more energy; to digest the food of cattle requires still more. The lower the form of life, the more time and energy is spent in digestion, and the less is the action of other parts, until the lowest forms of animals simply live to eat, and remain at rest except when eating food. A comparison of man's digestion with that of the lower animals is misleading. Man's alimentary canal is designed to deal with food upon which but little energy need be expended. More energy is thus available for his voluntary use. Because of his perfect food man can perform more labor and undergo more fatigue and exposure in proportion to his size than any other animal.

SUMMARY

1. The digestive organs of all animals are similar to man's, but modified according to the needs of the animal.
2. Cattle swallow grass whole, and then chew it at leisure. They have four stomachs.
3. Birds swallow food whole. It passes first into the crop, and later is ground in the gizzard.
4. Insects, worms, and shellfish each possess a simple stomach and intestine.
5. Man uses food which is more easily digested than the food of any lower animal. Thus he devotes less time to mere eating and digesting food.

REVIEW TOPICS

1. Show in what way and for what purpose a dog's digestive organs differ from those in man.
2. Show the use of four stomachs in cattle.
3. Show how birds digest their food.
4. Point out how the digestive organs are modified in worms; in insects; and in shellfish.
5. Show what advantage man's food gives him over the lower animals.

CHAPTER XII

ANIMAL FOOD

153. Food elements. — Anything which, taken inside of the body, supplies it with weight, heat, or energy is food. Man's food consists of a great variety of substances derived from the animal, vegetable, and mineral kingdoms. Yet all food consists of the proximate principles: water, mineral matter, albumin, fat, and starch or sugar. Neither alone makes a perfect food, but all must be present in proper proportions or else the body will suffer.

154. Water. — Water requires no digestion, but is continually entering and leaving the body unchanged in form. All solid food contains some water, and enough more is added in liquid food and in drink to supply the full needs of the body. Twelve or fifteen pints of fluid are used daily in the work of digestion, but it is absorbed back again to the blood and so little is lost. Within reasonable limits, water taken at meal times aids digestion. In order to digest food and wash away waste matter properly, two or three quarts must be swallowed daily. If the thirst is satisfied with pure water, there will be little danger of taking too much, and the indications of thirst will be the most reliable guide as to the times of drinking and of the quantity required.

155. Mineral matters. — Mineral matters are not changed during digestion, and they leave the body in the same form in which they enter. More than enough are found in all

ordinary food to supply the needs of the body. Only salt needs to be added to food, but man often adds far more than is necessary. Since water and mineral matters require no digestion, it makes little difference in what kind of food they are eaten. But albumin, fat, and starch or sugar require digestion, and some forms are more easily digested than others, so a discussion of their forms in different foods becomes necessary.

156. Digestibility of food. — In judging of the value of food four things must be considered:

First. The time and energy required. — Some forms of food require little or no energy in their digestion, while others cannot be digested at all. Grass contains all kinds of food substances, but man cannot digest it. The combination of meat, fruit, and flour which we call mince pie requires far more time and energy in its digestion than the same substances in the form of roast meat, bread, and fresh fruit, or in the form of a light pudding.

Second. The amount of indigestible matter. — All kinds of food contain some matter which is wholly indigestible. Only a little of fruit is digested. Careful experiments show that ordinarily at least one fifth of the albumin of vegetable food passes through the intestine undigested, while only one thirtieth of meat is thus wasted. Animal oil is easily emulsified and saponified, while vegetable oil can scarcely be changed at all, but if eaten in any quantity is a source of intestinal disturbance. Some wholly indigestible matter in food is valuable, for it affords something upon which the intestine can contract so as to force its contents down the tube.

Third. The amount of energy developed by the food. — Fat requires a large amount of oxygen in its oxidation, and yields a large amount of heat and energy. Sugar

requires only one third as much oxygen and develops less heat and energy. So food rich in fat yields more heat and energy than a food rich in sugar or starch.

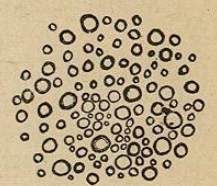
Fourth. Liability to ferment. — A food requiring a long time in digestion is more liable to ferment than one which is digested in a short time. Sugar and starch ferment easily, while fat ferments only with difficulty.

157. Milk. — Among all the different kinds of food milk seems to be most perfectly adapted for man and for many animals. The average cow's milk consists of

Water	86 per cent.
Albumin	4 "
Fat	$4\frac{1}{2}$ "
Sugar	5 "
Mineral matter	$\frac{1}{2}$ "

Milk thus contains all the five different kinds of food substances, which, moreover, are in about the proper proportions to support life best.

The albumin, fat, and sugar of milk each requires little time and energy in its digestion, and leaves but little undigested residue. Milk is more liable to undergo fermentation than some other kinds of food, but the quickness of its digestion overcomes this objection. It develops heat and energy in amounts best suited to support life. Milk is thus an ideal food, and can be digested when all other kinds of food are rejected.



Fat globules in milk (× 300).

158. Caseine. — The albumin of milk is called *caseine.* In its digestion the rennin ferment in the stomach coagulates it in fine flakes, which the acid and pepsin dissolve to peptone. When much acid is present in the stomach, as after a meal, or when fermentation has occurred, the caseine is apt to be coagulated in hard lumps which dis-

turb digestion, producing a bilious attack. The rennin ferment is produced the more rapidly when milk is hot, while the heat hinders the production of the acid of the gastric juice. So if the milk is taken hot, it will be coagulated in finer flakes, which the gastric juice can digest more easily. If milk is taken slowly in any form, it is coagulated in small amounts as fast as it enters the stomach, and so no large lumps can form. If taken before meals, hot and slowly, there are but few persons with whom milk will disagree.

159. Fermentation of milk. — Many kinds of living germs are continually falling into milk and growing, if the temperature is warm. Some are germs which produce acid fermentation and turn the milk sour. The acid coagulates the caseine, forming *clabber*. Germs of disease also will grow in milk, especially germs of typhoid fever and of tuberculosis. Children are very easily affected by sour milk. Often the germs of fermentation grow in their stomachs, souring the food and producing *summer complaint*. Boiling the milk destroys the germs but not the poisons which already have been produced. All cow's milk given to babies should be heated in order to destroy the germs.

160. Cheese. — Rennet is often added to milk in order to coagulate its caseine, which, when squeezed into a firm mass, is *cheese*. The cheese holds the fat of the milk, while the sugar remains in the whey. Cheese is about one third albumin. It contains no sugar or starch. The amount of fat which it contains depends upon how much cream was left in the milk of which it was made. It is a valuable article of food because of the large amount of albumin always present. It is easily digested by healthy persons. In some kinds germs are permitted to grow and develop various acids and flavors which make the cheese *strong*. These are somewhat harmful, but mild cheese furnishes a cheap supply of good albumin.

161. Butter. — When milk remains quiet for some hours, the fat rises to the surface in the form of *cream*. After this is removed, milk is called *skim milk*. Cream is made up of fine particles of fat, each surrounded by a thin envelope of caseine. When cream is shaken until the covering of the caseine is worn off, the fat collects in a form called *butter*. The liquid part remaining is called *buttermilk*, and does not differ much from milk, except that the fat is mostly removed. Butter is the most valuable form of fat eaten.

162. Value of milk. — In sickness milk is almost the only food which the stomach can digest at all. Only about one twentieth of the solid part of milk fails to be digested. When only milk is taken, there is but little residue upon which the intestine contracts, and so waste matters pass down the tube more slowly than when solid food is eaten. Those who eat much milk find it profitable to eat heartily of substances which, like oatmeal, leave a large undigested residue to sweep out the waste matters of the intestine.

163. Adulteration of milk. — It is difficult to set a standard for perfect milk, for no two cows give it of exactly the same composition. Milk which has a good quality of cream usually contains a good quantity of albumin and sugar and so is said to be *rich*. Such milk is yellow, in distinction from the bluish color of poor or *skim milk*. The richness of milk may be measured by observing how thick a layer of cream will rise in a deep glass tube full of milk. Another way is to determine how much solid matter the milk contains by means of a *lactometer*. This is a closed tube weighted so that it will float upright. As more solid matter is dissolved in the milk, it becomes heavier and will more easily sustain a body floating upon it. The richer the milk, the less the bulb and tube will sink. This instrument is called a *lactometer*. By means of it milk brought into large cities is tested by government inspectors, and all milk which falls below a certain standard is thrown away. The lactometer really records the specific gravity of the milk. If it falls below 1.029, it is considered to be either watered

or of too poor quality to be sold as good milk. While such milk may not be injurious, yet it is a fraud to sell it at the price of good milk. Skim milk is bluish in color from the loss of its cream. To make it the color of new milk, burnt sugar is often added, and it is then sometimes sold as new milk. It is very apt to become sour from its being kept for some days.

164. Condensed milk. — Large quantities of milk are boiled until its water is evaporated and the milk is like thin jelly. This is *condensed* milk. In order to keep it, sugar is added. Condensed milk contains all the nourishment of new milk, with some sugar added. It can safely be used in place of new milk for all cooking purposes. It is too sweet to be used as a drink, but babies take it readily. Still it is undesirable as a baby food, for it contains too much sugar.

165. Imitation cheese and butter. — Cheese made from skim milk contains but little fat. It easily ferments and becomes dry, so that it is very indigestible. There is an imitation of butter made from beef fat, called *oleomargarine*. It scarcely can be distinguished from real butter. *Butterine* is another imitation of butter made from beef fat and butter. The manufacture and sale of both kinds of imitation butter are permitted so long as the products are sold under their right names.

166. Eggs. — Hens' eggs consist of

Water	70 per cent.
Albumin	15 "
Fat	14 "
Mineral matter	1 "

Since they contain no starch or sugar, they are not a complete food for man, although a perfect chicken may be formed out of the egg, as the hen furnishes heat. The white of egg is almost pure albumin dissolved in water. The yolk is a mixture of albumin, fat, and water. Both the albumin and fat of eggs are digested with little expenditure of time and energy, and develop a large amount of heat and energy in their oxidation. They do not easily ferment in the stomach and intestine, and only about one

thirtieth is left over in their digestion. They are thus a valuable food, but yet do not rank so high as milk.

167. Digestion of egg albumin. — When boiled for a minute or two, the albumin of eggs is partly coagulated to a soft, jellylike mass. Boiling for three minutes coagulates all the albumin to an elastic, slippery mass; while after boiling for ten minutes the albumin becomes brittle, and is easily crushed to fine particles.

A lump of albumin of a raw egg is digested with less expense of time and energy than the same sized lump of coagulated albumin, and the longer an egg is boiled the more energy is required to digest it back to a liquid form. But the raw egg has a tendency to collect in masses which the gastric juice cannot penetrate.

An egg boiled for less than five minutes is usually masticated only to medium-sized particles, which, however, owing to their smaller size, may be digested sooner than the large masses of raw egg. But the egg boiled for ten minutes is easily chewed fine, and, owing to the still smaller size of its particles, is digested much sooner than small lumps of soft-boiled eggs or the masses of raw eggs. Thus an egg boiled for at least ten minutes is ordinarily the most available for digestion. When mixed with a considerable quantity of milk, the raw egg is prevented from forming a lump, and in this form it may digest more easily than a cooked egg.

168. Quality of eggs. — Fresh eggs vary but little in composition. In time they lose a little water by evaporation through the shell, which is porous. A fresh egg appears clear and pink when held in front of a strong light, while an old egg appears dark-colored, even if it has not begun to decay. It will first show a dark spot where the yolk settles to the side of the shell, and later will be dark all through. This test is reliable and is often applied in markets. The shell of a fresh egg is bright in color and slightly rough like common newspaper, but an old egg becomes duller in color and shiny in appearance like writing paper. Ducks' eggs are nearly like hens' eggs, except that sometimes they acquire a peculiar taste from the ducks' food. Nearly all kinds of birds' eggs, as well as the eggs of turtles, are used as food. They differ but little from hens' eggs.

169. Meat. — The flesh of oxen, sheep, and hogs is the common form of meat. All kinds of game, fowl, fish, and

shellfish are of the same nature. The muscles form the lean part of meat, but nearly every part of the animal is sometimes used as food. Ayerage meat consists of

Water	65 per cent.
Albumin	17 "
Fat	14 "
Mineral matter	4 "

Albumin is the principal part of .eat. Beef has high food value; mutton, fowl, and game rank next, in the order named.

170. Digestibility of meat. — Meat varies greatly in composition and digestibility. While man cannot digest stringy connective tissue and tough skin at all, yet good meat ranks next to milk and eggs, and exceeds all forms of vegetable food in all the four points of digestibility. It requires a small outlay of time and energy in its digestion, and its oxidation develops a large amount of heat and energy. It does not easily ferment, and only about one thirtieth remains undigested.

Meat is often salted or smoked or dried, or prepared in other ways so that germs of fermentation or decay will not grow in it, and thus it can be kept for a long time. When thus prepared, its fibers are partly coagulated and hardened, so that the gastric juice cannot penetrate them readily. The digestibility of such meat is greatly impaired. The toughness of meat is due to strings of connective tissue, which are digested with difficulty and yield little heat and energy to the body. Tender meat consists almost wholly of muscular fibers, which are the main nutritive parts of most meat. Since meat contains no starch or sugar, some must be added in order to make it a perfect food; and, very properly, bread is generally used.

171. Soup and beef tea. — The water in which meat is cooked is often eaten as *soup*. Soup contains some gelatine and fat, but only a small amount of albumin, for most of the albumin is coagulated by the heat, and thus prevented from dissolving. The water also dissolves the mineral and waste matters of the meat.

Beef juice is made by heating the meat and pressing out the juice. The best meat juice contains albumin and fat in about the same proportions as milk.

Beef tea is a kind of concentrated soup. Mineral and waste matters give it flavor. It is very poor in albumin and fat, and is of little value as a food, while its waste matters may render it harmful. There are no facts to warrant the assertion that beef tea contains some nutritious essence of the meat which is of special value as food. Its value must be judged solely by the amount of albumin and fat which it contains. Extracts of meat are sold, a teaspoonful of which added to a cup of water is said to contain the nourishment of a pound of beef. They consist of mineral and waste matters dissolved in water, and so are of no value as food. Their taste may be pleasant, and this may assist in the digestion of other food.

172. Fresh meat. — As a rule any meat is most wholesome if it is eaten soon after being killed. In the markets beef is usually hung in a room whose temperature is nearly freezing. There it remains fresh for weeks, or even months, and at the same time it becomes more tender and improves in flavor. When taken out and exposed for sale, it spoils much sooner than newly killed beef. If there is the slightest musty or decayed odor about meat, it is undesirable as food.

Game animals are often hung just as they are killed, until they are distinctly decayed, so as to develop peculiar flavors. Fowl and game are liable to be unwholesome if they are kept for many days without being opened and cleaned.

173. Points of good meat. — (1) Tender meat usually comes from well-fed animals, and such animals are always fat. A layer of fat from one fourth to one half inch in thickness, covering the outside of the meat just under the skin, usually denotes a well-fed animal. The

fat will also extend in fine white streaks irregularly in every direction through the meat and can be clearly seen upon its cut surface.

(2) The fat is deposited in the connective tissue which incloses separate bundles of muscles. If these bundles are from one eighth to one fourth inch in diameter, and preserve their shape when the finger is passed over them, they contain much connective tissue, and the meat is tough, as in meat from the neck. When a slice of such meat is gently pulled apart, the bundles separate from each other, and are connected together by strong, veil-like meshes of connective tissue.

On the other hand, if the bundles of muscle are small and not well marked, the connective tissue is small in amount. When a slice of such meat is pulled apart, its bundles do not separate, but the whole piece stretches.

(3) The cut edge of good beef soon becomes *bright red* in color. When the connective tissue is abundant between the bundles, it imparts a paler tint to the meat, and sometimes a bluish tinge. Good pork and veal are pale or almost white in color, but in other points resemble beef (see p. 218).

Good meat has an agreeable odor and is clean. Excepting as it is marked by connective tissue and fat, it should be of a uniform tint.

174. Fish. — Fish contains albumin about sixteen per cent, fat about six per cent. It is digested with rather less ease than meat, but it can take the place of meat as food. It used to be thought that it contained more nourishment for the brain than other kinds of food, but the brain is nourished by the same substances as the rest of the body, and fish is hardly so good for it as beefsteak.

Fish should always be eaten while fresh, for it is especially liable to decay.

175. Shellfish. — Shellfish, as oysters and clams, contain about sixteen per cent of albumin and three per cent of fat. The large dark mass in their bodies is the liver, which contains some sugar. When eaten raw, their own digestive fluids and their livers aid in the digestion of their bodies. When cooked, they require more time and energy for their digestion. Because of their ease of digestion, fresh raw oysters are a valuable food in sickness. Crabs and lobsters also are good food if well cooked.

176. Blood. — Blood is digested with difficulty. It contains little albumin and fat and no sugar. It adds nothing to the value of meat, and is very liable to decay. It should always be removed, as is usually done in killing the animal. By the law of Moses the Jews were forbidden to eat the meat of animals which had not been bled to death.

177. Inferior meat. — Meat cannot be adulterated, but inferior meat is sometimes sold as good meat. Old meat is sold for fresh meat, and tough meat for tender. Very young animals are dangerous as food, and yet they are often sold. Meat from sick animals is always unfit for use. In France, horseflesh is sold for food under its own name, and in this country it is sometimes substituted for beef in cheap shops.

178. Diseased meat. — Meat sometimes contains living germs, which may produce disease in those who eat it. The most common disease to be feared is *tuberculosis*, or *consumption*. Beef cattle are especially liable to have the disease, which may be located in their muscles as well as in any other part of their bodies, and is difficult of detection.

A *tapeworm* passes one stage of its existence in the muscles of an animal. Its eggs are accidentally eaten by an animal, and develop into minute worms, which pass through the walls of the stomach into the muscles and there form white cavities about the size of a pin head, in which they lie quietly. When flesh containing such a worm is eaten and digested by man, the worm is set free from its cavity, and, fastening itself to the inside of the intestine, grows to many feet in length. It lays eggs which will grow only when eaten by a lower animal.

In pork there are sometimes found microscopic worms called *trichinæ*. In the muscles of man they may grow and multiply enormously. The disease which they cause is both painful and deadly. It is extremely rare, at least in this country.

179. Prevention of disease. — A sure preventive against any of these diseases is thorough cooking, for heat destroys all living germs. It has not been proved that salting and smoking meat kills the germs in it. There is no way of making musty or spoiled meat fit for food. Such meat never should be used.

SUMMARY

1. Milk is the most easily digested and most perfect of foods.
2. Hens' eggs contain an abundance of albumin and fat, but no starch or sugar. They are next to milk in ease of digestion.
3. Next in order come meats, including fish and shellfish.
4. Of meats, beef has high food value; mutton, fowl, pork, game, fish, and shellfish rank next, in the order named.
5. Animal food in general is easily and quickly digested and only about one twentieth remains undigested.
6. Meat should be fresh and from a healthy animal.

DEMONSTRATIONS

52. Show samples of fresh milk and skim milk. Curdling of milk can be shown by adding vinegar to milk and gently stirring it until the curd collects in a lump. Show that this is cheese. By setting some milk aside in a deep bottle, the amount of cream which rises can be shown. Butter can be made from some cream, but the process is uncertain, especially in winter.

53. Test some milk with a lactometer or a specific gravity bulb. In good milk it should sink to 1.030.

54. By cutting a hole in a piece of pasteboard and holding eggs in it in front of a lamp in a darkened room, contrast the bright pink of a fresh egg with the dull color of a stale egg, as is done in testing eggs in the market.

55. Show some fresh meat and some that is stale. Show some very tender and some very tough meat. Show that the toughness of meat is due to white strings of connective tissue.

REVIEW TOPICS

1. Give a definition of *food* and tell what five substances are used for food.
2. Show why an abundance of *water* is needed in food.

3. Show why *salt* is the only mineral which man adds to his food.
4. Give the four points which determine the digestibility and value of a food.
5. Show that *milk* is a perfect food and how it may be used to the best advantage, and how to avoid diseases which it may contain.
6. Show how to distinguish good milk from poor, and describe two methods for testing it.
7. Describe *cheese*.
8. Describe *butter* and its imitations.
9. Show how *eggs* are valuable as food and how they are deficient and how they had best be eaten.
10. Show how a good egg can be told from a spoiled one.
11. Show how *meat* is valuable as food and how it is deficient.
12. Compare beef tea with meat.
13. Compare fresh meat with meat which has been kept and with decayed meat.
14. Describe what diseases may be transmitted by meat, and how to avoid them.
15. Show how to select good meat in the market.
16. Show how fish and shellfish resemble meat.