The Digestive Process Begins

Objectives
After completing this lesson, students will be able to
15.2.1 Describe the functions carried out in the digestive system
15.2.2 Explain the roles of the mouth, esophagus, and stomach in digestion

Target Reading Skill
Using Prior Knowledge Explain that using prior knowledge helps students connect what they already know to what they are about to read.

Answer
Graphic organizers should have two columns: “What You Know” and “What You Learned.” Have students write what they know in the first column. Then as they read, they can add new facts to the second column.

All in One Teaching Resources, Unit 3
• Transparency LS150

Preteach
Build Background Knowledge
What Happens During Digestion
Ask students to describe what they think happens after they eat a food item. Give students an example, such as a baked potato, and have them discuss what they know about the processes that change it from a potato to nutrients and energy.

Reading Preview
Key Concepts
• What functions are carried out in the digestive system?
• What roles do the mouth, esophagus, and stomach play in digestion?

Key Terms
• digestion • absorption
• saliva • enzyme • epiglottis
• esophagus • mucus
• peristalsis • stomach

Target Reading Skill
Using Prior Knowledge Before you read, look at the section headings and visuals to see what this section is about. Then write what you know about the digestive system in a graphic organizer like the one below. As you read, continue to write in what you learn.

<table>
<thead>
<tr>
<th>What You Know</th>
<th>What You Learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Food is digested in the stomach.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
</tr>
</tbody>
</table>

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. The wound, however, left an opening in St. Martin’s stomach that 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 inside the stomach. 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. Figure 12 shows the organs of the digestive system, which is about 9 meters long from beginning to end.

Skills Focus
Predicting
Materials 2 plastic jars with lids, water, sugar cubes
Time 15 minutes
Tips Pair students; each student can shake one jar. The jars must receive equal shaking. Have students synchronize their shaking techniques and predict what will happen to the sugar in each jar.

Expected Outcome The crushed sugar cube will dissolve more quickly than the whole cube.

Think It Over A large piece of food would take longer to digest than one that has been cut up in many small pieces because the large piece has to be broken down first.
**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 and Elimination** 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.

**What is chemical digestion?**

**Digestion**

**Absorption and Elimination**

**Functions of the Digestive System**

**Teach Key Concepts**

**Types of Digestion**

**Focus** Review the difference between mechanical and chemical changes.

**Teach** Ask: **What happens to the pizza during chemical digestion?** (It is broken down into molecules that the body can use.) **What nutrients in the cheese and crust would be absorbed?** (Protein, fat, and calcium from cheese; carbohydrates and B vitamins from the crust)

**Apply** Refer students to Figure 12. Explain that both types of digestion can occur at the same time in the same organ. Have students trace the path of food through the digestive system. **learning modality: visual**

**Independent Practice**

**All in One Teaching Resources, Unit 3**

- Guided Reading and Study Worksheet: The Digestive Process Begins

**Differentiated Instruction**

**English Learners/Beginning Vocabulary: Prior Knowledge** Point to each part of the digestive system labeled in Figure 12. Pronounce the terms and have students repeat them. Then have students write the terms in English and in their native languages. **learning modality: visual**

**English Learners/Intermediate Vocabulary: Science Glossary** Conduct the same activity as described for Beginning students. As students read this section and the next one, have them write a sentence in their own words that describes the function of each of the terms. **learning modality: verbal**

**Monitor Progress**

**Writing** Have students explain what happens to food when it is digested.

**Answers**

Figure 12 The esophagus, stomach, small intestine, and large intestine

**Checkpoint**

The process in which chemicals produced by the body break foods into their smaller chemical building blocks
The Mouth

Teach Key Concepts

Digestion Begins

Focus Review chemical and mechanical digestion.

Teach Refer students to Figure 13. Ask them to discuss the function of each part of the mouth: Salivary glands (Produce saliva, which moistens food and contains an enzyme that breaks down starch); Salivary duct (Narrow tube that conveys saliva from the salivary gland to the mouth); Tongue (Helps mix food with saliva and assists in swallowing); Teeth (Cut, tear, and grind food).

Apply Ask: Why is it important to keep your teeth healthy? (Healthy teeth allow you to eat different foods to obtain the variety of nutrients you need.) learning modality: visual

Action of Enzymes

Materials meat tenderizer, milk, orange juice, 2 flasks or clear glasses, 2 stirrers

Time 10 minutes

Focus Show students the container of meat tenderizer. Ask: What is meat tenderizer used for? (It is sprinkled on meats before cooking to make them more tender.) Explain that meat tenderizer contains papain, an enzyme that breaks down protein.

Teach At the beginning of class, place 2 tablespoons of milk into one flask and the same amount of orange juice in another. Add 1 tablespoon of the meat tenderizer to each flask, and stir well with separate stirrers. Ask: What will happen to the milk and orange juice? (The papain will act on the milk solution but not the orange juice because milk contains protein, while orange juice does not.) Set aside the flasks until the end of class, then display both flasks. The milk solution will be thick; the orange juice will be unchanged.

Apply Ask: What can you say about the action of digestive enzymes based on this demonstration? (An enzyme acts on only one type of nutrient.) learning modality: visual

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 preparing for the delicious meal it expects. Both mechanical and chemical digestion begin in the mouth. The fluid released when your mouth waters is saliva (suh L Y vuh). Saliva plays an important role in both kinds of digestion.

Mechanical Digestion in the Mouth 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 nynnz). These teeth tear and slash the food into smaller pieces. Behind the canines are the premolars and molars, which crush and grind the food. As the teeth do their work, saliva moistens the pieces of food 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.

FIGURE 13

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?
How Enzymes Work
The shape of an enzyme molecule is specific to the shape of the food molecule it breaks down. Here, an enzyme breaks down a starch into sugars.

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 14.

The Esophagus
If you've ever choked on food, your food may have "gone 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 goes into the esophagus (ih SAHF uh gus), a muscular tube that connects the mouth to the stomach. The esophagus is lined with mucus, a thick, slippery substance produced by the body. Mucus makes food easier to swallow and move 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.

How is food prevented from entering the windpipe?

The Function of the Esophagus
Focus Ask students to swallow and try to breathe at the same time. They will note that for a very brief time, they are not able to breathe.

Teach Ask: Why weren't you able to breathe when you swallowed? (The epiglottis sealed off the windpipe.) Tell students that the large, hollow organs of the digestive system contain muscles that help their walls to move. Ask: How do the muscles of the esophagus help food to move through the digestive system? (Muscles in the esophagus push food toward the stomach.)

Apply Ask: How does peristalsis explain how astronauts are able to eat in space? (Gravity doesn't affect how food travels from the mouth to the stomach. The muscles in the esophagus contract and push the food down into the stomach.) learning modality: logical/mathematical

Lab Zone Try This Activity

Modeling Peristalsis
1. Obtain a clear, flexible plastic straw.
2. 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 or blow into the straw.
3. Pinch the straw above the bead so 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?

Expected Outcome The bead will move ahead of where the straw is being pinched. The pinching motion models the contractions of the muscles around the esophagus. The straw models the esophagus, and the bead represents food.

Skills Check
Have students compare and contrast mechanical and chemical digestion.

Answers Figure 13 Incisors

As you swallow, a flap of tissue called the epiglottis seals off the windpipe, preventing the food from entering.
**Math Skill** Making and interpreting Graphs

**Focus** Remind students that a line graph is often used to show changes over time.

**Teach** Ask: What is being represented by the graph? (The time it takes for egg white to be digested)

**Answers**
1. Percentage of egg white digested
2. About 14 hours
3. About 70%
4. From 12 to 16 hours

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**The Stomach**

**Teach Key Concepts**

**Function of the Stomach**

**Focus** Ask: What is one way your stomach lets you know it is empty? (Sample answers: You feel hunger pangs; your stomach “growls” or rumbles.) Explain that these sounds are caused by hunger contractions, or peristaltic contractions in the stomach when it has been empty for a long time. People sometimes experience a sensation of pain, called hunger pangs.

**Teach** Refer students to Figure 15. Ask: How do the muscles in the stomach help it to perform its function? (They contract to squeeze food and mix it with fluids.) What happens to food in the stomach? (Food enters the stomach from the esophagus, where it is mixed with fluids. The proteins are chemically digested. Then the food is released into the small intestine.)

**Apply** Have students use what they have learned in this section to summarize where mechanical and chemical digestion have taken place to this point. (Mouth: chemical and mechanical digestion; esophagus: none; stomach: chemical and mechanical digestion)

Ask: Where is mechanical digestion complete? (The stomach) Is chemical digestion complete here? (No; it is complete in the small intestine.) **learning modality:** visual

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**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. **Interpreting Data** 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?

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**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 short chains of 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.

Why doesn’t stomach acid burn a hole in your stomach? The reason is that cells in the stomach lining produce a thick coating of mucus, which protects the stomach lining. Also, the cells that line the stomach are quickly replaced as they are damaged or worn out.

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**Differentiated Instruction**

**Less Proficient Readers**

**Making a Table** Have students draw a table with three columns: **Organ**, **Type of Digestion**, and **What Happens**. As they read this section and the next, have them complete the table. Model the first row for them: Organ—Mouth; Type of Digestion—Chemical and Mechanical; What Happens—Teeth cut, tear and grind food; tongue mixes food and helps in swallowing; enzymes in saliva break down carbohydrates. **learning modality:** visual
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.

**Figure 15**

**The Stomach**
The stomach has three layers of muscle that help to break down foods mechanically. The inset photo shows a microscopic view of the stomach lining. The yellow dots are mucus.

**Relating Cause and Effect**

What role does mucus play inside the stomach?

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**Section 2 Assessment**

**Target Reading Skill** Using Prior Knowledge
Review your graphic organizer and revise it based on what you just learned in the section.

**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.** Predicting  What could happen if your stomach didn’t produce enough mucus? Explain.

**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.

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**Keep Students on Track**
Students will have completed three days of record keeping. Provide resources to help them create bar graphs to compare their food intake to the numbers of servings recommended in the Food Guide Pyramid. Ask them to analyze their graphs to identify changes they could make in their diets.

**At-Home Activity**

**First Aid for Choking**
Suggest that students and their parents consult first-aid manuals or a health-care professional to learn the symptoms of choking and how to use the Heimlich maneuver. Encourage them to learn how to distinguish between situations in which the person can breathe and situations in which the Heimlich maneuver is required.

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**Monitor Progress**

**Answers**

**Figure 15**

Mucus in digestive juices coats and protects the stomach lining.

**Pepsin** is an enzyme that is part of the digestive juice.

**Assess**

**Reviewing Key Concepts**
1. **a.** To break down food into molecules that can be used by the body, to absorb the food molecules into the blood, and to eliminate wastes from the body. **b.** In mechanical digestion, foods are physically broken down into smaller pieces. In chemical digestion, chemicals produced by the body break foods into their smaller chemical building blocks. **c.** Mechanical digestion helps prepare food for chemical digestion by making smaller pieces that enzymes can act upon.

2. **a.** Mouth: saliva, which contains an enzyme that breaks down starch; stomach: pepsin and hydrochloric acid. **b.** HCl provides an acid environment, in which pepsin works best. **c.** The stomach lining would become irritated and might develop sores from the acid produced by the stomach.

**Reteach**
Use the illustrations in this section to review the parts and functions of the digestive system.

**Performance Assessment**

**Skills Check**
Have students prepare flowcharts that show the process of digestion from the mouth through the stomach.
As the Stomach Churns

Prepare for Inquiry

Key Concept
In the stomach, proteins are digested by the chemicals in the digestive juices and by the mechanical processes as the stomach churns.

Skills Objectives
After this lab students will be able to
• interpret data and draw conclusions about the conditions needed for the digestion of proteins in the stomach
• control variables to test their predictions
• draw conclusions about the role of pepsin in protein digestion

Prep Time 40 minutes
Class Time 40 minutes

Advance Planning
Obtain blue litmus paper and a 0.2% solution of hydrochloric acid. Boil eggs and cut whites into 1-cm cubes. Prepare enough eggs for students to have 3 cubes per test tube.

Safety
Make sure all students, teachers, and visitors wear goggles and aprons throughout the lab. Hydrochloric acid can cause burns. Review the safety guidelines in Appendix A.

All in One Teaching Resources, Unit 3
• Lab Worksheet: As the Stomach Churns

Guide Inquiry

Invitation
Ask students to name some foods that contain protein. (Sample answers: meat, poultry, fish, dairy products, nuts, beans, and lentils) Ask: What role does protein play in nutrition? (It aids in tissue growth and repair.) Ask: Why is it important for the stomach to be acidic? (To create an environment in which pepsin can act)

Introducing the Procedure
Review the litmus test procedure. Discuss ways to prevent cross-contamination of the test tubes by using a clean stirrer for each litmus test and by using clean graduated cylinders when adding fluids to a new test tube.

Troubleshooting the Experiment
Students’ results may be unconvincing if the egg white cubes are too large or if the hydrochloric acid solution is too weak.

Data Table

<table>
<thead>
<tr>
<th>Test Tube</th>
<th>Egg White Appearance</th>
<th>Litmus Color</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day 1</td>
<td>Day 2</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Expected Outcome

- Students will not observe changes in egg white appearance in test tubes A, B, or C. After one day, the egg white in test tube D will begin to dissolve and then disappear.
- The solution of pepsin and hydrochloric acid will digest protein. Pepsin is effective only in an acid environment, such as the stomach.

Analyze and Conclude

1. **Interpreting Data** Which materials were the best at digesting the egg white? What observations enabled you to determine this?
2. **Inferring** Is the chemical digestion of protein in food a fast or a slow reaction? Explain.
3. **Controlling Variables** Why was it important that the cubes of egg white all be about the same size?
4. **Drawing Conclusions** What did this lab show about the ability of pepsin to digest protein?
5. **Communicating** Write a paragraph in which you describe the purpose of test tube A and test tube C as they relate to the steps you followed in the procedure.

Design an Experiment

Design a way to test whether protein digestion is affected by the size of the food pieces. Write down your hypothesis and the procedure you will follow. **Obtain your teacher’s permission before carrying out your investigation.**

Extend Inquiry

**Design an Experiment** Students’ experiments should involve placing large egg white pieces and small egg white pieces in a pepsin and hydrochloric acid solution to test their hypothesis. If students set up this experiment correctly, they should learn that small pieces of food are digested faster than large pieces.