This image shows parts of the digestive system. The small intestine is the structure that looks like a tangled-up rope. The small intestine can be up to 6 m long.

- Why do you think the small intestine is so long?
- What do you think the function of the small intestine is?
- How might the digestive system help your body maintain homeostasis?
What do you think?

Before you read, decide if you agree or disagree with each of these statements. As you read this chapter, see if you change your mind about any of the statements.

1. An activity such as sleeping does not require energy.
2. All fats in food should be avoided.
3. Digestion begins in the mouth.
4. Energy from food stays in the digestive system.
5. Several human body systems work together to eliminate wastes.
6. Blood contains waste products that must be removed from the body.
Lesson 1

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

• Why do you eat?
• Why does your body need each of the six groups of nutrients?
• Why is eating a balanced diet important?

Vocabulary

Calorie
protein
carbohydrate
fat
vitamin p. 525
mineral

Multilingual eGlossary

Science Video

Time for Lunch?

This photo shows fried moth larvae on a banana leaf. It might not look appetizing, but it contains nutrients your body needs for energy and growth. Nutrients are in many different foods, from a cheeseburger to a fried insect.
How do you decide what to eat or when to eat? Although you can survive for weeks without food, you might become hungry within hours of your last meal. Hunger is your body’s way of telling you that it needs food. Why does your body need food? Food provides your body with the energy and nutrients it needs to survive.

Energy

Every activity you do, such as riding a bike or even sleeping, requires energy. Your digestive system processes food and releases energy that is used for cellular processes and all activities that you do.

The amount of energy in food is measured in Calories. A Calorie (Cal) is the amount of energy it takes to raise the temperature of 1 kg of water by 1°C. How much energy do foods contain? Each food is different. One grape contains 2 Cal, but a slice of cheese pizza has 220 Cal. All foods give your body energy to use.

For more information, visit the McKnight & Cibils Science Skills site at [www.mcknightandcibils.com](http://www.mcknightandcibils.com).

Think About This

1. Why do you eat?
2. What do you think happens to your body when you eat an almond?
Groups of Nutrients

The six groups of nutrients are proteins, carbohydrates, fats, vitamins, minerals, and water. Each nutrient has a different function in the body. To be healthy, you need foods from each group every day.

Proteins

Most of the tissues in your body are made of proteins. A protein is a large molecule that is made of amino acids and contains carbon, hydrogen, oxygen, nitrogen, and sometimes sulfur. Proteins have many functions, such as relaying signals between cells, protecting against disease, providing support to cells, and speeding up chemical reactions. All of these functions are needed to maintain homeostasis, or the regulation of an organism’s internal condition regardless of changes in its environment.

Combinations of 20 different amino acids make up the proteins in your body. Your cells can make more than half of these amino acids. The remaining amino acids must come from the foods that you eat. Some foods that are good sources of protein are shown in Figure 1.

Carbohydrates

What do pasta, bread, and potatoes have in common? They are all foods that have high levels of carbohydrates (kar boh HI drayts). Carbohydrates are molecules made of carbon, hydrogen, and oxygen atoms and are usually the body’s major source of energy. They are commonly in one of three forms—starches, sugars, or fibers. All of them are made of sugar molecules that are linked together like a chain. It is best to eat foods that contain carbohydrates from whole grains because they are easier to digest. Also shown in Figure 1 are some foods that are high in carbohydrates.
Fats
You might think that fats in food are bad for you. But, you need a certain amount of fat in your diet and on your body to stay healthy. **Fats**, also called lipids, provide energy and help your body absorb vitamins. They are a major part of cell membranes. Body fat helps to insulate against cold temperatures. Most people get plenty of fat in their diet, so deficiencies in fats are rare. But too much fat in your diet can lead to health problems. Only about 25–35 percent of the Calories you consume should be fats.

Fats are often classified as either saturated or unsaturated. A diet high in saturated fats can increase levels of cholesterol, which can increase the risk of heart disease. Most of the fat in your diet should come from unsaturated fats, such as those shown in Figure 2.

Vitamins
Has anyone ever told you to eat certain foods because you need vitamins? **Vitamins** are nutrients that are needed in small amounts for growth, regulation of body functions, and prevention of some diseases. You can obtain most of the vitamins you need by eating a well-balanced diet. If you do not consume enough of one or more vitamins, then you might develop symptoms of vitamin deficiency. The symptoms depend on which vitamin you are lacking. Table 1 lists some vitamins people need in their diet.

**Reading Check** Why do you need vitamins in your diet?

Minerals
In addition to vitamins, you also need other nutrients called minerals. **Minerals** are inorganic nutrients—that do not contain carbon—that help the body regulate many chemical reactions. Similar to vitamins, if you do not consume enough of certain minerals, you might develop a mineral deficiency. Table 1 also lists some minerals that you need in your diet.

Table 1 Vitamins and Minerals

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Good Sources</th>
<th>Health Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin B₂ (riboflavin)</td>
<td>milk, meats, vegetables</td>
<td>helps release energy from nutrients</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>oranges, broccoli, tomatoes, cabbage</td>
<td>growth and repair of body tissues</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>carrots, milk, sweet potatoes, broccoli</td>
<td>enhances night vision, helps maintain skin and bones</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Good Sources</th>
<th>Health Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>milk, spinach, green beans</td>
<td>builds strong bones and teeth</td>
</tr>
<tr>
<td>Iron</td>
<td>meat, eggs, green beans</td>
<td>helps carry oxygen throughout the body</td>
</tr>
<tr>
<td>Zinc</td>
<td>meat, fish, wheat/grains</td>
<td>aids protein formation</td>
</tr>
</tbody>
</table>

Table 1 Vitamins and minerals are essential for maintaining a healthy body.

**Visual Check** What foods are good sources of vitamin A?
You might recall that your body is mostly water. You need water for chemical reactions to occur in your body. Your body takes in water when you eat or drink. However, you lose water when you sweat, urinate, and breathe. To stay healthy, it is important to replace the water that your body loses. If you exercise, live in a warm area, or become sick, your body loses more water. When lost water is not replaced, you might become dehydrated. Symptoms of dehydration include thirst, headache, weakness, dizziness, and little or no urination.

**Key Concept Check** Why does your body need nutrients?

**Healthful Eating**

Imagine walking through a grocery store. Each aisle in the store contains hundreds of different foods. With so many choices, it’s difficult to choose foods that are part of a healthful diet. Healthful eaters need to be smart shoppers. They make grocery lists beforehand and buy products that are high in nutrients. Nutritious foods come from the major food groups, which include grains, vegetables, fruits, oils, milk products, and meats and beans.

**MiniLab 25 minutes**

**What nutrients are in foods?**

Food provides your body with nutrients and Calories. Each nutrient is important and has its own function in the body.

1. Using the materials provided by your teacher, search for foods that contain a high amount of your assigned nutrient.
2. Find the number of items for your nutrient that your teacher has assigned.
3. Once you have found the appropriate number of items, form a group with other students who were assigned the same nutrient.
4. As a group, make a chart listing your food items. Show the amount of your assigned nutrient present in each item. Share your chart with the class.

**Analyze and Conclude**

1. **Classify** the foods studied by all groups according to their nutrient value. Which foods were high in proteins? Fats? Carbohydrates?
2. **Explain** the function each nutrient has in the body.
3. **Key Concept** Describe what might happen if your body did not get enough of a particular nutrient.
### Table 2  Daily Recommended Amounts of Each Food Group for 9–13-Year-Olds

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Daily Amount males, 9–13 years old</th>
<th>Daily Amount females, 9–13 years old</th>
<th>Examples of Foods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grains</td>
<td>6-ounce equivalents</td>
<td>5-ounce equivalents</td>
<td>whole-wheat flour, rye bread, brown rice</td>
</tr>
<tr>
<td>Vegetables</td>
<td>2 1/2 cups</td>
<td>2 cups</td>
<td>broccoli, spinach, carrots</td>
</tr>
<tr>
<td>Fruits</td>
<td>1 1/2 cups</td>
<td>1 1/2 cups</td>
<td>apples, strawberries, oranges</td>
</tr>
<tr>
<td>Fats</td>
<td>5 teaspoons or less</td>
<td>5 teaspoons or less</td>
<td>canola oil, olive oil, avocados</td>
</tr>
<tr>
<td>Milk</td>
<td>3 cups</td>
<td>3 cups</td>
<td>milk, cheese, yogurt</td>
</tr>
<tr>
<td>Meat and beans</td>
<td>5 ounces or less</td>
<td>5 ounces or less</td>
<td>fish, beans, lean beef, lean chicken</td>
</tr>
</tbody>
</table>

### A Balanced Diet

A healthful diet includes carbohydrates, proteins, fats, vitamins, minerals, and water. But how do you know how much of each food group you should eat? Table 2 lists the daily recommended amounts of each food group for 9–13-year-olds.

The nutrient-rich foods that you choose might be different from the nutrient-rich foods eaten by people in China, Kenya, or Mexico. People usually eat foods that are grown and produced regionally. Regardless of where you live, eating a balanced diet ensures that your body has the nutrients it needs to function.

**Key Concept Check**  Why is eating a balanced diet important?

### Food Labels

What foods would you buy to follow the recommended guidelines in Table 2? Most grocery stores sell many varieties of bread, milk, meat, and other types of food. How would you know what nutrients these foods contain? You can look at food labels, such as the one in Figure 3. Food labels help you determine the amount of protein, carbohydrates, fats, and other substances in food.
Lesson 1 Review

Use Vocabulary

1. Nutrients made of long chains of amino acids are __________.
2. The major source of energy in your diet comes from ________.
3. The amount of energy in food is measured in ________.

Understand Key Concepts

4. Explain why it is important to consume vitamins.
5. Which nutrient helps your body absorb vitamins?
   A. carbohydrate  C. mineral
   B. fat  D. protein
6. Give an example of when you might need to drink more water than usual.

Interpret Graphics

7. Calculate How many grams of carbohydrates are in three servings of this food?

8. Summarize Copy and fill in the graphic organizer below to identify the six groups of nutrients.

Critical Thinking

9. Plan a meal that contains a food from each of the six food groups.
10. Analyze One serving of a certain food contains 370 Cal, 170 Cal from fat, and 12 g of saturated fat (60% of the daily value). Is this food a good choice for a healthful lifestyle? Why or why not?
How do foods compare?

As you have learned, not all foods are alike. Knowing about different types of nutrients will help you make good food choices. Foods with a lot of fat often taste good but might not be healthful for you in large amounts. It is important to be able to identify foods with different fat contents in order to have a balanced diet. How do these different foods compare?

Learn It

Observations can be analyzed by noting the similarities and differences between two or more objects or events that you observe. You compare objects or events by seeing how they are similar. You contrast objects or events by looking for differences.

Try It

1. Read and complete a lab safety form.
2. Create a data table like the one below in your Science Journal.
3. Use a permanent marker and a plastic cup to draw seven circles on a large piece of a brown paper grocery bag.
4. Obtain one each of the seven food items your teacher has provided. Label each circle with the name of the food to be tested.
5. Place one piece of the labeled food in each circle.
6. Allow the foods to sit for 30 minutes.
7. Remove the foods and properly dispose of them. Record in the table whether the food left a greasy mark, a wet mark, or no mark. Also record the diameter of the mark.
8. Dispose of the used grocery bag as directed by your teacher.

Apply It

9. Compare and contrast the marks produced by the foods. Describe both their appearances and their sizes.
10. Infer Which items left a greasy mark on the paper bag? How are these foods alike?

Key Concept Why is it important to eat a variety of foods every day?
Lesson 2

The Digestive System

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

• What does the digestive system do?
• How do the parts of the digestive system work together?
• How does the digestive system interact with other systems?

Vocabulary

digestion
mechanical digestion
chemical digestion
enzyme
esophagus
peristalsis
chyme
villi

Under the Sea?

These colorful projections look like something you might see on the ocean floor, but they are found in your body. They line the walls of the small intestine, which is part of your digestive system. What do you think these projections do?
Suppose you ate a cheeseburger and a pear for lunch. What happens to the food after it is eaten?

As soon as the food enters your mouth, it begins its journey through your digestive system. No matter what you eat, your food goes through four steps—ingestion, digestion, absorption, and elimination. All four steps happen in the organs and tissues of the digestive system in the following order:

• Food is ingested. Ingestion is the act of eating, or putting food in your mouth.

• Food is digested. **Digestion** is the mechanical and chemical breakdown of food into small particles and molecules that your body can absorb and use.

• Nutrients and water in the food are absorbed, or taken in, by cells. Absorption occurs when the cells of the digestive system take in small molecules of digested food.

• Undigested food is eliminated. Elimination is the removal of undigested food and other wastes from your body.

**Key Concept Check** What does the digestive system do?

**Launch Lab**

**Which dissolves faster?**

Has anyone ever told you to take small bites and chew your food thoroughly? The size of chewed food particles can affect how quickly food is digested. Similarly, the size of a sugar particle can affect how fast it dissolves in water.

1. Read and complete a lab safety form.
2. Add the contents of one serving package of **granulated sugar** to a **500-mL beaker** containing 300 mL of **warm water**.
3. Gently stir the contents of the beaker with a **plastic spoon**. Have your partner use a **stopwatch** to time how long it takes the sugar to dissolve. Record the time in your Science Journal.
4. Add a **sugar cube** to another **500-mL beaker** containing 300 mL of warm water.
5. Repeat step 3.

**Think About This**

1. Which dissolved faster—the granulated sugar or the sugar cube?
2. Why do you think particle size affects the rate at which sugar dissolves?
3. **Key Concept** How might food particle size affect how quickly food is digested?

**Functions of the Digestive System**

Suppose you ate a cheeseburger and a pear for lunch. What happens to the food after it is eaten?

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• Undigested food is eliminated. Elimination is the removal of undigested food and other wastes from your body.

**Word Origin**

**digestion** from Latin *digestus*, means “to separate, divide”
Types of Digestion

Before your body can absorb nutrients from food, the food must be broken down into small molecules by digestion. There are two types of digestion—mechanical and chemical. In mechanical digestion, food is physically broken into smaller pieces. Mechanical digestion happens when you chew, mash, and grind food with your teeth and tongue. Smaller pieces of food are easier to swallow and have more surface area, which helps with chemical digestion. In chemical digestion, chemical reactions break down pieces of food into small molecules.

Enzymes

Chemical digestion cannot occur without substances called enzymes (EN zimez). Enzymes are proteins that help break down larger molecules into smaller molecules. Enzymes also speed up, or catalyze, the rate of chemical reactions. Without enzymes, some chemical reactions would be too slow or would not occur at all.

There are many kinds of enzymes. Each one is specialized to help break down a specific molecule at a specific location.

Reading Check  What are enzymes?

MiniLab 20 minutes

How can you model digestion?  You can use radishes to model the effect saliva has on food. Radishes and saliva contain the same enzyme.

1. Read and complete a lab safety form.
2. Place a small amount of cooked rice into two 100-mL beakers.
3. Add a small amount of grated radish to one beaker and stir well with a plastic spoon.
4. Let the rice sit for 5 minutes.
5. Use a dropper to add three drops of iodine tincture solution to the rice in each beaker. Record the color of the rice in your Science Journal.

Analyze and Conclude
1. Compare the colors of the rice in the two beakers after the iodine was added.
2. Infer Iodine reacts with starches. Starches are made up of sugar molecules. Infer what happened to the starches in the rice when an enzyme was added.
3. Key Concept Summarize the role enzymes play in digestion.
The Role of Enzymes in Digestion

Nutrients in food are made of different molecules, such as carbohydrates, proteins, and fats. Many of these molecules are too large for your body to use. But, because these molecules are made of long chains of smaller molecules joined together, they can be broken down into smaller pieces.

The digestive system produces enzymes that are specialized to help break down each type of food molecule. For example, the enzyme amylase helps break down carbohydrates. The enzymes pepsin and papain help break down proteins. Fats are broken down with the help of the enzyme lipase. Figure 4 illustrates how an enzyme helps break down food molecules into smaller pieces.

Notice in Figure 4 that the food molecule breaks apart, but the enzyme itself does not change. Therefore, the enzyme can immediately be used to break down another food molecule.

Reading Check What happens to an enzyme after it helps break down a food molecule?

Organs of the Digestive System

In order for your body to use the nutrients in the foods you eat, the nutrients must pass through your digestive system. Your digestive system has two parts: the digestive tract and the other organs that help the body break down and absorb food. These organs include the tongue, salivary glands, liver, gallbladder, and pancreas.

The digestive tract extends from the mouth to the anus. It has different organs connected by tubelike structures. Each of these organs is specialized for a certain function.

Recall the cheeseburger and pear mentioned at the beginning of this lesson. Where do you think digestion of this food begins?
Figure 5 The digestive system includes the organs of the digestive tract, as well as other organs such as the tongue, salivary glands, liver, gallbladder, and pancreas.

**Visual Check** Which organ connects the mouth to the stomach?

**The Mouth**

You can follow the path food takes through your digestive tract in Figure 5. Mechanical digestion of food, such as a pear or a cheeseburger, begins in your mouth. Your teeth and tongue mechanically digest food as you chew. But even before chewing begins, your mouth prepares for digestion.

Your salivary (SA luh ver ee) glands produce saliva (suh LI vuh) at the very thought of food. They produce more than 1 L of saliva every day. Saliva contains an enzyme that helps break down carbohydrates, such as those found in a hamburger bun. Saliva also contains substances that neutralize acidic foods. It also contains a slippery substance that makes food easier to swallow.

**The Esophagus**

After you swallow a bite of your food, it enters your esophagus (ih SAH fuh gus). The esophagus is a muscular tube that connects the mouth to the stomach. Food moves through the esophagus and the rest of the digestive tract by waves of muscle contractions, called peristalsis (per uh STAHL sus).

Peristalsis is similar to squeezing a tube of toothpaste. When you squeeze the bottom of the tube, toothpaste is forced toward the top of the tube. As muscles in the esophagus contract and relax, partially digested food is pushed down the esophagus and into the stomach.
The Stomach

Once your partially digested food leaves the esophagus, it enters the stomach. The stomach is a large, hollow organ. One function of the stomach is to temporarily store food. This allows you to go many hours between meals. The stomach is like a balloon that can stretch when filled. An adult stomach can hold about 2 L of food and liquids.

Reading Check Why is the stomach’s ability to store food beneficial?

Another function of the stomach is to aid in chemical digestion. As shown in Figure 6, the walls of the stomach are folded. These folds enable the stomach to expand and hold large amounts of food. In addition, the cells in these folds produce chemicals that help break down proteins. For example, the stomach contains an acidic fluid called gastric juice. Gastric juice makes the stomach acidic. Acid helps break down some of the structures that hold plant and animal cells together, like the cells in hamburger meat, lettuce, tomatoes, and pears. Gastric juice also contains pepsin, an enzyme that helps break down proteins in foods into amino acids. Food and gastric juices mix as muscles in the stomach contract through peristalsis. As food mixes with gastric juice in the stomach, it forms a thin, watery liquid called chyme (KIME).

Figure 6 The stomach temporarily stores food and aids in chemical digestion.

Visual Check Where does food go after it leaves the stomach?
Chemical digestion of your cheeseburger and pear begins in the mouth and stomach. But most chemical digestion occurs in the small intestine. The small intestine is a long tube connected to the stomach. It is where chemical digestion and nutrient absorption occur. The small intestine is named for its small diameter—about 2.5 cm. It is about 7 m long.

Chemical digestion of proteins, carbohydrates, nucleic acids, and fats takes place in the first part of the small intestine, called the duodenum (doo uh DEE num). The remainder of the small intestine absorbs nutrients from food. Notice in Figure 8 that, like the stomach, the wall of the intestine is folded. The folds of the small intestine are covered with fingerlike projections called villi (VIH li) (singular, villus). Notice also that each villus contains small blood vessels. Nutrients in the small intestine diffuse into the blood through these blood vessels. You might recall that diffusion is the movement of particles from an area of higher concentration to an area of lower concentration.

The pancreas and the liver, shown in Figure 7, produce substances that enter the small intestine and help with chemical digestion. The pancreas produces an enzyme called amylase that helps break down carbohydrates and a substance that neutralizes stomach acid. The liver produces a substance called bile. Bile makes it easier to digest fats. The gallbladder stores bile until it is needed in the small intestine.

**Key Concept Check** What organs work together to help with chemical digestion?
**Figure 8** The bacteria shown here live in the large intestine. Without them, your food would not be digested well.

**Visual Check** Cocci bacteria are spherical, bacilli bacteria are rod-shaped, and spirilla bacteria are spiral-shaped. Which type of bacteria is shown in the photo?

**The Large Intestine**

The parts of your cheeseburger and pear that are not absorbed in the small intestine move by peristalsis into the large intestine, also called the colon. The large intestine, shown in Figure 8, has a larger diameter (about 5 cm) than the small intestine. However, at about 1.5 m long, it is much shorter than the small intestine.

Most of the water in ingested foods and liquids is absorbed in the small intestine. As food travels through the large intestine, even more water is absorbed. Materials that pass through the large intestine are the waste products of digestion. The waste products become more solid as excess water is absorbed. Peristalsis continues to force the remaining semisolid waste material into the last section of the large intestine, called the rectum. Muscles in the rectum and anus control the release of this semisolid waste, called feces (FEE seez).

**Bacteria and Digestion**

You might think that all bacteria are harmful. However, some bacteria have an important role in the digestive system. Bacteria, such as the ones shown in Figure 8, digest food and produce important vitamins and amino acids. Bacteria in the intestines are essential for proper digestion.

**The Digestive System and Homeostasis**

Recall that nutrients from food are absorbed in the small intestine. The digestive system must be functioning properly for this absorption to occur. These nutrients are necessary for other body systems to maintain homeostasis. For example, the blood in the circulatory system absorbs the products of digestion. The blood carries the nutrients to all other body systems, providing them with materials that contain energy.

**Key Concept Check** What might happen to other body systems if the digestive system did not function properly?

---

**Math Skills**

**Use Percentages**

A percentage is a ratio that compares a number to 100. For example, the total length of the intestines is about 8.5 m. That value represents 100%. If the rectum is 0.12 m long, what percentage of the intestines is made up of the rectum?

The ratio is \( \frac{0.12 \text{ m}}{8.5 \text{ m}} \).

Find the equivalent decimal for the ratio.

\[
\frac{0.12 \text{ m}}{8.5 \text{ m}} = 0.014
\]

Multiply by 100.

\[
0.014 \times 100 = 1.4\%
\]

**Practice**

The total length of the intestines is about 8.5 m. If the small intestine is 7.0 m long, what percentage of the intestines is made up of the small intestine?

---

**Review**

- Math Practice
- Personal Tutor
Enzymes in the digestive system break down food so nutrients can be absorbed by your body.

Food moves through the digestive tract by waves of peristalsis.

The liver and the pancreas produce substances that help with chemical digestion.

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

**Use Vocabulary**

1. Define *enzyme* in your own words.
2. Distinguish between absorption and digestion.

**Understand Key Concepts**

3. Where is the first place digestion occurs?
   - A. mouth
   - B. stomach
   - C. large intestine
   - D. small intestine
4. Compare the functions of the stomach and the small intestine.
5. Give an example of how the digestive system affects other body systems.

**Interpret Graphics**

6. Explain how do structures like the one to the right affect digestion?

7. Organize Information Copy and fill in the graphic organizer below to show how food moves through the digestive tract.

8. Infer what would happen if food passed more quickly than normal through the digestive system.

**Critical Thinking**

9. If the total length of the intestines is 8.5 m and the large intestine is 1.5 m long, what percentage of the intestines is made up of the small intestine?
Are digestive bacteria related to obesity?

Bacteria percentages might affect your health.

The worldwide rate of obesity greatly concerns medical and health professionals. New research reveals a possible link between bacteria in the human digestive tract and the risk of being overweight.

Your digestive system is home to between 10 and 100 trillion bacteria. That’s ten times the number of cells in your body! Certain bacteria are necessary, however, for the digestion of food. Without “friendly” bacteria, you could eat all you wanted, but the food would pass through your intestines mostly undigested.

Recent studies suggest there might be a link between the bacteria in the human digestive tract and obesity. Some people have a type of bacteria that causes them to absorb more calories than normal from their food. They gain more weight than people with a different type of bacteria. In general, obese humans have a lower percentage of a group of bacteria called Bacteroidetes (BAK-tear-oid-dee-teez) and more of a group of bacteria called Firmicutes (fir-MIC-cu-teez). It is not clear whether Firmicutes bacteria make people obese, or whether obese people have more of this type of bacteria. But evidence supports the idea that changing the bacteria in someone’s intestines and stomach—by means of diet or medications—might be an important weapon in the fight against obesity.

Additional research is needed to understand any link between digestive bacteria and obesity. But it is an exciting possibility that managing the bacteria in the digestive tract could be a new way to improve human health.

RESEARCH Find out more about the role of bacteria in human health. Research how the bacteria in your digestive tract help to regulate your immune system.
Lesson 3

The Excretory System

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

• What does the excretory system do?
• How do the parts of the excretory system work together?
• How does the excretory system interact with other body systems?

Vocabulary

excretory system
kidney
nephron
urine
ureter
bladder
urethra

A Sweaty Job?

Did you know that these are the ridges on a fingertip? The circular openings along the ridges are sweat glands. The sweat from these glands can leave a mark, or fingerprint, on objects that you touch. Why does sweat, or any material, leave your body?
Launch Lab

**What happens when you breathe out?**

Look again at the photo of the fingertip on the previous page. The sweat glands in your skin are one way substances leave your body. Do substances also leave your body when you breathe out?

1. Read and complete a lab safety form.
2. Take a deep breath and hold it.
3. Breathe out through your mouth into a **plastic bag**. Leave a small opening to allow some of the air to leave the bag as you blow into it.
4. Remove the bag from around your mouth. Let the air escape from the bag, but do not push the sides of the bag together.
5. Using the same plastic bag, repeat steps 2–4 three more times.
6. Observe the contents of the bag. Record your observations in your Science Journal.

**Think About This**

1. Did the plastic bag look different after you breathed into it? Explain.
2. What do you think was in the plastic bag at the end of the activity?
3. **Key Concept** Based on your observations, do you think the respiratory system is part of the excretory system? Explain.

### Functions of the Excretory System

You have read about the nutrients in food that are necessary to maintain health. You have also read how the digestive system processes that food. However, your body doesn’t use all the food that you ingest. The unused food parts are waste products. What happens to the wastes? They are processed by the excretory system. The **excretory system** collects and eliminates wastes from the body and regulates the level of fluid in the body.

**Collection and Elimination**

Your home probably has several places where waste is collected. You might have a trash can in the kitchen and another one in the bathroom. The furnace has an air filter that removes and collects dust from the air. Similarly, your body also collects wastes. The digestive system collects waste products in the intestines. The circulatory system collects waste products in the blood.

When the trash cans in your home fill up, you must take the trash outside. The same is true of the waste in your body. If waste is not removed, or eliminated, from your body, it could become toxic and damage your organs. You’ll read about the different body systems that eliminate waste later in this lesson.

**Regulation of Liquids**

Another function of the excretory system is to regulate the level of fluids in the body. You might recall that water is an essential nutrient for your body. Some of the water in your body is lost when waste is eliminated. The excretory system controls how much water leaves the body through elimination. This ensures that neither too little nor too much water is lost.

**Key Concept Check** What does the excretory system do?
Types of Excretion

Your body excretes, or eliminates, different substances from different body systems. The excretory system is made of four body systems.

- The digestive system collects and removes undigested solids from the foods you eat.
- The urinary system processes, transports, collects, and removes liquid waste from the body.
- The respiratory system removes carbon dioxide and water vapor from the body.
- The integumentary system, which includes the skin, secretes excess salt and water through sweat glands.

Figure 9 illustrates the body systems that make up the excretory system and identifies the substances they excrete. You read previously about how the organs of the digestive system, the respiratory system, and the integumentary system eliminate waste products from the body. In this lesson, you will read about the organs of the urinary system and their roles in eliminating waste from the body.

Reading Check What body systems make up the excretory system?

Visual Check What substances are eliminated by the body systems shown below?

The Excretory System

- **Urinary system** Removes liquid wastes
- **Integumentary system** Removes excess salt and water
- **Digestive system** Removes undigested food
- **Respiratory system** Removes carbon dioxide and water
Organs of the Urinary System

The urinary system produces, stores, and removes liquid waste from the body and helps maintain homeostasis. The organs of the urinary system are shown in Figure 10. They include two kidneys, two ureters, the bladder, and the urethra. These organs work together to process, transport, collect, and excrete liquid waste.

Reading Check What is the function of the urinary system?

The Kidneys

The bean-shaped organ that filters, or removes, wastes from blood is the kidney. You have two kidneys, one on each side of your body. They are near the back wall of your abdomen, above your waist, and below your rib cage. Each kidney is about the size of your fist. Kidneys are dark red in color because of the large volume of blood that passes through them.

The kidneys have several functions. This lesson will focus on the role of the kidneys in the urinary system. However, the kidneys also produce hormones that stimulate the production of red blood cells. In addition, they control blood pressure and help control calcium levels in the body.

The kidneys contain blood vessels and nephrons (NEH frahnz). Nephrons are networks of capillaries and small tubes, or tubules, where filtration of blood occurs. Each kidney contains about one million nephrons.

Blood contains waste products, salts, and sometimes toxins from cells that need to be removed from the body. These products are filtered from the blood as it passes through the kidneys. When blood is filtered, a fluid called urine is produced. The kidneys filter the blood and produce urine in two stages. You will read about this two-stage filtration process on the next page.
First Filtration  Blood is constantly circulating and filtering through the kidneys. In one day, the kidneys filter about 180 L of blood plasma, or the liquid part of blood. That’s enough liquid to fill 90 2-L bottles. Your body contains about 3 L of blood plasma. This means your entire blood supply is filtered by your kidneys about 60 times each day. As shown in Figure 11, the first filtration occurs in clusters of capillaries in the nephrons. These clusters of capillaries filter water, sugar, salt, and wastes out of the blood.

Second Filtration  If all of the liquid from the first filtration were excreted, your body would quickly dehydration and important nutrients would be lost. To regain some of this water, the kidneys filter the liquid collected in the first filtration again. As shown in Figure 11, the second filtration occurs in small tubes in the nephrons. During the second filtration, up to 99 percent of the water and nutrients from the first filtration are separated out and reabsorbed into the blood. The remaining liquid and waste products form urine. On average, an adult excretes about 1.5 L of urine per day.
The Ureters, Bladder, and Urethra

Do you remember the trash can you read about earlier in this lesson? What would happen if you put garbage in the trash can but never emptied the trash can? The garbage would pile up. After a while, there would be too much garbage for the trash can to hold. To keep this from happening, you must empty the trash from the trash can. In a similar way, the urine produced by your body cannot stay in the kidney. **Urine leaves each kidney through a tube called the ureter** (YOO ruh tur). Refer back to **Figure 10** to see the locations of the ureter and other organs of the urinary system.

Both ureters drain into the bladder. The **bladder** is a muscular sac that holds urine until the urine is excreted. The bladder expands and contracts like a balloon when filled or emptied. An adult bladder can hold about 0.5 L of urine.

**Urine leaves the bladder through a tube called the urethra** (yoo REE thruh). The urethra contains circular muscles called sphincters (SFINGK turz) that control the release of urine.

**Key Concept Check** How do the ureters, bladder, and urethra work together to excrete urine?

---

**MiniLab 30 minutes**

**How can you model the function of a kidney?**

The kidneys filter substances from blood plasma. How can you use everyday materials to model the function of the kidneys?

1. Read and complete a lab safety form.
2. Label three plastic cups 1, 2, and 3.
3. Mix a small amount of fine gravel and sand with water in cup 1.
4. Place a small piece of wire screen in a funnel, and place the funnel in cup 2.
5. Carefully pour the sand-water-gravel mixture into the funnel. Let it drain. Record your observations in your Science Journal.
6. Remove the screen. Replace it with a piece of filter paper. Place the funnel in cup 3.
7. Carefully pour the contents of cup 2 into the funnel. Let it drain. Record your observations.

**Analyze and Conclude**

1. Describe what happened during each filtration.
2. **Key Concept** Summarize how your filtration systems model the function of the kidneys.

---

**Word Origin**

**ureter**

from Greek *ourethra*, means “passage for urine”
Urinary Disorders

A urinary disorder is an illness that affects one or more organs of the urinary system. Some urinary disorders are described in Table 3. Several of these disorders are relatively common. Urinary tract infections, for example, are a leading cause of doctor visits, second only to respiratory infections.

<table>
<thead>
<tr>
<th>Urinary Disorder</th>
<th>Description</th>
<th>Possible Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kidney disease</td>
<td>The nephrons are damaged and the ability of the kidneys to filter blood is reduced. However, a person can have the beginning stages of kidney disease and experience no symptoms.</td>
<td>diabetes, high blood pressure, poisons, trauma</td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>Infections usually occur in the bladder or urethra, but infections can also occur in the kidney and ureters. Symptoms can include burning during urination, small and frequent urination, and blood in urine.</td>
<td>bacteria in the urinary system</td>
</tr>
<tr>
<td>Kidney stones</td>
<td>Kidney stones are solid substances that form in the kidney. The most common type is made of calcium. Stones that pass through the urinary system can be very painful.</td>
<td>calcium buildup in the kidney</td>
</tr>
<tr>
<td>Bladder control problems</td>
<td>The bladder releases urine involuntarily. Occurs in women more often than men.</td>
<td>urinary tract infections, muscle weakness, prostate enlargement</td>
</tr>
</tbody>
</table>

**Table 3 Urinary Disorders**

**Academic Vocabulary**

*area* (noun) a part of something that has a particular function

**The Excretory System and Homeostasis**

You have already read about some of the ways the excretory system helps to maintain homeostasis. For example, the excretory system filters wastes from the blood. The blood is part of the circulatory system. If wastes were allowed to build up in the circulatory system, they would become toxic.

Another example of maintaining homeostasis is the removal of wastes from the digestive system. Similar to the circulatory system, wastes would damage your body if they were not removed from the digestive system by the excretory system.

The excretory system also interacts with the nervous system. The hypothalamus is an area of the brain that helps to maintain homeostasis. One function of the hypothalamus is to control the secretion of some hormones. One such hormone causes the tubules in the kidney to absorb more water from the blood. This helps the body to regulate fluid levels. Water is retained in the blood instead of being excreted in the urine.

**Key Concept Check** How does the excretory system interact with the nervous system?
Lesson 3 Review

**Use Vocabulary**

1. Define the word *nephron* in your own words.
2. Distinguish between ureter and urethra.
3. Use the term *bladder* in a sentence.

**Understand Key Concepts**

4. The kidneys filter wastes from the
   A. blood.  
   B. intestine.  
   C. lungs.  
   D. skin.
5. Construct a diagram of the urinary system showing the production and flow of urine.
6. Distinguish between the excretory functions of the respiratory system and the integumentary system.

**Interpret Graphics**

7. Identify the function of the highlighted portion of the diagram to the right.

**Organize Information**

Copy and fill in the table below with details about each organ of the urinary system.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Structure and Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Critical Thinking**

9. Hypothesize What might happen if urine did not go through a second filtration?
10. Evaluate the role of the hypothalamus in maintaining the level of fluid in the body.

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.
Recall fromLesson 2 that all food goes through four steps: ingestion, digestion, absorption, and elimination. These steps happen in the digestive system. Your task is to model the four steps with the materials provided by your teacher. Before you create your model, think about all the digestive processes and plan each step. Will you model mechanical or chemical digestion or both?

**Question**
How does food change during the process of digestion? What are the steps in digestion?

**Procedure**
1. Read and complete a lab safety form.
2. In your Science Journal, make a chart like the one shown here that includes the parts of the digestive system. Record the functions of each part.
3. Using the materials provided by your teacher, design a model to show the steps in digestion. Begin with chewing and end with excretion.
4. Your teacher must approve your design before you test your model.
5. Pass food through your model.
6. Compare the food at the beginning and the end of digestion.
7. Dispose of the materials as directed by your teacher.
Copy and complete the chart at right. Then, compare your model to the four steps as outlined in the text. Does your model include everything? Is there another way to model some of the steps?

Make modifications to your model. Record your revisions in your Science Journal.

Analyze and Conclude

Analyze Is there a structure or function in digestion that was not included in your model? Did you model mechanical or chemical digestion or both?

Contrast How did the food change in your model? How does food change in the digestive process?

The Big Idea How does the digestive system maintain homeostasis in a healthy body?

Communicate Your Results

Share your results with the class. Discuss your chart with those of other groups. Demonstrate to the class how you modeled the digestive system.

Lab Tips

☐ This lab might be messy, so work on several layers of newspaper.
☐ Be careful not to cut large holes in bags or cups; small holes work better.
☐ Never eat anything during a lab exercise.

Remember to use scientific methods.

Make Observations

Ask a Question

Form a Hypothesis

Test your Hypothesis

Analyze and Conclude

Communicate Results

How might your model change if you were modeling a disease of the digestive system, such as an inability to produce saliva?
# Chapter 14 Study Guide

## The Big Idea
The digestive and excretory systems move materials through the body and remove waste. The digestive system also absorbs nutrients.

## Key Concepts Summary

### Lesson 1: Nutrition
- People eat food to obtain the energy their bodies need to function. The amount of energy in food is measured in **Calories**.
- The types and amounts of nutrients a person needs depend on age, gender, and activity level.
- The six groups of nutrients are **proteins**, **carbohydrates**, **fats**, **vitamins**, **minerals**, and **water**.
- A balanced diet provides nutrients and energy for a healthful lifestyle.

### Lesson 2: The Digestive System
- The function of the digestive system is to break down food and absorb nutrients for the body.
- Organs of the digestive system include the mouth, **esophagus**, stomach, small intestine, and large intestine.
- The digestive system interacts with other body systems to maintain the body’s internal balance.

### Lesson 3: The Excretory System
- The function of the **excretory system** is to collect and eliminate wastes from the body and regulate the level of fluids in the body.
- The excretory system is made up of the digestive system, respiratory system, urinary system, and the integumentary system.
- The excretory system works with other body systems, including the nervous system, to maintain homeostasis.

## Vocabulary

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Study Guide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Concepts Summary</td>
<td>Vocabulary</td>
</tr>
<tr>
<td><strong>Lesson 1: Nutrition</strong></td>
<td>Calorie, protein, carbohydrate, fat, vitamin, mineral</td>
</tr>
<tr>
<td><strong>Lesson 2: The Digestive System</strong></td>
<td>digestion, mechanical digestion, chemical digestion, enzyme, esophagus, peristalsis, chyme, villi</td>
</tr>
<tr>
<td><strong>Lesson 3: The Excretory System</strong></td>
<td>excretory system, kidney, nephron, urine, ureter, bladder, urethra</td>
</tr>
</tbody>
</table>
Use Vocabulary

1. About 25–35 percent of your total daily ________ should be from fats.

2. One type of nutrient, ________, is made of long chains of sugars.

3. Food moves down the esophagus by ________.

4. The breakdown of food into small particles and molecules is called ________.

5. A tube that connects a kidney to the bladder is called a(n) ________.

6. Urine is stored in the ________.

Link Vocabulary and Key Concepts

Copy this concept map, and then use vocabulary terms from the previous page to complete the concept map.

- Food
  - provides the body with nutrients, including fats, minerals, water, and ________
  - moves through the body using the digestive system and is broken down by mechanical digestion
  - then is absorbed in the small intestine by ________
  - wastes are produced and leave the body using the ________
    - Liquid waste travels through the urinary system and is filtered by ________ in the kidneys, and then stored in the ________ until it leaves the body as urine.
Understand Key Concepts

1 What are proteins made of?
   A. amino acids
   B. minerals
   C. sugars
   D. vitamins

2 Which would be considered a grain?
   A. black beans
   B. brown rice
   C. canola oil
   D. lean chicken

3 What is the main source of energy for your body?
   A. carbohydrates
   B. minerals
   C. proteins
   D. water

4 Look at the diagram below. Where does most absorption of nutrients occur?
   A. A
   B. B
   C. C
   D. D

5 What is the correct order for how food is processed in the digestive system?
   A. absorption, digestion, ingestion, elimination
   B. elimination, ingestion, absorption, digestion
   C. ingestion, absorption, digestion, elimination
   D. ingestion, digestion, absorption, elimination

6 What organ is shown below?
   A. bladder
   B. hypothalamus
   C. kidney
   D. ureter

7 What organ produces a substance that neutralizes acid from the stomach?
   A. esophagus
   B. gallbladder
   C. liver
   D. pancreas

8 What fluid produced in the mouth contains digestive enzymes?
   A. bile
   B. blood
   C. chyme
   D. saliva

9 Carbon dioxide is eliminated by which body system?
   A. digestive system
   B. integumentary system
   C. respiratory system
   D. urinary system

10 What is produced by the urinary system?
    A. blood
    B. feces
    C. perspiration
    D. urine

11 The bladder is most similar to which object?
    A. a balloon
    B. a tube
    C. a folded paper
    D. a rigid container
Chapter Review

Critical Thinking

12 Distinguish between minerals and vitamins.

13 Hypothesize why a child might have different nutritional needs than an adult over the age of 60.

14 Select Study the nutrient information below. Select the snack that would be a better choice as part of a healthful lifestyle. Explain your choice.

<table>
<thead>
<tr>
<th>Nutrient Information</th>
<th>Tortilla Chips</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fried</td>
</tr>
<tr>
<td>Calories</td>
<td>150</td>
</tr>
<tr>
<td>Calories from fat</td>
<td>60</td>
</tr>
<tr>
<td>Total fat (g)</td>
<td>7</td>
</tr>
<tr>
<td>Saturated fat (g)</td>
<td>1</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>135</td>
</tr>
<tr>
<td>Total carbohydrate (g)</td>
<td>22</td>
</tr>
<tr>
<td>Sugars</td>
<td>3</td>
</tr>
<tr>
<td>Protein</td>
<td>3</td>
</tr>
</tbody>
</table>

15 Differentiate Suppose your teacher showed you a diagram of a small intestine and a diagram of a large intestine. How might you distinguish between them?

16 Hypothesize How might digestion be affected if a person swallowed his or her food without first chewing it?

17 Critique the following statement: “Bacteria are harmful and should not be in the digestive system.”

18 Compare the excretions of the urinary system and the digestive system.

Writing in Science

19 Create a commercial to encourage people to eat a healthful amount from each food group. Include a setting and dialogue for your commercial.

20 Give examples of how the digestive system and excretory system help to maintain homeostasis.

21 What is the function of the small intestine?

Math Skills

Use Percentages

Use the table below to answer questions 22–24.

<table>
<thead>
<tr>
<th>Location of food</th>
<th>Time in location (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach</td>
<td>4</td>
</tr>
<tr>
<td>Small intestine</td>
<td>6</td>
</tr>
<tr>
<td>Large intestine</td>
<td>24</td>
</tr>
</tbody>
</table>

22 What percentage of the total digestive time does food spend in the stomach?

23 What percentage of the total digestive time does food spend in the large intestine?

24 What percentage of the total digestive time does food spend in the stomach and the small intestine combined?
Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

**Multiple Choice**

1. Which process depends on enzymes?
   A. chemical digestion  
   B. elimination  
   C. mechanical digestion  
   D. respiration  

   *Use the diagram below to answer question 2.*

2. Where does the first filtration process occur in the nephron shown above?
   A. A  
   B. B  
   C. C  
   D. D

3. Which factor does NOT influence how much energy a person needs?
   A. age  
   B. gender  
   C. height  
   D. weight

4. In which part of the system pictured above does chemical digestion begin?
   A. 1  
   B. 2  
   C. 3  
   D. 4

5. In the diagram above, from which organ are nutrients absorbed into the bloodstream?
   A. 2  
   B. 3  
   C. 4  
   D. 5

6. What is a main function of the excretory system?
   A. fight diseases  
   B. move limbs  
   C. pump blood  
   D. remove wastes
7. Which part of the brain works with the urinary system to help maintain homeostasis?
A. cerebellum  
B. cerebrum  
C. hypothalamus  
D. medulla  

Use the diagram below to answer question 8.

8. In the diagram above, where is urine produced?
A. 1  
B. 2  
C. 3  
D. 4  

9. Which system works with the digestive system to carry nutrients to the cells of the body?
A. circulatory  
B. excretory  
C. lymphatic  
D. respiratory  

**Constructed Response**

Use the table below to answer questions 10 and 11.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Example of Food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td></td>
</tr>
<tr>
<td>Fats</td>
<td></td>
</tr>
<tr>
<td>Minerals</td>
<td></td>
</tr>
<tr>
<td>Proteins</td>
<td></td>
</tr>
<tr>
<td>Vitamins</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
</tr>
</tbody>
</table>

10. In the table above, the six main groups of nutrients are provided. What is an example of a food that contains each nutrient? What is the function of each nutrient in the body?

11. Explain how the nutrients in the table above are related to eating a balanced diet.

Use the table below to answer question 12.

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingestion</td>
<td></td>
</tr>
<tr>
<td>Digestion</td>
<td></td>
</tr>
<tr>
<td>Absorption</td>
<td></td>
</tr>
<tr>
<td>Elimination</td>
<td></td>
</tr>
</tbody>
</table>

12. When a person eats food, the food undergoes four processes in the digestive system. Briefly describe each process provided in the table above.