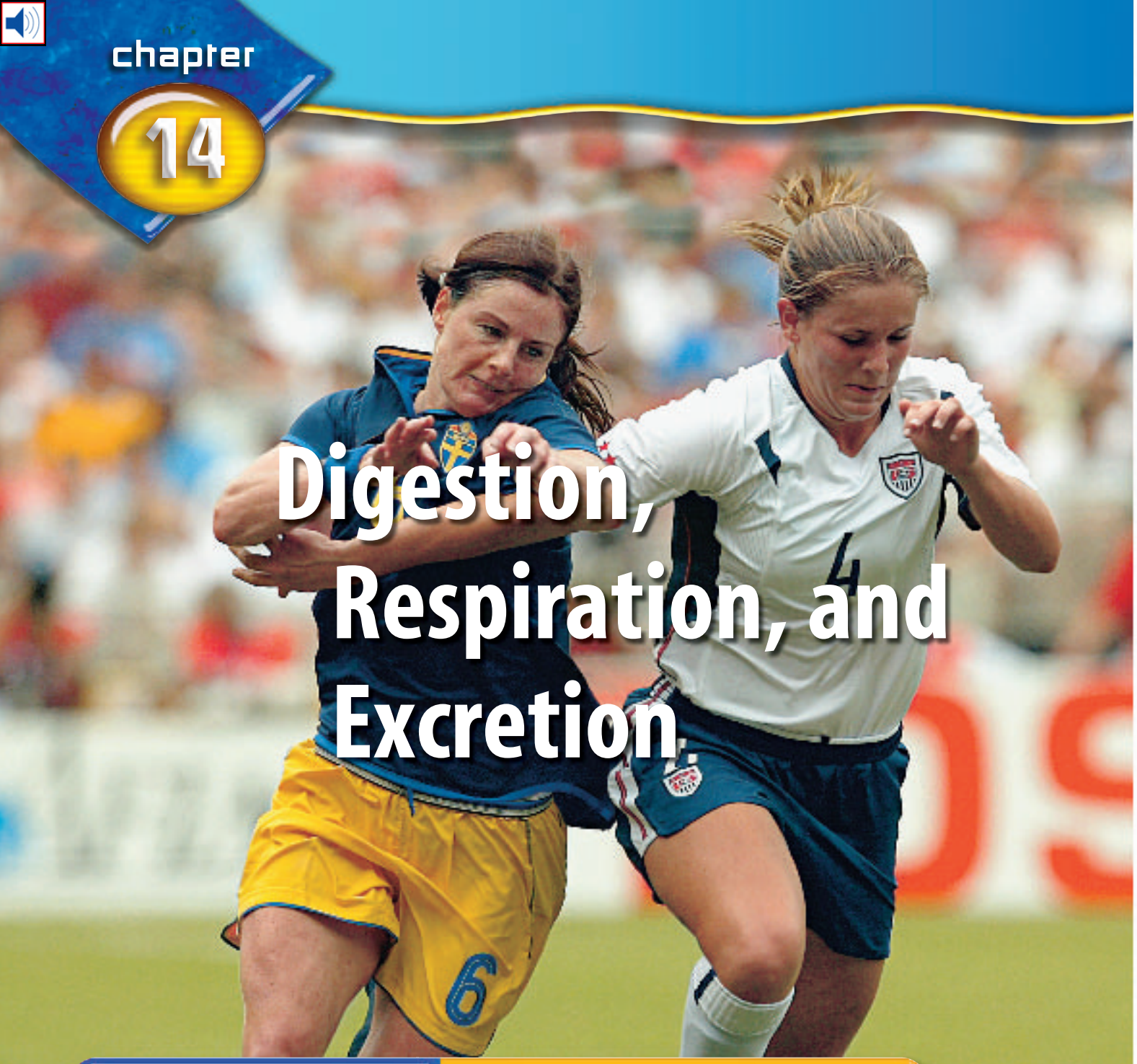
chapter 14

Digestion, Respiration, and Excretion



chapter preview

sections

Playing soccer is hard work.

If you're like most people, when you play an active game like soccer you probably breathe hard and perspire. You need a constant supply of oxygen and energy to keep your body cells functioning. Your body is adapted to meet that need.

Science Journal Write a paragraph describing what you do to help your body recover after an active game.

Chris Trotman/NewSport/Corbis

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Start-Up Activities

Launch LAB

Breathing Rate

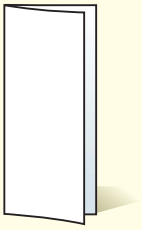
Your body can store food and water, but it cannot store much oxygen. Breathing brings oxygen into your body. In the following lab, find out about one factor that can change your breathing rate.

1. Put your hand on the side of your rib cage. Using a watch or clock with a second hand, count the number of breaths you take for 15 s. Multiply this number by four to calculate your normal breathing rate for one minute.
2. Repeat step 1 two more times, then calculate your average breathing rate.
3. Do a physical activity described by your teacher for one minute and repeat step 1 to determine your breathing rate now.
4. Time how long it takes for your breathing rate to return to normal.
5. **Think Critically** In your Science Journal, write a paragraph explaining how breathing rate appears to be related to physical activity.

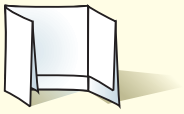
FOLDABLES™ Study Organizer

Respiration Make the following Foldable to help identify what you already know, what you want to know, and what you learn about respiration.

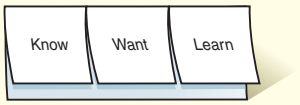
STEP 1 **Fold** a vertical sheet of paper from side to side. Make the front edge about 1.25 cm shorter than the back edge.



STEP 2 **Turn** lengthwise and **fold** into thirds.



STEP 3 **Unfold and cut** only the top layer along both folds to make three tabs. **Label** each tab.



Identify Questions Before you read the chapter, write *I breathe* under the left tab, and write *Why do I breathe?* under the center tab. As you read the chapter, write the answer you learn under the right tab.

ScienceOnline

Preview this chapter's content and activities at green.msscience.com

Chris Trotman/NewSport/Corbis

section 1

The Digestive System

as you read

What You'll Learn

- **Distinguish** the differences between mechanical digestion and chemical digestion.
- **Identify** the organs of the digestive system and what takes place in each.
- **Explain** how homeostasis is maintained in digestion.

Why It's Important

The processes of the digestive system make the food you eat available to your cells.

Review Vocabulary

bacteria: one-celled organisms without membrane-bound organelles

New Vocabulary

- nutrient
- enzyme
- peristalsis
- chyme
- villi

Functions of the Digestive System

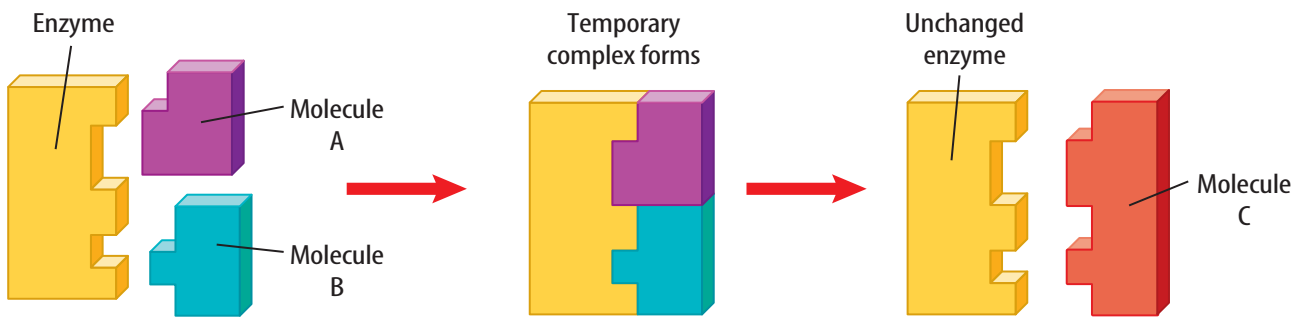
Food is processed in your body in four stages—ingestion, digestion, absorption, and elimination. Whether it is a piece of fruit or an entire meal, all the food you eat is treated to the same processes in your body. As soon as food enters your mouth, or is ingested, digestion begins. Digestion breaks down food so that nutrients (NEW tree unts) can be absorbed and moved into the blood. **Nutrients** are substances in food that provide energy and materials for cell development, growth, and repair. From the blood, these nutrients are transported across the cell membrane to be used by the cell. Unused substances pass out of your body as wastes.

Digestion is mechanical and chemical. Mechanical digestion takes place when food is chewed, mixed, and churned. Chemical digestion occurs when chemical reactions break down food.

Enzymes

Chemical digestion is possible only because of enzymes (EN zimez). An **enzyme** is a type of protein that speeds up the rate of a chemical reaction in your body. One way enzymes speed up reactions is by reducing the amount of energy necessary for a chemical reaction to begin. If enzymes weren't there to help, the rate of chemical reactions would be too slow. Some reactions might not even happen at all. As shown in **Figure 1,** enzymes work without being changed or used up.

Figure 1 Enzymes speed up the rate of certain body reactions.
Explain *what happens to the enzyme after it separates from the new molecule.*



Enzymes in Digestion Many enzymes help you digest carbohydrates, proteins, and fats. These enzymes are produced in the salivary glands, stomach, small intestine, and pancreas.

Reading Check *What is the role of enzymes in the chemical digestion of food?*

Other Enzyme Actions Enzyme-aided reactions are not limited to the digestive process. Enzymes also help speed up chemical reactions responsible for building your body. They are involved in the energy-releasing activities of your muscle and nerve cells. Enzymes also aid in the blood-clotting process. Without enzymes, the chemical reactions in your body would happen too slowly for you to exist.

Organs of the Digestive System

Your digestive system has two parts—the digestive tract and the accessory organs. The major organs of your digestive tract—mouth, esophagus (ih SAH fuh gus), stomach, small intestine, large intestine, rectum, and anus—are shown in **Figure 2.** Food passes through all of these organs. The tongue, teeth, salivary glands, liver, gallbladder, and pancreas, also shown in **Figure 2,** are the accessory organs. Although food doesn't pass through them, they are important in mechanical and chemical digestion. Your liver, gallbladder, and pancreas produce or store enzymes and other chemicals that help break down food as it passes through the digestive tract.

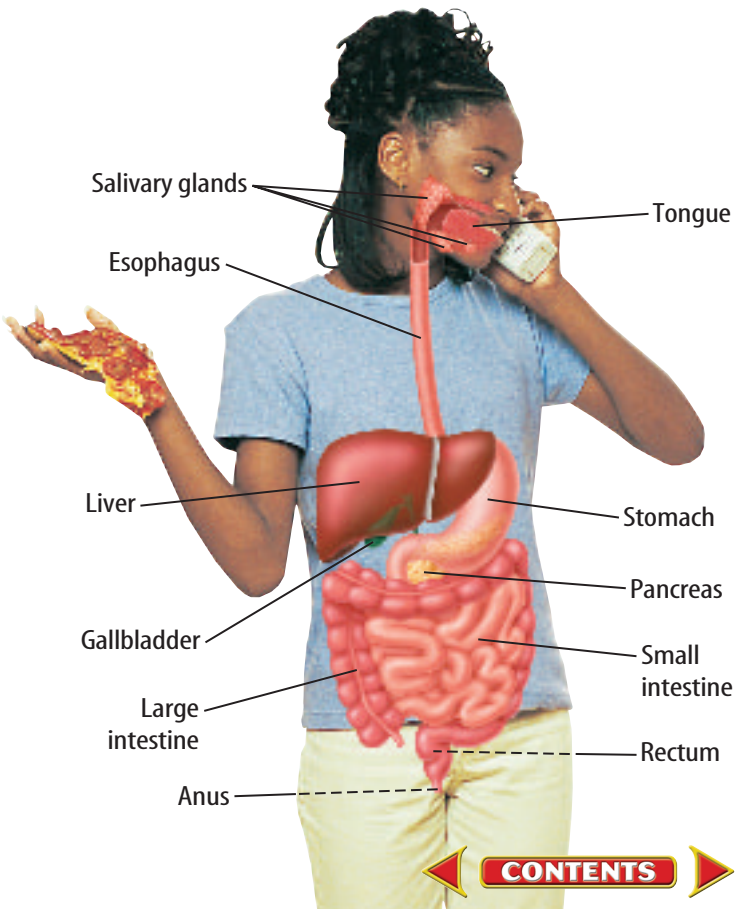


Figure 2 The human digestive system can be described as a tube divided into several specialized sections. If stretched out, an adult's digestive system is 6 m to 9 m long.

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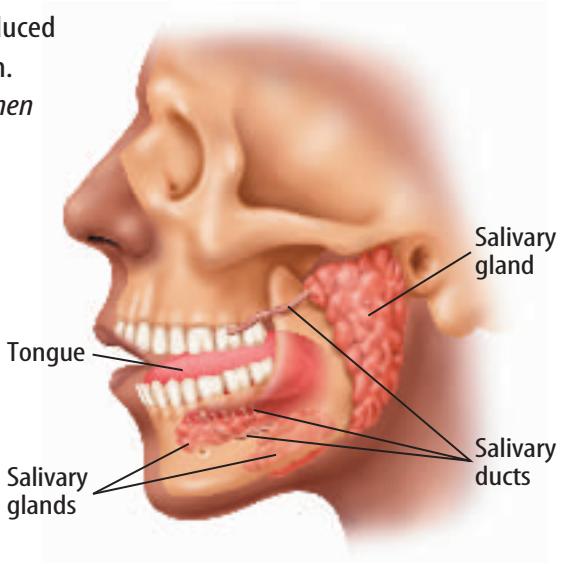
Figure 3 About 1.5 L of saliva are produced each day by salivary glands in your mouth. **Describe** *what happens in your mouth when you think about a food you like.*



The Mouth Mechanical and chemical digestion begin in your mouth. Mechanical digestion happens when you chew your food with your teeth and mix it with your tongue. Chemical digestion begins with the addition of a watery substance called saliva (suh LI vuh), which contains water, mucus, and an enzyme that aids in the breakdown of starch into sugar. Saliva is produced by three sets of glands near your mouth, shown in **Figure 3.** Food mixed with saliva becomes a soft mass and is moved to the back of your mouth by your tongue. It is swallowed and passes into your esophagus. Now ingestion is complete, but the process of digestion continues.

The Esophagus Food moving into the esophagus passes over a flap of tissue called the epiglottis (eh puh GLAH tus). This structure automatically covers the opening to the windpipe to prevent food from entering it, otherwise you would choke. Your esophagus is a muscular tube about 25 cm long. No digestion takes place in the esophagus. Smooth muscles in the wall of the esophagus move food downward with a squeezing action. These waves of muscle contractions, called **peristalsis** (per uh STAHL sus), move food through the entire digestive tract. Secretions from the mucous glands in the wall of the esophagus keep food moist.

The Stomach The stomach is a muscular bag. When empty, it is somewhat sausage shaped with folds on the inside. As food enters from the esophagus, the stomach expands and the folds smooth out. Mechanical and chemical digestion take place here. Mechanically, food is mixed in the stomach by peristalsis. Chemically, food is mixed with enzymes and strong digestive solutions, such as hydrochloric acid solution, to help break it down.

Specialized cells in the stomach's walls release about two liters of hydrochloric acid solution each day. This solution works with the enzyme pepsin to digest protein and destroys bacteria that are present in food. The stomach also produces mucus, which makes food more slippery and protects the stomach from the strong, digestive solutions. Food is changed in the stomach into a thin, watery liquid called **chyme** (KIME). Slowly, chyme moves out of your stomach and into your small intestine.

Reading Check ***Why isn't your stomach digested by the acidic digestive solution?***

The Small Intestine Your small intestine, shown in **Figure 4,** is small in diameter, but it measures 4 m to 7 m in length. As chyme leaves your stomach, it enters the first part of your small intestine, called the duodenum (doo AH duh num). Most digestion takes place in your duodenum. Here, bile—a greenish fluid from the liver—is added. The acidic solution from the stomach makes large fat particles float to the top of the chyme. Bile breaks up the large fat particles, similar to the way detergent breaks up grease.

Chemical digestion of carbohydrates, proteins, and fats occurs when a digestive solution from the pancreas is mixed in. This solution contains bicarbonate ions and enzymes. The bicarbonate ions help neutralize the stomach acid that is mixed with chyme. Your pancreas also makes insulin, a hormone that allows glucose to pass from the bloodstream into your cells.

Absorption of broken down food takes place in the small intestine. The wall of the small intestine, shown in **Figure 4,** has many ridges and folds. These folds are covered with fingerlike projections called **villi** (VIH li). Villi increase the surface area of the small intestine, which allows more places for nutrients to be absorbed. Nutrients move into blood vessels within the villi. From here, blood transports the nutrients to all cells of your body. Peristalsis continues to force the remaining undigested and unabsorbed materials slowly into the large intestine.

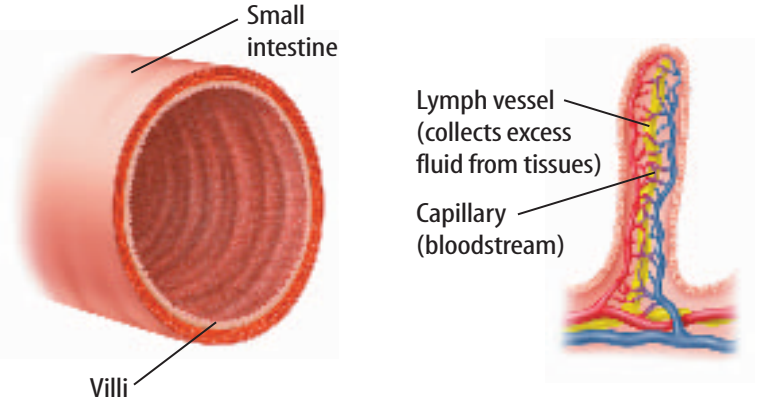


Figure 4 Hundreds of thousands of densely packed villi give the impression of a velvet cloth surface. If the surface area of your villi could be stretched out, it would cover an area the size of a tennis court.
Infer *what would happen to a person's weight if the number of villi were drastically reduced. Why?*

Large Intestine Bacteria
The species of bacteria that live in your large intestine are adapted to their habitat. What do you think would happen to the bacteria if their environment were to change? How would this affect your large intestine? Discuss your ideas with a classmate and write your answers in your Science Journal.

The Large Intestine When the chyme enters the large intestine, it is still a thin, watery mixture. The large intestine absorbs water from the undigested mass, which helps maintain homeostasis (hoh mee oh STAY sus). Peristalsis usually slows down in the large intestine. After the excess water is absorbed, the remaining undigested materials become more solid. Muscles in the rectum, which is the last section of the large intestine, and the anus control the release of semisolid wastes from the body in the form of feces (FEE seez).

Bacteria Are Important

Many types of bacteria live in your body. Some bacteria live in many of the organs of your digestive tract including your mouth and large intestine. Some of these bacteria live in a relationship that is beneficial to the bacteria and to your body. The bacteria in your large intestine feed on undigested material like cellulose and make vitamins you need—vitamin K and two B vitamins. Vitamin K is needed for blood clotting. The two B vitamins, niacin and thiamine, are important for your nervous system and for other body functions. Bacterial action also converts bile pigments into new compounds. The breakdown of intestinal materials by bacteria produces gas.

section 1 review

Summary

Functions of the Digestive System

- Food is processed in four stages—ingestion, digestion, absorption, and elimination.

Enzymes

- Enzymes make chemical digestion possible.
- Enzymes are used in other chemical reactions, including blood clotting.

Organs of the Digestive System

- In the digestive system, food passes through the mouth, esophagus, stomach, small intestine, large intestine, rectum, and anus.
- Accessory digestive organs help in mechanical and chemical digestion.

Bacteria Are Important

- Some bacteria that live in the organs of the digestive tract are helpful to your body.

Self Check

1. **Compare and contrast** mechanical digestion and chemical digestion.
2. **Describe** the function of each organ through which food passes as it moves through the digestive tract.
3. **Explain** how activities in the large intestine help maintain homeostasis.
4. **Describe** how the accessory organs aid digestion.
5. **Think Critically** Crackers contain starch. Explain why a cracker begins to taste sweet after it is in your mouth for five minutes without being chewed.

Applying Skills

6. **Recognize Cause and Effect** What would happen to some of the nutrients in chyme if the pancreas did not secrete its solution into the small intestine?
7. **Communicate** Write a paragraph in your Science Journal explaining what would happen to the mechanical and chemical digestion in a person missing a large portion of his or her stomach.

section 2

Nutrition

Why do you eat?

You might choose a food because of its taste, because it's readily available, or quickly prepared. However, as much as you don't want to admit it, the nutritional value of and Calories in foods are more important. A Calorie is a measurement of the amount of energy available in food. The amount of food energy a person requires varies with activity level, body weight, age, sex, and natural body efficiency. A chocolate donut might be tasty, quick to eat, and provide plenty of Calories, but it has only some of the nutrients that your body needs.

Classes of Nutrients

Six kinds of nutrients are available in food—proteins, carbohydrates, fats, vitamins, minerals, and water. Proteins, carbohydrates, vitamins, and fats all contain carbon and are called organic nutrients. Inorganic nutrients, such as water and minerals, do not contain carbon. Foods containing carbohydrates, fats, and proteins need to be digested or broken down before your body can use them. Water, vitamins, and minerals don't require digestion and are absorbed directly into your bloodstream.

Proteins Your body uses proteins for replacement and repair of body cells and for growth. Proteins are large molecules that contain carbon, hydrogen, oxygen, nitrogen, and sometimes sulfur. A molecule of protein is made up of a large number of smaller units, or building blocks, called **amino acids.** You can see some sources of proteins in **Figure 5.**

Figure 5 Meats, poultry, eggs, fish, peas, beans, and nuts are all rich in protein.

as you read

What You'll Learn

- **Distinguish** among the six classes of nutrients.
- **Identify** the importance of each type of nutrient.
- **Explain** the relationship between diet and health.

Why It's Important

You can make healthful food choices if you know what nutrients your body uses daily.

Review Vocabulary

molecule: the smallest particle of a substance that retains the properties of the substance and is composed of one or more atoms

New Vocabulary

- amino acid
- carbohydrate
- vitamin
- mineral

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Science Online

Topic: Fiber

Visit green.msscience.com for Web links to recent news or magazine articles about the importance of fiber in your diet.

Activity In your Science Journal, classify your favorite foods into two groups—*Good source of fiber* and *Little or no fiber.*

Protein Building Blocks Your body needs only 20 amino acids in various combinations to make the thousands of proteins used in your cells. Most of these amino acids can be made in your body's cells, but eight of them cannot. These eight are called essential amino acids. They have to be supplied by the foods you eat. Complete proteins provide all of the essential amino acids. Eggs, milk, cheese, and meat contain complete proteins. Incomplete proteins are missing one or more of the essential amino acids. If you are a vegetarian, you can get all of the essential amino acids by eating a wide variety of protein-rich vegetables, fruits, and grains.

Carbohydrates Study the nutrition label on several boxes of cereal. You'll notice that the number of grams of carbohydrates found in a typical serving of cereal is higher than the amounts of the other nutrients. **Carbohydrates** (kar boh HI drayts) usually are the main sources of energy for your body.

Three types of carbohydrates are sugar, starch, and fiber, shown in **Figure 6.** Sugars are called simple carbohydrates. You're probably most familiar with table sugar. However, fruits, honey, and milk also contain forms of sugar. Your cells break down glucose, a simple sugar.

The other two types of carbohydrates—starch and fiber—are called complex carbohydrates. Starch is found in potatoes and foods made from grains such as pasta. Starches are made up of many simple sugars. Fiber, such as cellulose, is found in the cell walls of plant cells. Foods like whole-grain breads and cereals, beans, peas, and other vegetables and fruits are good sources of fiber. Because different types of fiber are found in foods, you should eat a variety of fiber-rich plant foods. You cannot digest fiber, but it is needed to keep your digestive system running smoothly.

Fats The term *fat* has developed a negative meaning for some people. However, fats, also called lipids, are necessary because they provide energy and help your body absorb vitamins. Fat tissue cushions your internal organs. A major part of every cell membrane is made up of a type of fat.

Figure 6 These foods contain carbohydrates that provide energy for all the things that you do. **Describe** *the role of carbohydrates in your body.*

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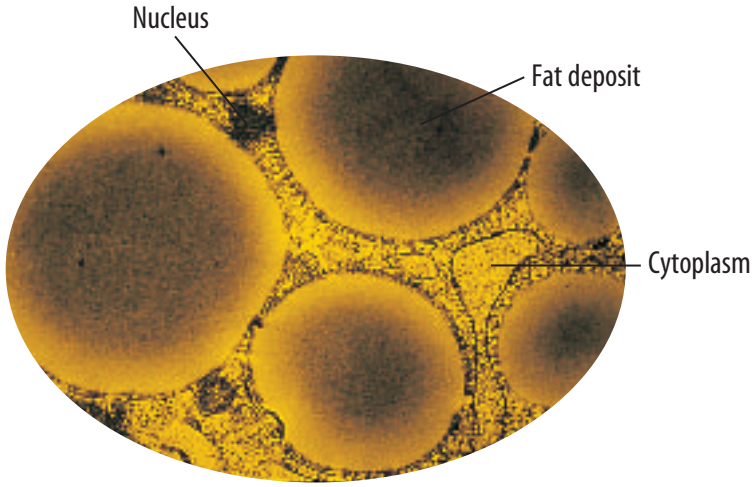


Figure 7 Fat is stored in certain cells in your body. Fat deposits push the cytoplasm and nucleus to the edge of the cell.

A gram of fat can release more than twice as much energy as a gram of carbohydrate can. Because fat is a good storage unit for energy, excess energy from the foods you eat is converted to fat and stored for later use, as shown in **Figure 7.**

Reading Check ***Why is fat a good storage unit for energy?***

Fats are classified as unsaturated or saturated based on their chemical structure. Unsaturated fats are usually liquid at room temperature. Vegetable oils as well as fats found in seeds are unsaturated fats. Saturated fats are found in meats, animal products, and some plants and are usually solid at room temperature. Saturated fats have been associated with high levels of blood cholesterol. Your body makes cholesterol in your liver. Cholesterol is part of the cell membrane in all of your cells. However, a diet high in cholesterol may result in deposits forming on the inside walls of blood vessels. These deposits can block the blood supply to organs and increase blood pressure. This can lead to heart disease and strokes.

Vitamins

Your bone cells need vitamin D to use calcium, and your blood needs vitamin K in order to clot. **Vitamins** are organic nutrients needed in small quantities for growth, regulating body functions, and preventing some diseases.

Vitamins are classified into two groups. Some vitamins dissolve easily in water and are called water-soluble vitamins. They are not stored by your body so you have to consume them daily. Other vitamins dissolve only in fat and are called fat-soluble vitamins. These vitamins are stored by your body. Although you eat or drink most vitamins, some are made by your body. Vitamin D is made when your skin is exposed to sunlight. Recall that vitamin K and two of the B vitamins are made in your large intestine with the help of bacteria that live there.

Mini LAB

Comparing the Fat Content of Foods

Procedure

1. Collect three pieces of each of the following foods: **potato chips; pretzels; peanuts;** and **small cubes of fruits, cheese, vegetables,** and **meat.**
2. Place the food items on a piece of **brown grocery bag.** Label the paper with the name of each food. Do not taste the foods.
3. Allow foods to sit for 30 min.
4. Remove the items, properly dispose of them, and observe the paper.

Analysis

1. Which items left a translucent (greasy) mark? Which left a wet mark?
2. How are the foods that left a greasy mark on the paper alike?
3. Use this test to determine which other foods contain fats. A greasy mark means the food contains fat. A wet mark means the food contains a lot of water.

Table 1 Minerals

Mineral	Health Effect	Food Sources
Calcium	strong bones and teeth, blood clotting, muscle and nerve activity	dairy products, eggs, green leafy vegetables, soy
Phosphorus	strong bones and teeth, muscle contraction, stores energy	cheese, meat, cereal
Potassium	balance of water in cells, nerve impulse conduction, muscle contraction	bananas, potatoes, nuts, meat, oranges
Sodium	fluid balance in tissues, nerve impulse conduction	meat, milk, cheese, salt, beets, carrots, nearly all foods
Iron	oxygen is transported in hemoglobin by red blood cells	red meat, raisins, beans, spinach, eggs
Iodine (trace)	thyroid activity, metabolic stimulation	seafood, iodized salt

Minerals Inorganic nutrients—nutrients that lack carbon and regulate many chemical reactions in your body—are called **minerals.** Of about 14 minerals that your body uses, calcium and phosphorus are used in the largest amounts for a variety of body functions. One of these functions is the formation and maintenance of bone. Some minerals, called trace minerals, are required only in small amounts. Copper and iodine usually are listed as trace minerals. Minerals are not used by the body as a source of energy. However, they do serve many different functions. Several minerals, their health effects, and some food sources for them are listed in **Table 1.**

Reading Check *Why is copper considered a trace mineral?*

Water Next to oxygen, water is the most important factor for survival. Different organisms need different amounts of water to survive. You could live for a few weeks without food but for only a few days without water because your cells need water to carry out their work. Most of the nutrients you have studied in this chapter can't be used by your body unless they are carried in a solution. This means that they have to be dissolved in water. In cells, chemical reactions take place in solutions.

INTEGRATE Social Studies

Salt Mines The mineral halite is processed to make table salt. In the United States, most salt comes from underground mines. Research to find the location of these mines, then label them on a map.

The human body is about 60 percent water by mass. About two-thirds of your body water is located in your body cells. Water also is found around cells and in body fluids such as blood. **Table 2** shows how your body loses water every day. To replace water lost each day, you need to drink about 2 L of liquids. However, drinking liquids isn't the only way to supply cells with water. Most foods have more water than you realize. An apple is about 80 percent water, and many meats are 90 percent water.

Table 2 Water Loss

Method of Loss	Amount (mL/day)
Exhaled air	350
Feces	150
Skin (mostly as sweat)	500
Urine	1,500

Why do you get thirsty? Your body is made up of systems that operate together. When your body needs to replace lost water, messages are sent to your brain that result in a feeling of thirst. Drinking water satisfies your thirst and usually restores the body's homeostasis. When homeostasis is restored, the signal to the brain stops and you no longer feel thirsty.

Food Groups

Because no naturally occurring food has every nutrient, you need to eat a variety of foods. Nutritionists have developed a simple system, called the food pyramid, shown in **Figure 8,** to help people select foods that supply all the nutrients needed for energy and growth. The recommended daily amount for each food group will supply your body with the nutrients it needs for good health.

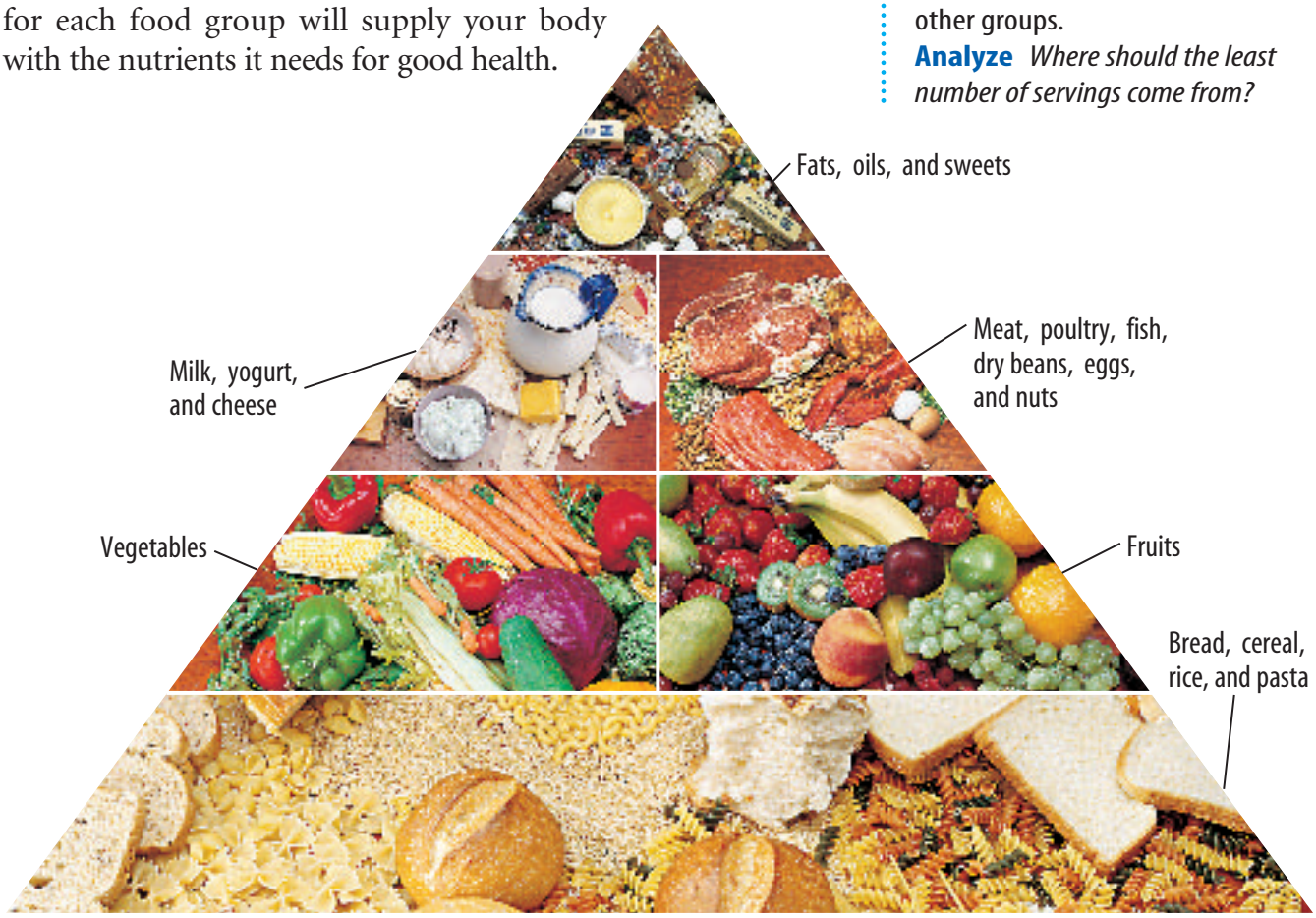
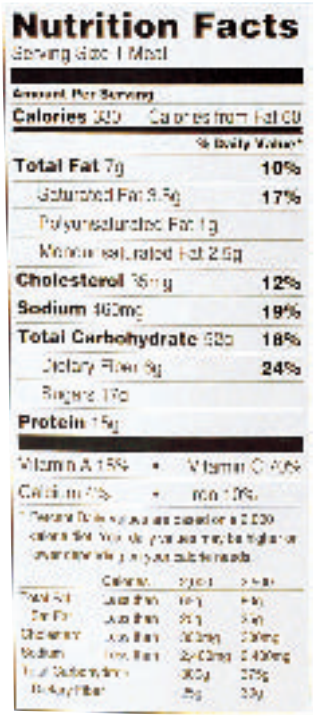


Figure 8 The pyramid shape reminds you that you should consume more servings from the bread and cereal group than from other groups.
Analyze *Where should the least number of servings come from?*

Figure 9 The information on a food label can help you decide what to eat.



Daily Servings Each day you should eat six to eleven servings from the bread and cereal group, three to five servings from the vegetable group, two to four servings from the fruit group, two to three servings from the milk group, and two to three servings from the meat and beans group. Only small amounts of fats, oils, and sweets should be consumed.

The size of a serving is different for different foods. For example, a slice of bread or one ounce of ready-to-eat cereal is a bread and cereal group serving. One cup of raw leafy vegetables or one-half cup of cooked or chopped raw vegetables make a serving from the vegetable group. One medium apple, banana, or orange, one-half cup of canned fruit, or three-quarter cup of fruit juice is a fruit serving. A serving from the milk group can be one cup of milk or yogurt. Two ounces of cooked lean meat, one-half cup of cooked dry beans, one egg, or two tablespoons of peanut butter counts as a serving from the meat and beans group.

Food Labels The nutritional facts found on all packaged foods make it easier to make healthful food choices. These labels, as shown in **Figure 9,** can help you plan meals that supply the daily recommended amounts of nutrients and meet special dietary requirements (for example, a low-fat diet).

section 2 review

Summary

Why do you eat?

- Nutrients in food provide energy and materials for cell development, growth, and repair.

Classes of Nutrients

- Six kinds of nutrients are found in food—proteins, carbohydrates, fats, vitamins, minerals, and water.
- Proteins are used for growth and repair, carbohydrates provide energy, and fats store energy and cushion organs.
- Vitamins and minerals regulate body functions.
- Next to oxygen, water is the most important factor for your survival.

Food Groups

- The food pyramid and nutritional labels can help you choose foods that supply all the nutrients you need for energy and growth.

Self Check

1. **List** one example of a food source for each of the six classes of nutrients.
2. **Explain** how your body uses each class of nutrients.
3. **Discuss** how food choices can positively and negatively affect your health.
4. **Explain** the importance of water in the body.
5. **Think Critically** What foods from each food group would provide a balanced breakfast? Explain.

Applying Skills

6. **Interpret Data** Nutritional information can be found on the labels of most foods. Interpret the labels found on three different types of food products.
7. **Use a Spreadsheet** Make a spreadsheet of the minerals listed in **Table 1.** Use reference books to gather information about minerals and add these to the table: *sulfur, magnesium, copper, manganese, cobalt,* and *zinc.*

LAB

Identifying Vitamin C Content

Vitamin C is found in many fruits and vegetables. Oranges have a high vitamin C content. Try this lab to test the vitamin C content in different orange juices.

Drops of Iodine Needed to Change Color

Juice	Trial 1	Trial 2	Trial 3	Average
1 Fresh juice				
2 Frozen juice				
3 Canned juice				
4 Carton juice				

Real-World Question

Which orange juice contains the most vitamin C?

Goals

- **Observe** the vitamin C content of different orange juices.

Materials

test tube (4)
**paper cups*
test-tube rack
masking tape
wooden stirrer (13)
graduated cylinder
**graduated container*
2% tincture of iodine
dropper
cornstarch
triple-beam balance
weighing paper
water (50 mL)
glass-marking pencil
dropper bottles (4) containing orange juice that is:
(1) freshly squeezed
(2) from frozen concentrate
(3) canned
(4) in a carton

** Alternate materials*

Safety Precautions

WARNING: *Do not taste any of the juices. Iodine is poisonous and can stain skin and clothing. It is an irritant and can cause damage if it comes in contact with your eyes. Notify your teacher if a spill occurs.*

Procedure

1. Make a data table like the example shown to record your observations.
2. Label four test tubes 1 through 4 and place them in the test-tube rack.
3. Measure and pour 5 mL of juice from bottle 1 into test tube 1, 5 mL from bottle 2 into test tube 2, 5 mL from bottle 3 into test tube 3, and 5 mL from bottle 4 into test tube 4.
4. Measure 0.3 g of cornstarch, then put it in a container. Slowly mix in 50 mL of water until the cornstarch completely dissolves.
5. Add 5 mL of the cornstarch solution to each of the four test tubes. Stir well.
6. Add iodine to test tube 1, one drop at a time. Stir after each drop. Record the number of drops it takes for the juice to change to a purple color. The more vitamin C that is present, the more drops it takes to change color.
7. Repeat step 6 with test tubes 2, 3, and 4.
8. Empty and clean the test tubes. Repeat steps 3 through 7 two more times, then average your results.
9. Dispose of all materials as directed by your teacher. Wash your hands thoroughly.

Conclude and Apply

1. **Compare and contrast** the amount of vitamin C in the orange juices tested.
2. **Infer** why the amount of vitamin C varies in the orange juices.

section 3

The Respiratory System

as you read

What You'll Learn

- **Describe** the functions of the respiratory system.
- **Explain** how oxygen and carbon dioxide are exchanged in the lungs and in tissues.
- **Identify** the pathway of air in and out of the lungs.
- **Explain** the effects of smoking on the respiratory system.

Why It's Important

Your body's cells depend on your respiratory system to supply oxygen and remove carbon dioxide.

Review Vocabulary

diaphragm: muscle beneath the lungs that contracts and relaxes to move gases in and out of the body

New Vocabulary

- larynx
- trachea
- bronchi
- alveoli

Functions of the Respiratory System

Can you imagine an astronaut walking on the Moon without a space suit or a diver exploring the ocean without scuba gear? Of course not. They couldn't survive in either location under those conditions because humans need to breathe air.

People often confuse the terms *breathing* and *respiration*. Breathing is the movement of the chest that brings air into the lungs and removes waste gases. The air entering the lungs contains oxygen. It passes from the lungs into the circulatory system because there is less oxygen in blood when it enters the lungs than in cells of the lungs.

Blood carries oxygen and glucose from digested food to individual cells. In cells, they are raw materials for a series of chemical reactions called cellular respiration. Without oxygen, cellular respiration cannot occur. Cellular respiration results in the release of energy from glucose. Water and carbon dioxide are waste products of cellular respiration. Blood carries them back to the lungs. As shown in **Figure 10,** exhaling, or breathing out, eliminates waste carbon dioxide and some water molecules.

Reading Check *What is cellular respiration?*

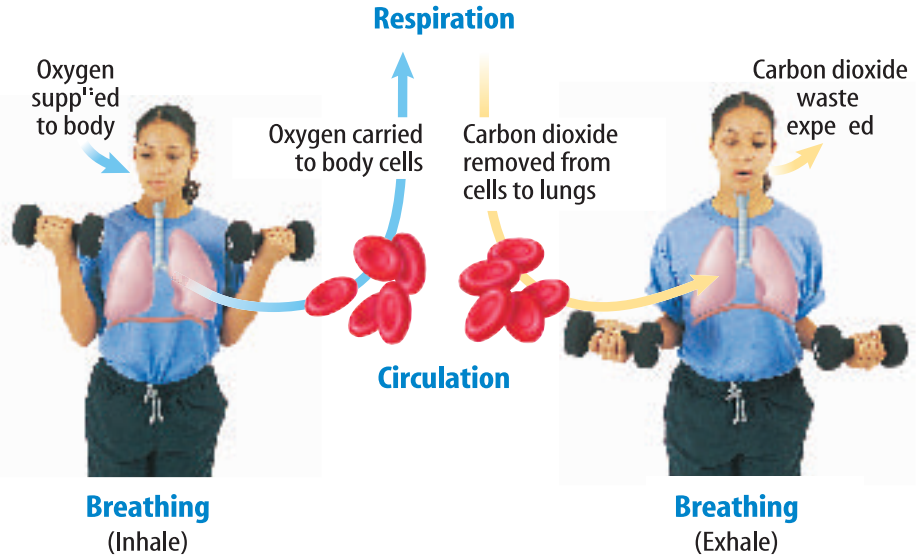


Figure 10 Several processes are involved in how the body obtains, transports, and uses oxygen.

CONTENTS

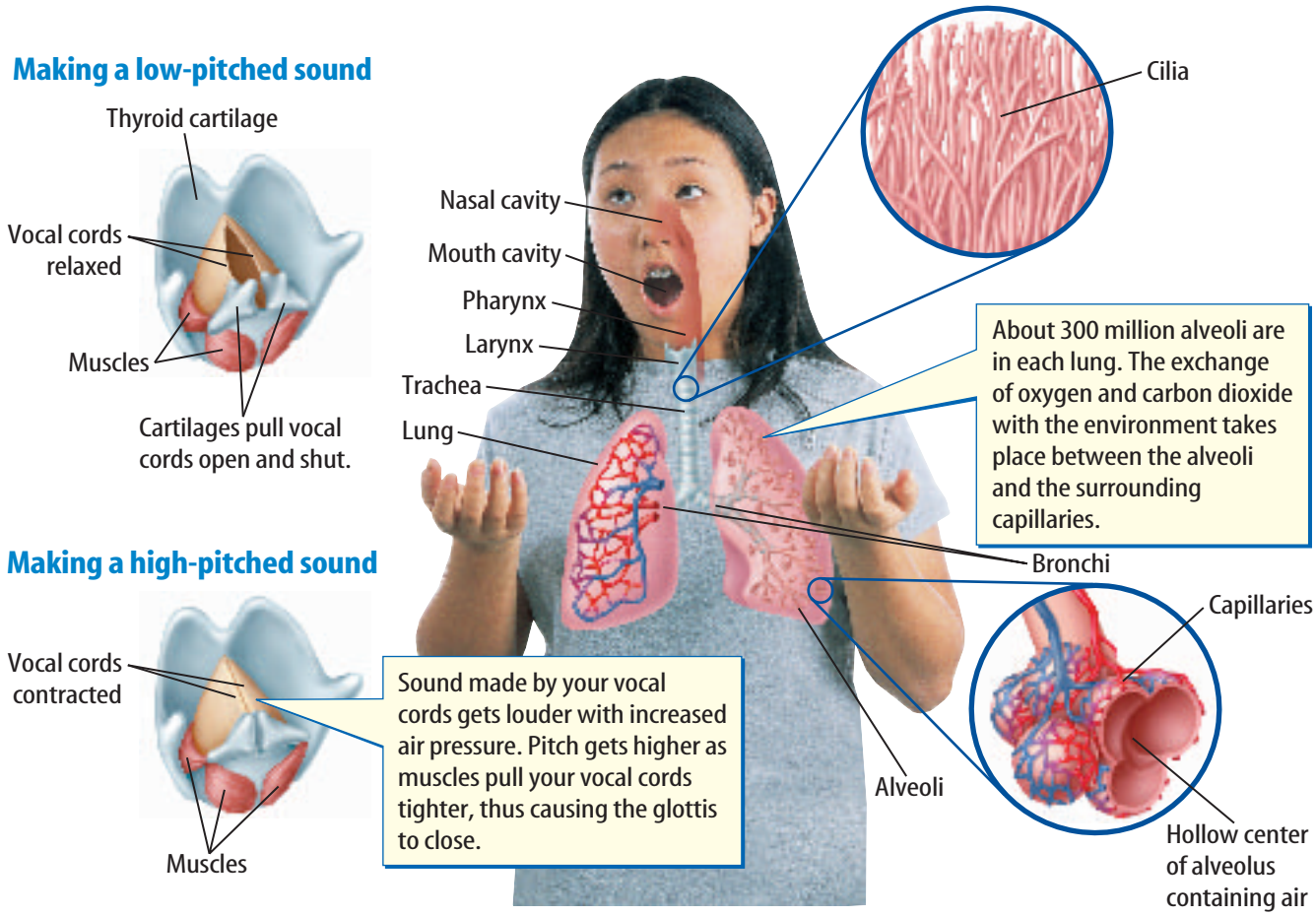


Figure 11 Air can enter the body through the nostrils and the mouth.
Explain *an advantage of having air enter through the nostrils.*

Organs of the Respiratory System

The respiratory system, shown in **Figure 11,** is made up of structures and organs that help move oxygen into the body and waste gases out of the body. Air enters your body through two openings in your nose called nostrils or through the mouth. Fine hairs inside the nostrils trap particles from the air. Air then passes through the nasal cavity, where it gets moistened and warmed by the body's heat. Glands that produce sticky mucus line the nasal cavity. The mucus traps particles that were not trapped by nasal hairs. This process helps filter and clean the air you breathe. Tiny, hairlike structures, called cilia (SIH lee uh), sweep mucus and trapped material to the back of the throat where it can be swallowed.

Pharynx Warmed, moist air then enters the pharynx (FER ingks), which is a tubelike passageway for food, liquids, and air. At the lower end of the pharynx is the epiglottis. When you swallow, your epiglottis folds down, which allows food or liquids to enter your esophagus instead of your airway. What do you think has happened if you begin to choke?

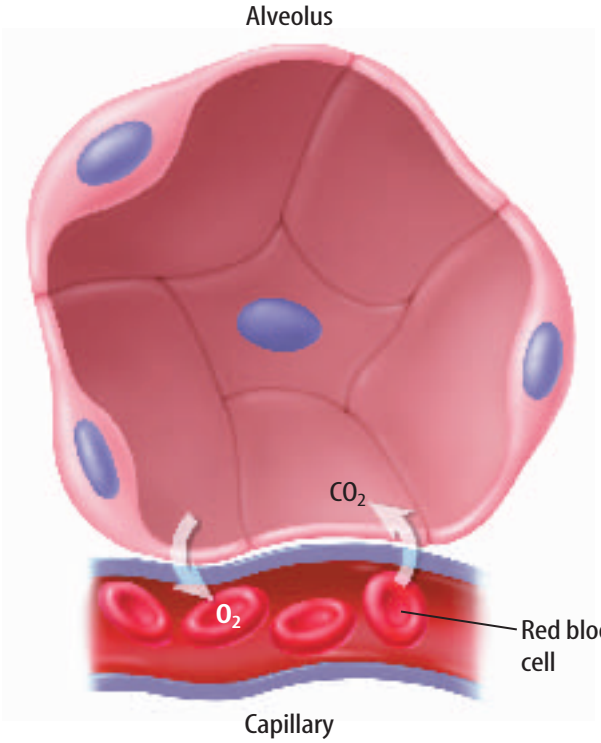


Figure 12 The thin capillary walls allow gases to be exchanged easily between the alveoli and the capillaries.
Name *the two gases that are exchanged by the capillaries and alveoli.*

Larynx and Trachea Next, the air moves into your larynx (LER ingks). The **larynx** is the airway to which two pairs of horizontal folds of tissue, called vocal cords, are attached, as shown in **Figure 11** on the previous page. Forcing air between the cords causes them to vibrate and produce sounds. When you speak, muscles tighten or loosen your vocal cords, resulting in different sounds. Your brain coordinates the movement of the muscles in your throat, tongue, cheeks, and lips when you talk, sing, or just make noise. Your teeth also are involved in forming letter sounds and words.

From the larynx, air moves into the **trachea** (TRAY kee uh). Strong, C-shaped rings of cartilage prevent the trachea from collapsing. It is lined with mucous membranes and cilia, also shown in **Figure 11** on the previous page. The mucous membranes trap dust, bacteria, and pollen. The cilia move the mucus upward, where it is either swallowed or expelled from the nose or mouth. Why must the trachea stay open all the time?

Bronchi and the Lungs Air is carried into your lungs by two short tubes called **bronchi** (BRAHN ki) (singular, *bronchus*) at the lower end of the trachea. Within the lungs, the bronchi branch into smaller and smaller tubes. The smallest tubes are called bronchioles (BRAHN kee ohlz). At the end of each bronchiole are clusters of tiny, thin-walled sacs called **alveoli** (al VEE uh li) (singular, *alveolus*). Air passes into the bronchi, then into the bronchioles, and finally into the alveoli. Lungs are masses of alveoli, like the one shown in **Figure 12,** arranged in grapelike clusters. The capillaries surround the alveoli like a net.

The exchange of oxygen and carbon dioxide takes place between the alveoli and capillaries. The walls of the alveoli and capillaries are only one cell thick, as shown in **Figure 12.** Oxygen moves through the cell membranes of alveoli and through cell membranes of the capillaries into the blood. In blood, oxygen is picked up by hemoglobin (HEE muh gloh bun), a molecule in red blood cells, and carried to all body cells. At the same time, carbon dioxide and other cellular wastes leave the body cells and move into capillaries. Then they are carried by the blood to the lungs. In the lungs, waste gases move through cell membranes from capillaries into alveoli. Then waste gases leave the body when you exhale.

Why do you breathe?

Signals from your brain tell the muscles in your chest and abdomen to contract and relax. You don't have to think about breathing to breathe, just like your heart beats without you telling it to beat. Your brain can change your breathing rate depending on the amount of carbon dioxide present in your blood. If a lot of carbon dioxide is present, your breathing rate increases. It decreases if less carbon dioxide is in your blood. You do have some control over your breathing—you can hold your breath if you want to. Eventually, your brain will respond to the buildup of carbon dioxide in your blood and signal your chest and abdomen muscles to work automatically. You will breathe whether you want to or not.

Inhaling and Exhaling Breathing is partly the result of changes in volume and resulting air pressure. Under normal conditions, a gas moves from an area of higher pressure to an area of lower pressure. When you squeeze an empty, soft-plastic bottle, air is pushed out. This happens because air pressure outside the top of the bottle is less than the pressure you create inside the bottle when you changed its volume. As you release your grip on the bottle, the air pressure inside the bottle becomes less than it is outside the bottle because the bottle's volume changed. Air rushes back in, and the bottle returns to its original shape.

Your lungs work in a way similar to the squeezed bottle. Your diaphragm (DI uh fram) contracts and relaxes, changing the volume of the chest, which helps move gases into and out of your lungs. **Figure 13** illustrates breathing.

Reading Check *How does your diaphragm help you breathe?*

When a person's airway is blocked, a rescuer can use abdominal thrusts, as shown in **Figure 14,** to save the life of the choking victim.

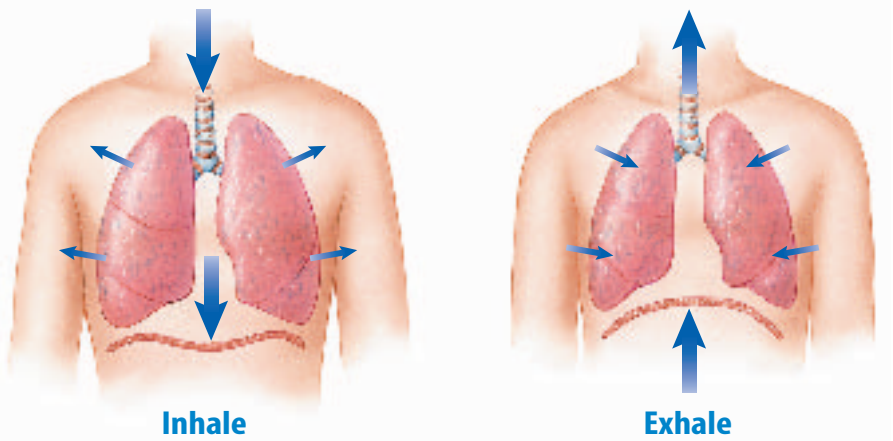


Figure 13 Your lungs inhale and exhale about 500 mL of air with an average breath. This can increase to 2,000 mL of air per breath when you do strenuous activity.

Mini LAB

Comparing Surface Area

Procedure

1. Stand a **bathroom-tissue cardboard tube** in an **empty bowl.**
2. Drop **marbles** into the tube, filling it to the top.
3. Count the number of marbles used.
4. Repeat steps 2 and 3 two more times. Calculate the average number of marbles needed to fill the tube.
5. The tube's inside surface area is approximately 161.29 cm^2. Each marble has a surface area of approximately 8.06 cm^2. Calculate the surface area of the average number of marbles.

Analysis

1. Compare the inside surface area of the tube with the surface area of the average number of marbles needed to fill the tube.
2. If the tube represents a bronchus, what do the marbles represent?
3. Using this model, explain what makes gas exchange in the lungs efficient.

Try at Home

NATIONAL GEOGRAPHIC

VISUALIZING ABDOMINAL THRUSTS

Figure 14

When food or other objects become lodged in the trachea, airflow between the lungs and the mouth and nasal cavity is blocked. Death can occur in minutes. However, prompt action by someone can save the life of a choking victim. The rescuer uses abdominal thrusts to force the victim's diaphragm up. This decreases the volume of the chest cavity and forces air up in the trachea. The result is a rush of air that dislodges and expels the food or other object. The victim can breathe again. This technique is shown at right and should only be performed in emergency situations.

A The rescuer stands behind the choking victim and wraps her arms around the victim's upper abdomen. She places a fist (thumb side in) against the victim's stomach. The fist should be below the ribs and above the navel.

B With a violent, sharp movement, the rescuer thrusts her fist up into the area below the ribs. This action should be repeated as many times as necessary.

Richard T. Nowitz

CONTENTS

Diseases and Disorders of the Respiratory System

If you were asked to make a list of some things that can harm your respiratory system, you probably would put smoking at the top. As you can see in **Table 3,** many serious diseases are related to smoking. The chemical substances in tobacco—nicotine and tars—are poisons and can destroy cells. The high temperatures, smoke, and carbon monoxide produced when tobacco burns also can injure a smoker's cells. Even if you are a nonsmoker, inhaling smoke from tobacco products—called secondhand smoke—is unhealthy and has the potential to harm your respiratory system. Smoking, polluted air, coal dust, and asbestos (as BES tus) have been related to respiratory problems such as asthma (AZ muh), bronchitis (brahn KI tus), emphysema (em fuh SEE muh), and cancer.

Table 3 Smokers' Risk of Death from Disease

Disease	Smokers' Risk Compared to Nonsmokers' Risk
Lung cancer	23 times higher for males; 11 times higher for females
Chronic bronchitis and emphysema	5 times higher
Heart disease	2 times higher

Respiratory Infections Bacteria, viruses, and other microorganisms can cause infections that affect any of the organs of the respiratory system. The common cold usually affects the upper part of the respiratory system—from the nose to the pharynx. The cold virus also can cause irritation and swelling in the larynx, trachea, and bronchi. The cilia that line the trachea and bronchi can be damaged. However, cilia usually heal rapidly.

Chronic Bronchitis When bronchial tubes are irritated and swell and too much mucus is produced, a disease called bronchitis develops. Many cases of bronchitis clear up within a few weeks, but the disease sometimes lasts for a long time. When this happens, it is called chronic (KRAH nihk) bronchitis.

Emphysema A disease in which the alveoli in the lungs enlarge is called emphysema. When cells in the alveoli are reddened and swollen, an enzyme is released that causes the walls of the alveoli to break down. As a result, alveoli can't push air out of the lungs, so less oxygen moves into the bloodstream from the alveoli. When blood becomes low in oxygen and high in carbon dioxide, shortness of breath occurs.

Topic: Secondhand Smoke

Visit green.msscience.com for Web links to information about the health aspects of secondhand smoke.

Activity Write a paragraph in your Science Journal summarizing the possible effects of secondhand smoke on your health.

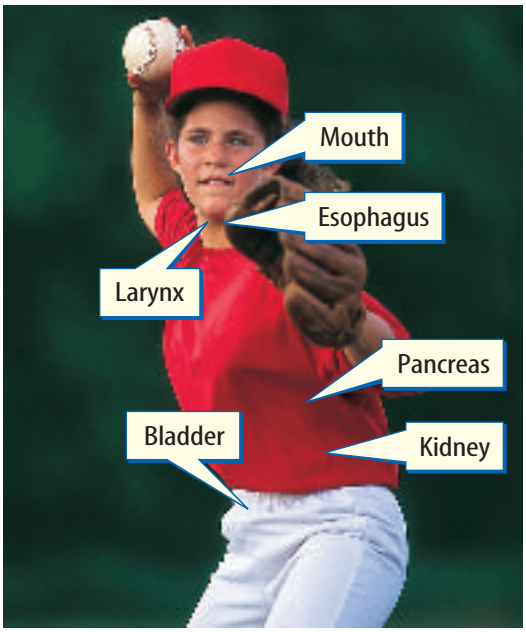


Figure 15 More than 85 percent of all lung cancer is related to smoking. Smoking also can play a part in the development of cancer in other body organs indicated above.

Lung Cancer The third leading cause of death in men and women in the United States is lung cancer. Inhaling the tar in cigarette smoke is the greatest contributing factor to lung cancer. In the body, tar and other ingredients found in smoke act as carcinogens (kar SIH nuh junz). Carcinogens are substances that can cause an uncontrolled growth of cells. In the lungs, this is called lung cancer. Lung cancer is not easy to detect in its early stages. Smoking also has been linked to the development of cancers of the mouth, esophagus, larynx, pancreas, kidney, and bladder. See **Figure 15.**

Asthma Shortness of breath, wheezing, or coughing can occur in a lung disorder called asthma. When a person has an asthma attack, the bronchial tubes contract quickly. Inhaling medicine that relaxes the bronchial tubes is the usual treatment for an asthma attack. Asthma can be an allergic reaction. An allergic reaction occurs when the body overreacts to a foreign substance. An asthma attack can result from breathing certain substances such as cigarette smoke or certain plant pollen, eating certain foods, or stress in a person's life.

section 3 review

Summary

Functions of the Respiratory System

- Breathing moves the chest to bring air into and remove wastes from the lungs.
- Cellular respiration uses oxygen to release energy from glucose.

Organs of the Respiratory System

- Air flows from your nostrils or mouth through the pharynx, larynx, trachea, bronchi, and into the alveoli of your lungs.
- Alveoli and capillaries exchange oxygen and carbon dioxide.

Why do you breathe?

- Your brain sends signals to your chest and abdominal muscles to contract and relax, which controls breathing rate.

Diseases of the Respiratory System

- Problems of the respiratory system include chronic bronchitis, emphysema, and lung cancer.

Self Check

1. **State** the main function of the respiratory system.
2. **Describe** the exchange of oxygen, carbon dioxide, and other waste gases in the lungs and body tissues.
3. **Explain** how air moves into and out of the lungs.
4. **Describe** the effects of smoking on the respiratory and circulatory systems.
5. **Think Critically** How is the work of the digestive and circulatory systems related to the respiratory system?

Applying Skills

6. **Research Information** Nicotine in tobacco is a poison. Using library references, find out how nicotine affects the body.
7. **Communicate** Use references to find out about lung disease common among coal miners, stonecutters, and sandblasters. Find out what safety measures are required now for these trades. In your Science Journal, write a paragraph about these safety measures.

Renee Lynn/Photo Researchers

section 4

The Excretory System

Functions of the Excretory System

It's your turn to take out the trash. You carry the bag outside and put it in the trash can. The next day, you bring out another bag of trash, but the trash can is full. When trash isn't collected, it piles up. Just as trash needs to be removed from your home to keep it livable, your body must eliminate wastes to remain healthy. Undigested material is eliminated by your large intestine. Waste gases are eliminated through the combined efforts of your circulatory and respiratory systems. Some salts are eliminated when you sweat. These systems function together as parts of your excretory system. If wastes aren't eliminated, toxic substances build up and damage organs. If not corrected, serious illness or death occurs.

The Urinary System

Figure 16 shows how the urinary system functions as a part of the excretory system. The urinary system rids the blood of wastes produced by the cells. It controls blood volume by removing excess water produced by body cells during cellular respiration. The urinary system also balances the amounts of certain salts and water that must be present for all cellular activities.

as you read

What You'll Learn

- **Distinguish** between the excretory and urinary systems.
- **Describe** how the kidneys work.
- **Explain** what happens when urinary organs don't work.

Why It's Important

The urinary system helps clean your blood of cellular wastes.

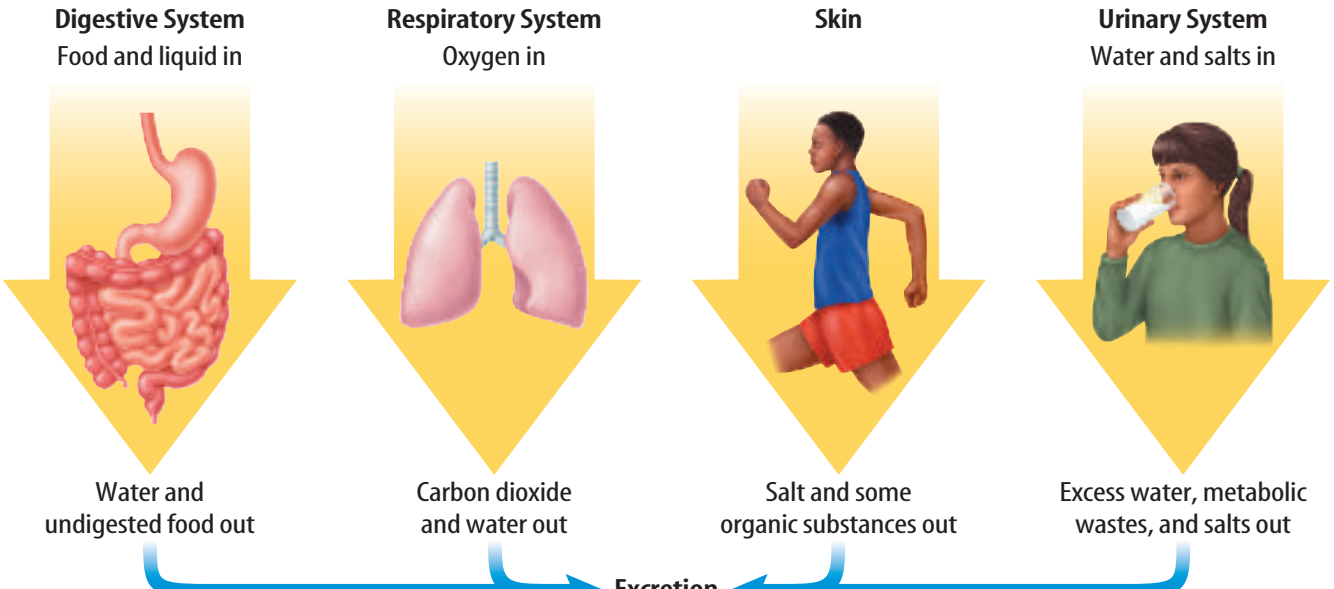
Review Vocabulary

capillary: blood vessel that connects arteries and veins

New Vocabulary

- nephron
- bladder
- ureter

Figure 16 The urinary, digestive, and respiratory systems, and the skin, make up the excretory system.



Regulating Fluid Levels To stay in good health, the fluid levels within the body must be balanced and normal blood pressure must be maintained. An area in the brain, the hypothalamus (hi poh THA luh mus), constantly monitors the amount of water in the blood. When the brain detects too much water in the blood, the hypothalamus releases a lesser amount of a specific hormone. This signals the kidneys to return less water to the blood and increase the amount of urine that is excreted.

Reading Check ***How does the urinary system control the volume of water in the blood?***

Organs of the Urinary System Excretory organs is another name for the organs of the urinary system. The main organs of the urinary system are two bean-shaped kidneys. Kidneys are located on the back wall of the abdomen at about waist level. The kidneys filter blood that contains wastes collected from cells. In approximately 5 min, all of the blood in your body passes through the kidneys. The red-brown color of the kidneys is due to their enormous blood supply. In **Figure 17,** you can see that blood enters the kidneys through a large artery and leaves through a large vein.

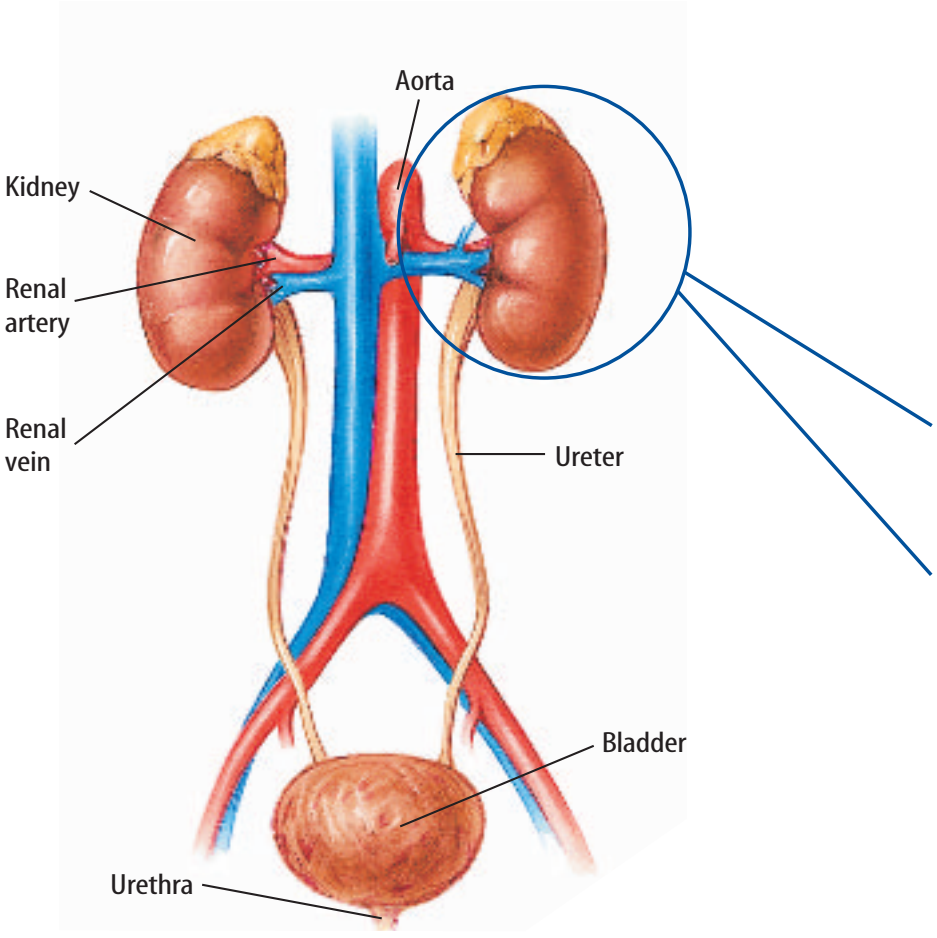


Figure 17 The urinary system removes wastes from the blood. The urinary system includes the kidneys, the bladder, and the connecting tubes.
Explain *how the kidneys help the body balance its fluid levels.*

Filtration in the Kidney A two-stage filtration system is an accurate description of a kidney, shown in **Figure 18.** It is made up of about one million tiny filtering units called **nephrons** (NE frahnz), also shown in **Figure 18.** Each nephron has a cuplike structure and a tubelike structure called a duct. Blood moves from a renal artery to capillaries in the cuplike structure. The first filtration occurs when water, sugar, salt, and wastes from the blood pass into the cuplike structure. Left behind in the blood are the red blood cells and proteins. Next, liquid in the cuplike structure is squeezed into a narrow tubule.

Capillaries that surround the tubule perform the second filtration. Most of the water, sugar, and salt are reabsorbed and returned to the blood. These collection capillaries merge to form small veins, which merge to form a renal vein in each kidney. Purified blood is returned to the main circulatory system. The liquid left behind flows into collecting tubules in each kidney. This wastewater, or urine, contains excess water, salts, and other wastes that are not reabsorbed by the body. An average-sized person produces about 1 L of urine per day.

Urine Collection and Release The urine in each collecting tubule drains into a funnel-shaped area of each kidney that leads to the **ureter** (YOO ruh tur). Ureters are tubes that lead from each kidney to the bladder. The **bladder** is an elastic, muscular organ that holds urine until it leaves the body. The elastic walls of the bladder can stretch to hold up to 0.5 L of urine. When empty, the bladder looks wrinkled and the cells lining the bladder are thick. When full, the bladder looks like an inflated balloon and the cells lining the bladder are stretched and thin. A tube called the urethra (yoo REE thruh) carries urine from the bladder to the outside of the body.

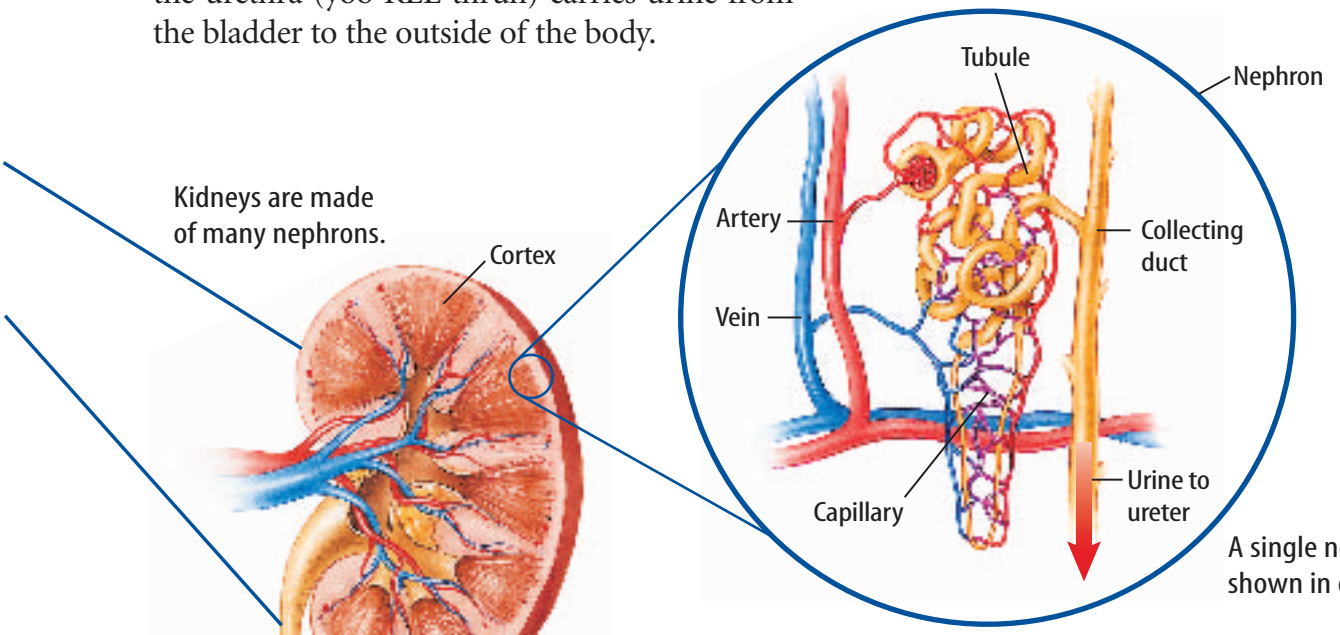


Figure 18 A single nephron is a complex structure.
Describe *the main function of a nephron.*

Urinary Diseases and Disorders

What happens when someone's kidneys don't work properly or stop working? Waste products that are not removed build up and act as poisons in body cells. Without excretion, an imbalance of salts occurs. The body responds by trying to restore this balance. If the balance isn't restored, the kidneys and other organs can be damaged. Kidney failure occurs when the kidneys don't work as they should. This is always a serious problem because the kidneys' job is so important to the rest of the body.

Applying Science

How does your body gain and lose water?

Your body depends on water. Without water, your cells could not carry out their activities and body systems could not function. Water is so important to your body that your brain and other body systems are involved in balancing water gain and water loss.

Identifying the Problem

Table A shows the major sources by which your body gains water. Oxidation of nutrients occurs when energy is released from nutrients by your body's cells. Water is a waste product of these reactions. **Table B** lists the major sources by which your body loses water. The data show you how daily gain and loss of water are related.

Table A Major Sources by Which Body Water Is Gained

Source	Amount (mL)	Percent
Oxidation of nutrients	250	10
Foods	750	30
Liquids	1,500	60
Total	**2,500**	**100**

Solving the Problem

1. What is the greatest source of water gained by your body? What is the greatest source of water lost by your body?
2. How would the percentages of water gained and lost change in a person who was working in extremely warm temperatures? In this case, what organ of the body would be the greatest contributor to water loss?

Table B Major Sources by Which Body Water Is Lost

Source	Amount (mL)	Percent
Urine	1,500	60
Skin	500	20
Lungs	350	14
Feces	150	6
Total	**2,500**	**100**

Because the ureters and urethra are narrow tubes, they can be blocked easily in some disorders. A blockage can cause serious problems because urine cannot flow out of the body properly. If the blockage is not corrected, the kidneys can be damaged.

Reading Check *Why is a blocked ureter or urethra a serious problem?*

Dialysis A person who has only one kidney still can live normally. The remaining kidney increases in size and works harder to make up for the loss of the other kidney. However, if both kidneys fail, the person will need to have his or her blood filtered by an artificial kidney machine in a process called dialysis (di AH luh sus), as shown in **Figure 19.**

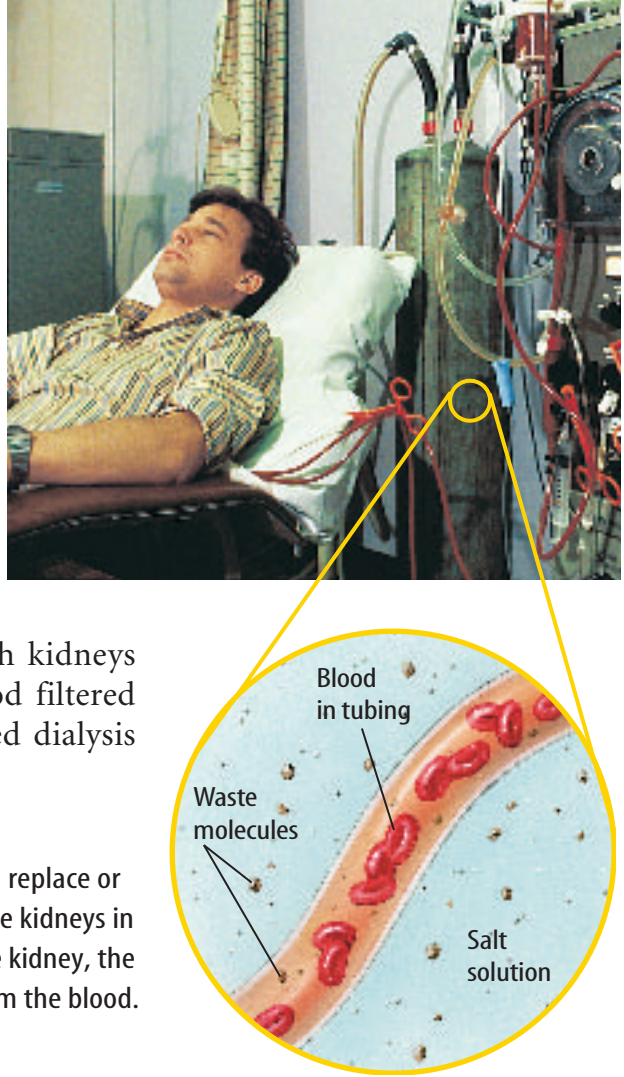


Figure 19 A dialysis machine can replace or help with some of the activities of the kidneys in a person with kidney failure. Like the kidney, the dialysis machine removes wastes from the blood.

section 4 review

Summary

Functions of the Excretory System

- The excretory system removes wastes from your body.
- The digestive, respiratory, and urinary systems and skin make up your excretory system.

The Urinary System

- The kidneys, which filter wastes from the blood, are the major organs of the urinary system.
- Urine moves from the kidneys through the ureters, into the bladder, then leaves the body through the urethra.

Urinary Diseases and Disorders

- Kidney failure can lead to a buildup of waste products in the body.
- An artificial kidney can be used to filter the blood in a process called dialysis.

Self Check

1. **List** the functions of a person's urinary system.
2. **Explain** how the kidneys remove wastes and keep fluids and salts in balance.
3. **Describe** what happens when the urinary system does not function properly.
4. **Compare** the excretory system and urinary system.
5. **Think Critically** Explain why reabsorption of certain materials in the kidneys is important to your health.

Applying Math

6. **Make and Use Graphs** Make a circle graph of major sources by which body water is gained. Use the data in **Table A** of the Applying Science activity.
7. **Concept Map** Using a network-tree concept map, compare the excretory functions of the kidneys and the lungs.

LAB

Particle Size and Absorption

Goals

- **Compare and contrast** the dissolving rates of different sized particles.
- **Predict** the dissolving rate of sugar particles larger than sugar cubes.
- **Predict** the dissolving rate of sugar particles smaller than particles of ground sugar.
- **Infer,** using the lab results, why the body must break down and dissolve food particles.

Materials

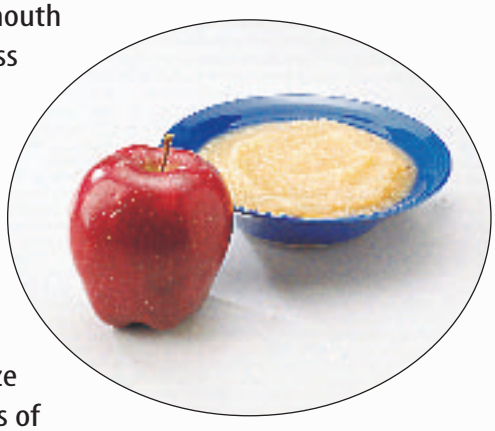
beakers or jars (3)
thermometers (3)
sugar granules
mortar and pestle
triple-beam balance
stirring rod
sugar cubes
weighing paper
warm water
stopwatch

Safety Precautions

WARNING: *Never taste, eat, or drink any materials used in the lab.*

Real-World Question

Before food reaches the small intestine, it is digested mechanically in the mouth and the stomach. The food mass is reduced to small particles. You can chew an apple into small pieces, but you would feed applesauce to a small child who didn't have teeth. What is the advantage of reducing the size of the food material? Does reducing the size of food particles aid the process of digestion?



Procedure

1. Copy the data table below into your Science Journal.

Dissolving Times of Sugar Particles

Size of Sugar Particles	Mass	Time Until Dissolved
Sugar cube		
Sugar granules		
Ground sugar particles		

2. Place a sugar cube into your mortar and grind up the cube with the pestle until the sugar becomes powder.
3. Using the triple-beam balance and weighing paper, measure the mass of the powdered sugar from your mortar. Using separate sheets of weighing paper, measure the mass of a sugar cube and the mass of a sample of the granular sugar. The masses of the powdered sugar, sugar cube, and granular sugar should be approximately equal to each other. Record the three masses in your data table.
4. Place warm water into the three beakers. Use the thermometers to be certain the water in each beaker is the same temperature.

5. Place the sugar cube in a beaker, the powdered sugar in a second beaker, and the granular sugar in a third beaker. Place all the sugar samples in the beakers at the same time and start the stopwatch when you put the sugar samples in the beaker.
6. Stir each sample equally.
7. Measure the time it takes each sugar sample to dissolve and record the times in your data table.

Analyze Your Data

1. **Identify** the experiment's constants and variables.
2. **Compare** the rates at which the sugar samples dissolved. What type of sugar dissolved most rapidly? Which was the slowest to dissolve?

Conclude and Apply

1. **Predict** how long it would take sugar particles larger than the sugar cubes to dissolve. Predict how long it would take sugar particles smaller than the powdered sugar to dissolve.
2. **Infer** and explain the reason why small particles dissolve more rapidly than large particles.
3. **Infer** why you should thoroughly chew your food.
4. **Explain** how reducing the size of food particles aids the process of digestion.

Communicating Your Data

Write a news column for a health magazine explaining to health-conscious people what they can do to digest their food better.

Matt Meadows

Does the same diet work for everyone?

Growing up in India in the first half of the twentieth century, R. Rajalakshmi (RAH jah lok shmee) saw many people around her who did not get enough food. Breakfast for a poor child might have been a cup of tea. Lunch might have consisted of a slice of bread. For dinner, a child might have eaten a serving of rice with a small piece of fish. This type of diet, low in calories and nutrients, produced children who were often sick and died young.

In the 1960s, R. Rajalakshmi was asked to help manage a program to improve nutrition in her country. North American and European nutritionists suggested foods that were common and worked well for people who lived in these nations. But Rajalakshmi knew this advice was useless in a country such as India.

The Proper Diet for India

Rajalakshmi knew that for a nutrition program to work, it had to fit Indian culture. First, she found out what healthy middle-class people in India ate. She took note of the nutrients available in those foods. Then she looked for cheap, easy-to-find foods that would provide the same nutrients. Rajalakshmi created a balanced diet of locally grown fruits, vegetables, and grains.

Rajalakshmi's ideas were thought unusual in the 1960s. For example, she insisted that a diet without meat could provide all major nutrients. It took persistence to get others to accept her ideas. Because of Rajalakshmi's program, Indian children almost doubled their food intake. Many children who would have been hungry and ill, grew healthy and strong.

Thanks to R. Rajalakshmi and other nutritionists, many children in India are eating well and staying healthy.

Report Choose a continent and research what foods are native to that area. As a class, compile a list of the foods and where they originated. Using the class list, create a world map on a bulletin board that shows the origins of the different foods.

ScienceOnline
For more information, visit green.msscience.com/time

Reviewing Main Ideas

Section 1 The Digestive System

1. Mechanical digestion breaks down food through chewing and churning. Enzymes and other chemicals aid chemical digestion.
2. Food passes through the mouth, esophagus, stomach, small intestine, large intestine, and rectum and then out the anus.
3. The large intestine absorbs water, which helps the body maintain homeostasis.

Section 2 Nutrition

1. Proteins, carbohydrates, fats, vitamins, minerals, and water are the six nutrients found in foods.
2. Health is affected by the combination of foods that make up a diet.

Section 3 The Respiratory System

1. The respiratory system brings oxygen into the body and removes carbon dioxide.
2. Breathing is the movement of the chest that allows air to move into the lungs and waste gases to leave the lungs.
3. The chemical reaction in cells that needs oxygen to release energy and produces carbon dioxide and water as wastes is called cellular respiration.
4. Smoking causes many respiratory problems, including chronic bronchitis, emphysema, and lung cancer.

Section 4 The Excretory System

1. The urinary system is part of the excretory system. The skin, lungs, liver, and large intestine are also excretory organs.
2. The kidneys are the major organs of the urinary system and have a two-stage filtration system that removes wastes.
3. When kidneys fail to work, an artificial kidney can be used to filter the blood in a process called dialysis.

Visualizing Main Ideas

Copy and complete the following table on the respiratory and excretory systems.

Human Body Systems

	Respiratory System	Excretory System
Major Organs		
Wastes Eliminated		
Disorders		

chapter 14 Review

Using Vocabulary

alveoli p. 414
amino acid p. 405
bladder p. 421
bronchi p. 414
carbohydrate p. 406
chyme p. 403
enzyme p. 400
larynx p. 414
mineral p. 408
nephron p. 421
nutrient p. 400
peristalsis p. 402
trachea p. 414
ureter p. 421
villi p. 403
vitamin p. 407

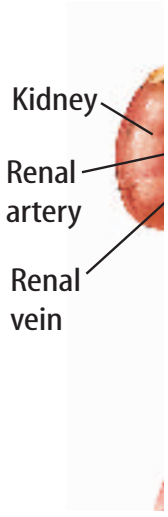
Fill in the blanks with the correct vocabulary word or words.

1. _____ is the muscular contractions of the esophagus.
2. The building blocks of proteins are _____.
3. The liquid product of digestion is called _____.
4. _____ are inorganic nutrients.
5. _____ are the filtering units of the kidney.
6. _____ are thin-walled sacs in the lungs.
7. The _____ is an elastic muscular organ that holds urine.

Checking Concepts

Choose the word or phrase that best answers the question.

8. Where in humans does most chemical digestion occur?
   A) duodenum **C)** liver
   B) stomach **D)** large intestine
9. In which organ is water absorbed?
   A) liver **C)** small intestine
   B) esophagus **D)** large intestine
10. Which of these organs is an accessory organ?
    A) mouth **C)** small intestine
    B) stomach **D)** liver
11. What beneficial substances are produced by bacteria in the large intestine?
    A) fats **C)** vitamins
    B) minerals **D)** proteins
12. Which food group contains yogurt and cheese?
    A) dairy **C)** meat
    B) grain **D)** fruit
13. When you inhale, which of the following contracts and moves down?
    A) bronchioles **C)** nephrons
    B) diaphragm **D)** kidneys
14. Exchange of gases occurs between capillaries and which of the following structures?
    A) alveoli **C)** bronchioles
    B) bronchi **D)** trachea
15. Which of the following conditions does smoking worsen?
    A) arthritis **C)** excretion
    B) respiration **D)** emphysema
16. Urine is held temporarily in which of the following structures?



17. Which of the following substances is not reabsorbed by blood after it passes through the kidneys?
    A) salt **C)** wastes
    B) sugar **D)** water

Thinking Critically

18. Make and use a table to sequence the order of organs in the digestive system through which food passes. Indicate whether ingestion, digestion, absorption, or elimination takes place in each.

19. Compare and contrast the three types of carbohydrates—sugar, starch, and fiber.

20. Classify the parts of your favorite sandwich into three of the nutrient categories—carbohydrates, proteins, and fats.

21. Recognize cause and effect by discussing how lack of oxygen is related to lack of energy.

22. Form a hypothesis about the number of breaths a person might take per minute in each of these situations: asleep, exercising, and on top of Mount Everest. Give a reason for each hypothesis.

23. Concept Map Make an events-chain concept map showing how urine forms in the kidneys. Begin with, "In the nephron …"

Use the table below to answer question 24.

Materials Filtered by the Kidneys

Substance Filtered in Urine	Amount Moving Through Kidney	Amount Excreted
Water	125 L	1 L
Salt	350 g	10 g
Urea	1 g	1 g
Glucose	50 g	0 g

24. Interpret Data Study the data above. How much of each substance is reabsorbed into the blood in the kidneys? What substance is excreted completely in the urine?

25. Describe how bile aids the diegestive process.

26. Explain how the bacteria that live in your large intestine help your body.

Performance Activities

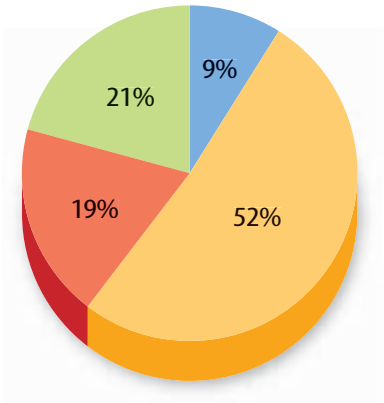
27. Questionnaire and Interview Prepare a questionnaire that can be used to interview a health specialist who works with lung cancer patients. Include questions on reasons for choosing the career, new methods of treatment, and the most encouraging or discouraging part of the job.

Applying Math

28. Kidney Blood Flow In approximately 5 min, all 5 L of blood in the body pass through the kidneys. Calculate the average rate of flow through the kidneys in liters per minute.

Use the graph below to answer question 29.

Total Lung Capacity



Total Lung Capacity = 5800 mL

- Volume of air normally inhaled or exhaled
- Volume of additional air that can be inhaled forcefully
- Volume of additional air that can be exhaled forcefully
- Volume of air left in lungs after forcefully exhaling

29. Total Lung Capacity What volume of air (mL) is left in the lungs after forcefully exhaling?

Part 1 Multiple Choice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Use the table below to answer questions 1 and 2.

Nutrition Facts of Vanilla Ice Cream		
Item	**Amount**	**DV (Daily Values)**
Serving Size	112 g	0
Calories	208	0
Total Fat	19 g	29%
Saturated Fat	11 g	55%
Cholesterol	0.125 g	42%
Sodium	0.90 g	4%
Total Carbohydrates	22 g	7%
Fiber	0 g	0%
Sugars	22 g	n/a
Protein	5 g	n/a
Calcium	0.117 g	15%
Iron	n/a	0%

1. According to this information, which mineral has the greatest Daily Value (DV) percentage?

A. sodium **C.** iron
B. cholesterol **D.** calcium

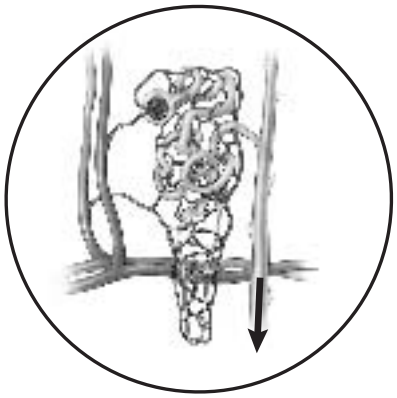
2. How many grams of saturated fat and Daily Value (DV) percentage in two servings of this ice cream?

A. 11 g, 110% **C.** 21 g, 55%
B. 22 g, 110% **D.** 5.5 g, 110%

Test-Taking Tip

Answer All Questions Never skip a question. If you are unsure of an answer, mark your best guess on another sheet of paper and mark the question in your test booklet to remind you to come back to it at the end of the test.

Use the illustration below to answer question 3.



3. What is the structure shown above and to what body system does it belong?

A. capillary—circulatory
B. alveolus—respiratory
C. nephron—urinary
D. ureter—excretory

4. If all of the blood in your body passes through the kidneys in 5 minutes, how many times does all of your blood pass through the kidneys in one hour?

A. 12 times **C.** 5 times
B. 6 times **D.** 20 times

5. Which of the following is the correct sequence of the organs of the digestive tract?

A. mouth, stomach, esophagus, small intestine, large intestine
B. esophagus, mouth, stomach, small intestine, large intestine
C. mouth, small intestine, stomach, large intestine
D. mouth, esophagus, stomach, small intestine, large intestine

6. Which of the following diseases may be caused by smoking?

A. lung cancer **C.** influenza
B. diabetes **D.** bladder infection

Part 2 Short Response/Grid In

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

7. Explain the difference between organic and inorganic nutrients. Name a class of nutrients for each.

8. Enzymes play an important role in the digestive process. But enzyme-aided reactions are also involved in other body systems. Give an example of how enzymes are used by the body in a way that does not involve the digestive system.

Use the table and paragraph below to answer questions 9–12.

For one week, research scientists collected and accurately measured the amount of body water lost and gained per day for four different patients. The following table lists results from their investigation.

Body Water Gained (+) and Lost (−)				
Patient	**Day 1 (L)**	**Day 2 (L)**	**Day 3 (L)**	**Day 4 (L)**
Mr. Stoler	+0.15	+0.15	−0.35	+0.12
Mr. Jemma	−0.01	0.00	−0.20	−0.01
Mr. Lowe	0.00	+0.20	−0.28	+0.01
Mr. Cheng	−0.50	−0.50	−0.55	−0.32

9. What was Mr. Cheng's average daily body water loss for the 4 days shown in the table?

10. Which patient had the greatest amount of body water gained on days 1 and 2?

11. According to the data in the table, on which day was the temperature in each patient's hospital room probably the hottest?

12. Which patient had the highest total gain in body water over the 4-day period?

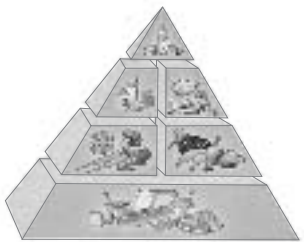
Part 3 Open Ended

Record your answers on a sheet of paper.

13. Explain the role of cilia in the respiratory system. In chronic bronchitis, cilia are damaged. What effects does this damage have on the respiratory system?

14. Antibiotics may be given to help a person fight off a bacterial infection. If a person is taking antibiotics, what might happen to the normal bacteria living in the large intestine? How would this affect the body?

Use the illustration below to answer questions 15 and 16.



15. Identify the food group shown at the base of the food pyramid. Explain why the greatest number of servings should come from this group.

16. Identify the food group at the top of the pyramid. Explain why the least number of servings should come from this group.

17. Sometimes the esophagus can be affected by a disease in which the smooth muscle in the wall of the esophagus does not work properly. What do you think would happen to food that the person swallowed? Why?

18. Compare and contrast the roles of mucus in the digestive and respiratory systems.

19. Urine can be tested for any signs of a urinary tract disease. Mrs. Chavez had a urine test that showed protein in the urine. What might the results of this urine test mean?