

# The Digestive Process Begins

## Reading Preview

### Key Concepts

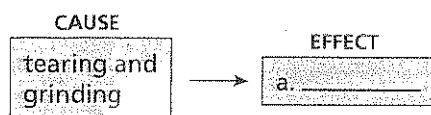
- What functions are carried out in the digestive system?
- What roles do the mouth, esophagus, and stomach have in digestion?

### Key Terms

- digestion • absorption
- saliva • enzyme • epiglottis
- esophagus • mucus
- peristalsis • stomach

## Target Reading Skill

**Relating Cause and Effect** As you read, identify what happens when food is digested mechanically in the mouth. Write the information in a graphic organizer like the one below.



Lab zone

## Discover Activity

### How Can You Speed Up Digestion?

1. Obtain two plastic jars with lids. Fill the jars with equal amounts of water at the same temperature.
2. Place a whole sugar cube into one jar. Place a crushed sugar cube into the other jar.
3. Fasten the lids on the jars. Holding one jar in each hand, shake the two jars gently and for equal amounts of time.
4. Place the jars on a flat surface. Observe whether the whole cube or the crushed cube dissolves faster.

### Think It Over

**Predicting** Use the results of this activity to predict which would take longer to digest: a large piece of food or one that has been cut up into many small pieces. Explain your answer.

In 1822, a man named Alexis St. Martin was wounded in the stomach. Dr. William Beaumont saved St. Martin's life. His wound, however, never healed completely. Beaumont realized that by looking through the opening in St. Martin's abdomen, he could observe what was happening inside the stomach. Beaumont observed that food changed chemically. He hypothesized that chemical reactions in the stomach broke down foods into smaller particles. Beaumont removed liquid from St. Martin's stomach and analyzed it. The stomach liquid contained an acid that played a role in the breakdown of foods into simpler substances.

## Functions of the Digestive System


Beaumont's observations helped scientists understand the role of the stomach in the digestive system. The digestive system has three main functions. First, it breaks down food into molecules the body can use. Then, the molecules are absorbed into the blood and carried throughout the body. Finally, wastes are eliminated from the body.

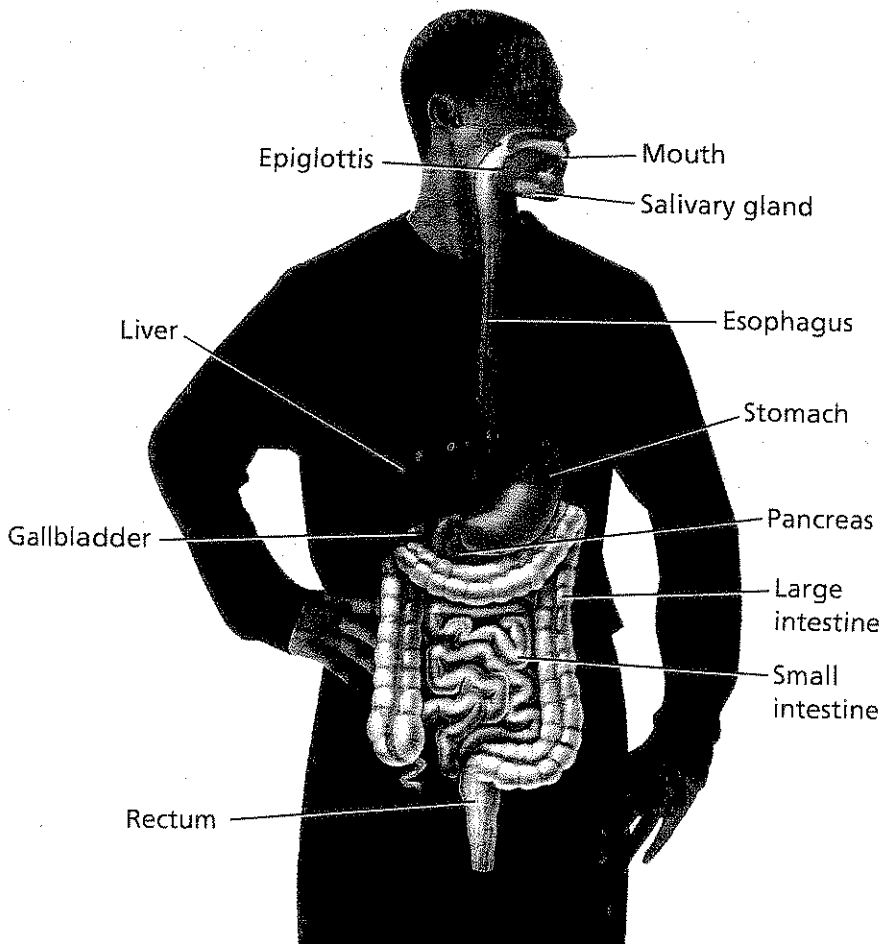
**Digestion** The process by which your body breaks down food into small nutrient molecules is called **digestion**. There are two kinds of digestion—mechanical and chemical. In mechanical digestion, foods are physically broken down into smaller pieces. Mechanical digestion occurs when you bite into a sandwich and chew it into small pieces.

In chemical digestion, chemicals produced by the body break foods into their smaller chemical building blocks. For example, the starch in bread is broken down into individual sugar molecules.

**Absorption** After your food is digested, the molecules are ready to be transported throughout your body. **Absorption** (ab SAWRP shun) is the process by which nutrient molecules pass through the wall of your digestive system into your blood. Materials that are not absorbed, such as fiber, are eliminated from the body as wastes.

Figure 14 shows the organs of the digestive system, which is about 9 meters long from beginning to end. As food moves through the digestive system, the processes of digestion, absorption, and elimination occur one after the other in an efficient, continuous process.

 **Reading Checkpoint** What is chemical digestion?



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**FIGURE 14**  
**The Digestive System**  
The work of the digestive system is to break down food into simpler substances that can be used by the body.  
**Interpreting Diagrams** Which organs does food pass through after leaving the mouth?

## The Mouth

Have you ever walked past a bakery or restaurant and noticed your mouth watering? Smelling or even just thinking about food when you're hungry is enough to start your mouth watering. This response isn't accidental. When your mouth waters, your body is responding to hunger and thoughts of food by preparing for the delicious meal it expects. **Both mechanical and chemical digestion begin in the mouth.** The fluid released when your mouth waters is called **saliva** (suh LY vuh). Saliva plays an important role in both kinds of digestion.

FIGURE 15

### Digestion in the Mouth

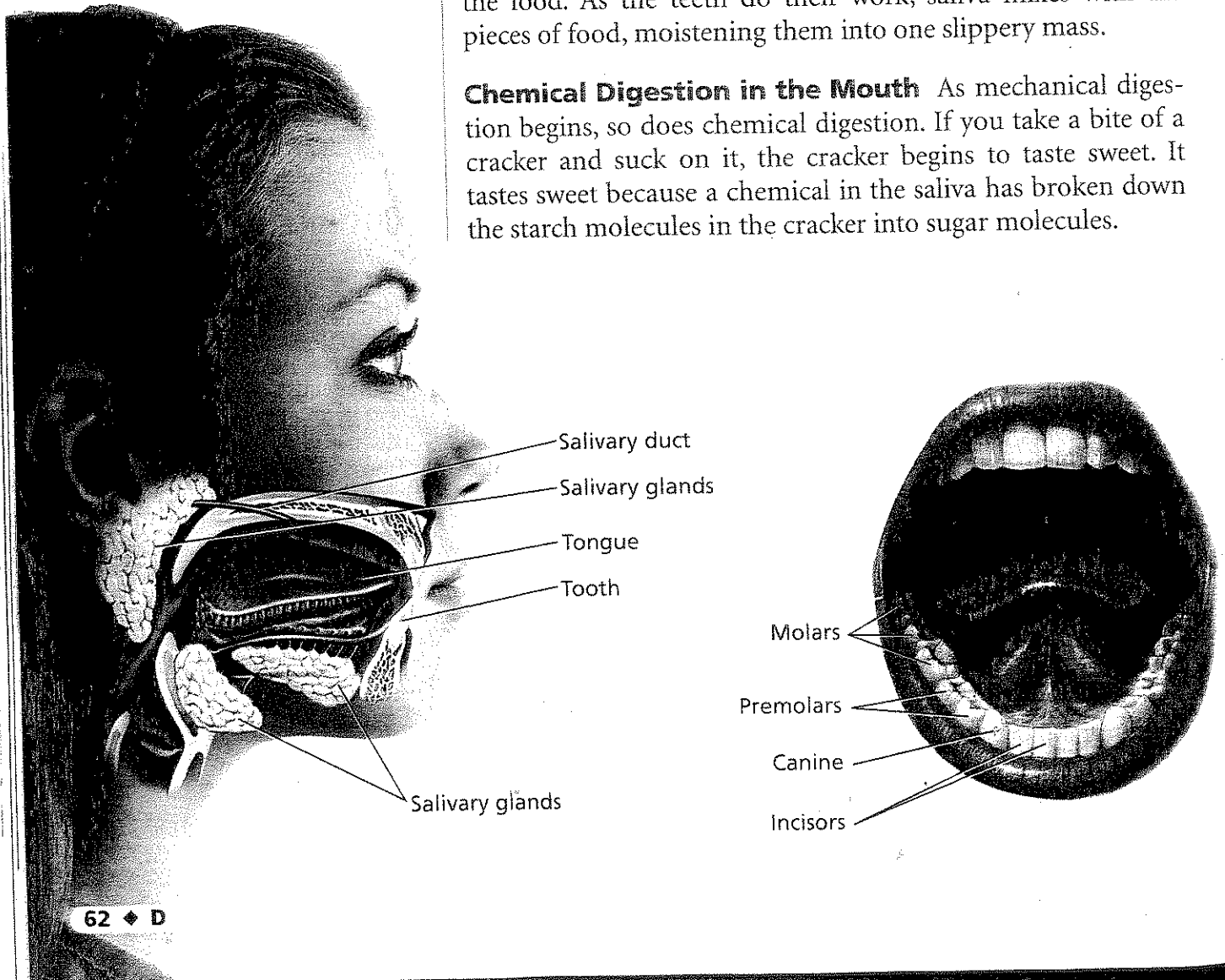
Mechanical digestion begins in the mouth, where the teeth cut and tear food into smaller pieces.

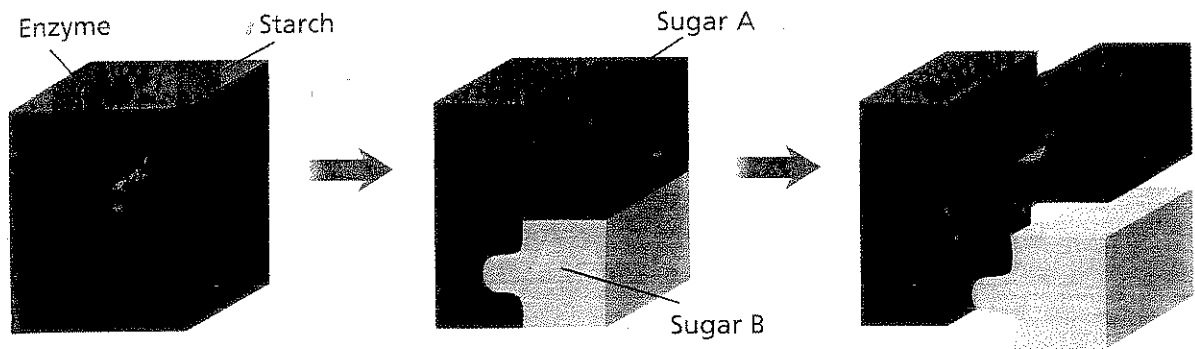
Salivary glands release enzymes that begin chemical digestion.

**Observing** Which teeth are best suited for biting into a juicy apple?

**Mechanical Digestion in the Mouth** The process of mechanical digestion begins as you take your first bite of food. Your teeth carry out the first stage of mechanical digestion. Your center teeth, or incisors (in SY zurz), cut the food into bite-sized pieces. On either side of the incisors there are sharp, pointy teeth called canines (KAY nynz). These teeth tear and slash the food in your mouth into smaller pieces. Behind the canines are the premolars and molars, which crush and grind the food. As the teeth do their work, saliva mixes with the pieces of food, moistening them into one slippery mass.

**Chemical Digestion in the Mouth** As mechanical digestion begins, so does chemical digestion. If you take a bite of a cracker and suck on it, the cracker begins to taste sweet. It tastes sweet because a chemical in the saliva has broken down the starch molecules in the cracker into sugar molecules.






**A** The shape of the enzyme fits the starch molecule.

**B** A chemical reaction occurs between the enzyme and starch molecule.

**C** The starch molecule has been broken down into sugar molecules.

The chemical in saliva that digests starch is an enzyme. **Enzymes** are proteins that speed up chemical reactions in the body. Your body produces many different enzymes. Each enzyme has a specific chemical shape. Its shape enables it to take part in only one kind of chemical reaction. An example of enzyme action is shown in Figure 16.

 **Reading Checkpoint** What are enzymes?

## The Esophagus

If you've ever choked on food, someone may have said that your food "went down the wrong way." That's because there are two openings at the back of your mouth. One opening leads to your windpipe, which carries air into your lungs. As you swallow, a flap of tissue called the **epiglottis** (ep uh GLAHT is) seals off your windpipe, preventing the food from entering. The food you swallow goes into the **esophagus** (ih SAHF uh gus), a muscular tube that connects the mouth to the stomach. The esophagus is lined with mucus. **Mucus** is a thick, slippery substance produced by the body. In the digestive system, mucus makes food easier to swallow and to be moved along.

Food remains in the esophagus for only about 10 seconds. **After food enters the esophagus, contractions of smooth muscles push the food toward the stomach.** These involuntary waves of muscle contraction are called **peristalsis** (pehr ih STAWL sis). Peristalsis also occurs in the stomach and farther down the digestive system. These muscular waves keep food moving in one direction.


 **Reading Checkpoint** How is food prevented from entering the windpipe?

FIGURE 16

### How Enzymes Work

The shape of the enzyme molecule is specific to the shape of the food molecule it breaks down. Here, an enzyme undergoes a chemical reaction with starch and breaks down the starch into sugars.

## Lab zone Try This Activity

### Modeling Peristalsis

1. Obtain a clear, flexible plastic straw.
2. Put on your goggles. Hold the straw vertically and insert a small bead into the top of the straw. The bead should fit snugly into the straw. **CAUTION:** Do not put the straw in your mouth. Do not blow into the straw.
3. Pinch the straw above the bead so that the bead begins to move down the length of the tubing.
4. Repeat Step 3 until the bead exits the straw.

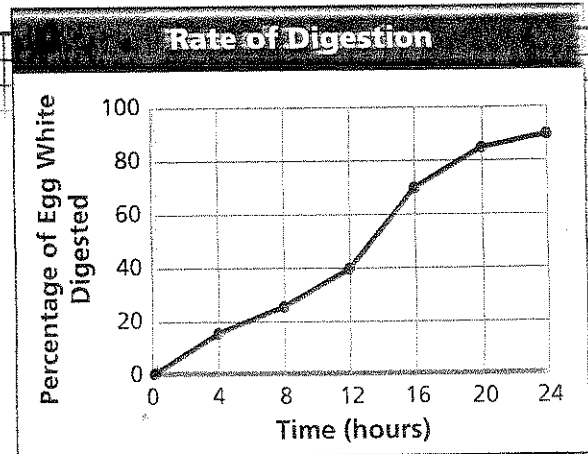
**Making Models** How does this action compare with peristalsis? What do the bead and the straw represent in this model?

## Math Analyzing Data

### Protein Digestion

A scientist performed an experiment to determine the amount of time needed to digest protein. He placed small pieces of hard-boiled egg white (a protein) in a test tube containing hydrochloric acid, water, and the enzyme pepsin. He measured the rate at which the egg white was digested over a 24-hour period. His data are recorded in the graph.

1. **Reading Graphs** What do the values on the *y*-axis represent?
2. **Calculating** After about how many hours would you estimate that half of the protein was digested?
3. **Interpreting Data** How much digestion occurred in 16 hours?
4. **Drawing Conclusions** During which 4-hour period did the most digestion take place?



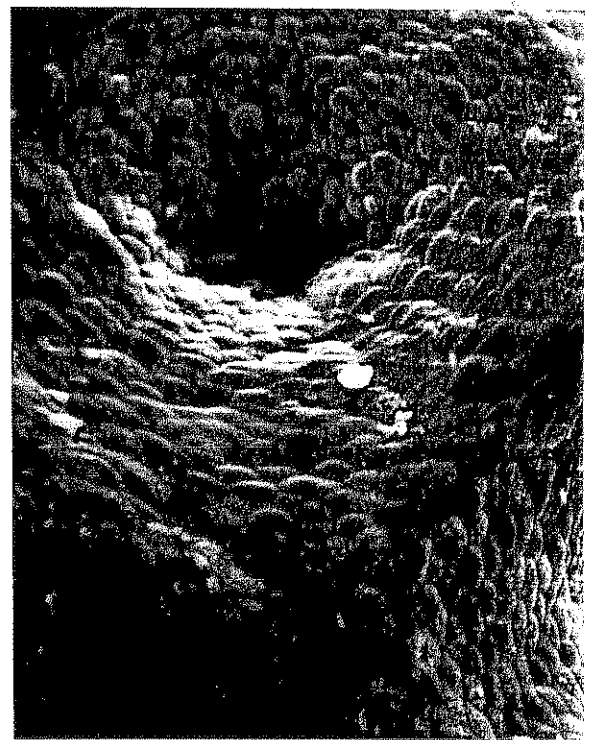
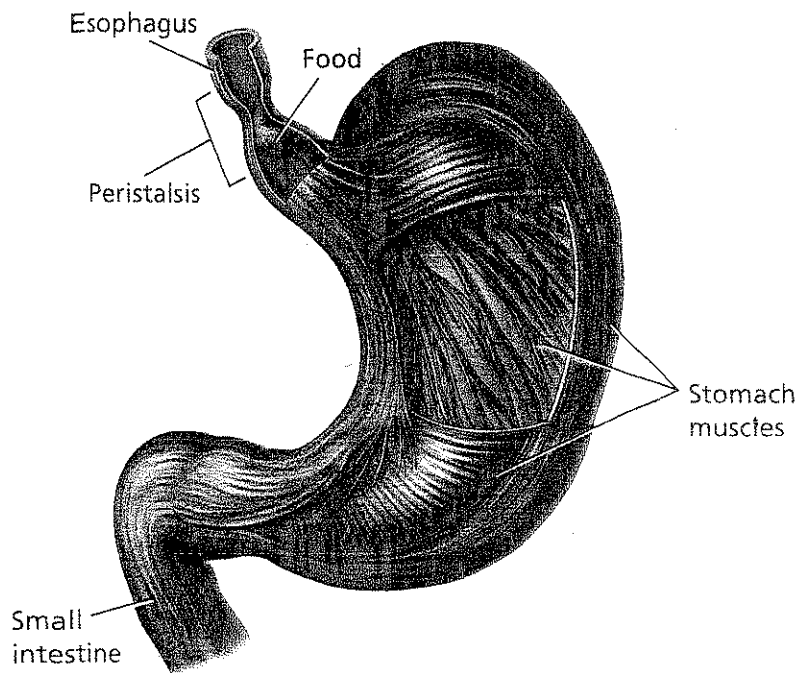
## The Stomach

When food leaves the esophagus, it enters the **stomach**, a J-shaped, muscular pouch located in the abdomen. As you eat, your stomach expands to hold all of the food that you swallow. **Most mechanical digestion and some chemical digestion occur in the stomach.**

**Mechanical Digestion in the Stomach** The process of mechanical digestion occurs as three strong layers of smooth muscle contract to produce a churning motion. This action mixes the food with fluids in somewhat the same way that clothes and soapy water are mixed in a washing machine.

**Chemical Digestion in the Stomach** Chemical digestion occurs as the churning food makes contact with digestive juice, a fluid produced by cells in the lining of the stomach. Digestive juice contains the enzyme pepsin. Pepsin chemically digests the proteins in your food, breaking them down into amino acids. Digestive juice also contains hydrochloric acid, a very strong acid. Without this strong acid, your stomach could not function properly. First, pepsin works best in an acid environment. Second, the acid kills many bacteria that you swallow with your food.

You may wonder why stomach acid doesn't burn a hole in your stomach. The reason is that digestive juice also contains mucus, which coats and protects the stomach lining. Also, the cells that line the stomach are quickly replaced as they are damaged or worn out.

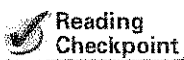


**FIGURE 17-**  
**The Stomach**

The stomach has three layers of muscle that help to break down foods mechanically. The small photo shows the lining of the stomach.

**Relating Cause and Effect** What protects the lining of the stomach from being damaged by digestive juices?

Food remains in the stomach until all of the solid material has been broken down into liquid form. A few hours after you finish eating, the stomach completes mechanical digestion of the food. By that time, most of the proteins have been chemically digested into shorter chains of amino acids. The food, now a thick liquid, is released into the next part of the digestive system. That is where final chemical digestion and absorption will take place.



**Reading Checkpoint**

What is pepsin?

## Section 3 Assessment

### Target Reading Skill

**Relating Cause and Effect** Refer to your graphic organizer about mechanical digestion to help you answer Question 1 below.

### Reviewing Key Concepts

1. a. **Listing** What are the functions of the digestive system?
- b. **Comparing and Contrasting** Distinguish between mechanical and chemical digestion.
- c. **Inferring** Why must mechanical digestion start before chemical digestion?
2. a. **Reviewing** What key chemicals do the mouth and stomach contain?
- b. **Describing** How do pepsin and hydrochloric acid work together to digest food in the stomach?

- c. **Developing Hypotheses** What could happen if your stomach didn't produce enough mucus?

**Lab zone**

### At-Home Activity

**First Aid for Choking** Explain to your family what happens when people choke on food. With your family, find out how to recognize when a person is choking and what to do to help the person. Learn about the Heimlich maneuver and how it is used to help someone who is choking.