The result of stomach digestion is a fluid called *chyme*. Peptone imparts to it a bitter taste, while small particles of fat give it a milky appearance. Food then appears as it would if it had been boiled for a long time.

91. Use of the acid. — Pepsin can act only in the presence of the acid, in an amount at least sufficient to neutralize the alkali always

present in the food. The gastric juice is more often deficient in acid than in pepsin.

Besides assisting the pepsin the acid alone can perform the first stages of changing albumin to peptone. Living germs of fermentation and disease are sometimes swallowed. The acid destroys them if it is present in the gastric juice in its full amount. This is a provision of nature to prevent fermentation from taking place in the stomach, which might otherwise become sour at every meal. This explains why diseases are more easily caught when the stomach is deranged. In a healthy person the germs meet the destroying acid almost at the entrance to the body.

92. Amount of stomach digestion.—The stomach digests only albumin. The main uses of the stomach are, to act as a storehouse for food, to mix it with the watery gastric juice, and to reduce it to a form still more liquid than when it left the mouth. The acid prevents the food from spoiling, and, with the pepsin, begins the digestion of the albumin. The stomach is not absolutely necessary for digestion, but because of its capacity it enables us to carry a store of food so that we do not need to eat every few minutes.

93. Passage of food into the intestine.—Every minute or two the pylorus opens, permitting a little of the chyme to escape into the intestine, where the main work of digestion is performed.

Some food begins to pass out of the stomach within a few moments after eating. The time required for the stomach to empty itself completely is from two to five hours, depending upon the amount of food and the ease with which it is broken up. Thus we commonly say that it takes from two to five hours for food to digest.

When the stomach has been empty for some time, there is a sense of hunger. Yet the intestine may still contain enough undigested food to supply the body for hours.

SUMMARY

1. The diaphragm divides the inside of the body into an upper cavity called the *thorax* and a lower one called the *abdomen*.
2. In the abdomen are the organs of digestion.
3. The lining of the abdomen and the covering of its organs is a smooth membrane called *peritoneum*.
4. The stomach is a muscular bag lined with mucous membrane and covered with peritoneum. In its mucous membrane are glands which produce the *gastric juice*.
5. The gastric juice is water containing *hydrochloric acid*, and two *ferments*. It changes albumin to peptone.
6. The actions of the stomach may be summed up in three things: (1) It is a storehouse in which food is held while being passed on to the intestine in a slow and steady stream. (2) Its peristaltic movements break up the food and mix it with the gastric juice. (3) It digests some albumin by means of the acid and pepsin of the gastric juice.
7. Every minute or two some of the liquefied food passes through the pylorus into the intestine.
8. In from two to five hours after a full meal the stomach is usually empty.
9. The stomach has no action upon starch or fat, and digests only a part of the albumin.

DEMONSTRATIONS

35. Show the internal organs of an animal. A frog or a mouse will do; but a rat, a rabbit, or a cat will be better.

Always prepare the specimen in private, and leave it before the class only while it is actually being shown. Cover all the parts except those to be shown, and wash away all traces of blood. Any small animal may

be killed quickly and painlessly by placing it in a tight box or covered pail and pouring in half an ounce of chloroform. Demonstrations of the internal organs had better be made only before those members of classes who wish to see them.

36. It is well to preserve permanent specimens of the different organs. One part of formalin to 30 parts of water is most excellent. It is neither expensive nor poisonous, while it preserves specimens in their natural form and color. The following inexpensive mixture, known as *Müller's fluid*, is also good.

Sodium sulphate (Glauber's salt),	1 part,
Potassium bichromate,	2 parts,
Water,	100 parts.

This forms a yellow fluid and stains the specimens yellow. It is only slightly poisonous, even if taken into the mouth, while soap and water will remove it from the hands.

Put the specimen in a large covered earthen or glass jar, with an amount of the fluid equal to at least five times the bulk of the specimen. Remove it from the jar to a platter when showing it to the class. The fluid will harden the tissues so that even soft organs may be handled with safety.

Special training is required in preparing microscopic specimens showing the tissues in their proper position. The difficulty consists in cutting a slice thin enough; for the microscope magnifies in thickness as well as in length and breadth.

37. Open the abdomen of a dead animal by a cut from the ribs to the end of the body. Notice that the organs and walls of the abdomen are shiny from their covering of peritoneum. Notice that the peritoneum is thin and strong, that its appearance differs from that of a mucous membrane, and that it can be peeled from the abdominal walls. (See demonstration 35.)

38. Notice the shape and position of the stomach. Open it to show the folds in the mucous membrane. With a specimen of mucous membrane under the microscope show the short, straight gastric glands standing side by side. Sketch them. (See demonstration 35.)

39. Notice the dome of muscle extending completely across the body above the stomach. Explain that this is the diaphragm, and that it divides the body into two cavities. Open the chest and show its cavity and the top of the diaphragm, which separates it from the abdominal cavity. (See demonstration 35.)

40. Illustrate stomach action by placing small slices of hard-boiled egg in—

Hydrochloric acid,	40 drops,
Pepsin,	1 grain,
Water,	$\frac{1}{2}$ pint.

Keep the mixture in a warm place, shaking it occasionally. In a few days the egg will completely dissolve. Show some powdered pepsin and some dilute hydrochloric acid.

41. Boil some potatoes and meat for several hours, to illustrate the appearance of chyme as it leaves the stomach.

REVIEW TOPICS

1. Describe the two main cavities of the body.
2. Describe the *lining of the abdomen*.
3. Describe a *serous membrane*.
4. Describe the *stomach*.
5. Describe the *gastric juice* and the *glands* in which it is formed.
6. Tell the name and the action of the *acid* of the gastric juice.
7. Tell the names and the actions of the two *ferments*.
8. Tell how each *class of food* is affected by the stomach, and how much.
9. Describe the *peristaltic* movements of the stomach.
10. Tell how the food passes from the stomach into the intestine.
11. Tell how important the work of the stomach is in comparison with the work done in the intestine.

CHAPTER VII

ABNORMAL ACTION OF THE STOMACH

94. The appetite. — Eating is designed to furnish the body with proper nourishment, but many “live to eat,” and pay for their meals with a host of bad feelings. The amount and kind of food, and the time of eating, must be suited to the needs of the body. A wild animal eats and thrives without thought of what it eats, for nature has given it certain signs which it follows blindly and yet securely. Man possesses the same signs, and if they were followed, indigestion would be rare. The sign of the need of food is the feeling of hunger and thirst, or the *appetite*. The kind of food required is indicated by the sense of *taste*, and the proper amount of food is known by the absence of hunger and by the sense of taste beginning to fail.

95. Natural taste of food. — The simplest kind of food tastes the best to a hungry person. He eats it with keen enjoyment until his hunger is satisfied. If he leaves the table now and goes about his work, his meal will digest without producing unpleasant feelings.

Food flavored only with salt has a natural taste of which we never tire, and which gives reliable signs as to the quantity needed, and the time of eating. If only this kind of food is placed upon the table, the sense of taste and the satisfied feeling at the end of the meal are reliable guides as to the amount and kind of food needed.

96. Perverted appetite. — After hunger has been satisfied with all the food needed, a food with an artificial taste is often brought on, and a new appetite arises. The taste soon learns to prefer the artificially prepared food, and the education of “living to eat” is begun. Pie, cake, sweets of all kinds, spices, and seasonings are eaten mainly to please an acquired appetite.

Sweets and highly seasoned food do not satisfy a hungry man as plain food does, but on the contrary their taste becomes sickening to the stomach, before they begin to satisfy his hunger. Moreover, the appetite for artificial things may persist after the stomach is filled.

97. Intemperate eating. — In the hurry of business or pleasure men gulp down their dinners in huge mouthfuls, and overload their stomachs before the surprised organs can take account of the kind or quantity of food eaten. Some eat too much in prolonging the pleasures of taste. Nearly everybody indulges an appetite for sweets and highly seasoned food. Satisfying an appetite which is not the expression of actual need of the body is as much *intemperance* as drinking strong drink, and leads to the same kind of serious results.

98. Insufficient mastication. — A whole train of evils follows intemperate eating. When food is swallowed in large lumps instead of being masticated to a thin gruel, too little saliva is mixed with it. It reaches the stomach too dry, and so a larger amount of gastric juice is needed. But the saliva is the natural stimulant to the flow of juice, and if it is small in amount, the gastric juice does not flow in sufficient quantity and food is not well digested.

99. Too much food. — An excessive amount of food stretches and weakens the stomach, and peristalsis cannot take place so vigorously as it should. The lumps of food are neither penetrated by the gastric juice nor ground to pieces by the peristalsis, but only their outer surfaces are slowly dissolved. The food thus remains too long a time in the stomach, and some may stay there until the next meal.

100. Eating between meals. — Eating at irregular hours or between meals also disturbs the stomach. Two or three hours after a meal the work of the stomach should be done, and it should be permitted to rest. If more food of any kind is eaten, the stomach must either be overworked or the food not be digested.

Food which the gastric juice softens with difficulty behaves like large lumps of food, and finally either is vomited, or is passed on to the intestine to create more trouble there.

101. Fermentation in the stomach. — The stomach cannot be abused in any way without suffering in all its actions. It gives expression to its suffering by pain, headache, heart beating, and a host of other bad feelings. It makes the whole body weak and sick. Its imperfect action also permits fermentation to go on, which makes the food sour. Living germs like those producing alcohol and vinegar are continually being eaten. In health, the acid of the gastric juice destroys them, but when anything weakens the acid or prevents it from reaching the germs, they grow and produce vinegar and other acids, and also gases. The result is a *sour stomach* and "wind on the stomach," which comes up and out of the mouth as though it were vomited. This is a sign of indigestion.

The gas distends the stomach and presses it against the heart, so that the beats are felt; and then the heart and not the stomach receives the blame. A sour stomach is at first the result of improper action, not the cause; but, once developed, it may cause a greater disturbance, and then there is only a step to actual stomach disease.

102. Drinking while eating. — A great part of the work of digestion consists in mixing food with water. When dry food is eaten, the gastric juice must be produced in large amount before digestion can begin. A glass or two of water, either alone or with tea or coffee, aids the action of the gastric juice. If the water is not used in place of saliva in moistening the food, or is not employed to hasten the act of swallowing food, drinking during meals will be beneficial. Many drink too little liquid.

103. Hot or cold food. — Food either too hot or too cold hinders the production and action of the gastric juice and disturbs peristalsis, so that the movements of the stomach may not resume their natural course until a long time after the temperature of the food becomes that of the body. A glass of ice water may remain perceptibly cold to the stomach for from one quarter to half an hour, and its effects upon the movements of digestion may last much longer.

104. Rest and eating. — When the body is very tired, the stomach has not the proper energy for digesting food. If food is eaten just as a person comes home fatigued by a hard day's work, there is apt to be a night of pain and indigestion. If, before eating, a glass of warm water or coffee or milk is taken, followed by a short nap, so as to rest the body, the meal will be enjoyed, and digestion will go on unaccompanied by bad feelings.

After a meal the stomach requires an extra amount of blood and energy. A rest of fifteen minutes after each meal would be a great health saver.

105. Rules for eating. — Chew each mouthful to a paste and swallow it before taking another.

Stop as soon as the taste of plain food begins to pall.

Allow four or five hours to elapse before eating again.

SUMMARY

1. Hunger indicates the need of food, and taste indicates the kind.
2. When only plain food is eaten, these two signs are correct guides in eating.
3. An appetite for sweet and highly seasoned food may persist after hunger has been satisfied with plain food.
4. Sweet and seasoned foods soon disgust the sense of taste, thus showing that they are not needed.
5. Eating food for mere pleasure is *intemperance*.
6. Eating too much, too rapidly, or too often is *intemperance*.
7. As a result of intemperate eating, acid fermentation often occurs in the stomach, producing discomfort and sickness.
8. A person should eat only plain food, slowly, and at intervals of not less than four or five hours.

DEMONSTRATION

42. Nearly every one has felt the effects of intemperate eating. When "stomach sick," a sharp-tasting gas and very sour food often come up to the mouth, showing that acid fermentation is going on. Notice how plainly a person feels his own heart beats after a large meal, owing to the pressure of the distended stomach upon the heart.

REVIEW TOPICS

1. Tell how a person knows when and how much to eat or drink.
2. Define an appetite and tell how it can be satisfied naturally.
3. Illustrate an artificial appetite and tell how it can be distinguished from a natural appetite.
4. Tell some of the ways in which men abuse their stomachs by indulging their artificial appetites.
5. Tell some of the effects of too rapid eating; of imperfect mastication; of overeating; of eating between meals.
6. Tell how food sours within the stomach.
7. Tell how drinking at meal times is beneficial, and in what way it can be harmful.
8. Tell how hot or cold food affects the stomach.
9. Give some simple rules for eating.

CHAPTER VIII

INTESTINAL DIGESTION

106. **The intestine.** — The part of the alimentary canal below the stomach is called the *intestine*. The intestine is

a tube of varying size, whose different parts have different names. Next to the stomach is the *small intestine*, which is about one inch in diameter and about twenty feet in length. It opens into the *large intestine*, which is about two inches in diameter and five feet in length.

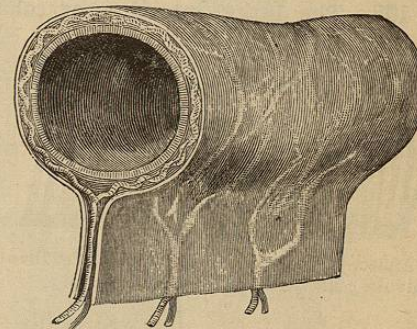


Diagram representing a cross section of the small intestine, showing the three layers, and the way in which the blood tubes pass between the two folds of serous membrane (the peritoneum) which forms the mesentery.

107. **The small intestine.** — The small intestine is very movable, and is coiled in the abdomen in no definite order. It is held in place by a fanlike fold of peritoneum, called the *mesentery*. The mesentery is about four inches in length along its back edge, which is fastened to the spinal column, and twenty feet at its outer edge, to which the intestine is attached. Its breadth from the spinal column to the intestine is about four inches.