Chapter 14

Maintaining the Body

14.5 Digestion

If you go a few hours without eating, you're likely to start thinking about food. Food provides your body with energy-containing organic molecules that are the raw materials for making ATP, the standard energy molecule used by your cells. Food also provides many essential molecules that your body cannot produce on its own. Finally, the breakdown of food releases heat. This heat allows you to maintain a high, stable body temperature, the defining characteristic of mammals and other endotherms.

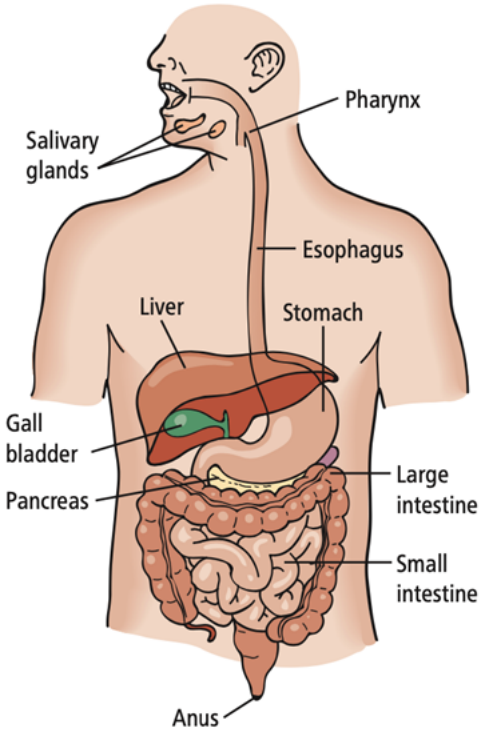


FIGURE 14.11

The digestive system breaks food down into small molecules that can be absorbed and used by the body.

Although you need food for many reasons, a chunk of food is way too big to travel in your bloodstream or move into your cells. During the process of **digestion**, food is broken down into small organic molecules that can be absorbed and used by the body. You may remember that living things are made up of different kinds of macromolecules—large molecules made up of smaller molecules linked together. During digestion, the macromolecules in your food are broken down into the small molecules that comprise them. For example, the proteins in food are broken down into separate amino acids, and the carbohydrates in food are broken down into simple sugars. These small molecules are then absorbed and used by your body.

Digestion takes place in the digestive system, which is shown in Figure 14.11. You begin to digest your food as soon as it enters your mouth. You chew food with your teeth, breaking it into little pieces.

You also mix your food with *saliva*. Saliva contains a digestive enzyme that breaks down starches. Saliva also moistens food, so that the food can be moved easily around the mouth. Finally, because your taste buds can taste only molecules dissolved in liquid, saliva allows you to taste your food. Eating, or even just thinking about food, causes you to release saliva (Figure 14.12).

FIGURE 14.12

Just thinking about food can cause the release of saliva.

After food is chewed and mixed with saliva, you swallow it. Swallowed food is pushed into the pharynx. There are two openings in the pharynx: one to the **esophagus** and one to the trachea. You will choke if food goes down the trachea by mistake. A small flap of cartilage at the back of your tongue—the *epiglottis*—covers the trachea when you swallow so that food will not get into it. This is why you cannot breathe while you are swallowing, which is something you may have noticed.

Swallowing begins as a voluntary action. The muscles at the top of the esophagus are voluntary muscles. However, at a certain point, swallowing becomes involuntary. The lower part of the esophagus is made of involuntary muscle, like that found in the rest of the digestive tract. In this part of the esophagus, food is pushed down by a moving wave of involuntary muscle contractions known as **peristalsis**. Peristalsis squeezes food down the esophagus by constricting behind it and pushing it along. You do something similar when you squeeze a LifeSavers® candy out of its paper-tube wrapper (Figure 14.13). Notice that swallowing does not require gravity—peristalsis does all the work necessary. Astronauts in the zero gravity of space have no trouble swallowing at all. In fact, peristalsis is so effective that you can swallow even while you are upside down.

At the bottom of the esophagus, food moves through a *sphincter*, or ring-shaped muscle, into the **stomach**. Glands in the stomach wall release *gastric juice*, a highly acidic mixture of hydrochloric acid and digestive enzymes (Figure 14.14). When you vomit, the acidic nature of your stomach contents becomes immediately apparent, both from the taste and from the burning sensation left in your throat. The digestive enzymes in the stomach, along with the churning of the stomach's muscular walls, convert food into a thick liquid called *chyme*. Meanwhile, the acidity of gastric juice kills any bacteria you swallow with your food.

FIGURE 14.13

Peristalsis describes the moving wave of muscle contractions that moves food down the esophagus. It works a lot like the way you squeeze a LifeSavers® candy out of its wrapper.

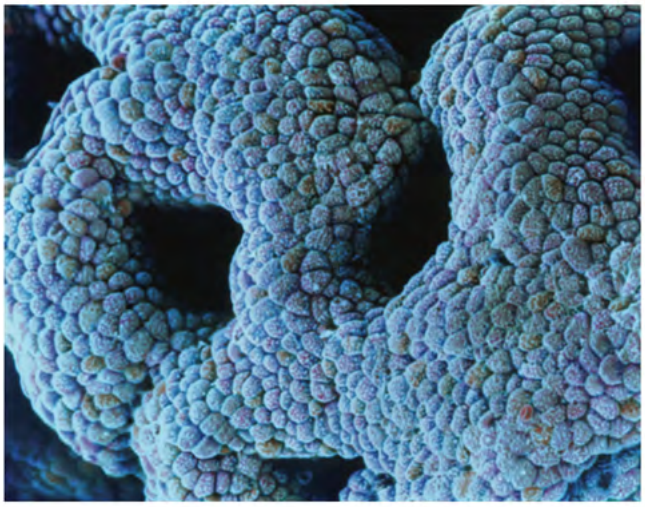


FIGURE 14.14

The stomach has numerous pits on its inner surface. These pits house the glands that release gastric juice.

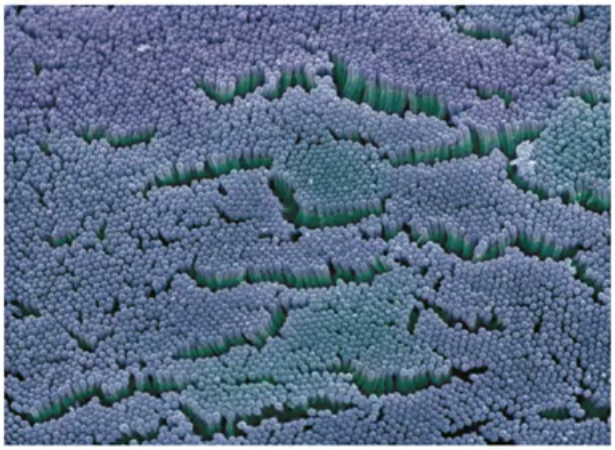
Gastric juice also contains a protective mucus that helps prevent the stomach from digesting its own tissues. Chyme leaves the stomach through a second sphincter and enters the small intestine. Usually, it takes the stomach about 4 hours to process a meal.

The **small intestine** is about 20 feet long. In the first foot of the small intestine, digestion continues with the breakdown of proteins, fats, carbohydrates, and nucleic acids. Some of the digestive enzymes at work in the small intestine are made by the small intestine itself. Others are made by the pancreas and sent to the small intestine. Pancreatic enzymes also play an important role in neutralizing food, which is highly acidic when it arrives from the stomach. The small intestine also receives bile, a substance that is made by the liver and stored in the gall bladder. Bile is an emulsifier—it breaks fats into tiny droplets that are more easily attacked by enzymes.

The rest of the small intestine is responsible for absorbing nutrients into the body. In order to do this job effectively, the small intestine has a huge surface area. The small intestine's inner surface is covered with fingerlike projections called *villi*. The villi are covered with even tinier projections called *microvilli* (Figure 14.15). Both the villi and microvilli increase the surface area of the small intestine. If your small intestine were flattened, it would fill the area of a tennis court! This impressive surface area enables your small intestine to absorb many digested nutrients at the same time. Most nutrients are absorbed into the body through facilitated diffusion or active transport. Certain bacteria living in your small intestine also play a role in helping you to absorb nutrients. Absorbed nutrients enter capillaries located inside each villus and then are carried to all your tissues by the circulatory system.

After the nutrients are absorbed, what is left of your food moves into the **large intestine**. In the large intestine, some more water and minerals are absorbed into the body. Huge numbers of bacteria live in the large intestine, where they feed on some of the undigested materials. Some of the bacteria make important vitamins, including vitamin K and some B vitamins. These bacteria are an important part of your microbiome, which includes all the bacteria that live in and on your body. In recent years, scientists have gradually realized how important a healthy microbiome is to human health. From the large intestine, feces are eliminated from the body through the anus. Feces are not exhausted food. Rather, feces are composed primarily of living and dead bacteria as well as indigestible materials such as plant cellulose.

(a)



(b)

FIGURE 14.15

(a) Villi are fingerlike projections that increase the surface area of the small intestine. (b) Each villus in the small intestine is covered with even tinier projections called microvilli.

READING CHECK

How does bile help you digest your food?

CHECK YOUR ANSWER

Bile breaks fats into tiny droplets. Fats, which are hydrophobic, normally stay clumped together. By separating fats into tiny droplets, bile increases the surface area of the fats. This allows digestive enzymes to reach the fat molecules and break them down more quickly.

You can read more about the digestive system at the following websites:

https://www.niddk.nih.gov/health-information/digestive-diseases/digestive-system-how-it-works

https://www.mayoclinic.org/digestive-system/sls-20076373

https://www.uchicagomedicine.org/forefront/gastrointestinal-articles/specific-bacteria-in-the-small-intestine-are-crucial-for-fat-absorption