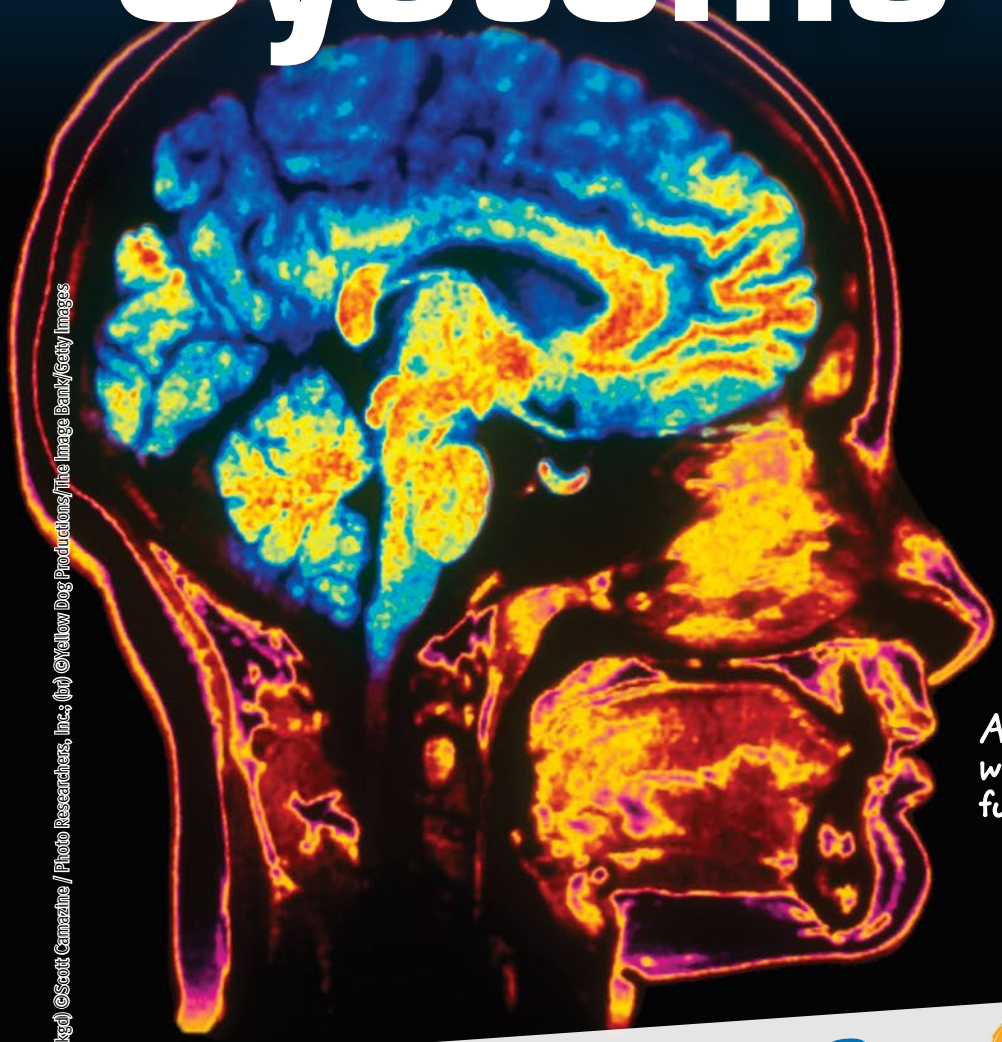
UNIT 4

Human Body Systems



A brain scan can show whether the brain is functioning normally.

Big Idea

The human body is made up of systems that have different functions, and these systems interact to carry out life processes.

S7L2., S7L2.c

What do you think?

Technology like the MRI scanner allows us to study the living body. How does the living body work? As you explore the unit, gather evidence to help you state and support claims to answer this question.

A patient must stay still to get an accurate MRI scan.

Unit 4

Human Body Systems

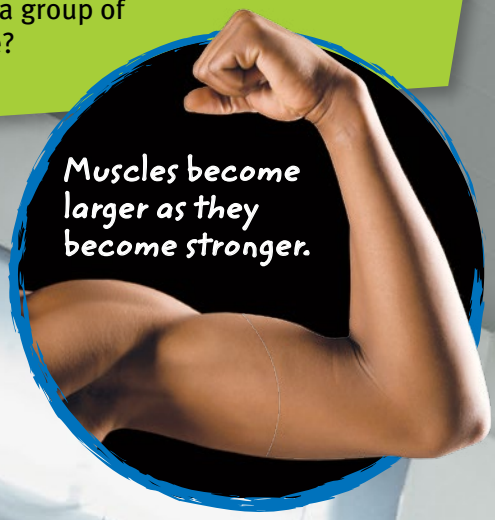
CITIZEN SCIENCE

Muscles at Work

Design a test for muscle endurance or strength.

1 Define The Problem

Unlike many things that wear out with use, our muscles actually get stronger the more often they are used. Doing different kinds of exercises helps different groups of muscles. But how can you tell if you are improving? How can you tell how strong a group of muscles are?



Muscles become larger as they become stronger.

Strength moves like this hold take practice and training.

2 Think About It

Design a test for a group of muscles.

Choose a group of muscles that you would like to work with. Then, come up with one or two simple exercises that can be done to show either how strong the muscles are or how well they are able to work continuously. Place a time limit on your tests so that the tests don't take too long.

Check off the points below as you use them to design your test.

- ☐ The kind of action the muscles can do.
- ☐ To do the test safely, remember to isolate the group of muscles. (Research how to do an exercise safely.)
- ☐ The equipment you will need for the test.

3 Plan and Test Your Design

A Write out how you will conduct your test in the space below. Check your plan with your teacher before proceeding.

B Conduct the test on yourself. Have a classmate time you, help you count, or make any other measurements that you might need help with. Briefly state your findings.

Take It Home

Do the same exercises at home for two weeks. Do strength training exercises every second day to avoid injury. Do continuous movement exercises, such as running, every day. Then, conduct your test again. See if there is any improvement. Report your findings to the class. See *ScienceSaurus*® for more information about muscular systems.

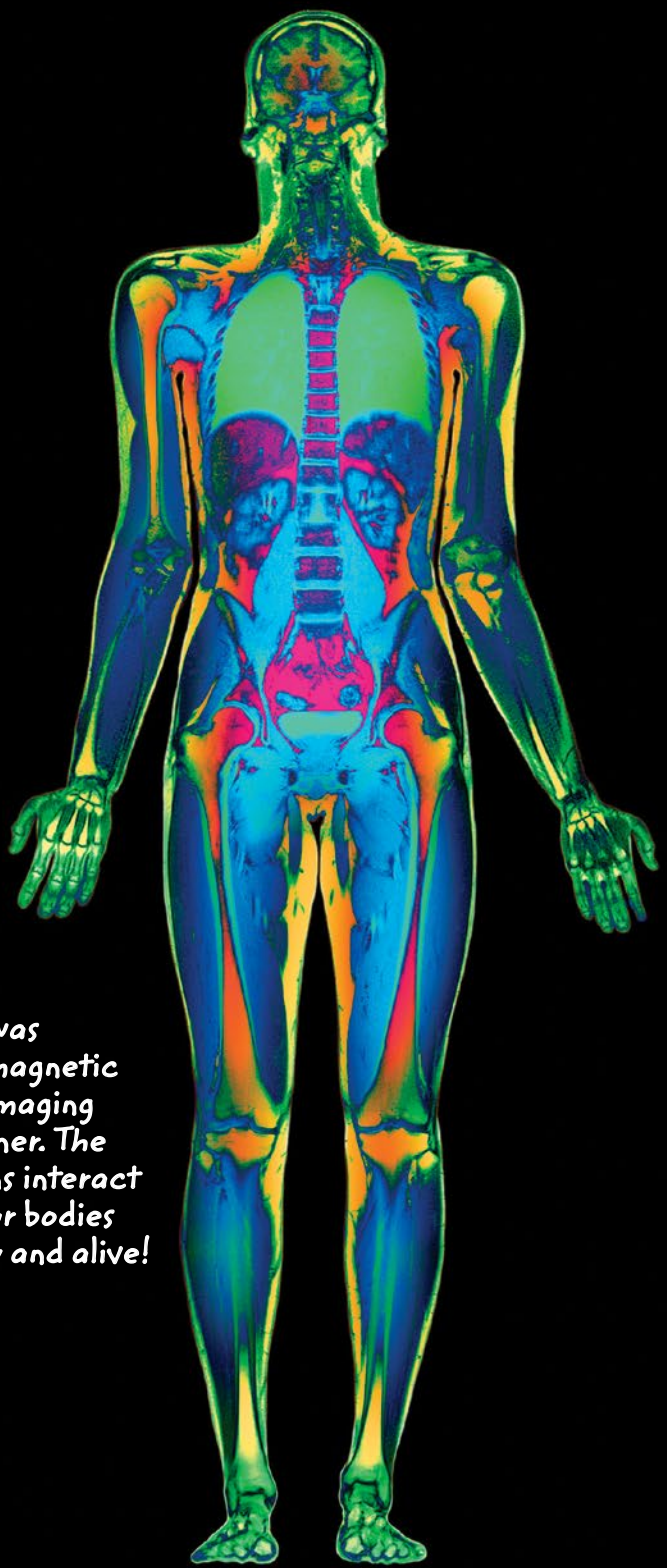
Lesson 1

Introduction to Body Systems

ESSENTIAL QUESTION

How do the body systems interact to maintain homeostasis?

By the end of this lesson, you should be able to describe the functions of the human body systems, including how they interact to maintain homeostasis.



This image was made by a magnetic resonance imaging (MRI) scanner. The body's organs interact to ensure our bodies stay healthy and alive!

S7L2.c Body systems interactions

Lesson Labs

Quick Labs

- Balancing Act
- Body Systems: Their Structures and Functions

Engage Your Brain

1 Predict Check T or F to show whether you think each statement is true or false.

T	F	
☐	☐	Your muscles provide a framework that supports and protects your body.
☐	☐	When you breathe in and out, you're using your lungs.
☐	☐	Your nervous system gets rid of wastes from your body.
☐	☐	When you eat food, it enters your digestive system.

2 Identify Draw a diagram of your body showing at least four organs. As you read the lesson, write down the organ system that each organ is a part of.

Active Reading

3 Synthesize You can often define an unknown word if you know the meaning of its word parts. Use the word parts and sentence below to make an educated guess about the meaning of the word *homeostasis*.

Greek word	Meaning
homoios	same
stasis	standing

Example sentence

In order to maintain homeostasis, the cardiovascular system and the respiratory system interact to move oxygen-carrying blood around the body.

homeostasis:

Vocabulary Term

- **homeostasis**

4 Apply As you learn the definition of the vocabulary term in this lesson, make a sketch that shows the meaning of the term or an example of that term. Next to your drawing, write your own definition of the term.

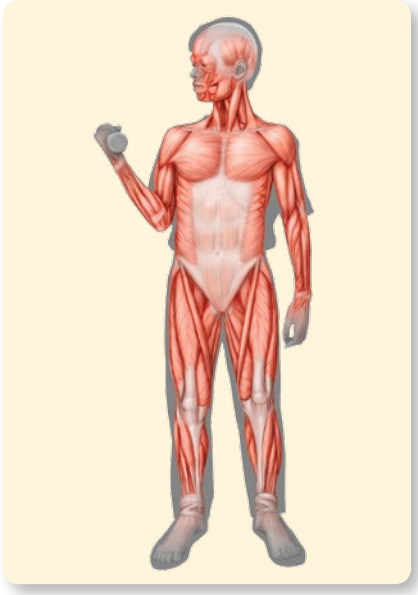
What do the body systems do?

Humans and other organisms need to get energy. They need to use energy to run their bodies and move. They need to reproduce. They need to get rid of waste and protect their bodies. Body systems, also called *organ systems*, help organisms do all of these things. They interact to carry out life processes, and they also coordinate all the functions of a body.

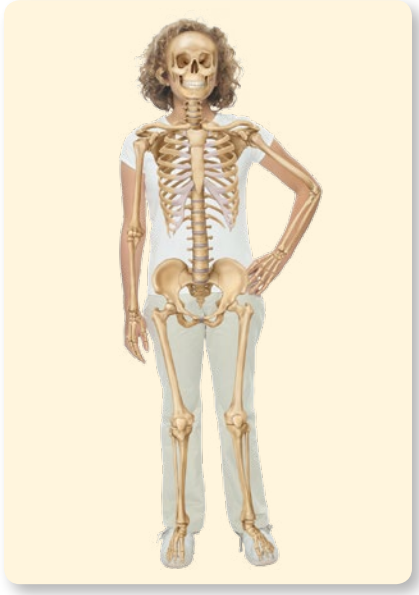
Groups of organs that interact form body systems. Nerves detect a stimulus in the environment and send a signal through the spinal cord to the brain. The brain sends a signal to respond. Without all the parts, the system would not work. Some organs work in more than one organ system.

Inside Out

Active Reading **5 Identify** As you read about body systems on these pages, underline the main function of each body system.

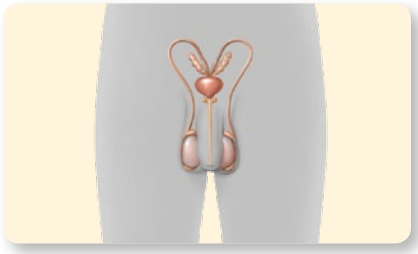


The muscular system allows movement of body parts. It interacts with the skeletal system to help you move.

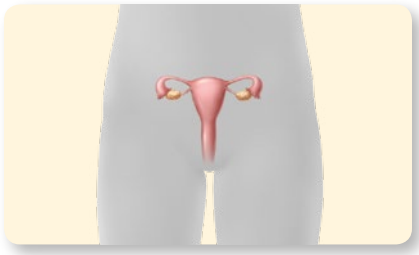


The skeletal system is made up of bones, ligaments, and cartilage. It supports the body and protects important organs. It also makes blood cells.

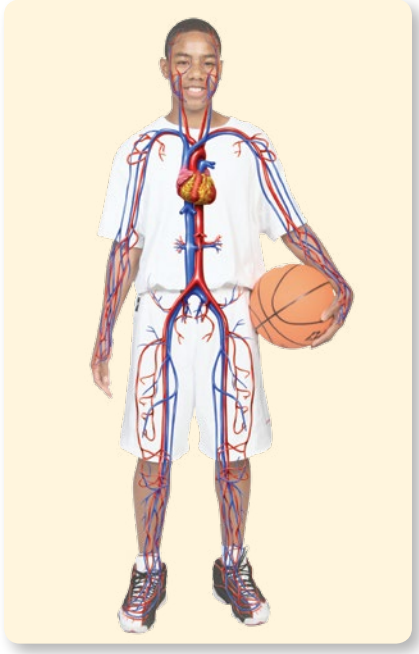
The respiratory system gathers oxygen from the environment and gets rid of carbon dioxide from the body. The exchange occurs in the lungs.



The male reproductive system produces sperm and delivers it to the female reproductive system.



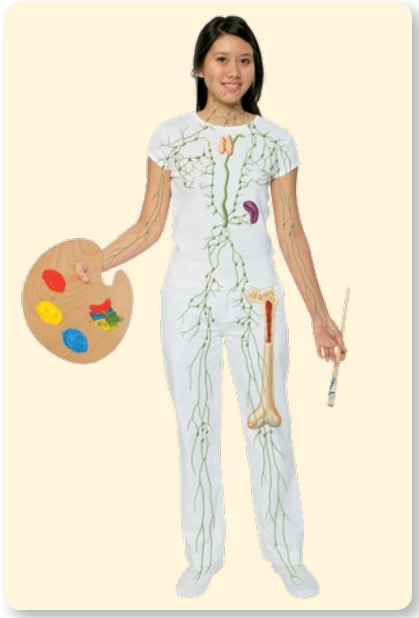
The female reproductive system produces eggs and nourishes a developing fetus.



The cardiovascular system moves blood through the body. The heart is the pump for this system. Blood flows through blood vessels.

Visualize It!

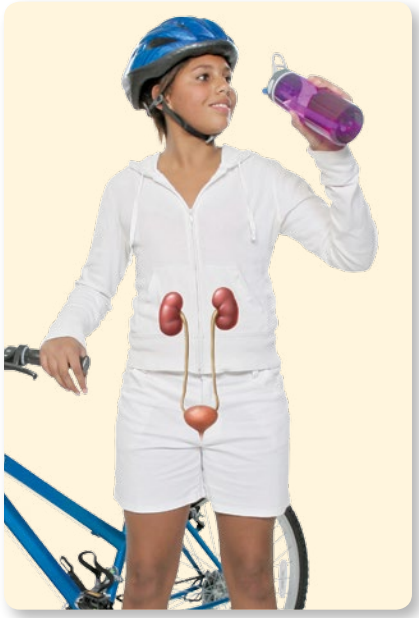
6 Analyze Look closely at the body systems shown on these pages. Then circle the two parts that make up the immune system and explain how this system of the body interacts with other systems.



The lymphatic system returns leaked fluid back to the blood. As a major part of the immune system, it has cells that help get rid of invading bacteria and viruses.

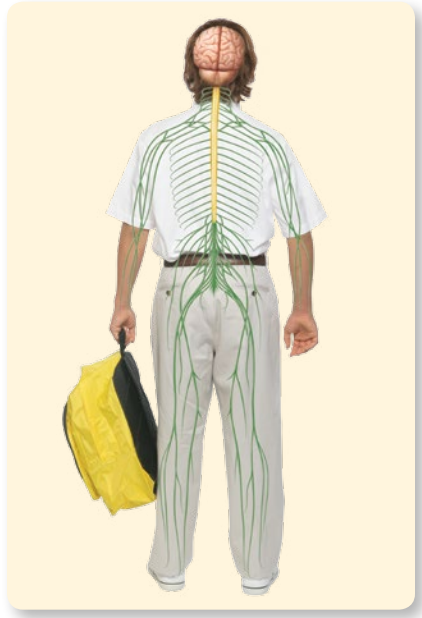
The endocrine system makes chemical messages. These messages help to regulate conditions inside the body. They also influence growth and development.

The integumentary system is the protective covering of the body. It includes the skin, hair, and nails. As part of the immune system, the skin acts as a barrier that protects the body from infection.



The excretory system gets rid of the body's wastes. The urinary system, shown here, removes wastes from blood. The skin, lungs, and digestive system also remove wastes from the body.

The digestive system breaks down food into nutrients that can be used by the body. The stomach breaks down food into tiny pieces. Nutrients are absorbed in the small intestine.



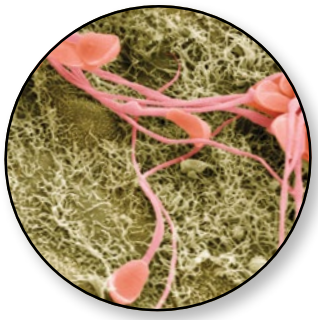
The nervous system collects information and responds to it by sending electrical messages. This information may come from outside or inside the body. The brain is the center of the nervous system.

A Closer Look

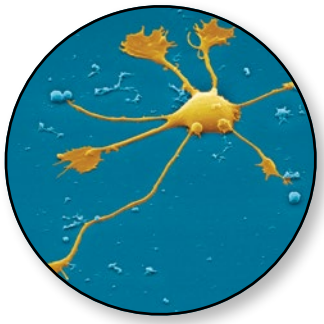
How are structure and function linked?

Even though animals may look very different on the outside, on the inside, their cells, tissues, and organs look very similar. This is because these structures do the same basic job. For example, a frog's heart, a bird's heart, and a human's heart all have the same function, to pump blood around the body. They are all made of the same type of muscle tissue, which is made up of the same type of muscle cells. The structure of the hearts is similar, too. Though their shape may be a little different from each other, they are all muscular pumps that push blood around the body.

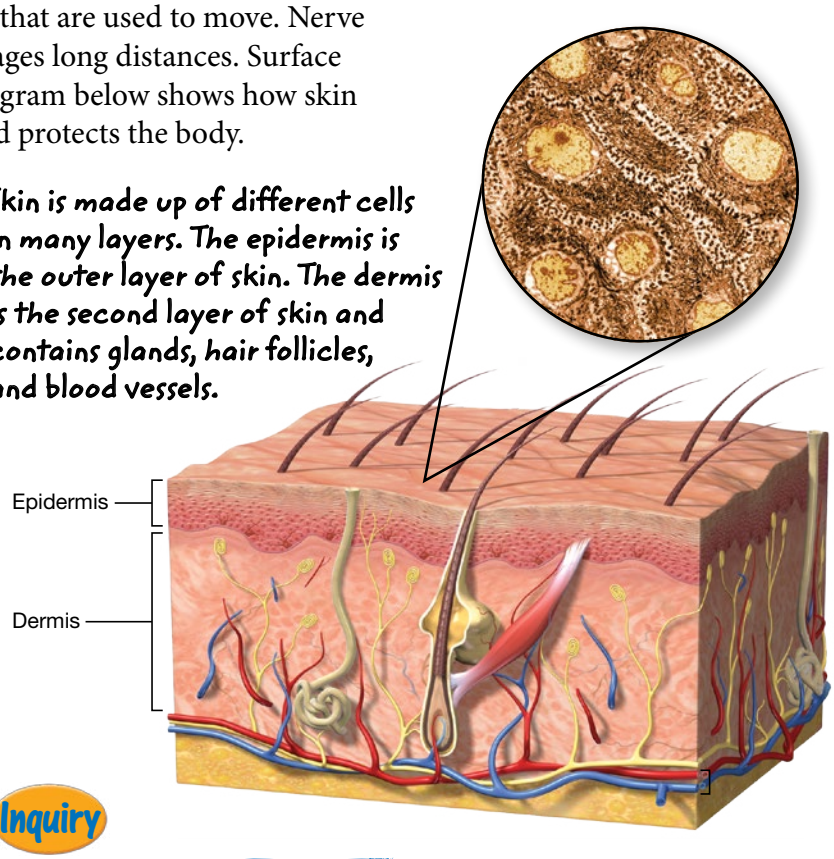
The shapes and sizes of cells are related to their function. For example, sperm cells have long tails that are used to move. Nerve cells are long and thin to send messages long distances. Surface skin cells are broad and flat. The diagram below shows how skin cells form the skin, which covers and protects the body.



Sperm cells can "swim." They have long tails that whip around to move the cells.



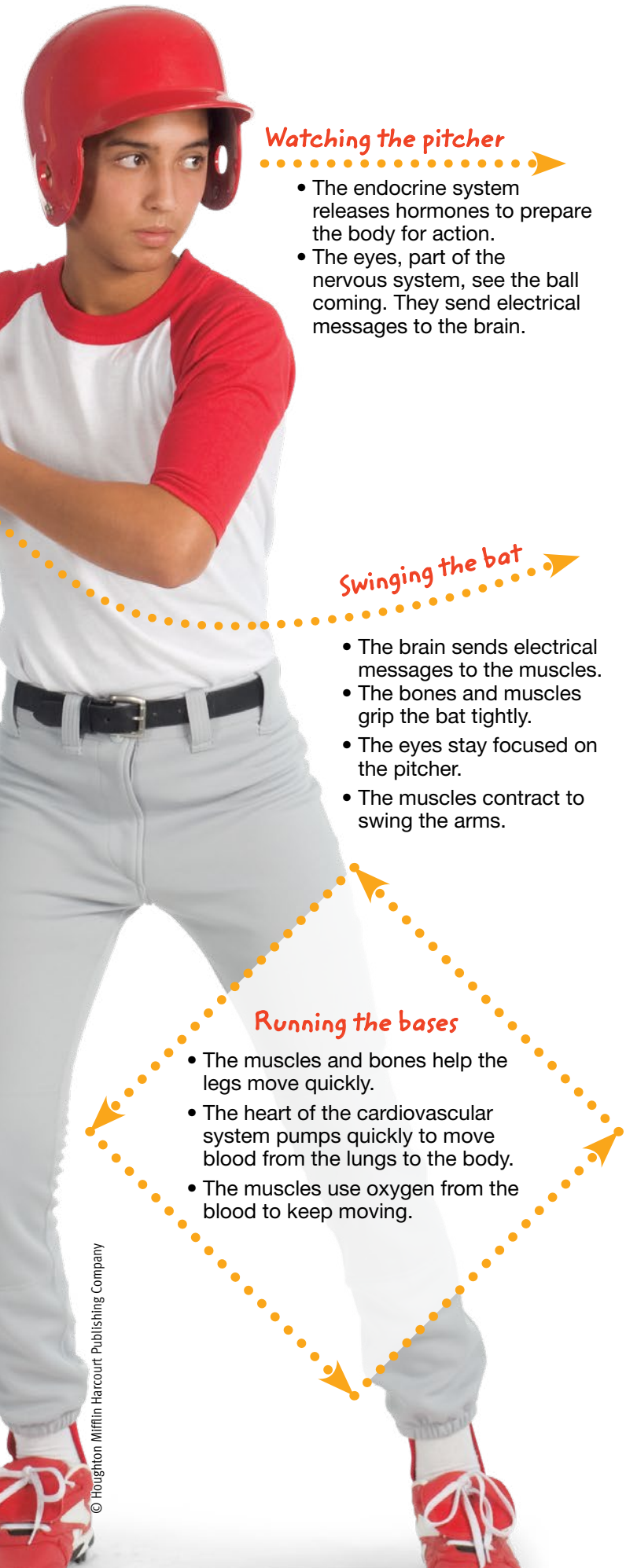
Nerve cells have long, thin branches to send electrical messages between the brain and far-away body parts.



Skin is made up of different cells in many layers. The epidermis is the outer layer of skin. The dermis is the second layer of skin and contains glands, hair follicles, and blood vessels.

Inquiry

7 Infer Muscle cells can get longer and shorter. How does this ability fit in with their job in the body? State your claim. Give examples to support your reasoning.



Watching the pitcher

- The endocrine system releases hormones to prepare the body for action.
- The eyes, part of the nervous system, see the ball coming. They send electrical messages to the brain.

Swinging the bat

- The brain sends electrical messages to the muscles.
- The bones and muscles grip the bat tightly.
- The eyes stay focused on the pitcher.
- The muscles contract to swing the arms.

Running the bases

- The muscles and bones help the legs move quickly.
- The heart of the cardiovascular system pumps quickly to move blood from the lungs to the body.
- The muscles use oxygen from the blood to keep moving.

How do body systems interact?

Our body systems can do a lot, but they can't work alone! Almost everything we need for our bodies to work properly requires many body systems to interact. For example, the nervous system may sense danger. The endocrine system releases hormones that cause the heart to beat faster to deliver more oxygen through the circulatory system to muscles. The muscular system and skeletal system interact to run away from danger.

Active Reading **8 Identify** As you read the captions on the left, underline examples of body systems interacting.

Body Systems Share Organs

Many organs are part of several body systems. Reproductive organs are part of the reproductive system and part of the endocrine system. The liver works in the digestive system, but it is also part of the excretory system. The heart is part of the muscular system and the cardiovascular system. Blood vessels, too, are shared. For example, blood vessels transport chemical messages from the endocrine system and cells from the lymphatic and cardiovascular systems.

Body Systems Communicate

There are two basic ways cells communicate: by electrical messages and by chemical messages. Nerve cells transfer information between the body and the spinal cord and brain. Nerves pass electrical messages from one cell to the next along the line. The endocrine system sends chemical messages through the bloodstream to certain cells.

9 Apply When you are finished running the bases, you are sweating and you feel thirsty. What body systems are interacting in this case?

Keeping the Balance

What is homeostasis?

Cells need certain conditions to work properly. They need food and oxygen and to have their wastes taken away. If body conditions were to change too much, cells would not be able to do their jobs. **Homeostasis** (hoh•mee•oh•STAY•sis) is the maintenance of a constant internal environment when outside conditions change. Responding to change allows all systems to work properly.

Responding to Change

If the external environment changes, body systems interact to keep conditions stable within the body. For example, if body cells were to get too cold, they would not work properly and they could die. So, if the brain senses the body temperature is getting too low, it tells the muscles to shiver. Shivering muscles release energy as heat, which warms the body. Your brain will also tell you to put on a sweater!

Maintaining a Balance

To maintain homeostasis, the body has to recognize that conditions are changing and then respond in the right way. In order to work, organ systems need to communicate properly. The electrical messages of the nervous system and chemical signals of the endocrine system tell the body what changes to make. If the body cannot respond properly to the internal messages or to an external change, a disease may develop.

A thermostat keeps an even temperature in a room by turning the heater off when it gets too warm, and on when it gets too cold. Your body does the same thing, but in a different way.

Visualize It!

10 Relate How does the body react when the outside temperature gets too hot?

What can go wrong with homeostasis?

If one body system does not work properly, other systems of the body can be affected. For example, body cells that do not get enough energy or nutrients cannot work properly. A lack of food harms many systems and may cause disease or even death. The presence of toxins or pathogens also can disrupt homeostasis. Toxins can prevent cells from carrying out life processes and pathogens can break down cells. Problems also occur if the body's messages do not work, or they are not sent when or where they are needed. Many diseases which affect homeostasis are hereditary.

Active Reading

11 Identify As you read this page, underline what can happen if homeostasis is disrupted.

Structure or Function Diseases

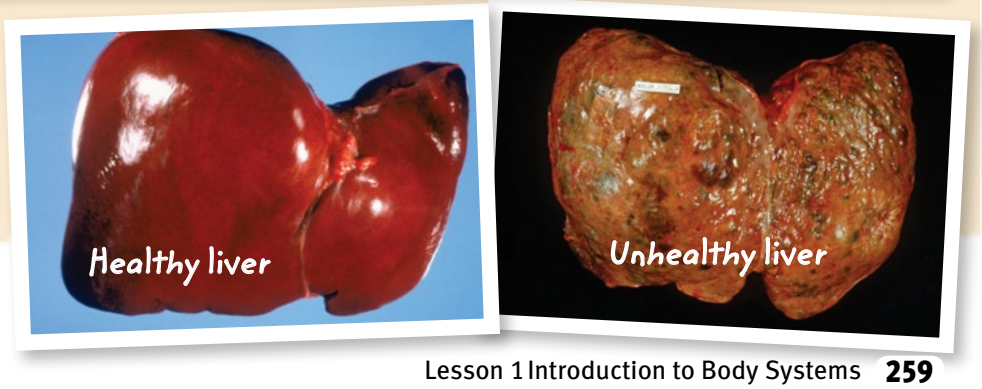
Problems with the structure or function of cells, tissues, or organs can affect the body. For example, diabetes is a disease that affects cell function. Certain changes in body cells stop them from taking glucose in from the blood as they normally do. If cells cannot get energy in the form of glucose, they cannot work properly.

Pathogens and Disease

When the body cannot maintain homeostasis, it is easier for pathogens to invade the body. Pathogens can also cause a disruption in homeostasis. For example, tuberculosis is a lung disease caused by bacteria. It weakens the lungs and body. Weakened lungs cannot take in oxygen well. Low oxygen levels affect the whole body.

12 Apply Alcoholism is a disease that disrupts homeostasis. Below are three body systems that are affected by alcohol. The effects on the nervous system are filled in. In the space provided, predict what might happen when the function of the two remaining systems is affected.

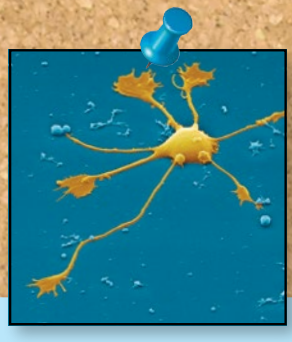
Body systems affected	What are the effects?
Nervous system	Disrupts proper functioning of the brain. The brain cannot respond properly to internal or external messages.
Digestive system	
Reproductive system	



Alcoholism can damage the structure and function of the liver and reduce its ability to remove toxins from the blood.

Visual Summary

To complete this summary, fill in the blanks with the correct word or phrase. Then use the key below to check your answers. You can use this page to review the main concepts of the lesson.



Body Systems and Homeostasis

Body systems each have specific jobs.

13 The _____ system brings oxygen into the blood and releases carbon dioxide from the body.

The structure of cells, tissues, and organs are linked to their functions.

14 The long, thin cells of the _____ system help transmit electrical messages around the body.

The muscular heart pushes _____ around the body .

Body systems interact, which allows the body to work properly.

15 The _____ and _____ systems interact to allow the player to swing the bat.

The body maintains homeostasis by adjusting to change.

16 If body temperature goes up, the _____ senses the change and will work to reduce the body temperature to normal.

Answers: 13 respiratory; 14 nervous, blood; 15 nervous, muscular (either order); 16 brain

17 Claims • Evidence • Reasoning How might disruption of the respiratory system affect homeostasis of the body? State your claim. Summarize evidence to support your claim and explain your reasoning.

Lesson Review

Vocabulary

Use a term from the lesson to complete each sentence below.

1 _____ is maintaining stable conditions inside the body.

2 A group of organs that interact is called a(n) _____ .

Key Concepts

3 Compare How are the functions of the skeletal and muscular systems related?

4 Identify What body system receives information from inside and outside the body and responds to that information?

5 Explain How is skin part of the integumentary system and the excretory system?

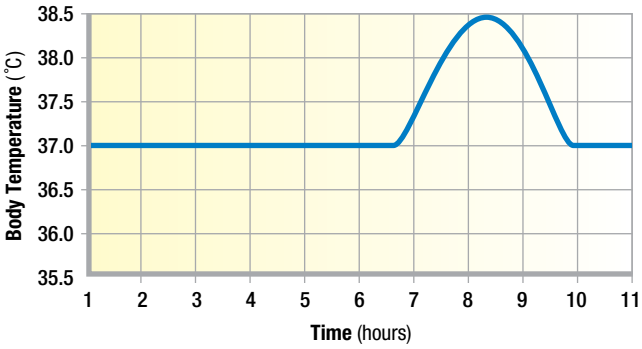
6 Describe What are the basic needs of all cells in the body?

7 Relate Give an example of how a cell's structure relates to its function in the body.

Critical Thinking

Use the graph to answer the following questions.

Body Temperature over Time



8 Analyze Is the body in homeostasis during the entire time shown in the graph? Explain.

9 Predict What would happen to the body if the body temperature continued to decrease during the tenth hour instead of leveling off?

10 Apply Make a claim about how drinking large volumes of plain water after exercising may affect the salt balance in the body. Summarize evidence and explain your reasoning.

11 Infer Reflect on how the failure of a specific body system to function properly would affect other body systems. Build an argument for why all body systems must interact to carry out life processes based on your example. Provide evidence and give details.

My Notes

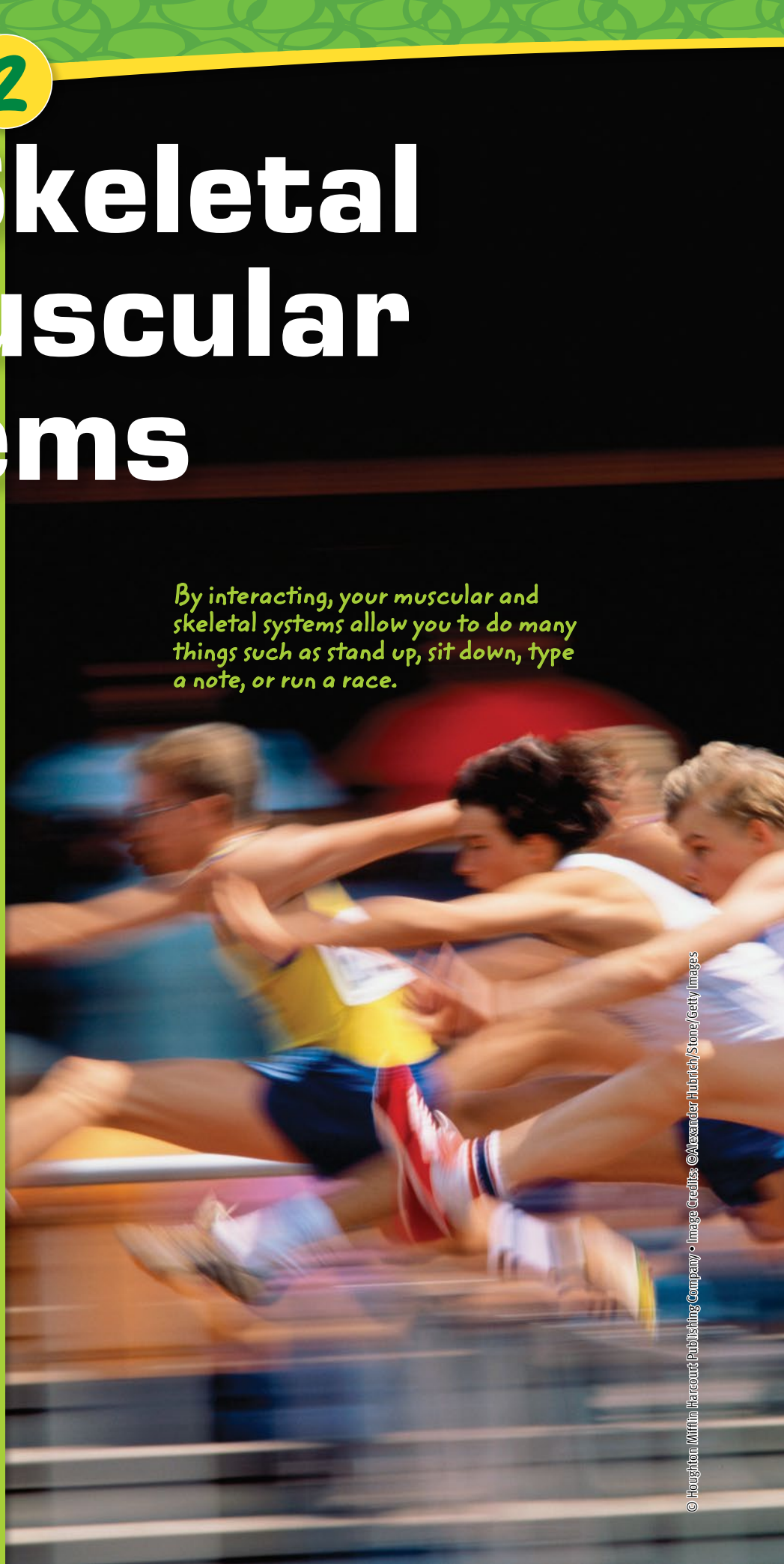
Lesson 2

The Skeletal and Muscular Systems

ESSENTIAL QUESTION

How do your skeletal and muscular systems work?

By the end of this lesson, you should be able to explain how the skeletal and muscular systems interact to allow movement of the body.



By interacting, your muscular and skeletal systems allow you to do many things such as stand up, sit down, type a note, or run a race.

Lesson Labs

Quick Labs
- Power in Pairs
- Speed of a Reflex

Exploration Lab
- A Closer Look at Muscles

Engage Your Brain

1 Identify Circle the terms that best complete the following sentences.

The *skeletal / muscular* system is responsible for supporting the body.

Bones are part of your *skeletal / muscular* system.

Your heart is made up of *bone / muscle* tissue.

You can increase your flexibility by stretching your *bones / muscles*.

2 Infer This x-ray shows a broken arm. How might this injury affect your ability to move?

Active Reading

3 Synthesize You can often identify functions of a body part if you know what its name means. Use the Latin words below and context clues to make an educated guess about a function of *ligaments* and *tendons*.

Latin word	Meaning
ligare	to tie
tendere	to stretch

Example sentence
Ligaments are found at the ends of bones.

ligament:

Example Sentence
Tendons connect muscles to bones.

tendon:

Vocabulary Terms

- **skeletal system**
- **muscular system**
- **ligament**
- **tendon**
- **joint**

4 Apply As you learn the definition of each vocabulary term in this lesson, create your own definition or sketch it to help you remember the meaning of the term.

What's Inside?

What are the main functions of the skeletal system?

When you hear the word *skeleton*, you might think of the dry, white bones that you see in the models in your science class. You might think your bones are lifeless, but they are very much alive. The **skeletal system** is the organ system that supports and protects the body and allows it to move. Its other jobs include storing minerals and producing red blood cells. A human's skeleton is inside the body, so it is called an *endoskeleton*.

Active Reading

5 Identify As you read, underline the main functions of the skeletal system.

Visualize It!

6 Relate How might a suit of armor be a good analogy for a function of the skeletal system? State your claim. Summarize evidence to support your claim.

Protection

Bones provide protection to organs. For example, your ribs protect your heart and lungs, your vertebrae protect your spinal cord, and your skull protects your brain.

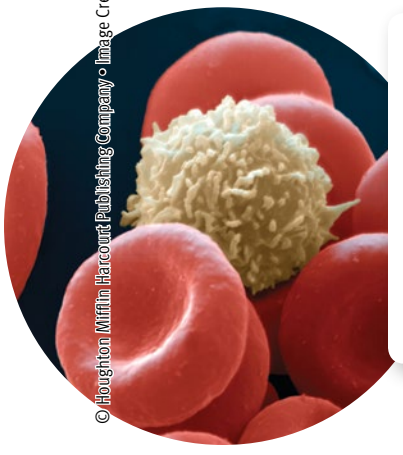
Storage

The hard outer layer of bone, called *compact bone*, stores important minerals such as calcium. These minerals are necessary for nerves and muscles to work properly.

Support

Bones provide support for your body and make it possible for you to sit or stand upright. If you did not have bones, you would be a mass of soft tissue, like a slug. However, unlike a slug, you would not be able to move around without your bones.

Skull
Clavicle
Humerus
Ulna
Ribs
Vertebrae
Pelvis
Radius
Femur
Patella
Fibula
Tibia



Blood Cell Production

At the center of bones, such as the long bones in the man's and dog's legs, is soft tissue called *marrow*. Red marrow, a type of marrow that makes blood cells, is found mostly in flat bones, such as the ribs, pelvis, and skull. The red and white blood cells shown here are made in the red bone marrow.

Movement

Bones play an important role in movement by providing a place for muscles to attach. Muscles pull on bones to move the body. Without bones, muscles could not do their job of moving the body.

No Bones About It!

What are the parts of the skeletal system?

Bones, ligaments, and cartilage make up your skeletal system. The skeletal system is divided into two parts. The skull, vertebrae, and ribs make up the *axial skeleton*, which supports the body's weight and protects internal organs. The arms, legs, shoulders, and pelvis make up the *appendicular skeleton*, which allows for most of the body's movement.

Bones

Bones are alive! They have blood vessels, which supply nutrients, and nerves, which signal pain. The body of a newborn baby has about 300 bones, but the average adult has only 206 bones. As a child grows, some bones fuse together.

Ligaments

The tough, flexible strand of connective tissue that holds bones together is a **ligament**. Ligaments allow movement, and are found at the end of bones. Some ligaments, such as the ones on your vertebrae, prevent too much movement of bones.

7 Compare How does the axial skeleton differ from the appendicular skeleton?

Cartilage

Cartilage is a strong, flexible, and smooth connective tissue found at the end of bones. It allows bones to move smoothly across each other. The tip of your nose and your ears are soft and bendy because they contain only cartilage. Cartilage does not contain blood vessels.

What are bones made of?

Bones are hard organs made of minerals and connective tissue. If you looked inside a bone, you would notice two kinds of bone tissue. One kind, called *compact bone*, is dense and does not have any visible open spaces. Compact bone makes bones rigid and hard. Tiny canals within compact bone contain blood capillaries. The other kind of bone tissue, called *spongy bone*, has many open spaces. Spongy bone provides most of the strength and support for a bone. In long bones, such as those of the arm or the leg, an outer layer of compact bone surrounds spongy bone and another soft tissue called *marrow*.

Active Reading **8 Identify** As you read, underline the name of a protein found in bone.

Minerals

Calcium is the most plentiful mineral in bones. The minerals in bones are deposited by bone cells called *osteoblasts*. Minerals, such as calcium, make the bones strong and hard.

Connective Tissue

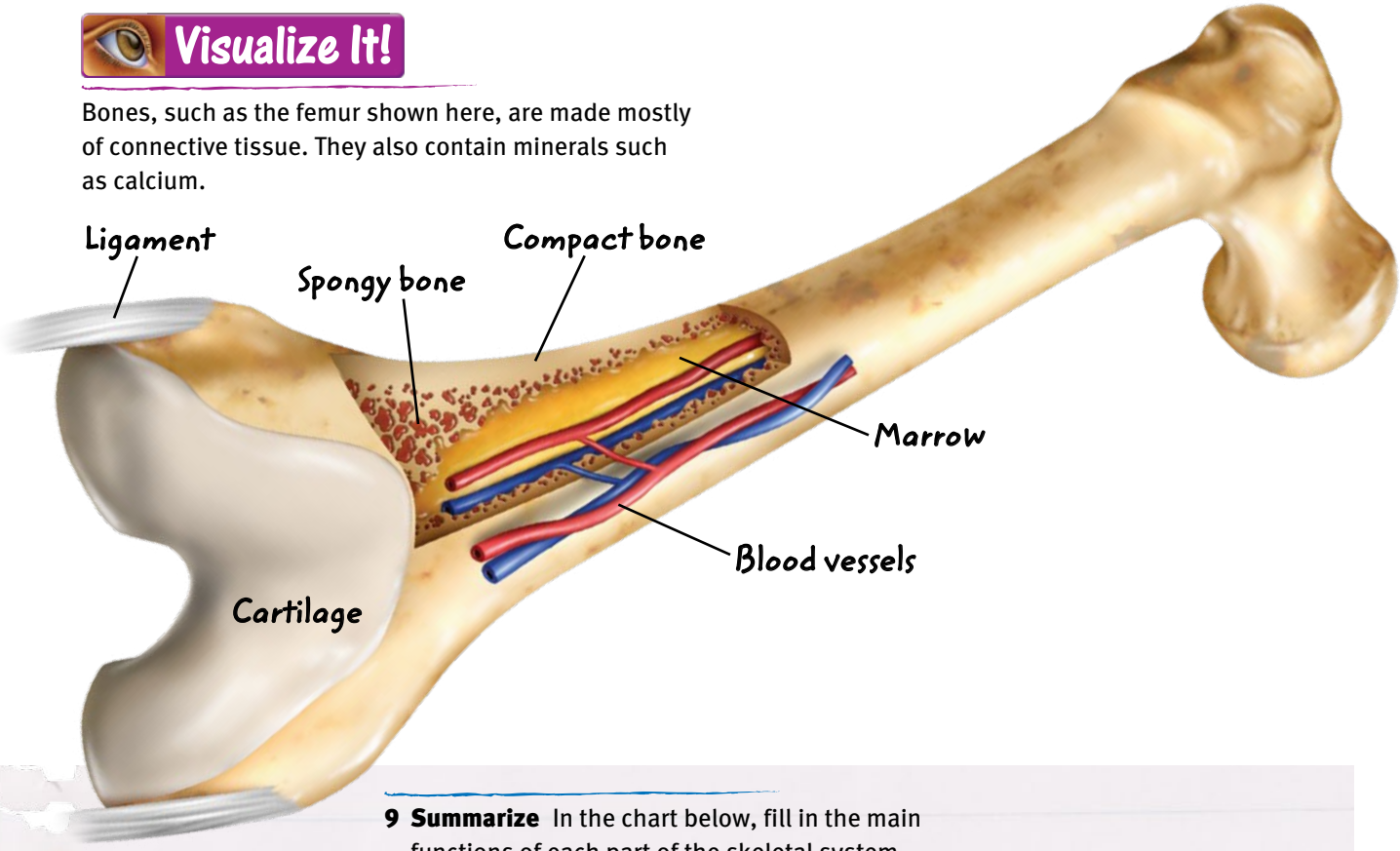
The connective tissue in bone is made mostly of a protein called *collagen*. Minerals make the bones strong and hard, but the collagen in bones allows them to be flexible enough to withstand knocks and bumps. Otherwise, each time you bumped a bone, it would crack like a china cup.

Marrow

Bones also contain a soft tissue called *marrow*. There are two types of marrow. Red marrow is the site of platelet and red and white blood cell production. Red marrow is in the center of flat bones such as the ribs. Yellow marrow, which is found in the center of long bones such as the femur, stores fat.

Visualize It!

Bones, such as the femur shown here, are made mostly of connective tissue. They also contain minerals such as calcium.



9 Summarize In the chart below, fill in the main functions of each part of the skeletal system.

Structure	Function
Spongy bone	
Compact bone	
Cartilage	
Ligaments	

How do bones grow?

The skeleton of a fetus growing inside its mother's body does not contain hard bones. Instead, most bones start out as flexible cartilage. When a baby is born, it still has a lot of cartilage. As the baby grows, most of the cartilage is replaced by bone.

The bones of a child continue to grow. The long bones lengthen at their ends, in areas called *growth plates*. Growth plates are areas of cartilage that continue to make new cells. Bone cells called *osteocytes* move into the cartilage, hardening it and changing it into bone. Growth continues into adolescence and sometimes even into early adulthood. Most bones harden completely after they stop growing. Even after bones have stopped growing, they can still repair themselves if they break.

This baby's skeleton has more cartilage than his older brother's skeleton has.

Bone Connections

How are bones connected?

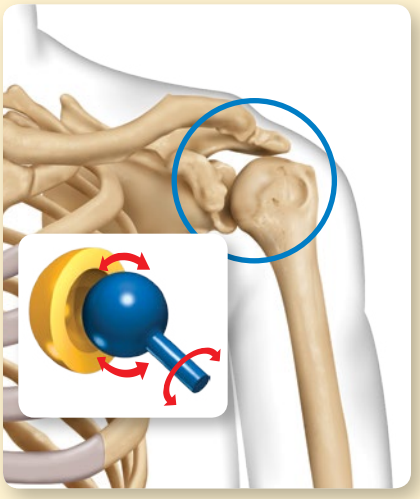
The place where two or more bones connect is called a **joint**. Some joints allow movement of body parts, others stop or limit movement. Just imagine how difficult it would be to do everyday things such as tying your shoelaces if you could not bend the joints in your arms, legs, neck, or fingers!

Your joints allow you to do everyday tasks easily.

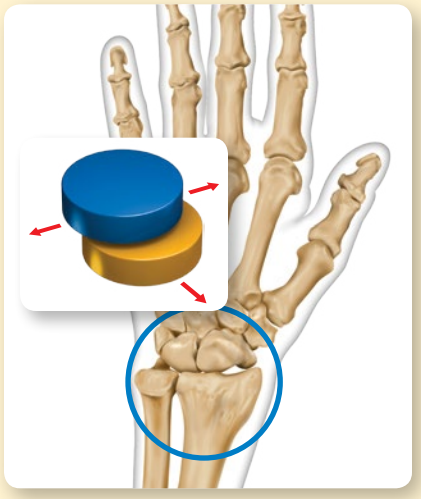
Joints

Bones are connected to each other at joints by strong, flexible ligaments. The ends of the bone are covered with cartilage. Cartilage is a smooth, flexible connective tissue that helps cushion the area in a joint where bones meet. Some joints allow little or no movement. These *fixed joints* can be found in the skull. Other joints, called *movable joints*, allow movement of the bones.

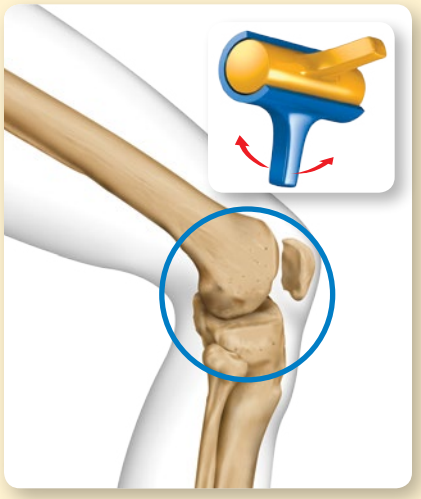
Some Examples of Movable Joints



Ball-and-Socket joint
Shoulders and hips are ball-and-socket joints. Ball-and-socket joints allow one of the bones of the joint to rotate in a large circle.



Gliding joint
Wrists and ankles are gliding joints. Gliding joints allow a great deal of flexibility in many directions.



Hinge joint
Knees and elbows are hinge joints. Hinge joints work like door hinges, allowing bones to move back and forth.

Inquiry

10 Apply Some joints, such as the ones in your skull, do not move at all. Why do you think it is important that skull joints cannot move?

What are some injuries and disorders of the skeletal system?

Sometimes the skeletal system can become injured or diseased. Injuries and diseases of the skeletal system affect the body's support system and ability to move. Hereditary factors may play a role in the incidence of diseases such as osteoporosis and arthritis.

Active Reading

11 Identify As you read, underline the characteristics of each injury and disease.

Fractures

Bones may be fractured, or broken. Bones can be broken by a high-force impact such as a fall from a bike. A broken bone usually repairs itself in six to eight weeks.

Sprains

A sprain is an injury to a ligament that is caused by stretching a joint too far. The tissues in the sprained ligament can tear and the joint becomes swollen and painful to move. Sprains are common sports injuries.

12 Apply How could someone sprain a ligament?

Osteoporosis

Osteoporosis is a disease that causes bone tissue to become thin. The bones become weak and break more easily. It is most common among adults who do not get enough calcium in their diet. What you eat now can affect your risk of developing osteoporosis later in life.

13 Claims • Evidence • Reasoning Is it important to get enough calcium in your diet? State your claim. Summarize evidence to support your claim and explain your reasoning.

Arthritis

Arthritis is a disease that causes joints to swell, stiffen, and become painful. It may also cause the joint to become misshapen, as shown in the photo. A person with arthritis finds it difficult to move the affected joint. Arthritis can be treated with drugs that reduce swelling.

Keep Moving!

What are the main functions of the muscular system?

Muscles pump blood through your body, enable you to breathe, hold you upright, and allow you to move. All animals, except the simplest invertebrates, have muscles for movement. The **muscular system** is mostly made of the muscles that allow your body to move and be flexible. Other muscles move materials inside your body. *Muscle* is the tissue that contracts and relaxes, making movement possible. Muscle tissue is made up of muscle cells. Muscle cells contain special proteins that allow them to shorten and lengthen.

Active Reading **14 Identify** How do muscles make movement possible?

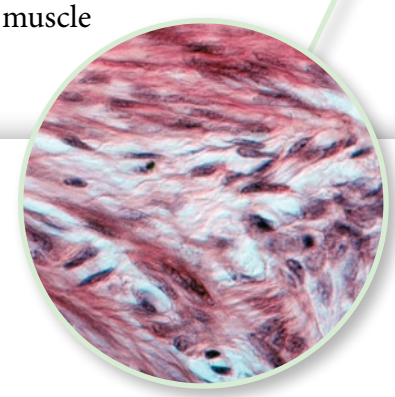
What are the three types of muscles?

Your body has three kinds of muscle tissue: *skeletal muscle, smooth muscle*, and *cardiac muscle*. Each muscle type has a specific function in your body.

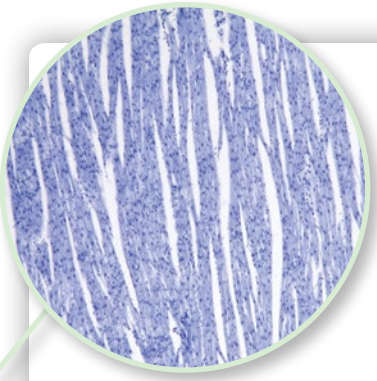
You are able to control the movement of skeletal muscle, so it is called *voluntary muscle*. You are not able to control the movement of smooth muscle and cardiac muscles. Muscle action that is not under your control is *involuntary*. Smooth muscle and cardiac muscle are called *involuntary muscles*.

Smooth Muscle

Smooth muscle is found in internal organs and blood vessels. It helps move materials through the body. Arteries and veins contain a layer of smooth muscle that can contract and relax. This action controls blood flow through the blood vessel. Smooth muscle movement in your digestive system helps move food through your intestines. Smooth muscle is involuntary muscle.



Smooth muscle cells are spindle-shaped. They are fat in the middle with thin ends.

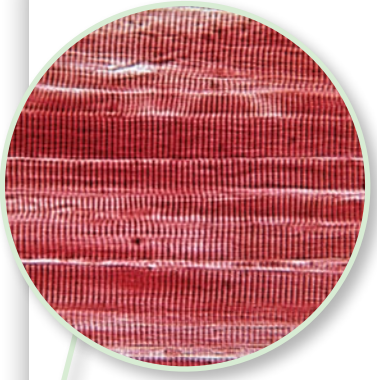


Cardiac muscle cells are long, thin, and branched.

Cardiac Muscle

Cardiac muscle is the tissue that makes up the heart. Your heart never gets tired like your skeletal muscle can. This is because cardiac muscle cells are able to contract and relax without ever getting tired. In order to supply lots of energy to the cells, cardiac muscle cells contain many mitochondria. Your cardiac muscles do not stop moving your entire lifetime!

The contractions of cardiac muscle push blood out of the heart and pump it around the body. Cardiac muscle is involuntary; you cannot consciously stop your heart from pumping.



Skeletal muscle cells are long and thin with stripes, or striations.

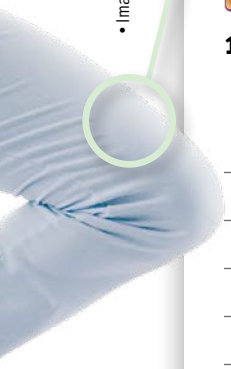
Skeletal Muscle

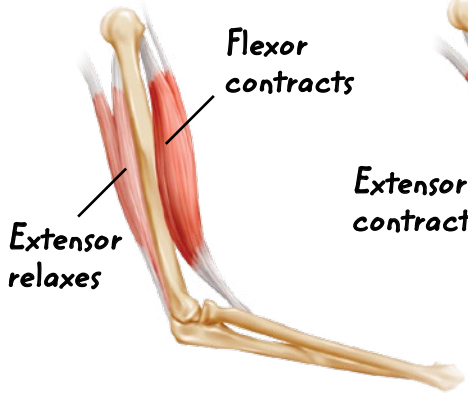
Skeletal muscle is attached to your bones and allows you to move. You have control over your skeletal muscle. For example, you can bring your arm up to your mouth to take a bite from an apple. The tough strand of tissue that connects a muscle to a bone is called a **tendon**. When a muscle contracts, or shortens, the attached bones are pulled closer to each other. For example, when the bicep muscle shortens, the arm bends at the elbow.

Most skeletal muscles work in pairs around a joint, as shown below. One muscle in the pair, called a *flexor*, bends a joint. The other muscle, the *extensor*, straightens the joint. When one muscle of a pair contracts, the other muscle relaxes to allow movement of the body part. Muscle pairs are found all around the body.

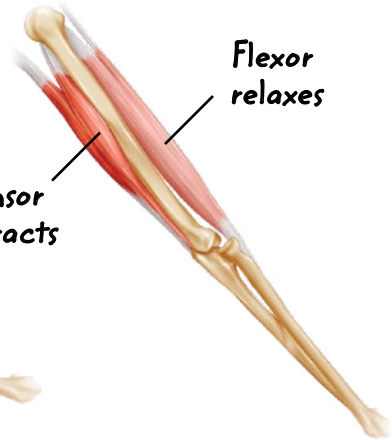
Visualize It!

15 Apply What would happen to the arm if the flexor was not able to contract?





The biceps muscle is the flexor that contracts to bend the arm.



The triceps muscle is the extensor that contracts to straighten the arm.

Visualize It!

16 Compare How do the three muscle tissue types look similar and different?

Move It or Lose It!

What are some injuries and disorders of the muscular system?

Like other systems, the muscular system can suffer injury or disease. As a result, muscles may lose normal function. Some muscle diseases are hereditary. Diseases that affect muscle function can also affect other body systems. For example, myocarditis is an inflammation of the heart muscle that can cause heart failure and harm the cardiovascular system.

Muscle Strain and Tears

A *strain* is a muscle injury in which a muscle is overstretched or torn. This can happen when muscles have not been stretched properly or when they are overworked. Strains cause the muscle tissue to swell and can be painful. Strains and tears need rest to heal.

Muscular Dystrophy

Muscular dystrophy is a hereditary disease that causes skeletal muscle to become weaker over time. It affects how muscle proteins form. A person with muscular dystrophy has poor balance and difficulty walking or doing other everyday activities.

Tendinitis

Tendons connect muscles to bones. Tendons can become inflamed or even torn when muscles are overused. This painful condition is called *tendinitis*. Tendinitis needs rest to heal. It may also be treated with medicines that reduce swelling.

17 Contrast What is the difference between a muscle strain and tendinitis?

Physical therapy can help people gain full use of their muscles and joints after an injury.

Think Outside the Book

18 Plan With a classmate, research the recommendations for regular physical activity. Then design a poster to show how people can fit 30–60 minutes of physical activity into their daily lives.

What are some benefits of exercise?

Exercising is one of the best things you can do to keep your body healthy. *Exercise* is any activity that helps improve physical fitness and health. Exercise benefits the muscular system by increasing strength, endurance, and flexibility. Exercise helps other body systems, too. It helps keep your heart, blood vessels, lungs, and bones healthy. Exercise also reduces stress, helps you sleep well, and makes you feel good.

Exercises that raise your heart rate to a certain level for at least 60 minutes improve the fitness of the heart. A fit heart is a more efficient pump. It can pump more blood around the body with each beat. It is also less likely to develop heart disease. Good muscle strength and joint flexibility may help a person avoid injuries. Weight training helps bones stay dense and strong. Dense, strong bones are less likely to break. Thirty to sixty minutes of physical activity every day can help improve the health of people of all ages, from children to older adults.

Active Reading **19 Identify** As you read, underline the characteristics of anaerobic and aerobic exercise.

Muscle Strength

Resistance exercise helps improve muscle strength by building skeletal muscle and increasing muscle power. Resistance exercise involves short bursts of intense effort lasting no more than a few minutes. Resistance exercises are also called *anaerobic exercises* because the muscle cells contract without using oxygen. Lifting weights and doing pushups are examples of anaerobic exercises.

Muscle Endurance

Endurance exercises allow muscles to contract for a longer time without getting tired. Endurance exercises are also called *aerobic exercises* because the muscle cells use oxygen when contracting. Aerobic exercises involve moderately intense activity from about 30 to 60 minutes at a time. Some examples of aerobic exercises are walking, jogging, bicycling, skating, and swimming.

Flexibility

Can you reach down and touch your toes? If a joint can move through a wide range of motions, it has good flexibility. *Flexibility* refers to the full range of motion of a joint. Stretching exercises help improve flexibility of a joint. Having good flexibility can help prevent ligament, tendon, and muscle injuries. Stretching after aerobic or anaerobic exercises may also help prevent injuries.

Visual Summary

To complete this summary, fill in the blanks with the correct word or phrase. Then, use the key below to check your answers. You can use this page to review the main concepts of the lesson.

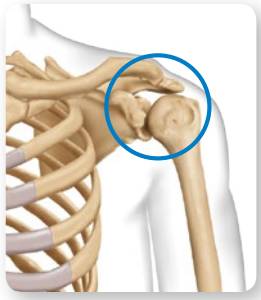
The Skeletal and Muscular Systems

The skeletal system supports and protects the body and allows for movement.

20 The three main parts of the skeletal system are bones, _____, and _____.

Joints connect two or more bones.

21 The shoulder is an example of a _____ joint.



The muscular system allows for movement and flexibility.

22 Muscles work in _____ to move body parts.

Exercise benefits the body in many ways.

23 Aerobic exercises improve muscle _____.

Anaerobic exercises improve muscle _____.

Answers: 20 cartilage, ligaments; 21 ball-and-socket; 22 pairs; 23 endurance, strength

24 Synthesize Explain why you need both muscles and bones to move your body.

Lesson Review

Vocabulary

Draw a line to connect the following terms to their definitions.

1 skeletal system	**A** groups of muscles that allow you to move and that move materials inside your body
2 ligament	**B** a place where two or more bones connect
3 muscular system	**C** bones, cartilage, and the ligaments that hold bones together
4 joint	**D** tough strands of tissue that connect muscles to bones
5 tendon	**E** a type of tough, flexible connective tissue that holds bones together

Key Concepts

6 List What are the functions of the skeletal system?

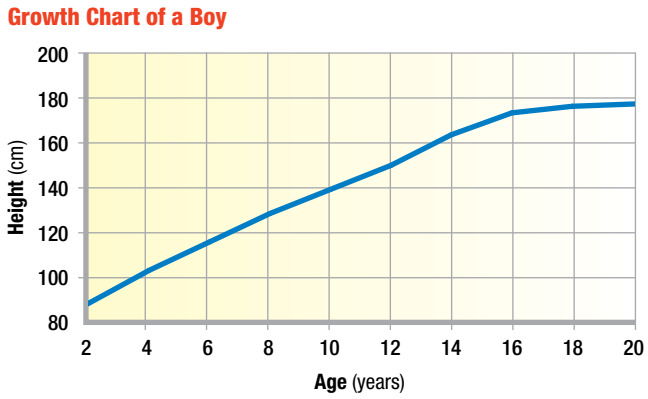
7 Analyze What are bones made of?

8 Explain How do muscles work in pairs to move the body?

9 Identify What bone disease is caused by a lack of calcium in the diet?

Critical Thinking

Use this graph to answer the following questions.



10 Analyze At which points on this graph is bone growing at the fastest rate?

11 Infer At which times on this graph would you expect that the boy's growth plates have stopped creating new bone? Explain your reasoning.

12 Claims • Evidence • Reasoning If aerobic exercise improves heart strength so that it pumps more blood with each beat, what likely happens to the heart rate as the cardiac muscle gets stronger? Use evidence to support your claim and explain your reasoning.

My Notes

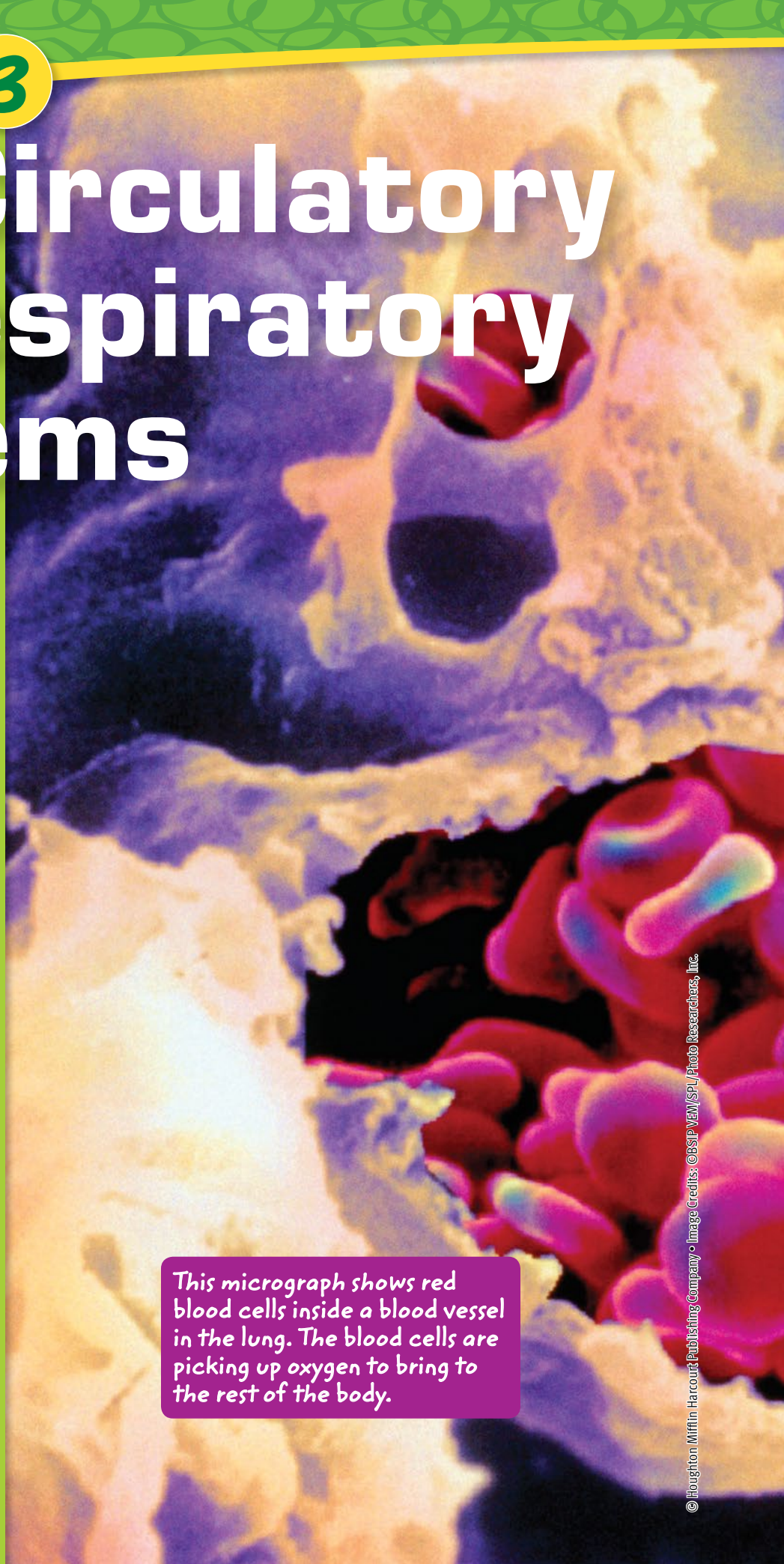
Lesson 3

The Circulatory and Respiratory Systems

ESSENTIAL QUESTION

How do the circulatory and respiratory systems work?

By the end of this lesson, you should be able to relate the structures of the circulatory and respiratory systems to their functions in the human body.



This micrograph shows red blood cells inside a blood vessel in the lung. The blood cells are picking up oxygen to bring to the rest of the body.

Lesson Labs

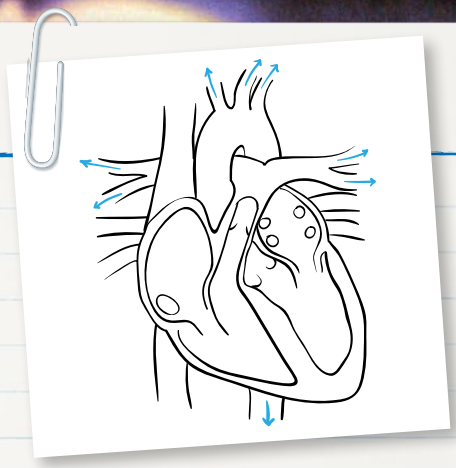
Quick Labs

- Build a Model Lung
- Clogged Arteries

Engage Your Brain

1 Identify Check T or F to show whether you think each statement is true or false.

T	F	
☐	☐	Air is carried through blood vessels.
☐	☐	The cardiovascular system does not interact with any other body system.
☐	☐	The respiratory system gets rid of carbon dioxide from the body.
☐	☐	Smoking cigarettes can lead to lung disease.



2 Identify What is the name of the organ, shown here, that makes the "lub-dub" sound in your chest?

_____

3 Infer What is the function of this organ?

_____

_____

_____

Active Reading

4 Synthesize You can sometimes tell a lot about the structure of an unknown object by understanding the meaning of its name. Use the meaning of the Latin word and the sentence below to write your own definition of *capillary*.

Latin word	Meaning
capillaris	thin and hairlike

Example sentence

Oxygen that is carried by blood cells moves across the capillary wall and into body cells.

capillary:

_____

_____

_____

_____

Vocabulary Terms

- **cardiovascular system**
- **blood**
- **lymphatic system**
- **lymph**
- **lymph node**
- **artery**
- **capillary**
- **vein**
- **respiratory system**
- **pharynx**
- **larynx**
- **trachea**
- **bronchi**
- **alveoli**

5 Apply As you learn the definition of each vocabulary term in this lesson, create your own definition or sketch to help you remember the meaning of the term.

Go with the Flow!

What is the circulatory system?

Active Reading

6 Identify As you read, underline the functions of the cardiovascular system and the lymphatic system.

When you hear the term *circulatory system,* what do you think of? If you said "heart, blood, and blood vessels," you are half right. The term circulatory system describes both the cardiovascular system and the lymphatic system. Both systems interact closely to move fluids around your body and protect it from disease. Your moving blood helps to keep all parts of your body warm. In these ways, the two systems interact to help maintain homeostasis and carry out life processes.

Both systems are made up of vessels.

Both systems are part of your body's defenses against bacteria, viruses, and other pathogens.

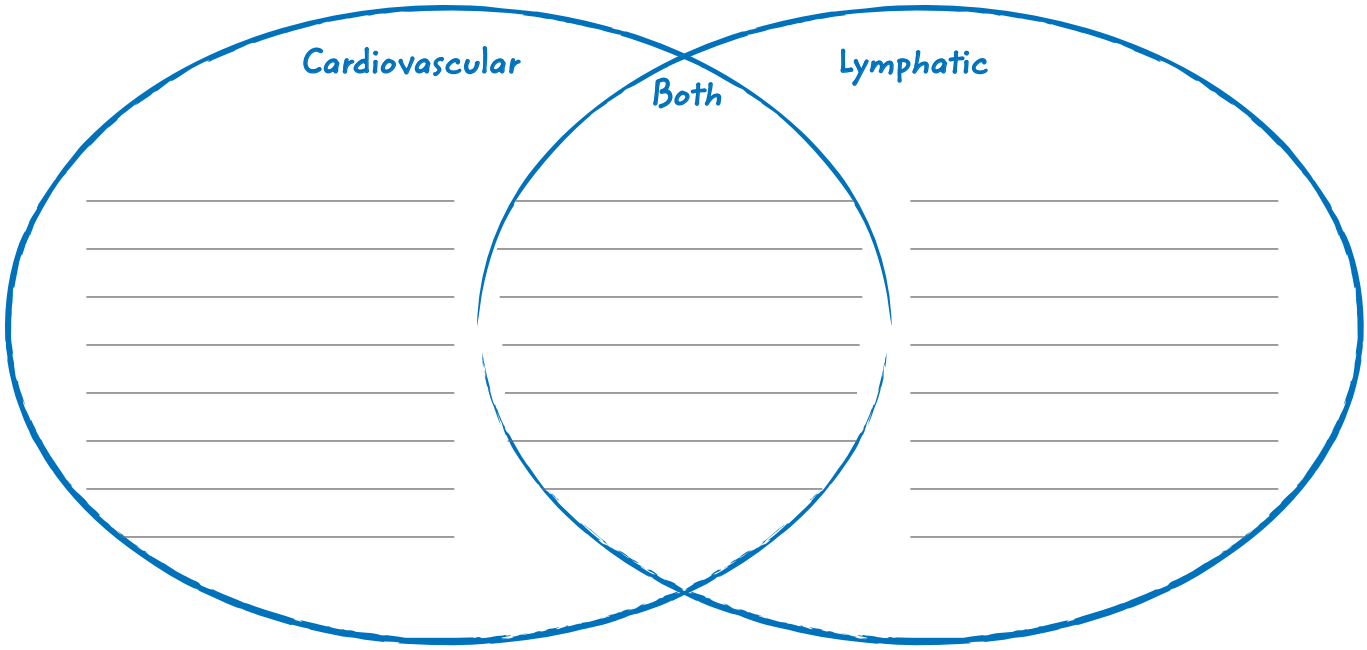
The Cardiovascular System

Your heart, blood, and blood vessels make up your **cardiovascular system**, which transports blood around your body. **Blood** is the fluid that carries gases, nutrients, and wastes through the body. The cardiovascular system is a closed circulatory system; the blood is carried in vessels that form a closed loop. The blood maintains homeostasis by transporting hormones, nutrients, and oxygen to cells and by carrying wastes away from cells.

The Lymphatic System

The **lymphatic system** is a group of organs and tissues that collect the fluid that leaks from blood and returns it to the blood. The leaked fluid is called **lymph**. The lymphatic system is an open circulatory system, and lymph can move in and out of the vessels. The lymphatic system is also part of the immune system, which provides defenses against disease. Certain lymph vessels in the abdomen move fats from the intestine and into the blood.

7 Compare Fill in the Venn diagram to compare the structures and functions of both these systems. You can add more details as you read more about these systems in this lesson.



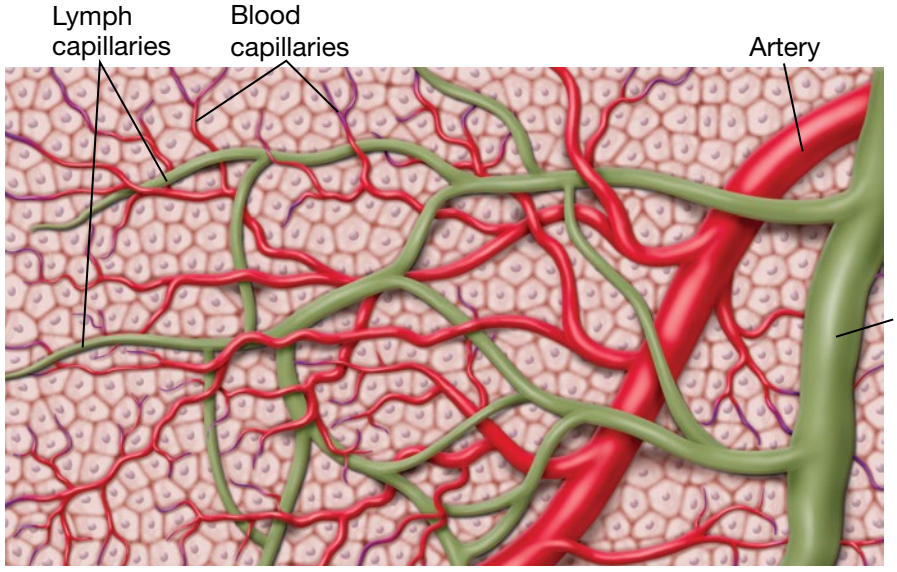
How do the systems interact?

Every time your heart pumps, a little fluid is forced out of the thin walls of the tiniest blood vessels, called *capillaries.* Most of this fluid is reabsorbed by the capillaries, and the remaining fluid is collected by lymph capillaries. *Lymph capillaries* absorb fluid, particles such as dead cells, and pathogens from around body cells. The lymph capillaries carry the fluid, now called *lymph,* to larger lymph vessels. Lymph is returned to the cardiovascular system when it drains into blood vessels at the base of the neck.

The lymphatic system is the place where certain blood cells, called *white blood cells,* mature. Some of these white blood cells stay in the lymphatic system where they attack invading pathogens.

Active Reading

8 Synthesize How does returning leaked fluid from the blood help maintain homeostasis?



The fluid that leaks from blood capillaries moves into lymph capillaries and is eventually returned to the blood.

Node Doubt!

What are the parts of the lymphatic system?

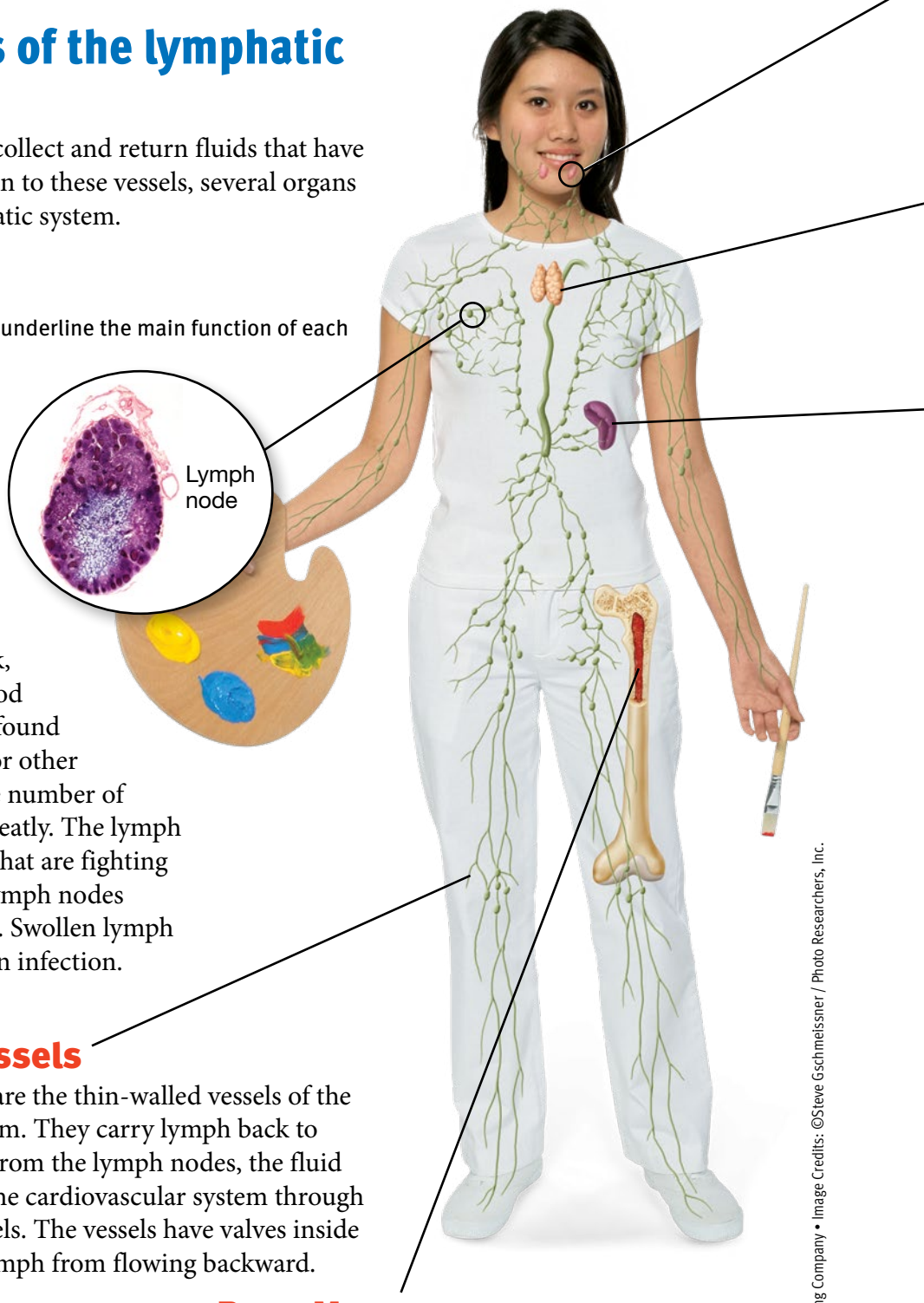
As you have read, lymph vessels collect and return fluids that have leaked from the blood. In addition to these vessels, several organs and tissues are part of the lymphatic system.

Active Reading

9 Identify As you read these pages, underline the main function of each part of the lymphatic system.

Lymph Nodes

As lymph travels through lymph vessels, it passes through lymph nodes. **Lymph nodes** are small, bean-shaped organs that remove pathogens and dead cells from lymph. Lymph nodes are concentrated in the armpits, neck, and groin. Infection-fighting blood cells, called *white blood cells,* are found in lymph nodes. When bacteria or other pathogens cause an infection, the number of these blood cells may multiply greatly. The lymph nodes fill with white blood cells that are fighting the infection. As a result, some lymph nodes may become swollen and painful. Swollen lymph nodes might be an early clue of an infection.



Lymph Vessels

Lymph vessels are the thin-walled vessels of the lymphatic system. They carry lymph back to lymph nodes. From the lymph nodes, the fluid is returned to the cardiovascular system through the lymph vessels. The vessels have valves inside them to stop lymph from flowing backward.

Bone Marrow

Bones—part of your skeletal system—are very important to your lymphatic system. *Bone marrow* is the soft tissue inside of bones where blood cells are produced.

Tonsils

Tonsils are small lymphatic organs at the back of the throat and tongue. The tonsils at the back of the throat are the most visible. Tonsils help defend the body against infection. White blood cells in the tonsil tissues trap pathogens. Tonsils in the throat sometimes get infected. An infection of the tonsils is called *tonsillitis*. When tonsils get infected, they may become swollen, as shown here.

Swollen tonsils

Thymus

The *thymus* is an organ in the chest. Some white blood cells made in the bone marrow finish developing in the thymus. From the thymus, the white blood cells travel through the lymphatic system to other areas of the body. The thymus gets smaller as a person gets older. This organ is also a part of the endocrine system.

Visualize It!

10 Predict A bad case of tonsillitis can sometimes affect a person's breathing. How is this possible?

Spleen

The *spleen* is the largest lymphatic organ. It stores white blood cells and also allows them to mature. As blood flows through the spleen, white blood cells attack or mark pathogens in the blood. If pathogens cause an infection, the spleen may also release white blood cells into the bloodstream.

What are some disorders of the lymphatic system?

Lymphoma is a type of cancer that often begins in a lymph node. It can cause a swelling in the node called a *tumor*. There are many different types of lymphomas. Another disorder of the lymph system is lymphedema (lim•fih•DEE•muh). Lymphedema is a swelling of body tissues caused by a blockage or injury to lymph vessels. Lymph vessels are unable to drain lymph from a certain area, and that area becomes swollen. Filariasis is a disease caused by threadlike worms called *nematodes*. The nematodes may enter lymphatic vessels and block them, preventing lymph from moving around the body. Bubonic plague is a bacterial infection of the lymphatic system. The bacteria can enter the body through the bite of an infected flea. The bacteria grow inside lymph nodes, causing the nodes to swell.

Active Reading

11 Identify As you read, underline the names of the lymphatic system diseases discussed here.

A person gets infected with filarial worms by being bitten by an infected fly. Filariasis is rare in the United States, but is common in some developing countries.

The Heart of the Matter

What are the parts of the cardiovascular system?

Your cardiovascular system is the organ system that carries nutrients, gases, and hormones to body cells and waste products from body cells. It also helps keep the different parts of your body at an even temperature. Your cardiovascular system is made up of the heart, blood vessels, and blood.

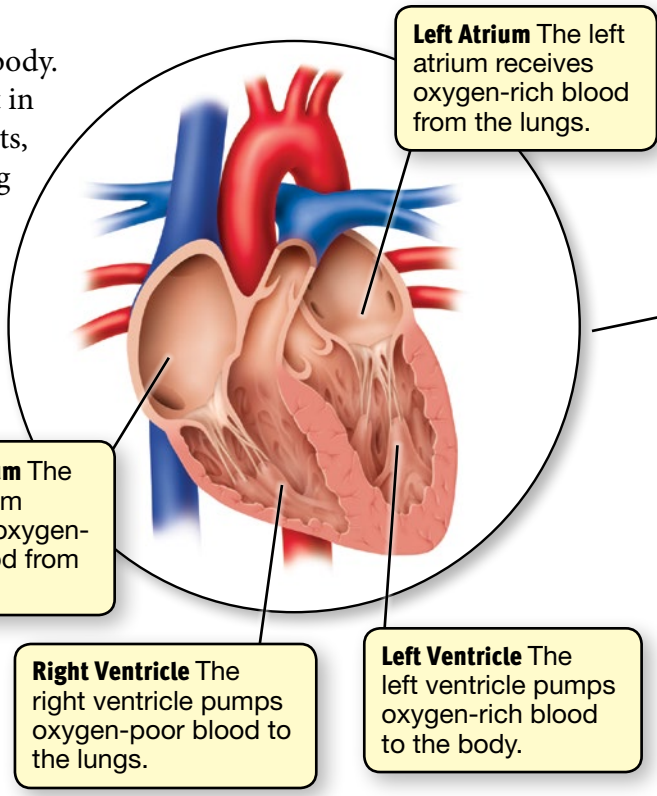
Heart

The heart is the pump that sends blood around the body. Your heart is about the size of your fist and is almost in the center of your chest. When heart muscle contracts, it squeezes the blood inside the heart. This squeezing creates a pressure that pushes blood through the body.

Your heart has a left side and a right side. The two sides are separated by a thick wall. The right side of the heart pumps oxygen-poor blood to the lungs. The left side pumps oxygen-rich blood to the body. Each side has an upper chamber and a lower chamber. Each upper chamber is called an *atrium*. Each lower chamber is called a *ventricle*. Blood enters the atria and is pumped down to the ventricles. Flaplike structures called *valves* are located between the atria and the ventricles and in places where large vessels are attached to the heart. As blood moves through the heart, these valves close to prevent blood from going backward. The "lub-dub" sound of a beating heart is caused by the valves closing.

Active Reading

12 Identify As you read this page, underline the parts of the heart that stop the blood from flowing backward.



13 Claims • Evidence • Reasoning How important is it for your heart to keep oxygen-rich blood separate from oxygen-poor blood? Use evidence to support your claim and explain your reasoning.

Blood

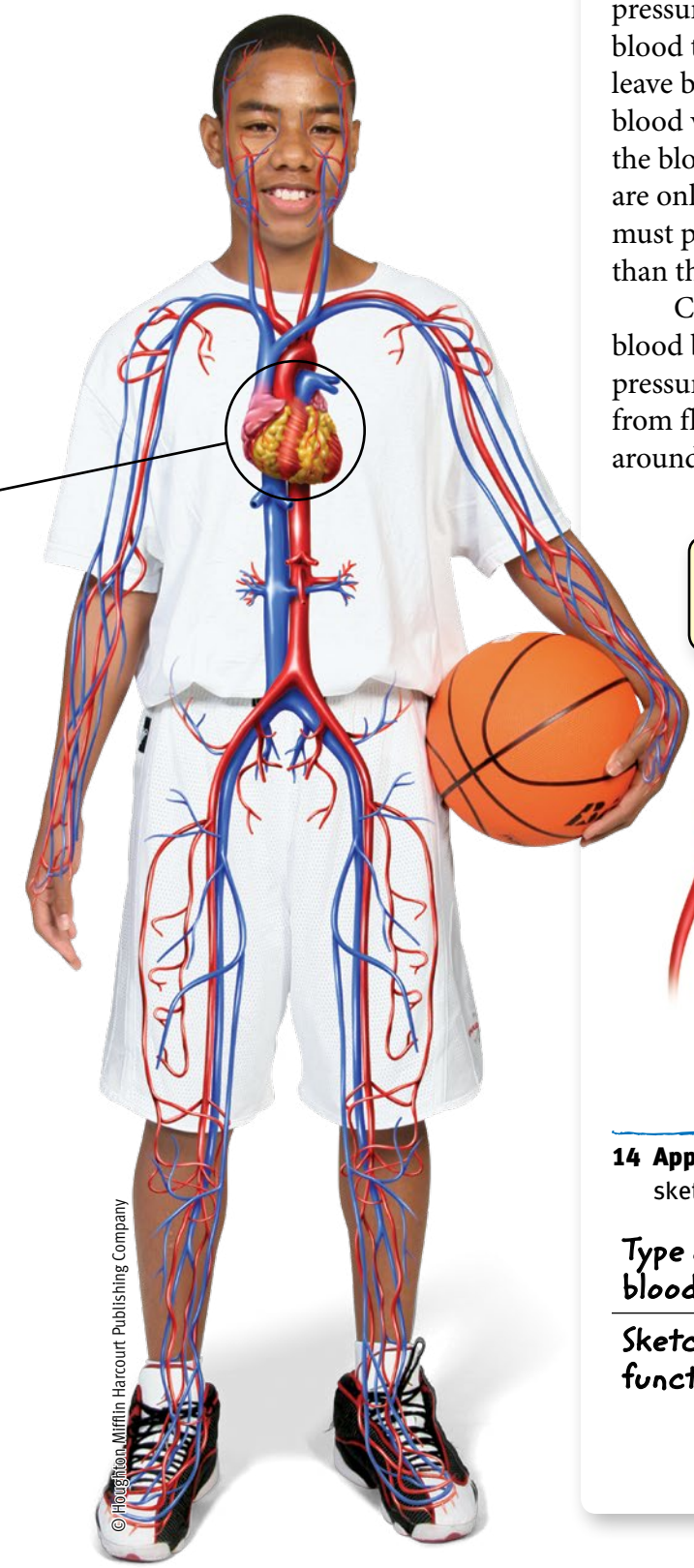
Blood is a type of connective tissue that is part of the cardiovascular system. It serves as a transport system, providing supplies for cells, carrying chemical messages, and removing wastes so cells can maintain homeostasis. Blood contains cells, fluid, and other substances. It travels through miles and miles of blood vessels to reach every cell in your body.

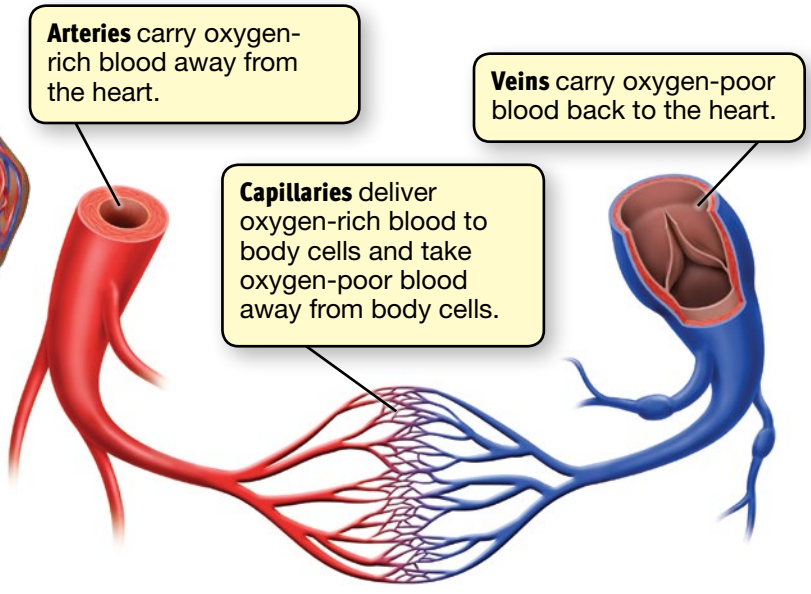
Blood Vessels

Blood travels throughout your body in tubes called *blood vessels*. The three types of blood vessels are arteries, capillaries, and veins.

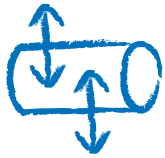
An **artery** is a blood vessel that carries blood away from the heart. Arteries have thick walls with a layer of smooth muscle. Each heartbeat pumps blood into your arteries at high pressure, which is your *blood pressure*. This pressure pushes blood through the arteries. Artery walls are strong and stretch to withstand the pressure. Nutrients, oxygen, and other substances must leave the blood to get to your body's cells. Carbon dioxide and other wastes leave body cells and are carried away by blood. A **capillary** is a tiny blood vessel that allows these exchanges between body cells and the blood. The gas exchange can take place because capillary walls are only one cell thick. Capillaries are so narrow that blood cells must pass through them in single file! No cell in the body is more than three or four cells away from a capillary.

Capillaries lead to veins. A **vein** is a blood vessel that carries blood back to the heart. Blood in veins is not under as much pressure as blood in arteries is. Valves in the veins keep the blood from flowing backward. The contraction of skeletal muscles around veins can help blood move in the veins.





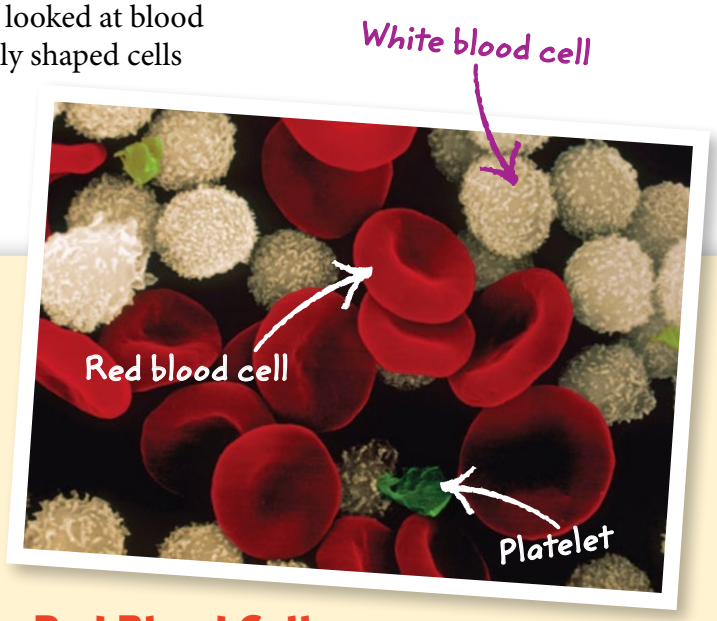
14 Apply Complete the table below by naming the blood vessels and by sketching their function. Your sketch may be a symbol, as shown here.

Type of blood vessel		Vein	
Sketch of function			

It's in the Blood

What is blood made of?

An adult human body has about 5 liters of blood. Your body probably has a little less than that. Blood is made up of plasma, platelets, and red and white blood cells. Blood is a tissue because it is made of at least two different cell types. If you looked at blood under a microscope, you would see these differently shaped cells and platelets.



The Blood Files

Plasma

The fluid part of the blood is called *plasma*. Plasma is a mixture of water, minerals, nutrients, sugars, proteins, and other substances. This fluid also carries waste. Red blood cells, white blood cells, and platelets are found in plasma.

Platelets

Platelets are tiny pieces of larger cells found in bone marrow. Platelets last for only five to ten days, but they have an important role. When you cut or scrape your skin, you bleed because blood vessels have been cut open. As soon as bleeding starts, platelets begin to clump together in the cut area. They form a plug that helps reduce blood loss. Platelets also release chemicals that react with proteins in plasma. The reaction causes tiny fibers to form. The fibers help create a blood clot.

White Blood Cells

White blood cells help keep you healthy by fighting pathogens such as bacteria and viruses. Some white blood cells squeeze out of blood vessels to search for pathogens. When they find one, they destroy it. Other white blood cells form antibodies. *Antibodies* are chemicals that identify pathogens. White blood cells also keep you healthy by destroying body cells that have died or have been damaged.

Red Blood Cells

Most blood cells are red blood cells. *Red blood cells* are disk-shaped cells that do not have a nucleus. They bring oxygen to every cell in your body. Cells need oxygen to carry out life processes. Each red blood cell has hemoglobin. *Hemoglobin* is an oxygen-carrying protein; it clings to the oxygen molecules you inhale. Red blood cells can then transport oxygen to cells in every part of the body. The disk shape of red blood cells helps them squeeze into capillaries.

15 Predict How would the body be affected if red blood cells had low levels of hemoglobin? Use evidence to support your claim and explain your reasoning.

How does blood move through the body?

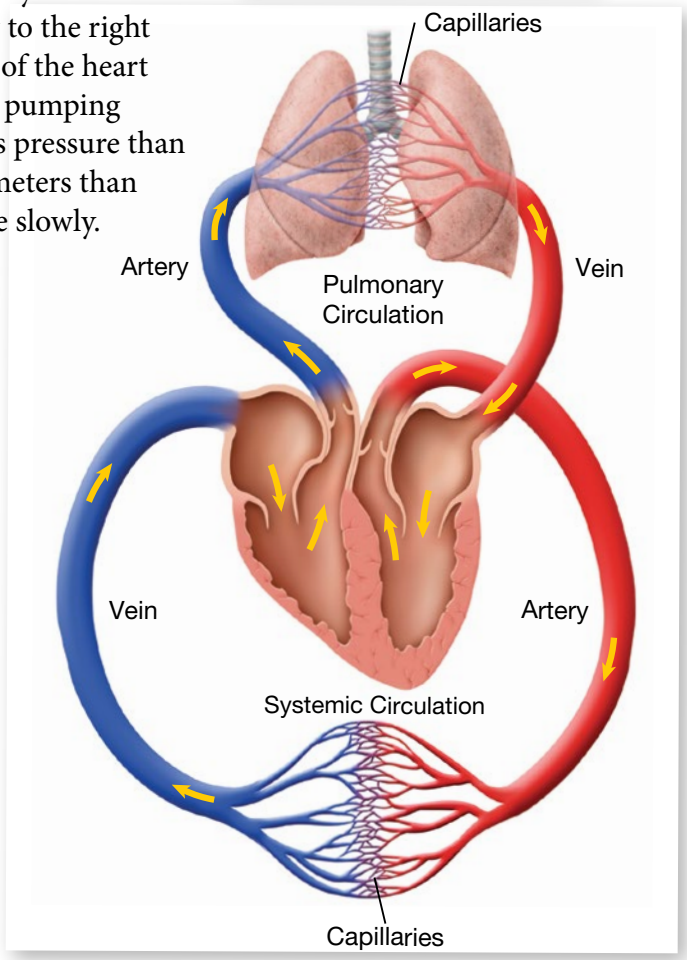
Blood is pumped from the right side of the heart to the lungs. From the lungs it returns to the left side of the heart. The blood is then pumped from the left side of the heart to the body. It flows to the tiny capillaries around the body before returning to the right side of the heart. Blood in the arteries that come out of the heart is under great pressure because of the force from the pumping action of the heart. Blood in veins is under much less pressure than arterial blood because veins have larger internal diameters than arteries do. Veins carry larger volumes of blood more slowly.

Blood Moves in Circuits

Blood moves in two loops or circuits around the body. The beating heart moves blood to the lungs and also around the body. The flow of blood between the heart and the lungs is called the *pulmonary circulation*. As blood passes through the lungs, carbon dioxide leaves the blood and oxygen is picked up. The oxygen-rich blood then flows back to the heart, where it is pumped around the rest of the body. The circulation of blood between the heart and the rest of the body is called *systemic circulation*. Oxygen-poor blood returns to the heart from body cells in the systemic circulation.

Active Reading **16 Compare** What is the difference between the pulmonary and systemic circulations?

In pulmonary circulation, blood is pumped to the lungs where carbon dioxide leaves the blood and oxygen enters the blood.



In systemic circulation, blood moves around the body.

Visualize It!

17 Apply Put a box around the part of the diagram that shows the pulmonary circulation. Where in the diagram would you find oxygen-poor blood?

How does circulation help maintain body temperature?

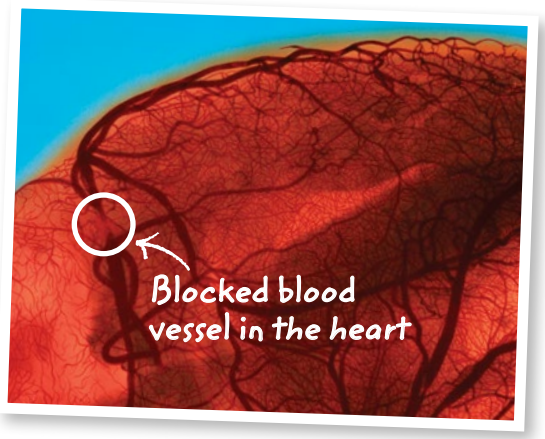
The circulation of blood also helps homeostasis. When the brain senses that body temperature is rising, it signals blood vessels in the skin to widen. As the vessels get wider, heat from the blood is transferred to the air around the skin. This transfer helps lower body temperature. When the brain senses that body temperature is normal, it signals the blood vessels to return to normal. When the brain senses the body temperature is getting too low, it signals the blood vessels near the skin to get narrower. This allows the blood to stay close to internal organs to keep them warm.

What are some problems that affect the cardiovascular system?

Cardiovascular disease is the leading cause of death in the United States. Cardiovascular disease can be caused by smoking, poor diet, stress, physical inactivity, or in some cases, heredity. Eating a healthy diet and regular exercise can reduce the risk of developing cardiovascular problems.

Atherosclerosis

A major cause of heart disease is a condition called *atherosclerosis* (ath•uh•roh•skluh•ROH•sis). Atherosclerosis is a hardening of artery walls caused by the buildup of cholesterol and other lipids. The buildup causes the blood vessels to become narrower and less elastic. Blood cannot flow easily through a narrowed artery. When an artery supplying blood to the heart becomes blocked, oxygen cannot reach the heart muscle and the person may have a heart attack.



Blood pressure checks can help detect illness.

Hypertension

Hypertension is abnormally high blood pressure. Atherosclerosis may be caused in part by hypertension. The higher a person's blood pressure is, the greater their risk of developing cardiovascular problems, such as heart attacks and strokes. Hypertension that is not treated can also cause kidney damage and shorten life expectancy. Regular checkups can help detect problems with blood pressure. Hypertension can be controlled with diet and sometimes with medication.

Heart Attacks and Strokes

A heart attack happens when an artery that supplies blood to the heart becomes blocked and the heart muscle tissue that depends on that blood supply does not get oxygen. Cells and tissues that do not get oxygen get damaged and can die. If enough heart muscle cells are damaged, the heart may stop beating.

A stroke can happen when a blood vessel in the brain becomes blocked or bursts. As a result, that part of the brain receives no oxygen. Without oxygen, brain cells die. Brain damage that occurs during a stroke can affect many parts of the body. People who have had a stroke may experience paralysis or difficulty in speaking.

Think Outside the Book Inquiry

18 Research Doctors often use an electrocardiogram (EKG) reading to see if there is something wrong with how a person's heart is beating. An EKG is a type of graph that "draws" the pumping activity of the heart. How might graphing the heartbeat help a doctor tell if there is a problem?

Take a Deep Breath

What are the functions of the respiratory system?

Your cells need a constant supply of oxygen to stay alive. Your cells must also be able to get rid of the waste product carbon dioxide, which is toxic to them. Breathing takes care of both of these needs. The **respiratory system** is the group of organs that takes in oxygen and gets rid of carbon dioxide. *Respiration,* or breathing, is the transport of oxygen from outside the body to cells and tissues, and the transport of carbon dioxide and wastes away from cells and to the environment.

Active Reading

19 Identify As you read this page, underline the gas that is needed by your body for cellular respiration.

Takes in Oxygen

When a person inhales, air is drawn into the lungs. Oxygen in the air moves into the blood from the lungs. The oxygen-rich blood flowing away from the lungs is carried to all the cells in the body. Oxygen leaves the capillaries and enters the body cells. Inside each cell, oxygen is used for cellular respiration. During cellular respiration, the energy that is stored in food molecules is released. Without oxygen, body cells would not be able to survive.

Releases Carbon Dioxide

When a person exhales, carbon dioxide is released from the body. Carbon dioxide is a waste product of cellular respiration, and the body needs to get rid of it. Carbon dioxide moves from body cells and into capillaries, where it is carried in the blood all the way to the lungs. Blood that flows to the lungs contains more carbon dioxide than oxygen. The carbon dioxide moves out of the lung capillaries and into the lungs, where it is exhaled.

Visualize It!

20 Apply Scuba divers breathe air from the tanks strapped to their bodies. Check the box next to the gas you would expect to find in the greatest concentration in the air tank on the diver's back and in the air bubbles he is exhaling.

Breathe Easy

What are the parts of the respiratory system?

Breathing is made possible by your respiratory system. Air enters your respiratory system through your nose or mouth when you breathe in. From there, the air moves through a series of tubes to get to your lungs.

Nose, Pharynx, and Larynx

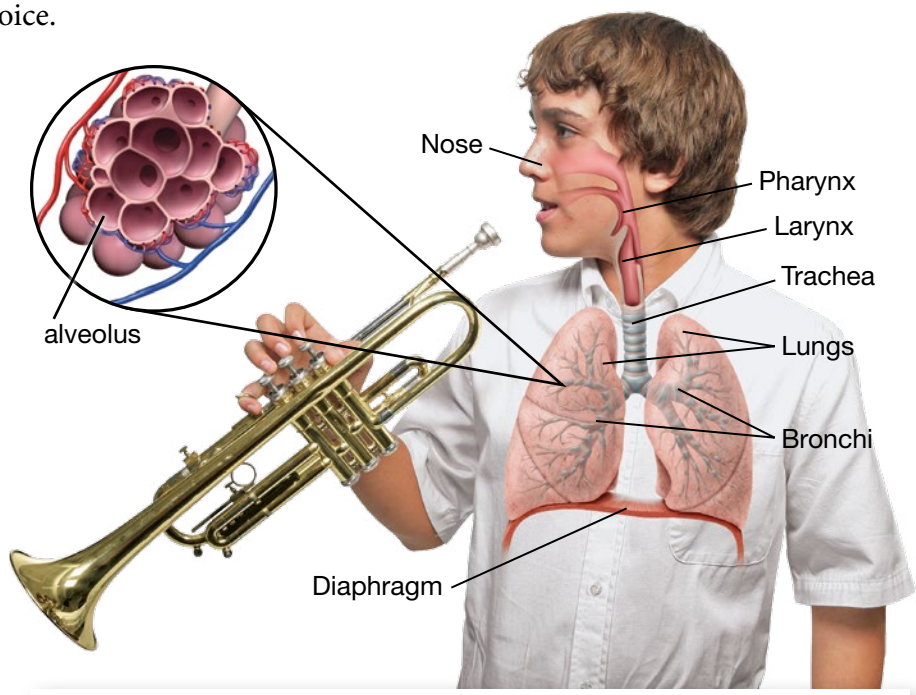
Air enters your respiratory system through your nose and your mouth. From the nose, air flows into the **pharynx** (FAIR•ingks), or throat. The pharynx branches into two tubes. One tube, the *esophagus*, leads to the stomach. The other tube, called the *larynx,* leads to the lungs. The **larynx** (LAIR•ingks) is the part of the throat that holds the vocal cords. When air passes across the vocal cords, they vibrate, making the voice.

Trachea

The larynx is connected to a large tube called the **trachea** (TRAY•kee•uh), or windpipe. Air flows from the larynx through the trachea to the lungs. The trachea splits into two branches called **bronchi** (singular, *bronchus*). One bronchus connects to each lung. Each bronchus branches into smaller tubes called *bronchioles*.

Bronchioles and Alveoli

In the lungs, the bronchioles lead to tiny sacs called **alveoli** (singular, *alveolus*). Alveoli are surrounded by blood vessels. Gases in the air move across the thin walls of the alveoli and blood vessels. As you breathe, air is sucked into and forced out of alveoli. Breathing is carried out by the diaphragm and rib muscles. The *diaphragm* is a dome-shaped muscle below the lungs. As you inhale, the diaphragm contracts and moves down. The volume of the chest increases. As a result, a vacuum is created and air is sucked in. Exhaling reverses this process.



Visualize It!

21 Apply Draw arrows showing the direction of air flow into the lungs. How would an object blocking a bronchus affect this airflow?

What are some disorders of the respiratory system?

Millions of people suffer from respiratory disorders. These disorders include asthma, pneumonia, emphysema, and lung cancer. Some respiratory problems, such as emphysema and lung cancer, are strongly linked to cigarette smoke. Other respiratory disorders, such as pneumonia, are caused by pathogens, and some are genetic disorders. Depending on the cause, there are many different ways to treat respiratory diseases.

Active Reading

22 Identify As you read, underline the characteristics of the different respiratory disorders.

Asthma

Asthma is a condition in which the airways are narrowed due to inflammation of the bronchi. During an asthma attack, the muscles in the bronchi tighten and the airways become inflamed. This reduces the amount of air that can get into or out of the lungs. Asthma is treated with medicines that open the bronchioles.

Pneumonia

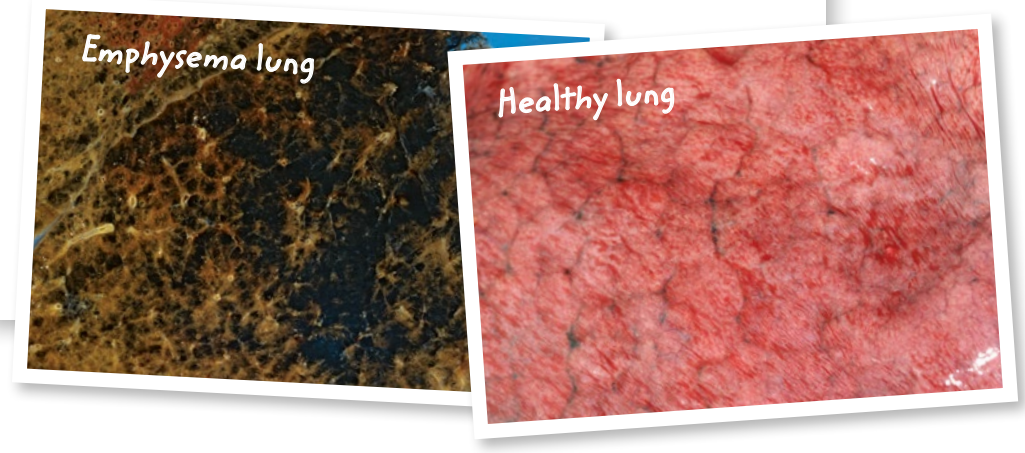
Pneumonia (noo•MOHN•yuh) is an inflammation of the lungs that is usually caused by bacteria or viruses. Inflamed alveoli may fill with fluid. If the alveoli are filled with too much fluid, the person cannot take in enough oxygen and he or she may suffocate. Pneumonia can be treated with medicines that kill the pathogens.

Emphysema

Emphysema (em•fuh•SEE•muh) occurs when the alveoli have been damaged. As a result, oxygen cannot pass across into the blood as well as it could in a normal alveolus. People who have emphysema have trouble getting the oxygen they need and removing carbon dioxide from the lungs. This condition is often linked to long-term use of tobacco.

Visualize It!

23 Compare How are these two lungs different? How can you tell the diseased lung from the healthy lung? Support your claim with evidence.



Think Outside the Book

24 Imagine Pretend you are a lung. The behavior of your body has not been very healthy, and as a result you are sick. Write a plea to your body to help you improve your health. Be sure to include the important functions that you perform and what the body can do to make you healthier.

Visual Summary

To complete this summary, fill in the blanks with the correct word or phrase. Then use the key below to check your answers. You can use this page to review the main concepts of the lesson.

Circulatory and Respiratory Systems

The lymphatic system returns fluid to the blood.

25 The lymph organs found in your throat are called _____.

The cardiovascular system moves blood throughout the body and carries nutrients and oxygen to body cells.

26 The two gases that the blood carries around the body are _____ and _____.

The respiratory system takes oxygen into the body and releases carbon dioxide.

27 Oxygen enters the blood and carbon dioxide leaves the blood in the _____ of the lungs.

Answers: 25 tonsils; 26 oxygen, carbon dioxide; 27 alveoli

28 Relate Describe how a problem with the respiratory system could directly affect the cardiovascular system.

Lesson Review

Vocabulary

In your own words, define the following terms.

1 blood

2 lymph

3 alveoli

Key Concepts

Fill in the table below.

System	Structures
4 Identify What are the main structures of the lymphatic system?	
5 Identify What are the main structures of the cardiovascular system?	
6 Identify What are the main structures of the respiratory system?	

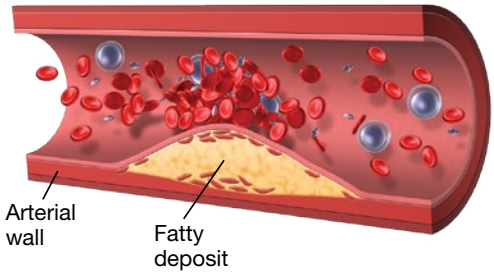
7 Explain How does blood help maintain homeostasis in the body?

8 Contrast How are arteries and veins different?

9 Relate How might a blockage of the lymph vessels affect the function of the cardiovascular system?

Critical Thinking

Use this image to answer the following questions.



10 Relate To what body system does this structure belong?

11 Predict How might what is happening in this image affect the nervous system?

12 Claims • Evidence • Reasoning Is it important that lymph vessels are spread throughout the body? Use evidence to support your claim and explain your reasoning.

My Notes

People in Science

Olufunmilayo Falusi Olopade

MEDICAL DOCTOR

Dr. Olufunmilayo Olopade is the head of the University of Chicago's Cancer Risk Clinic. The MacArthur Foundation awarded her $500,000 for her creative work in breast cancer research.

Born in Nigeria, Dr. Olopade began her career as a medical officer at the Nigerian Navy Hospital in Lagos. She later came to Chicago to do cancer research. She became a professor at the University of Chicago in 1991. She founded the Cancer Risk Clinic shortly after this.

Dr. Olopade has found that tumors in African-American women often come from a different group of cells than they do in Caucasian women. These tumors, therefore, need different treatment. Dr. Olopade designs treatments that address the source of the tumor. More importantly, her treatments try to address the particular risk factors of each patient. These can include diet, heredity, age, and activity. The MacArthur Foundation recognized Dr. Olopade for designing such new and practical treatment plans for patients. Studying cells has provided Dr. Olopade with clues on how to improve the lives of millions of African-American women.

A color-enhanced scanning electron micrograph (SEM) of a breast cancer cell

JOB BOARD

Diagnostic Medical Sonographer

What You'll Do: Operate and take care of the sonogram equipment that uses sound waves to create pictures of inside human bodies that a doctor can interpret.

Where You Might Work: Hospitals, clinics, and private offices that have sonogram equipment.

Education: A two- or four-year undergraduate degree or a special certification program is necessary.

Physical Therapist

What You'll Do: Use exercise, ultrasound, heat, and other treatments when working with patients to help them improve their muscular strength, endurance, and flexibility.

Where You Might Work: Hospitals, clinics, and private physiotherapy offices, as well as some gyms and yoga studios.

Education: A master's degree from an accredited physical therapy program is required.

Prosthetics Technician

What You'll Do: Create, test, fit, maintain, and repair artificial limbs and other prosthetic devices for people who need them.

Where You Might Work: Hospitals with prosthetic divisions and private companies.

Education: Technicians must have an associate, bachelor's, or post-graduate degree in orthotics and prosthetics. Some companies may require additional certification.

Language Arts Connection

Find one report of a new discovery in cancer prevention. Summarize the key points of the discovery in a paragraph. Be sure to include information about what the discovery is, who made it, how the discovery was made, and how it changes what we know about cancer.

Lesson 4

The Digestive and Excretory Systems

ESSENTIAL QUESTION

How do your body's digestive and excretory systems work?

By the end of this lesson, you should be able to relate the parts of the digestive and excretory systems to their roles in the human body.

Your digestive system works to get all of the nutrients out of the food you eat.

Lesson Labs

Quick Labs
- Bile Function
- Peristalsis Race
- Mechanical Digestion

S.T.E.M. Lab
- Modeling a Kidney

Engage Your Brain

1 Predict Fill in the blanks with the words that you think best complete the following sentences.

Inside your _____, food is chewed and broken down by teeth and saliva.

The _____ is a muscle inside your mouth that helps you to swallow food and liquids.

If you eat too much food too quickly, you may get a _____ache.

2 Imagine How is a blender like your stomach?

_____

_____

_____

_____

Active Reading

3 Synthesize You can often define an unknown word if you see it used in a sentence. Use the sentence below to make an educated guess about the meaning of the word *enzyme*.

Example sentence

Enzymes in the mouth, stomach, and small intestine help in the chemical digestion of food.

enzyme:

_____

_____

_____

_____

_____

Vocabulary Terms

- **digestive system**
- **enzyme**
- **esophagus**
- **stomach**
- **small intestine**
- **large intestine**
- **pancreas**
- **liver**
- **excretory system**
- **kidney**
- **nephron**
- **urine**

4 Apply As you learn the meaning of each vocabulary term in this lesson, create your own definition or sketch to help you remember the meaning of the term.

You are what you eat!

What is the digestive system?

Active Reading

5 Identify As you read, underline the ways that your body uses nutrients.

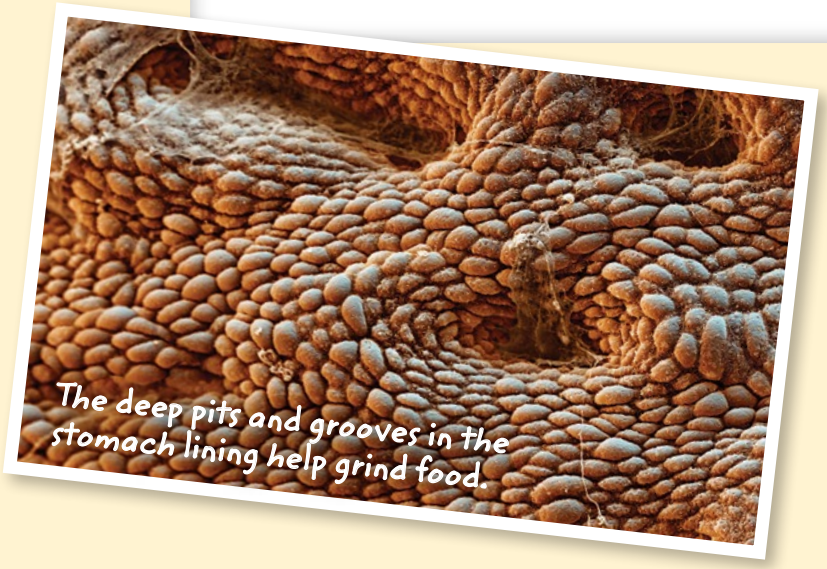
Your cells need a lot of energy for their daily activities. Cells use nutrients, which are substances in food, for energy, growth, maintenance, and repair. The **digestive system** breaks down the food you eat into nutrients that can be used as building materials and that can provide energy for cells.

The digestive system interacts with other body systems to obtain and use energy from food. Blood, part of the circulatory system, transports nutrients to other tissues. In order to extract energy from nutrients, cells need oxygen. The respiratory system is responsible for obtaining this oxygen from the environment. The nervous system controls and regulates the functioning of the digestive system.

What are the two types of digestion?

Digestion is the process of breaking down food into a form that can pass from the digestive system into the bloodstream. There are two types of digestion: mechanical and chemical.

The Stomach



The deep pits and grooves in the stomach lining help grind food.

Inquiry

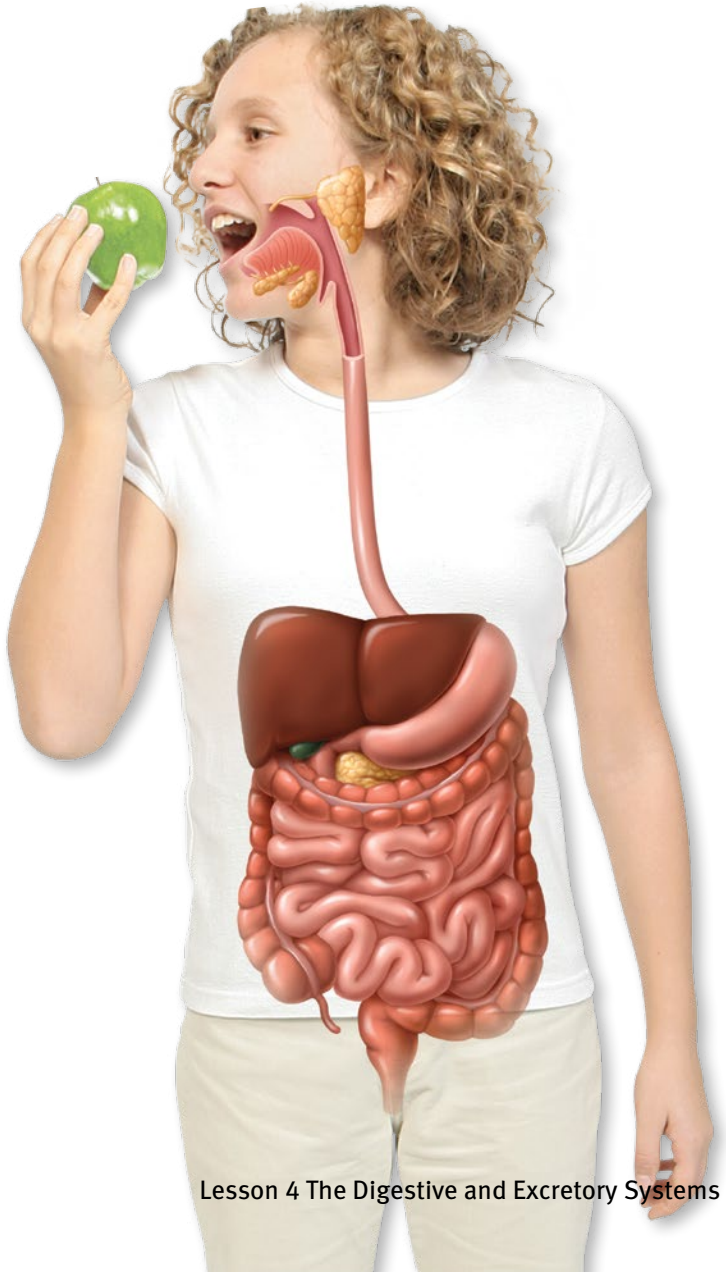
6 Infer The stomach lining is made up of deep muscular grooves. How do you think these structures help the stomach to break down food?

Mechanical Digestion

Mechanical digestion is the breaking, crushing, and mashing of food. Chewing is a type of mechanical digestion. Chewing creates small pieces of food that are easier to swallow and digest than large pieces are. Mechanical digestion increases the surface area of food for the action of chemical digestion.

Chemical Digestion

Chemical digestion is the process in which large molecules of food are broken down into smaller molecules so that they can pass into the bloodstream. An **enzyme** (EN•zym) is a chemical that the body uses to break down large molecules into smaller molecules. Enzymes act like chemical scissors. They "cut up" large molecules into smaller pieces. Mechanical digestion breaks up food and increases surface area so that enzymes can break nutrients into smaller molecules. Without mechanical digestion, chemical digestion would take days instead of hours!



Visualize It!

7 Categorize Decide whether each of these steps in digestion is an example of mechanical digestion or chemical digestion. Then put a check in the correct box.

In your mouth, teeth grind food.

- ☐ mechanical
- ☐ chemical

Salivary glands release a liquid called saliva, which helps to break food down.

- ☐ mechanical
- ☐ chemical

In the stomach, muscles contract to grind food into a pulpy mixture.

- ☐ mechanical
- ☐ chemical

In the small intestine, most nutrients are broken down by enzymes.

- ☐ mechanical
- ☐ chemical

Chew on this

What are the parts of the digestive system?

Has anyone ever reminded you to chew your food? Chewing food is the first part of digestion. After food is chewed and swallowed, pieces of that food move through other organs in the digestive system, where the food is broken down even more.

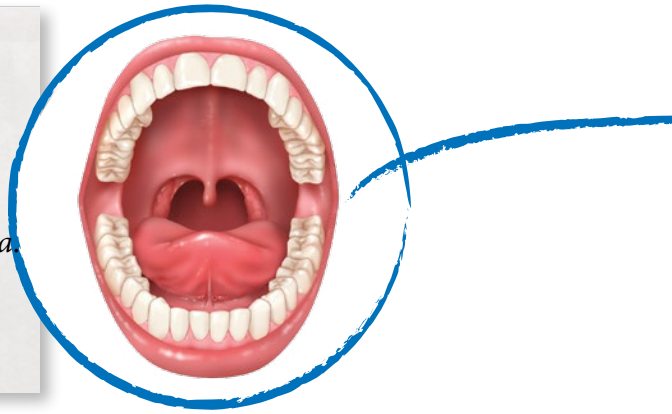
Active Reading

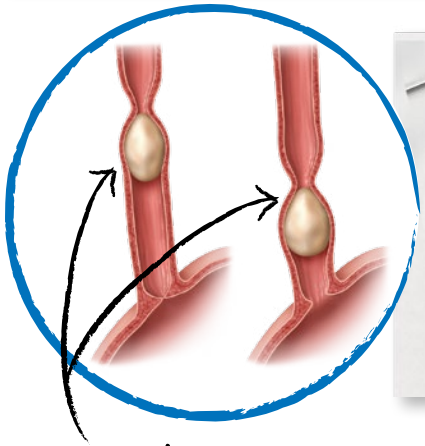
8 As you read, underline the function of each organ of the digestive system.

The Mouth

Digestion begins in the mouth with both mechanical and chemical digestion. Teeth, with the help of strong jaw muscles, break and crush food.

As you chew, food is moistened by a liquid called *saliva*. Glands in your mouth make saliva. Saliva contains many substances, including an enzyme that begins the chemical digestion of starches in food.





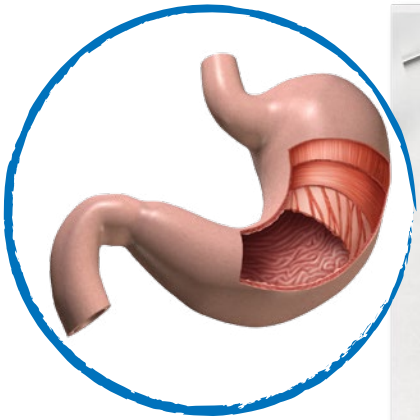
Muscles in the esophagus move this clump of food from your mouth to your stomach.

The Esophagus

Once food has been chewed, it is swallowed. The food moves through the throat and into a long tube called the **esophagus** (ih•SAWF•uh•gus). Waves of muscle contractions called *peristalsis* (per•ih•STAWL•sis) move the food into the stomach. The muscles move food along in much the same way as you move toothpaste from the bottom of the tube with your thumbs.

Visualize It!

9 Claims • Evidence • Reasoning Do you think digestion is more efficient if you are sitting up, slumped over, or lying down? To support your claim, consider the order of organs in the digestive system and their positions in the body. Explain your reasoning.



Stomach

The **stomach** is a muscular bag that crushes food and contains acids and enzymes for killing bacteria and breaking down proteins. The walls of the stomach contain layers of muscle so the stomach walls can churn and mix food. This is the final step in the process of mechanical digestion of the food you have eaten.

Tiny glands in the stomach release a special type of acid that is so harsh that it kills most bacteria that might be swallowed with your food. A coating of thick mucus protects the stomach lining from the acid. The glands in the stomach also release enzymes that begin the process of breaking down proteins. The enzymes that break down proteins can function only in the acidic environment of the stomach.

Small Intestine

After a few hours in the stomach, food is reduced to a soupy mixture called *chyme* (kym). Chyme leaves the stomach and moves into the small intestine. The **small intestine** is a muscular tube where most chemical digestion takes place and most nutrients are absorbed.

Large Intestine

After food moves through the small intestine, it moves to the **large intestine.** In the large intestine, water and nutrients are absorbed. Most of the solid material remaining is waste, which is compacted and stored. Eventually it is eliminated from the body.

Where are nutrients absorbed?

The digestion of nutrients in the small intestine takes place with the help of three organs that attach to the small intestine. These organs are the *pancreas*, *liver*, and *gall bladder*.

The **pancreas** (PANG•kree•uhz) makes fluids that break down every type of material found in foods: proteins, carbohydrates, fats, and nucleic acids. The **liver** makes and releases a mixture called *bile* that is then stored in the gall bladder. Bile breaks up large fat droplets into very small fat droplets.

In the Small Intestine

After nutrients are broken down, they are absorbed into the bloodstream and used by the body's cells. The inside wall of the small intestine has three features that allow it to absorb nutrients efficiently: folds, villi, and microvilli.

First, the walls of the small intestine have many folds. These folds increase the surface area inside the intestine wall, creating more room for nutrients to be absorbed. Each fold is covered with tiny fingerlike projections called *villi* (VIL•eye). In turn, the villi are covered with projections called *microvilli*. Microvilli increase the surface area of the villi. Villi contain blood and lymph vessels that absorb nutrients from food as it passes through the small intestine.

In the Large Intestine

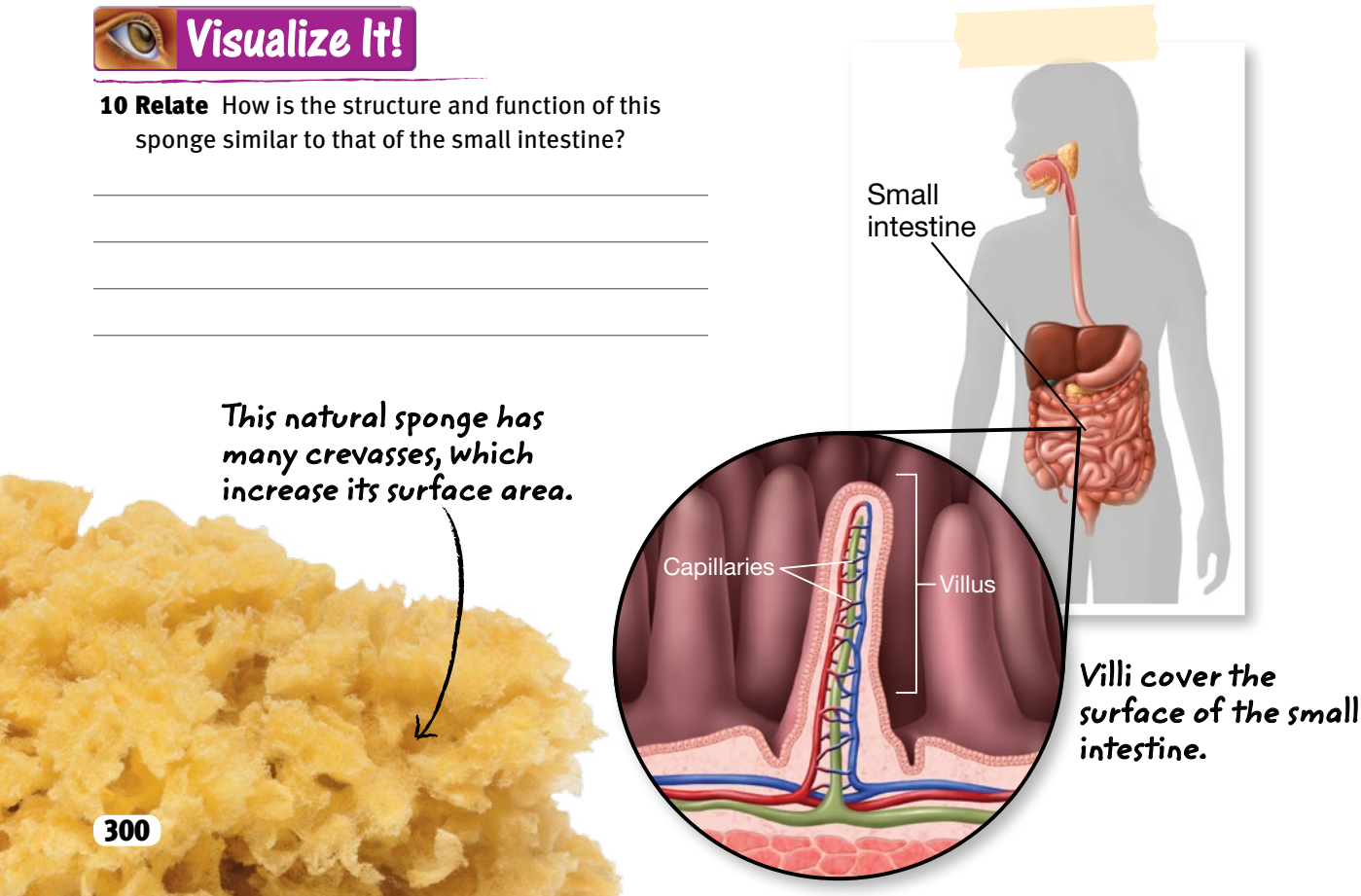
The large intestine removes water from mostly-digested food, absorbs vitamins, and turns food waste into semi-solid waste called *feces*.

Some parts of food, such as the cell walls of plants, cannot be absorbed by the body. Bacteria live in the large intestine that feed off of this undigested food. The bacteria produce vitamins that are absorbed by the large intestine along with most of the water in the undigested food.

The *rectum* is the last part of the large intestine. The rectum stores feces until they can be expelled. Feces pass to the outside of the body through an opening called the *anus*. It takes about 24 hours for a meal to make the full journey through a person's digestive system.

Visualize It!

10 Relate How is the structure and function of this sponge similar to that of the small intestine?



Toxic Waste!

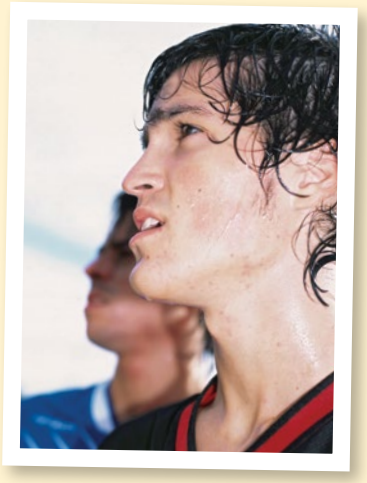
What are the functions of the excretory system?

You have toxic waste in your body! As your cells perform the chemical activities that keep you alive, waste products, such as carbon dioxide and ammonia, are made. These waste products are toxic to cells. If waste builds up in a cell, homeostasis will be disrupted and the cell may die. The **excretory system** eliminates cellular wastes from the body through the lungs, skin, kidneys, and digestive system.

Waste Removal

To Sweat

Your skin is part of the excretory and the integumentary systems. Waste products, such as excess salts, are released through your skin when you sweat.



After you read the text, answer the associated questions below.

11 Identify Sweat releases wastes through your _____.

To Exhale

Your lungs are part of the excretory and respiratory systems. Lungs release water and toxic carbon dioxide when you exhale.

12 List Two waste products that are released when you exhale are _____ and _____.

To Produce Urine and Feces

Kidneys, part of the urinary system, remove all types of cellular waste products from your blood. Your digestive system eliminates feces from your body.

13 Identify The urinary system filters waste out of your _____.

Cleanup crew

What organs are in the urinary system?

The urinary system collects cellular waste and eliminates it from the body in the form of liquid waste. Waste products enter the urinary system through the kidneys.

Active Reading

14 Identify As you read, underline the functions of the organs in the urinary system.

Kidneys

The **kidney** is one of a pair of organs that remove waste from the blood. Inside each kidney are more than 1 million microscopic structures called **nephrons** (NEF•rahnz). Fluid is filtered from the blood into the nephron through a structure called the *glomerulus* (gloh•MEHR•yuh•luhs). Filtered blood leaves the glomerulus and circulates around the tubes that make up the nephron. These structures return valuable salts and ions to the blood. Tubes in the kidneys collect the wastes from the nephrons. Water and the wastes filtered out of the blood form a liquid known as **urine.**

Ureters

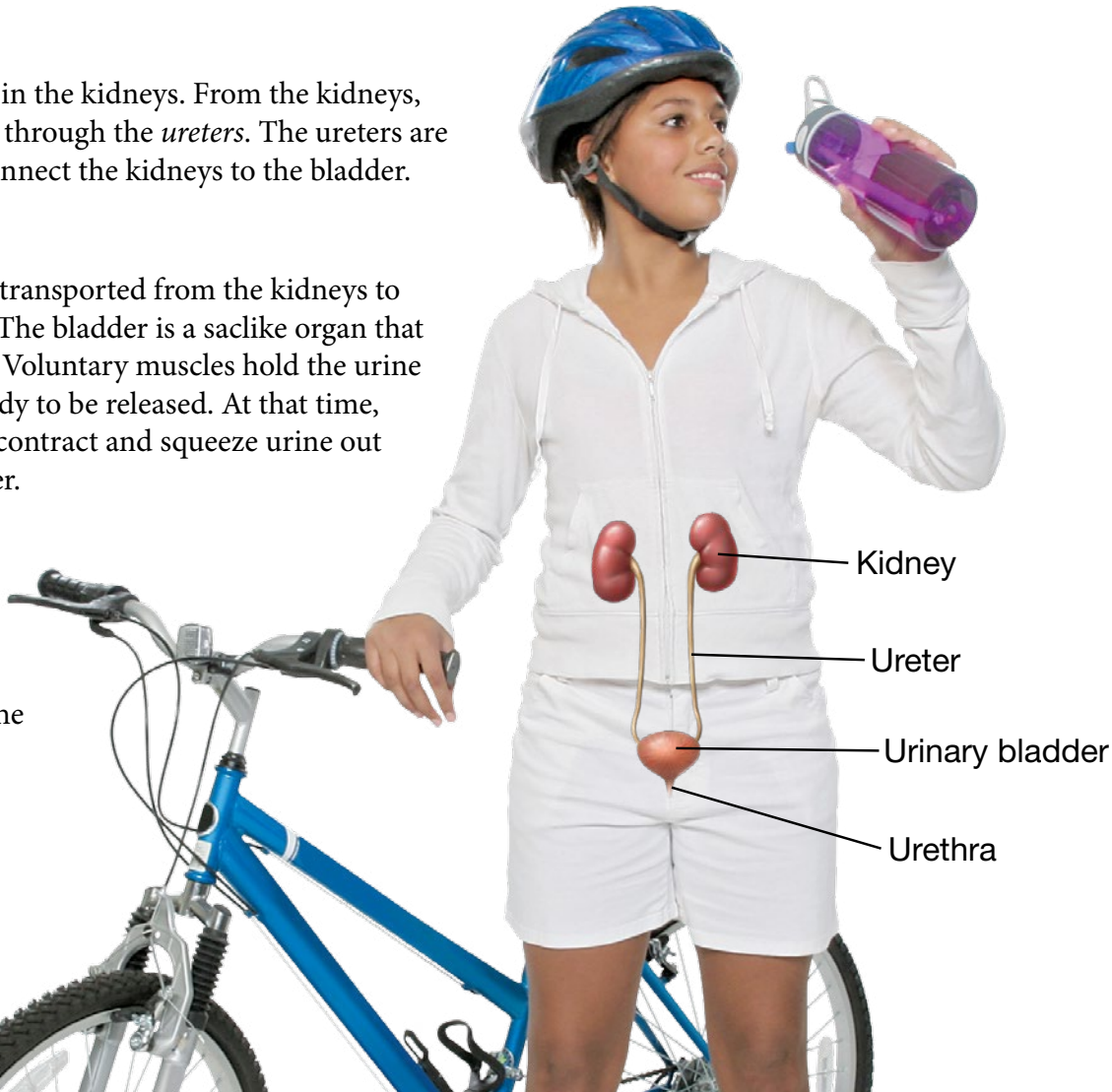
Urine forms in the kidneys. From the kidneys, urine travels through the *ureters*. The ureters are tubes that connect the kidneys to the bladder.

Bladder

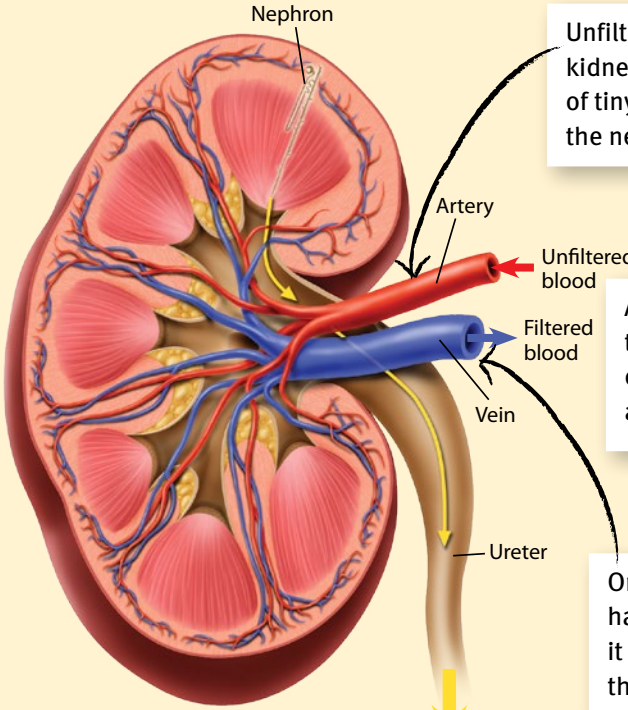
The urine is transported from the kidneys to the *bladder*. The bladder is a saclike organ that stores urine. Voluntary muscles hold the urine until it is ready to be released. At that time, the muscles contract and squeeze urine out of the bladder.

Urethra

Urine exits the bladder through a tube called the *urethra*.



Filtering Blood



Unfiltered blood enters the kidney and flows into millions of tiny capillaries attached to the nephrons.

As blood flows through the capillaries, wastes are drawn out of the blood and into the nephron.

Once the blood has been filtered, it flows back out of the kidney.

Urine is collected from all of the nephrons and then flows out of the kidney through the ureter.

Visualize It!

15 Identify After blood enters the kidneys, name the two paths the fluid takes.

How does the urinary system maintain homeostasis?

Your cells have to maintain a certain level of water and salt in order to function properly. The excretory system interacts with the endocrine system to help maintain homeostasis and carry out life processes. Chemical messengers called *hormones* signal the kidneys to filter more or less water or salt, depending on the levels of water and salt in the body. For example, when you sweat a lot, the water content of your blood can drop. When this happens, a hormone is released that signals the kidneys to conserve more water and make less urine. When your blood has too much water, less of the hormone is released. As a result, the nephrons conserve less water, and more urine is produced by the kidneys.

Household or environmental toxins that enter the body through the skin, lungs, or mouth eventually end up in the bloodstream. When the kidneys are damaged, many toxins can accumulate in the blood. Infections can also affect the kidneys. Bacterial infections can occur when bacteria around the opening of the urethra travel up to the bladder and possibly the kidneys.

Active Reading

16 Explain How does exercise affect the balance of salt and water in your body? Synthesize evidence to support your claim.

Visual Summary

To complete this summary, fill in the blanks with the correct word or phrase. Then, use the answer key to check your answers. You can use this page to review the main concepts of the lesson.

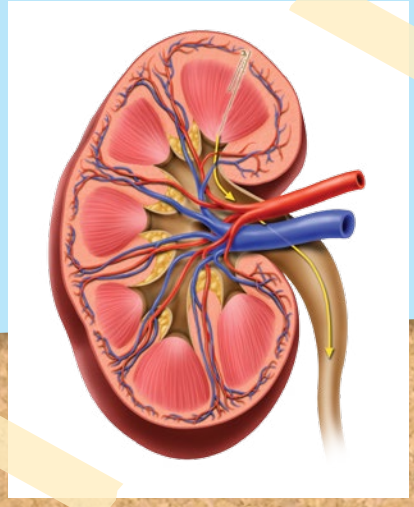
The digestive system breaks down the food you eat into nutrients that provide energy and building materials for cells.

17 The two types of digestion that take place in the mouth are _____ and _____.

Digestion and Excretion

The excretory system removes waste from the body.

18 The _____ remove waste from the blood.



The digestive and excretory systems interact to process the food that you eat.

19 To process this salad, food is broken down by the _____ _____ and wastes are removed by the _____.

Answers: 17 mechanical, chemical; 18 kidneys; 19 digestive system, excretory system

20 Summarize What types of wastes does the excretory system remove?

Lesson Review

Vocabulary

Fill in the blank with the term that best completes the following sentences.

1 The _____ system helps the body maintain homeostasis by giving it the nutrients it needs to perform different functions.

2 The _____ system eliminates cellular waste through the lungs, skin, and kidneys.

3 The _____ is the name for the hollow muscular organ that stores urine.

Key Concepts

4 Compare What is the difference between mechanical digestion and chemical digestion in the mouth?

5 Describe Starting with the mouth, describe the pathway that food takes through the digestive system.

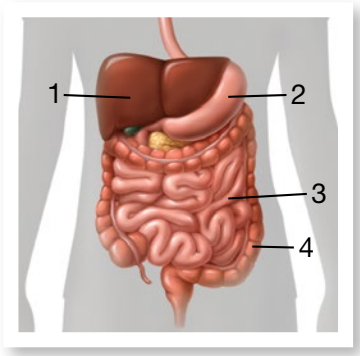
6 Explain How does the circulatory system interact with the digestive system?

7 Identify Where does urine go after it exits the kidneys?

8 Summarize How do kidneys interact with other body systems to maintain homeostasis?

Use the diagram to answer the following question.

9 Apply Identify the organs numbered below.



Critical Thinking

10 Relate How would damaged kidneys affect your health? Explain your reasoning.

11 Claims • Evidence • Reasoning Suppose a person has a small intestine that has fewer villi than normal. Would the person most likely be overweight or underweight? State your claim. Summarize evidence to support your claim and explain your reasoning.

My Notes

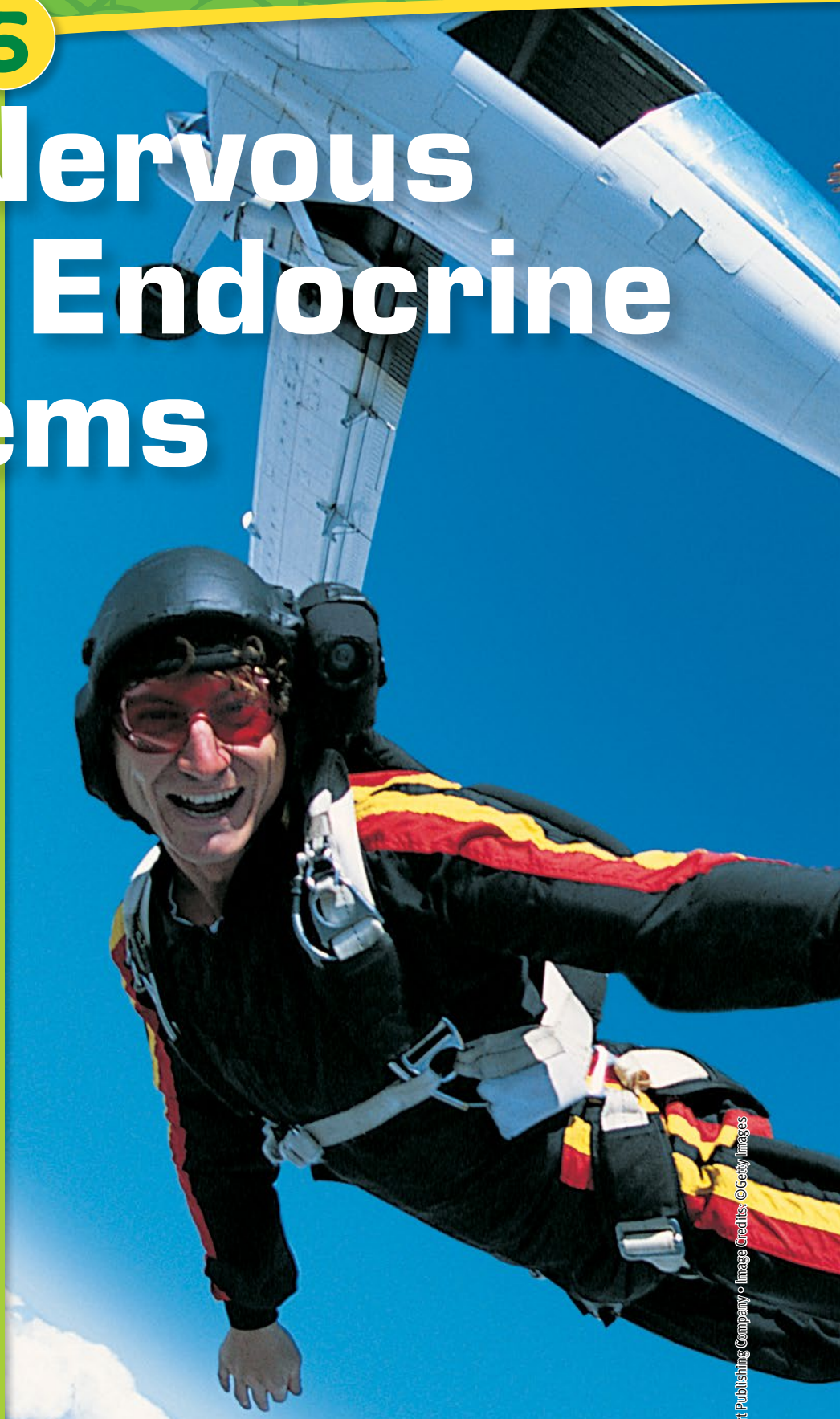
Lesson 5

The Nervous and Endocrine Systems

ESSENTIAL QUESTION

How do the nervous and endocrine systems work?

By the end of this lesson, you should be able to relate the structures of the nervous and endocrine systems to their functions in the human body.



This sky diver can sense his surroundings and feel the rush of excitement with the help of his nervous and endocrine systems.

Lesson Labs

Quick Labs
- Negative Feedback
- Measuring Reaction Time

Exploration Lab
- Mapping Sensory Receptors

Engage Your Brain

1 Predict Check T or F to show whether you think each statement is true or false.

T	F	
☐	☐	The central nervous system allows us to sense the environment.
☐	☐	The endocrine system functions by sending chemical signals.
☐	☐	The spinal cord is part of the peripheral nervous system.
☐	☐	The endocrine system helps regulate our blood sugar after we eat a meal.

2 Describe Think about a situation that makes you feel very nervous or anxious. Describe how this makes you feel inside. What do you think is going on in your body?

Active Reading

3 Apply You can often understand the meaning of a word if you use it in a sentence. Use the following definition to write your own sentence that has the word *gland*.

Definition
gland: a group of cells that make special chemicals for the body

gland:

Vocabulary Terms

- **nervous system**
- **brain**
- **spinal cord**
- **neuron**
- **axon**
- **dendrite**
- **endocrine system**
- **hormone**
- **gland**

4 Apply As you learn the definition of each vocabulary term in this lesson, create your own definition or sketch to help you remember the meaning of the term.

Brainiac!

What is the function of the nervous system?

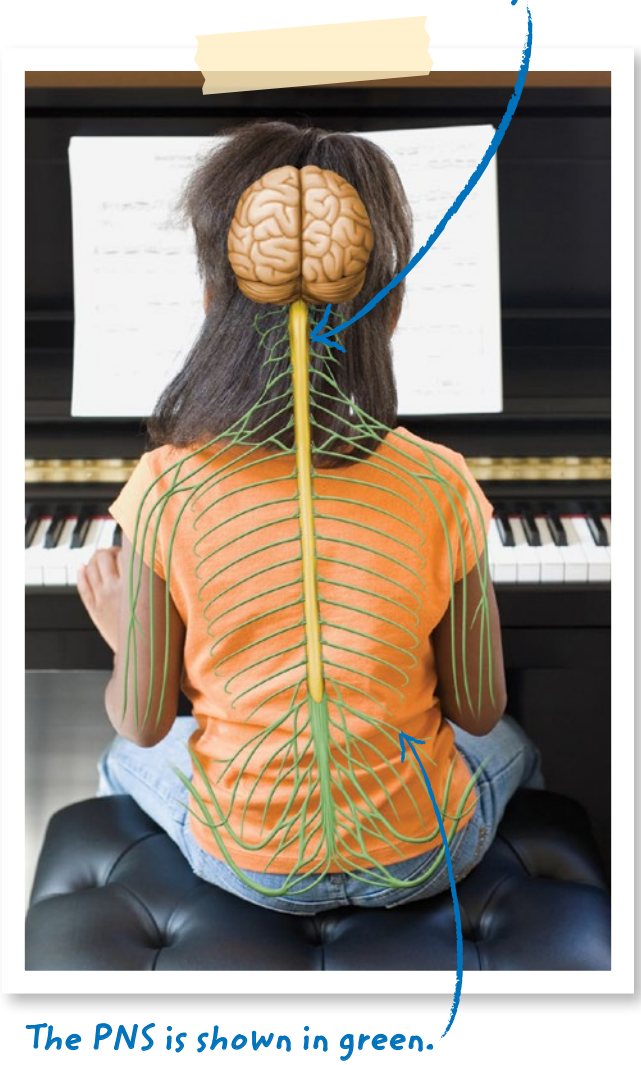
The **nervous system** is made of the structures that control the actions and reactions of the body in response to stimuli from the environment. Your nervous system has two parts: the central nervous system (CNS) and the peripheral (puh•RIFF•uh•rahl) nervous system (PNS).

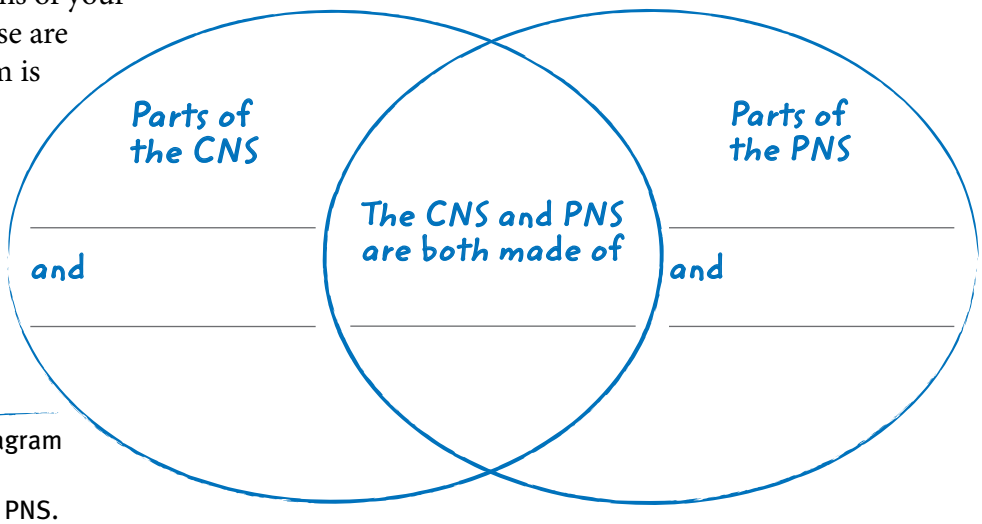
The CNS Processes Information

The brain and the spinal cord make up the CNS. The **brain** is the body's central command organ. It constantly receives impulses from all over the body. Your **spinal cord** allows your brain to communicate with the rest of your body. Your nervous system is mostly made up of specialized cells that send and receive electrical signals.

The PNS Connects the CNS to Muscles and Organs

Your PNS connects your CNS to the rest of your body. The PNS has two main parts—the sensory part and the motor part. Many processes that the brain controls happen automatically—you have no control over them. These processes are called *involuntary*. For example, you could not stop your heart from beating even if you tried. However, some of the actions of your brain you can control—these are *voluntary*. Moving your arm is a voluntary action.





5 Compare Fill in the Venn diagram to compare and contrast the structure of the CNS and the PNS.

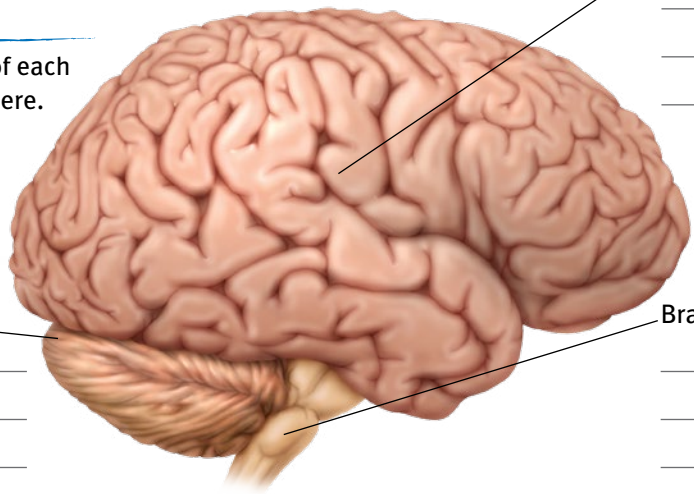
What are the parts of the CNS?

The CNS is made up of the brain and the spinal cord.

The Brain

The three main areas of the brain are the cerebrum, the cerebellum, and the brain stem. The largest part of the brain is the cerebrum. The cerebrum is where you think and problem-solve, and where most of your memories are stored. It controls voluntary movements and allows you to sense touch, light, sound, odors, taste, pain, heat, and cold. The second largest part of your brain is the cerebellum. It processes information from your body. This allows the brain to keep track of your body's position and coordinate movements. The brain stem connects your brain to your spinal cord. The medulla is part of the brain stem. It controls involuntary processes, such as blood pressure, body temperature, heart rate, and involuntary breathing.

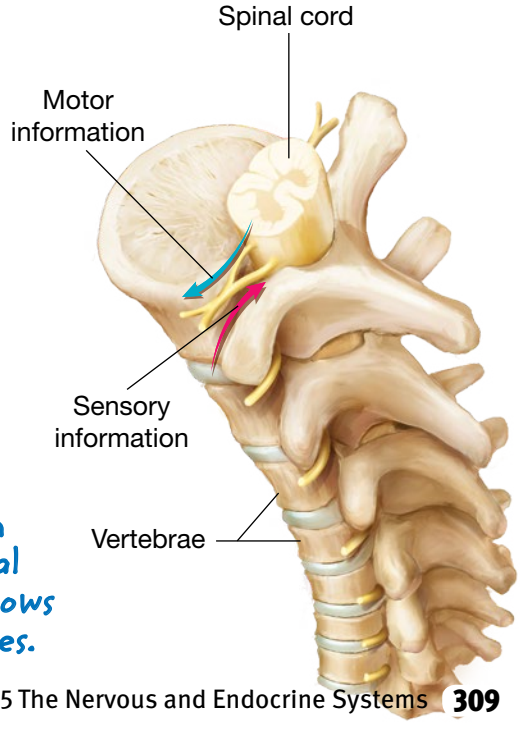
6 Identify List a function of each part of the brain shown here.



The Spinal Cord

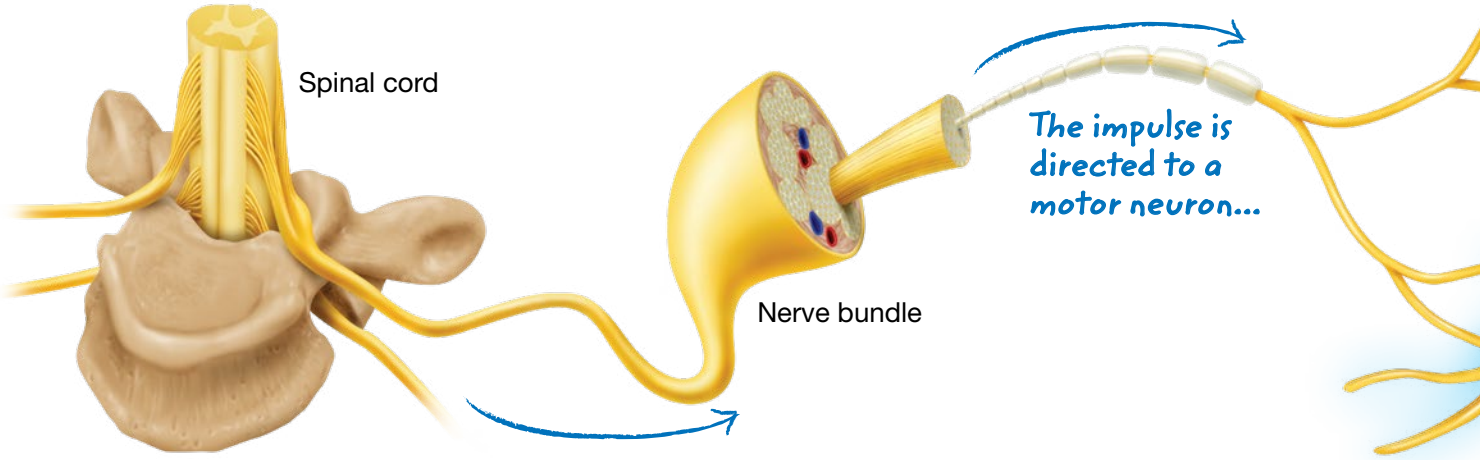
The spinal cord is made of bundles of nerves. A *nerve* is a collection of nerve cell extensions bundled together with blood vessels and connective tissue. Nerves are everywhere in your body. The spinal cord is surrounded by protective bones called *vertebrae.*

Special cells in your skin and muscles carry sensory information to the spinal cord. The spinal cord carries these impulses to the brain. The brain interprets these impulses as warmth, pain, or other sensations and sends information back to the spinal cord. Different cells in the spinal cord then send impulses to the rest of the body to create a response.



Sensory information (red) flows in from the environment to the spinal cord. Motor information (blue) flows out from the spinal cord to muscles.

You've Got Nerves!



If you notice that your shoe is untied, your brain interprets this information and sends an impulse down the spinal cord.

How do signals move through the nervous system?

Your nervous system works by receiving information from the environment and translating that information into electrical signals. Those electrical signals are sent from the brain to the rest of the body by special cells called *neurons*. A **neuron** is a cell that moves messages in the form of fast-moving electrical energy. These electrical messages are called *impulses*.

Signals move through the central and peripheral nervous systems with the help of glial (GLEE•uhl) cells. Glial cells do not transmit nerve impulses, but they protect and support neurons. Without glial cells, neurons would not work properly. Your brain has about 100 billion neurons, but there are about 10 to 50 times more glial cells in your brain.

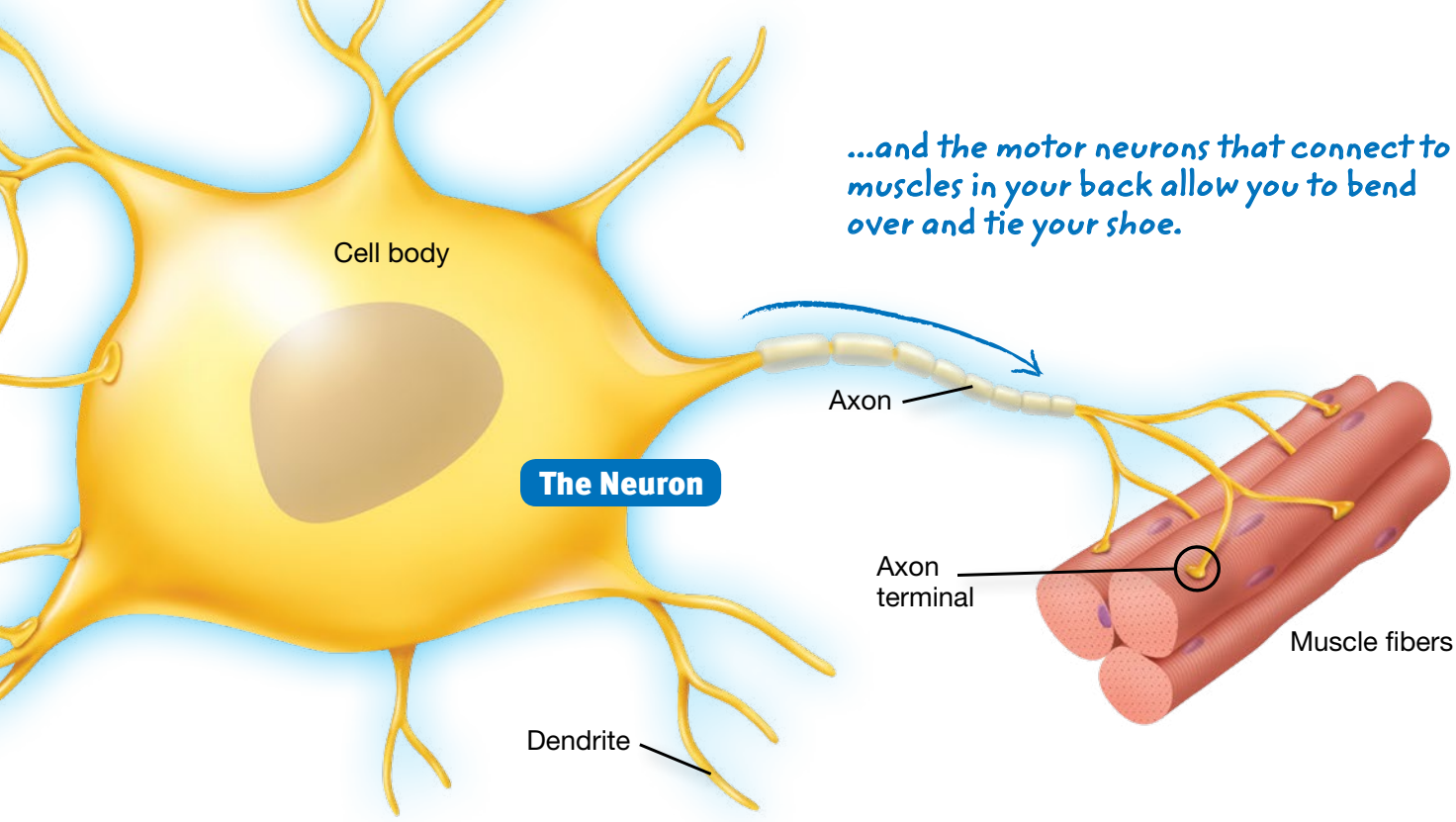
Through Sensory and Motor Neurons

Neurons carry information from the body to the brain, and carry instructions from the brain back to the rest of the body. The two groups of neurons are sensory neurons and motor neurons.

Sensory neurons gather information from in and around your body. They then move this information to the brain. Motor neurons move impulses from the brain and spinal cord to other parts of the body. For example, when you are hot, motor neurons move messages from your brain to your sweat glands to tell the sweat glands to make sweat. Sweating cools your body.

Active Reading

7 Identify As you read, underline the special types of neurons that receive and send messages.



What are the parts of a neuron?

A neuron is made up of a large region called the *cell body,* a long extension called the *axon*, and short branches called *dendrites*. At the end of the axon is the *axon terminal*.

Like other cells, a neuron's cell body has a nucleus and organelles. But neurons have other structures that allow them to communicate with other cells. A **dendrite** (DEHN•dryt) is a usually short, branched extension of the cell body. A neuron may have one, two, or many dendrites. Neurons with many dendrites can receive impulses from thousands of cells at a time. The cell body gathers information from the dendrites and creates an impulse.

Impulses are carried away from the cell body by extensions of the neuron, called an **axon**. A neuron has only one axon, and they can be very short or quite long. Some long axons extend almost 1 m from your lower back to your toes! Impulses move in one direction along the axon.

At the end of an axon is the axon terminal, where a signal is changed from an electrical signal to a chemical signal. This chemical signal, called a *neurotransmitter,* is released into the gap between the neuron and other cells.

Visualize It!

8 Apply In the boxes below, fill in the appropriate neuron parts, structures, or functions.

NEURON PART	STRUCTURE	FUNCTION
Cell body	region containing nucleus and organelles	
	branches of the cell body	gathers information from other cells
Axon		sends impulse away from cell body
	end of an axon	changes electrical signal to chemical signal

That Makes Sense!

What are the main senses?

The body senses the environment with specialized structures called *sensory organs*. These structures include the eyes, the skin, the ears, the mouth, and the nose.

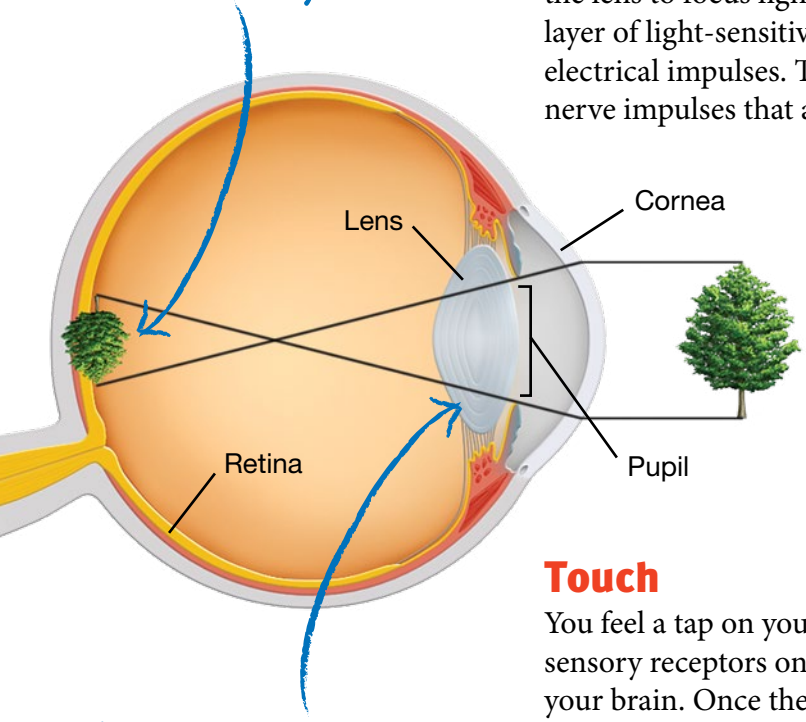
Inquiry

9 Imagine If you were at this amusement park, what do you think you would see, hear, smell, taste, and feel?

Sight

Your eye allows you to see the size, shape, motion, and color of objects around you. The front of the eye is covered by a clear membrane called the *cornea*. Light from an object passes through an opening called the *pupil*. Light hits the eye's lens, an oval-shaped piece of clear, curved material. Eye muscles change the shape of the lens to focus light onto the retina. The *retina* (RET•nuh) is a layer of light-sensitive photoreceptor cells that change light into electrical impulses. These cells, called *rods* and *cones,* generate nerve impulses that are sent to the brain.

Rays form an upside-down image on the retina at the back of the eye. This image is translated by the brain.



Light enters the eye through the lens. Light rays are bent by the cornea.

Visualize It!

10 Identify What part of the eye focuses light on to the retina?

Touch

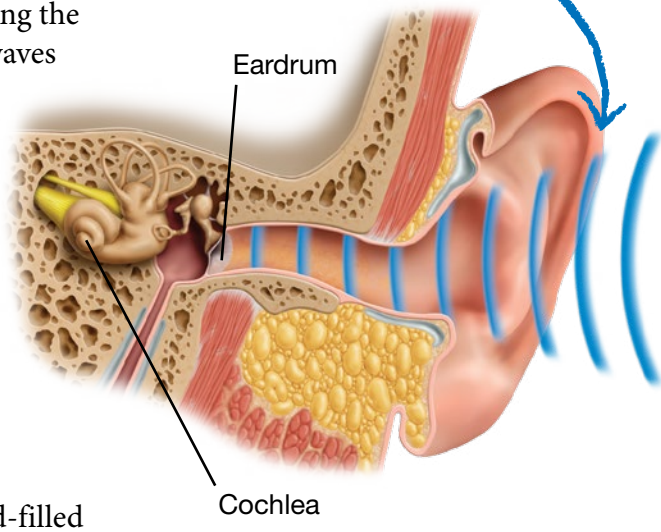
You feel a tap on your shoulder. The tap produces impulses in sensory receptors on your shoulder. These impulses travel to your brain. Once the impulses reach your brain, they create an awareness called a *sensation.* In this case, the sensation is that of your shoulder being touched. The skin has different kinds of receptors that detect pressure, temperature, pain, and vibration.

Hearing

Ears pick up sound wave vibrations. These sound waves push air particles, creating a wave of sound energy. The sensory cells of your ears turn sound waves into electrical impulses. These electrical impulses then travel to your brain. Each ear has an outer, a middle, and an inner portion. Sound waves reaching the outer ear are funneled toward the middle ear. There, the waves make the eardrum vibrate. The *eardrum* is a thin membrane separating the outer ear from the middle ear. The vibrating eardrum makes three tiny bones in the middle ear vibrate. The last of these bones vibrates against the *cochlea* (KOH•klee•uh), a fluid-filled organ of the inner ear. Inside the cochlea, the vibrations make waves in the fluid. Sensory receptors called *hair cells* move about in the fluid. Movement of the hair cells causes neurons in the cochlea to send electrical impulses. These impulses travel to the brain via the auditory nerve and are interpreted as sound.

The ears also help you maintain balance. Special fluid-filled canals in the inner ear are filled with hair cells that respond to changes in head orientation. These hair cells then send signals to the brain about the position of the head with respect to gravity.

Sound waves enter the ear and cause the eardrum to vibrate. The vibrations are translated by receptors.



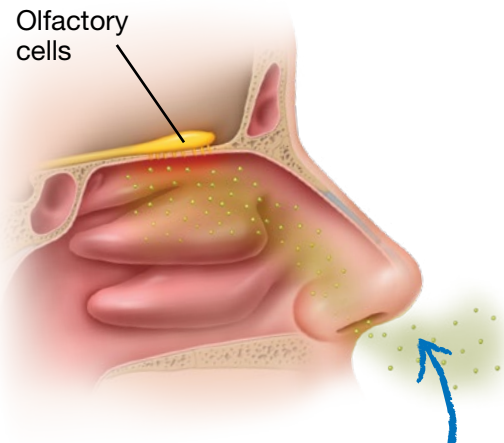
Taste

Your tongue is covered with taste buds. These taste buds contain clusters of *taste cells* that respond to signals in dissolved molecules in food. Taste cells react to five basic tastes: sweet, sour, salty, bitter, and savory. Your sense of taste can protect you from eating something that could be harmful.

Smell

The nose is your sense organ for smell. Receptors for smell are located in the upper part of your nasal cavity. Sensory receptors called *olfactory cells* react to chemicals in the air. These molecules dissolve in the moist lining of the nasal cavity and trigger an impulse in the receptors. The nerve impulses are sent to the brain, where they are interpreted as an odor. Your senses of taste and smell work together to allow you to taste a variety of food flavors. Both senses detect chemical cues in the environment.

11 Apply If you have a cold that causes congestion in your sinuses, how might that affect your sense of smell? Support your claim with evidence.



Molecules in the air enter your nose. There, they bind to receptors in the top of your nasal cavity.

Keep Your Cool!

What is the function of the endocrine system?

Your **endocrine system** controls body functions and helps maintain homeostasis by using hormones. A **hormone** is a chemical messenger made in one cell or tissue that causes a change in another cell or tissue in a different part of the body. Hormones are produced by endocrine glands or tissues. A **gland** is a group of cells that make special chemicals for your body. Unlike direct signals of the nervous system, the signals sent by the endocrine system are indirect because they cycle through the whole body.

How do hormones work?

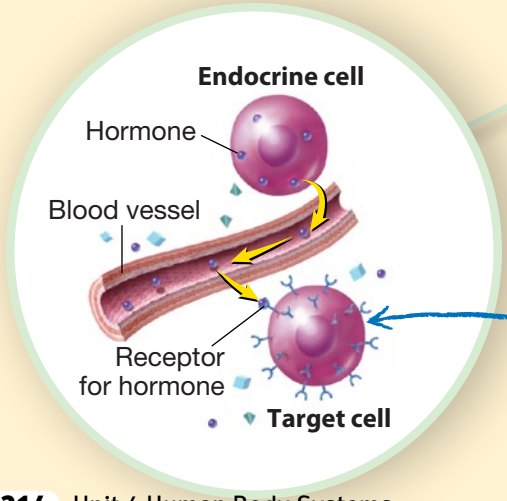
Active Reading

12 Identify As you read, underline the structure which allows hormones to affect only certain cells.

Hormones travel through the bloodstream. They travel from the endocrine gland where they are made and can reach every cell in the body. However, hormones affect only the cells that have specific *receptors*. Each hormone has its own receptor and affects only cells that have that receptor. These cells are called *target cells*. Many cells throughout the body have the same receptors, so hormones are able to perform many functions at the same time in different cells.

Visualize It!

13 Apply Explain the difference between an endocrine cell and a target cell.

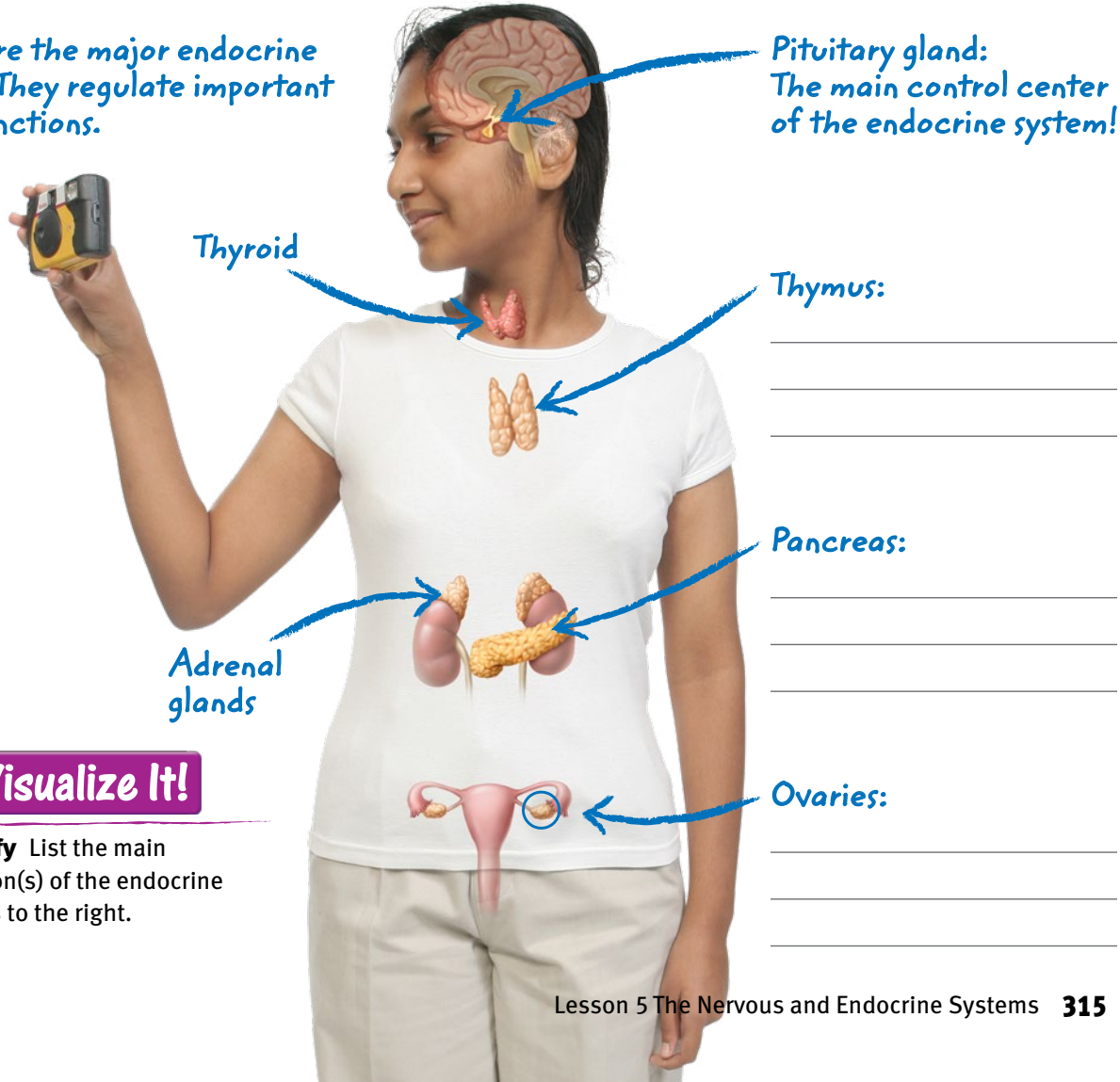


Hormones are released from an endocrine cell and travel through the bloodstream to bind to a receptor on a target cell. Sometimes a target cell is very far away!

What glands make up the endocrine system?

Your body has several endocrine glands or tissues that make up the endocrine system.

- Your pituitary gland is very important because it secretes hormones that affect other glands. It also stimulates growth and sexual development.
- The hypothalamus is a gland in the brain that controls the release of hormones from the pituitary gland.
- The pineal gland, also in the brain, produces hormones essential in the control of sleep, aging, reproduction, and body temperature.
- Hormones from the thyroid control your metabolism.
- The parathyroid gland controls calcium levels in the blood.
- Hormones made in the reproductive organs (ovaries or testes) control reproduction.
- Other endocrine glands include the pancreas and adrenal glands. The pancreas regulates blood sugar levels and the adrenal glands control the body's fight or flight response in dangerous situations.



Visualize It!

14 Identify List the main function(s) of the endocrine glands to the right.

Feedback

How are hormone levels controlled?

The endocrine system keeps the body's internal environment in homeostasis. It does this by increasing or decreasing the amount of hormones in the bloodstream, some of which may have opposite effects on body cells. Such a process is called a feedback mechanism. A *feedback mechanism* is a cycle of events in which information from one step controls or affects a previous step.

By Feedback Mechanisms

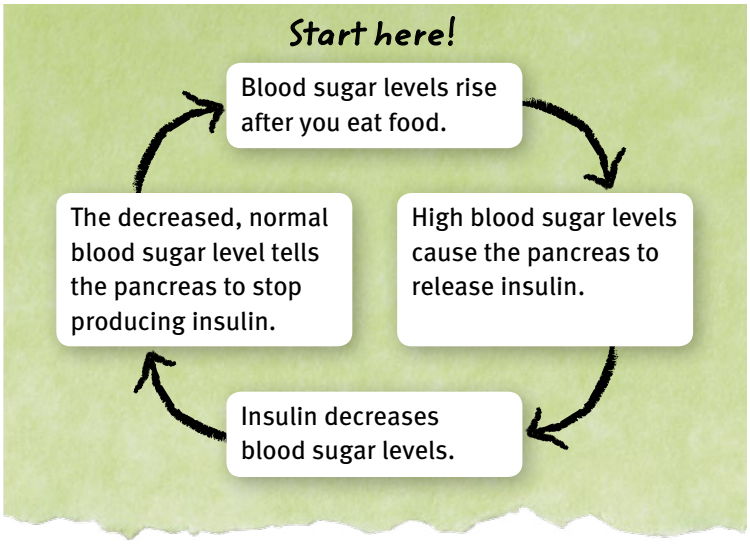
There are two types of feedback, positive and negative. In negative feedback, the effects of a hormone in the body cause the release of that hormone to be turned down. For example, when you eat food, your blood sugar levels go up. Insulin is released and blood sugar levels are lowered. Once this happens, the lower blood sugar levels tell the pancreas to stop releasing insulin. In other words, when the proper level of blood sugar is reached, the insulin-releasing cells are turned off.

In positive feedback, the effects of a hormone stimulate the release of more of that hormone. For example, the hormone oxytocin stimulates contractions of the uterus. When a fetus matures in the uterus, both it and the mother produce oxytocin. The oxytocin stimulates contractions, and these contractions stimulate more oxytocin to be released. The contractions expel a baby from the mother's uterus at birth.

Active Reading

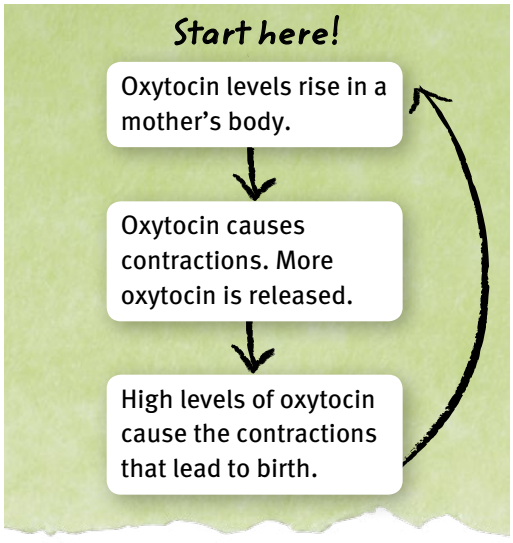
15 Compare Describe the difference between negative and positive feedback.

Negative Feedback



In negative feedback, hormone levels are kept from rising too high.

Positive Feedback



In positive feedback, the level of hormones continues to rise.

What are disorders of the endocrine and nervous systems?

The endocrine system and nervous system are both responsible for sending messages around our bodies. If a problem developed with one or more of these systems, other systems of the body would need to adjust to compensate for this loss.

Hormone Imbalances

Disorders of the endocrine system occur when an endocrine gland makes too much or not enough of a hormone. For example, a person whose pancreas does not make enough insulin has a condition called *type 1 diabetes*. This condition causes an imbalance of the blood sugar. A person who has diabetes may need daily injections of insulin to keep blood sugar levels within safe limits. Some patients receive their insulin automatically from a small pump worn next to the body. New technology allows people with type 1 diabetes to intake insulin using an inhaler.

17 Describe How does the insulin pump help a person with type 1 diabetes maintain homeostasis?

Think Outside the Book

16 Compare Many systems you use every day send messages, such as e-mail, a thermostat, and TV remote controls. Research how one of these systems sends and receives messages. Make a chart to compare this system to the endocrine system.

Nerve Damage

Disorders of the nervous system include Parkinson's disease, multiple sclerosis, and spinal cord injury. In Parkinson's disease, the cells that control movement are damaged. Multiple sclerosis affects the brain's ability to send signals to the rest of the body.

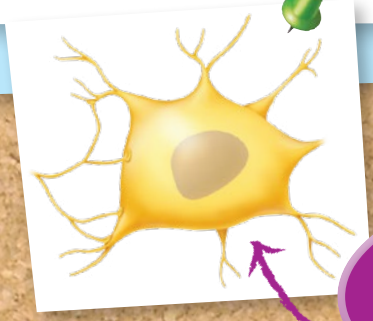
A spinal cord injury may block information to and from the brain. For example, impulses coming from the feet and legs may be blocked. People with such an injury cannot sense pain in their legs. The person would also not be able to move his or her legs, because impulses from the brain could not get past the injury site.

Visual Summary

To complete this summary, fill in the blank to answer the question. Then, use the key below to check your answers. You can use this page to review the main concepts of the lesson.

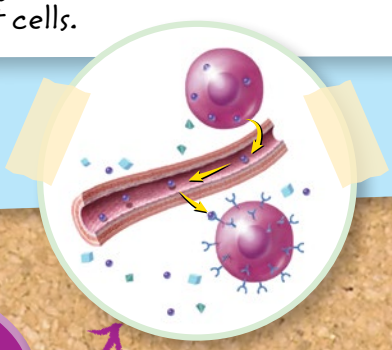
The nervous system gathers information and responds by sending electrical signals.

18 Nerve cells called _____ carry electrical messages called _____.



The endocrine system controls conditions in your body by sending chemical messages.

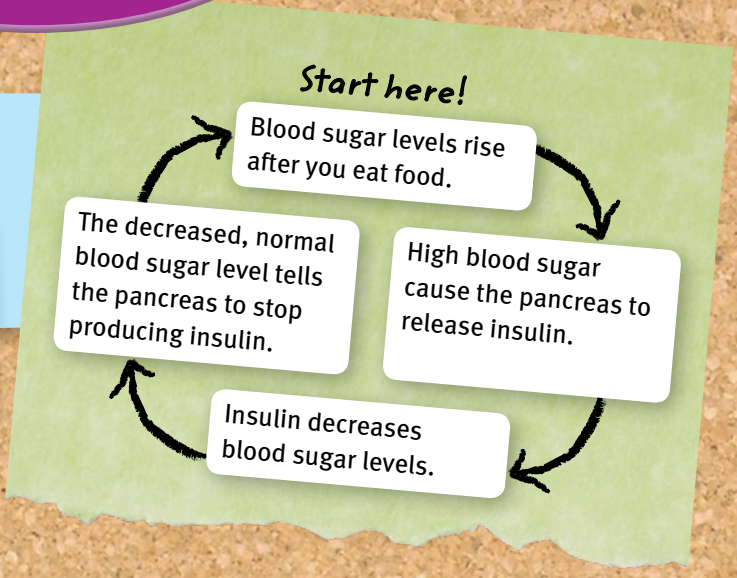
19 Hormones have specific actions by attaching to _____ on target cells.



Sending Signals

Hormones are controlled by feedback mechanisms.

20 _____ feedback is when higher levels of a hormone turn off the production of that hormone.



Answers: 18 neurons, impulses; 19 receptors; 20 Negative

21 Claims • Evidence • Reasoning Describe how both your nervous and endocrine systems would be involved if you walked into a surprise party and were truly surprised. Synthesize evidence to support your claim and explain your reasoning.

Lesson Review

Vocabulary

Use a term from the section to complete each sentence below.

1 The _____ is made up of the brain and spinal cord.

2 Glands in the _____ send messages to target cells.

3 Use *gland* and *hormone* in the same sentence.

4 Use *hormone* and *feedback mechanism* in the same sentence.

Key Concepts

5 Identify Describe the function of the PNS and the CNS.

6 Apply What are the parts of a neuron?

7 Identify How are the messages of the endocrine system moved around the body?

8 Identify What is the main sense organ for each of the five senses?

Critical Thinking

The images below show how an eye responds to different light levels. Use the image to answer the following question.

9 Interpret The pupil opens and closes automatically in response to light. What part of your nervous system controls this response?

10 Infer Explain whether this is a voluntary or involuntary action.

11 Claims • Evidence • Reasoning How would your body be affected if your pituitary gland was not working properly? State your claim. Summarize evidence to support your claim and explain your reasoning.

My Notes

S.T.E.M. Engineering & Technology

Engineering Design Process

Skills
✔ Identify a need
Conduct research
✔ Brainstorm solutions
✔ Select a solution
Build a prototype
Test and evaluate
Redesign to improve
✔ Communicate results

Objectives
• Identify a market need.
• Design an assistive device.
• Draw a prototype.

Designing a Device

The human body is an amazing machine, but sometimes it can use a little help. *Assistive devices* are devices that are designed for use by people with disabilities. Creating assistive devices to meet the needs of targeted groups of individuals is known as market needs. Some of these devices are integrated with the body, some are worn on the body, and some are tools that people use. Major categories of assistive devices include communication devices, hygiene (HY•jeen) or medication aids, vision aids, hearing aids, mobility aids, and eating aids. These devices include wheelchairs or grab bars, pacemakers, and internal insulin (IN•suh•lin) pumps. Also, hand railings help people climb stairs, shower handles help people get in and out of the shower, and sidewalk bumps help the visually impaired. These are all examples of ways that engineering is applied to life science.

1 Describe Look at the photo on this page. What examples of assistive devices do you see?

We Can All Use a Little Help

Some of the better-known assistive devices, such as wheelchairs or crutches, help with injuries or disabilities. For example, if you break your leg, your doctor will likely give you crutches to help you to get around while you heal. But many assistive or adaptive devices just simplify daily tasks. Small tools such as buttonhooks help people button their shirts, long-handled shoehorns make it easier to put on shoes, and special utensils make eating easier. Many adaptive devices are also integrated into your everyday environment. For example, some people wear glasses or contact lenses to improve their vision or get hearing aids to help their hearing.

Assistive devices help people perform tasks.

2 Explain For one of the devices shown above, state what the assistive device is and how it is helpful.

You Try It!

Now it's your turn to design an assistive device.

You Try It!

Now it's your turn to design a realistic assistive device that people need. You will think about what people might need to do, decide which is the most promising idea, draw a prototype of your device, and present your idea to your class.

1 Identify a Need

A Imagine a need for each category of assistive device given below. Think of people you know of who need an assistive device for a daily task. Consider what an older person might need, or someone who is physically disabled.

Grasping	Hygiene	Communication	Mobility	Eating

B To find which idea has the biggest potential impact, make a Pugh chart from the following model. Rank each idea from 1 to 10, with 10 indicating the best fit with the criterion indicated in the criteria column. Find the total for each column.

Criteria	Grasping	Hygiene	Communication	Mobility	Eating
Frequency of use 1 = not often 10 = very often					
Number of users 1 = few 10 = many					
Product lifetime 1 = long 10 = short					
Total					

2 Brainstorm Solutions

In your group, brainstorm ideas for assistive devices that would address the biggest market identified in your Pugh chart.

3 Select a Solution

With the members of your group, decide on the best idea from your brainstorming session. Then, in the space below, draw a prototype of your chosen idea, and list the materials needed to make it. Be as detailed as possible (use extra paper if necessary).

4 Communicate Results

Summarize the information about your device. Describe the need that the device addresses, who the users would be, the device itself and how it works, and any other things you think are important to explain your device to another person. Then, as a group, use the summary information to create a poster of your idea to present to the class.

Lesson 6

The Reproductive System

ESSENTIAL QUESTION

How does your reproductive system work?

By the end of this lesson, you should be able to relate the structure of the reproductive system to its function in the human body.

Many pregnant women do exercises, such as yoga or other stretches, to stay healthy as their baby develops.

Lesson Labs

Quick Labs

- Life Grows On
- Egg-Protection Engineering

Engage Your Brain

1 Predict Have you met a woman who was pregnant? Write a short answer describing what type of development you think is going on inside a pregnant woman.

2 Apply Name five things that have changed about you from your fifth to your tenth birthday.

Active Reading

3 Explain You may be familiar with the eggs that farmers collect from chickens. Females of many species, including humans, produce eggs as part of the reproductive cycle. How do you think a human egg is similar to a chicken egg? How do you think they are different?

Vocabulary Terms

- **sperm**
- **testes**
- **penis**
- **egg**
- **ovary**
- **uterus**
- **vagina**
- **embryo**
- **placenta**
- **umbilical cord**
- **fetus**

4 Apply As you learn the definition of each vocabulary term in this lesson, create your own definition or sketch to help you remember the meaning of the term.

Reproduction

What are the main functions of the male reproductive system?

Active Reading

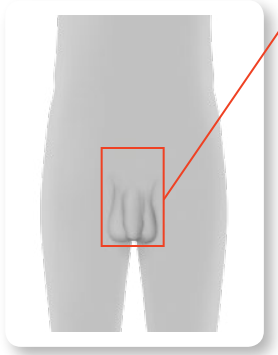
5 Identify As you read, underline the functions of the main hormones in the male and female reproductive systems.

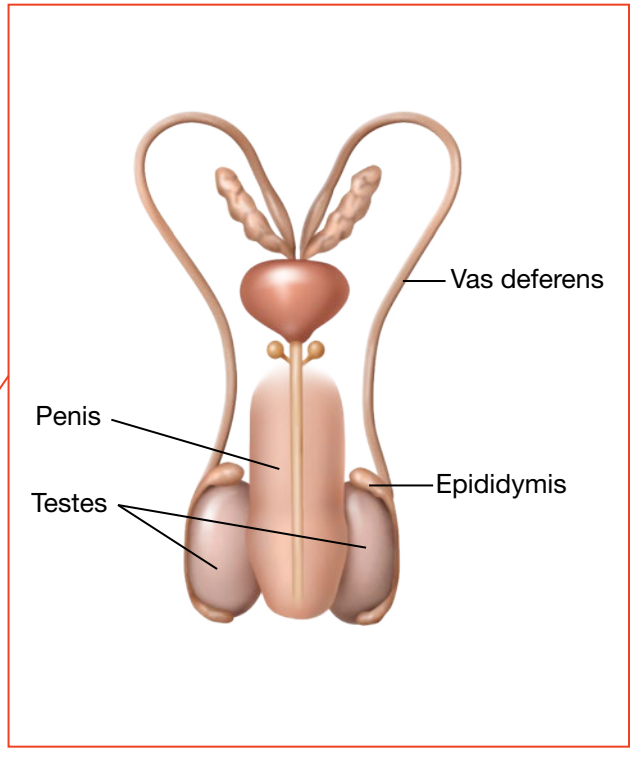
The male reproductive system functions to produce sperm and deliver sperm to the female reproductive system. **Sperm** are the male cells that are used for reproduction. Each sperm cell carries 23 chromosomes, half of the chromosomes of other body cells. The male reproductive system also produces hormones.

Hormones are chemical messengers that control many important body functions, such as growth, development, and sex-cell production. The **testes** (singular, *testis*) are the main organs of the male reproductive system. These organs produce *testosterone,* the male sex hormone. Testosterone causes male characteristics to develop, such as facial hair and a deep voice.

The testes also make sperm. After sperm mature, they are stored in the *epididymis* (EH•puh•DIH•duh•miss). They leave the epididymis through a tube called the *vas deferens* and mix with fluids from several glands. This mixture of sperm and fluids is called *semen*. To leave the body, semen passes through the *urethra*, the tube that runs through the penis. The **penis** is the organ that delivers semen into the female reproductive system.

Male Reproductive System



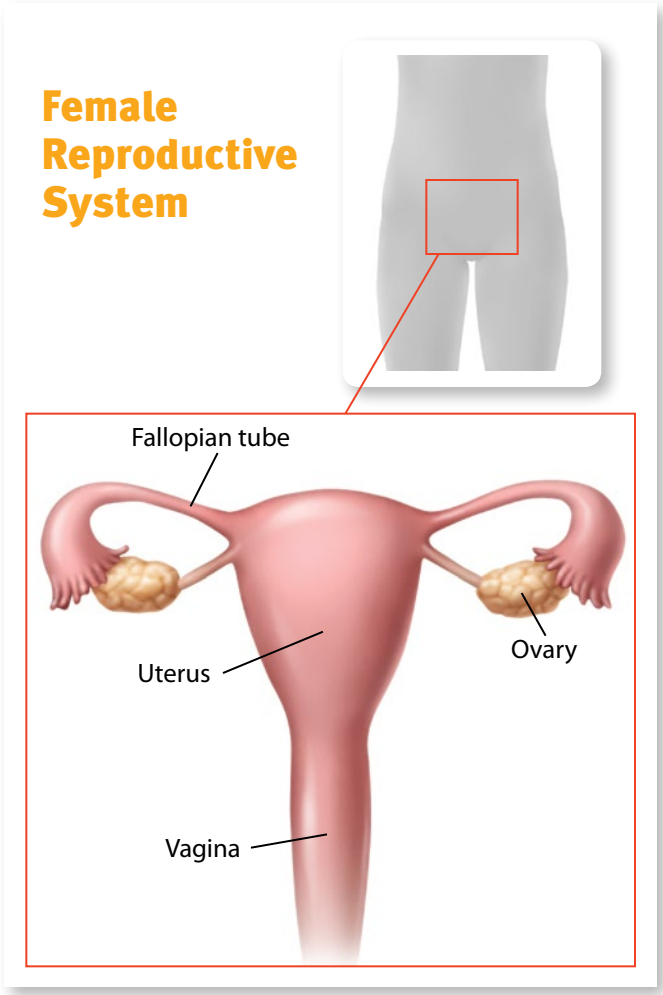


What are the main functions of the female reproductive system?

The female reproductive system produces hormones and eggs, and provides a place to nourish a developing human. An **egg** is the female sex cell. Like sperm, egg cells have 23 chromosomes, only half the number of other body cells.

The female reproductive system produces the sex hormones *estrogen* and *progesterone*. These hormones control the development of female characteristics, such as breasts and wider hips. They also regulate the development and release of eggs, and they prepare the body for pregnancy.

An **ovary** is the reproductive organ that produces eggs. At sexual maturity, females have hundreds of thousands of immature eggs in their ovaries. Eggs are produced through the process of meiosis. During a female's lifetime, usually about 400 of her eggs will mature and be released from the ovaries.



6 Summarize Fill in the chart below to summarize the structures of the male and female reproductive systems.

Sex	Sex cell	Organ that produces sex cell	Other reproductive organs
Male			
Female			

7 Contrast What makes sperm cells and egg cells different from almost all other types of body cells?

Fertile ground

How are eggs released?

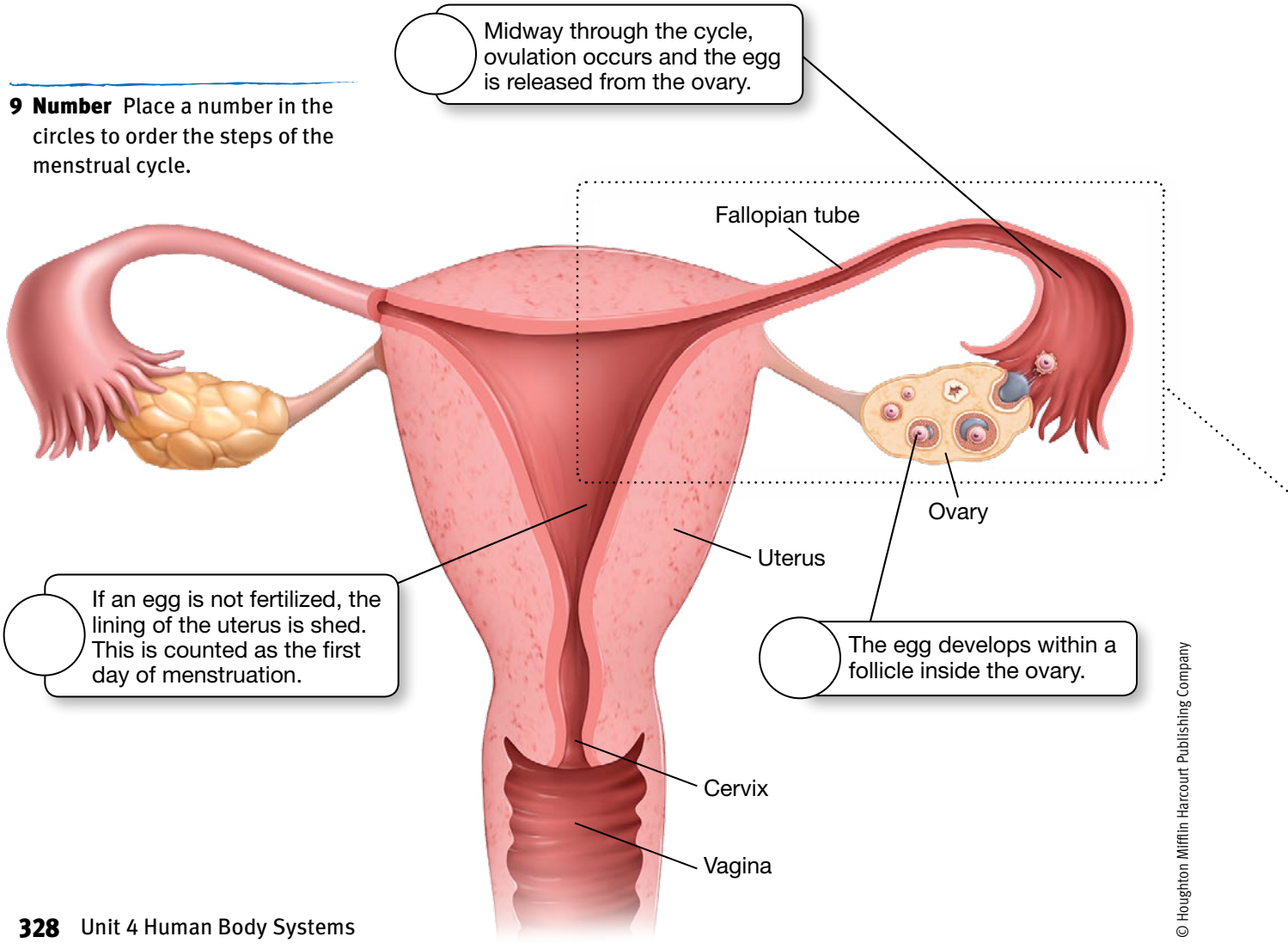
Active Reading

8 Summarize As you read, underline the path an egg takes through the female reproductive system.

A woman's reproductive system goes through changes that produce an egg, release the egg, and prepare the body for pregnancy. These changes are called the *menstrual cycle* and usually take about one month. About halfway through the cycle, an egg is released from the ovary. The egg travels through one of the *fallopian tubes,* a pair of tubes that connect each ovary to the uterus. The **uterus** is the organ in which a fertilized egg develops into a baby. When a baby is born, it passes through the **vagina**, the canal between the uterus and the outside of the body.

If an egg is not fertilized, it is shed with the lining of the uterus. The monthly discharge of blood and tissue from the uterus is called *menstruation.* When menstruation ends, the lining of the uterus thickens and the cycle begins again.

9 Number Place a number in the circles to order the steps of the menstrual cycle.



How are eggs fertilized?

When sperm enter the female reproductive system, a few hundred make it through the uterus into a fallopian tube. There, the sperm release enzymes that help dissolve the egg's outer covering.

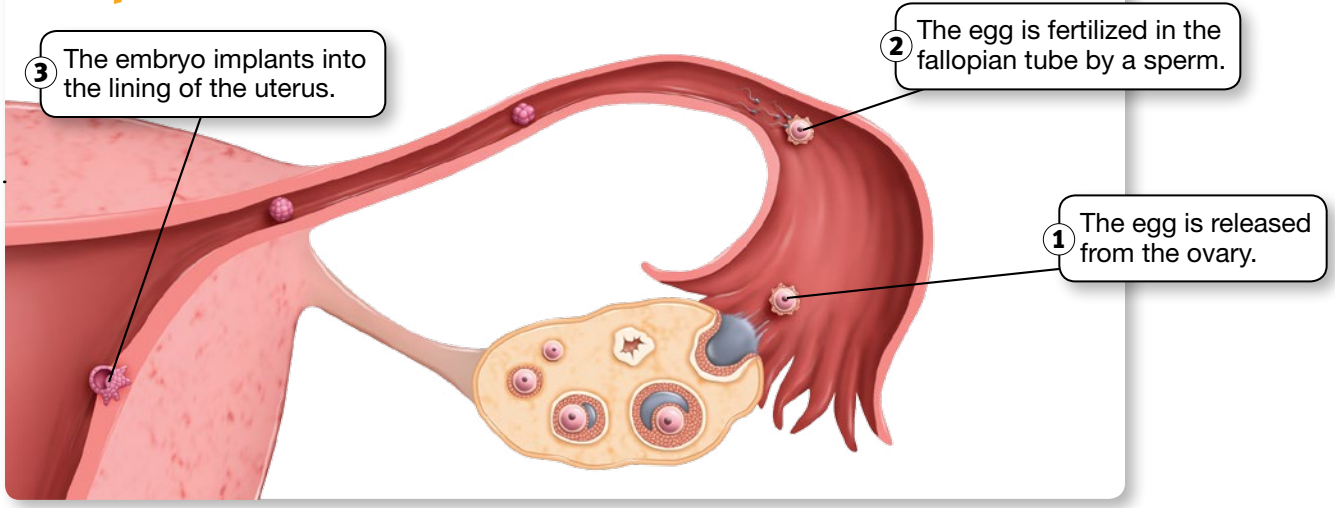
When a sperm enters an egg, the egg's membrane changes to stop other sperm from entering. During fertilization, the egg and sperm combine to form one cell. Once cell division occurs, the fertilized egg becomes an **embryo**. The genetic material from the father and the mother combine and a unique individual begins to develop. Usually, only one sperm gets through the outer covering of the egg. Sometimes, the fertilized egg splits, resulting in identical twins; sometimes, two eggs are fertilized by two sperm, resulting in fraternal twins. However, if more than one sperm enter the egg, which is rare, it is called *polyspermy* and usually results in the egg not surviving. After fertilization, the embryo travels from the fallopian tube to the uterus over five to six days, and attaches to the thickened and nutrient-rich lining of the uterus.

Inquiry

10 Claims • Evidence • Reasoning Sometimes more than one egg is released at a time. What do you think would happen if two eggs were released and both were fertilized? State your claim and support it with evidence. Explain your reasoning.

11 Summarize Determine what happens if an egg is fertilized and if it is not fertilized, and fill in both of the boxes below.

Steps of Fertilization



Happy Birthday!

What are the stages of pregnancy?

A normal pregnancy lasts about nine months. These nine months are broken down into three 3-month periods, called *trimesters*.

Active Reading **12 Identify** Underline three things that take place during each trimester.

First Trimester

Soon after implantation, the placenta begins to grow. The **placenta** is a network of blood vessels that provides the embryo with oxygen and nutrients from the mother's blood and carries away wastes. The embryo is surrounded by the *amnion,* a sac filled with fluid that protects the embryo. The embryo connects to the placenta by the **umbilical cord**. After week 10, the embryo is called a **fetus**. Many organs, such as the heart, liver, and brain, form. Arms and legs, as well as fingers and toes, also form during this trimester.

Second Trimester

During the second trimester, joints and bones start to form. The fetus's muscles grow stronger. As a result, the fetus can make a fist and begins to move. The fetus triples its size within a month and its brain begins to grow rapidly. Eventually, the fetus can make faces. The fetus starts to make movements the mother can feel. Toward the end of the trimester, the fetus can breathe and swallow.

Third Trimester

During the third trimester, the fetus can respond to light and sound outside the uterus. The brain develops further, and the organs become fully functional. Bones grow and harden, and the lungs completely develop. By week 32, the fetus's eyes can open and close. By the third trimester the fetus can also dream. After 36 weeks, the fetus is almost ready to be born. A full-term pregnancy usually lasts about 40 weeks.

How are babies born?

As birth begins, the mother's uterus starts a series of muscular contractions called *labor*. Usually, these contractions push the fetus through the mother's vagina, and the baby is born. The umbilical cord is tied and cut. All that will remain of the place where the umbilical cord was attached is the navel. Finally, the mother pushes out the placenta, and labor is complete.

What changes occur during infancy and childhood?

Development during infancy and childhood includes gaining control of skeletal muscles and learning to speak. Generally, infancy is the stage from birth to age 2. During infancy, babies grow quickly and baby teeth appear. The nervous system develops, and babies become more coordinated and start to walk. Many babies begin to say words by age 1. During this time, the body is growing rapidly. Childhood lasts from age 2 to puberty. Baby teeth are replaced by permanent teeth. Children learn to speak fluently and their muscles become more coordinated, allowing them to run, jump, and perform other activities.

What changes occur during adolescence and adulthood?

The stage from puberty to adulthood is *adolescence*. During adolescence, a person's reproductive system becomes mature. In most boys, puberty takes place between the ages of 9 and 16. During this time, the young male's body becomes more muscular, his voice becomes deeper, and body and facial hair appear. In most girls, puberty takes place between the ages of 9 and 15. During this time, the amount of fat in the hips and thighs increases, the breasts enlarge, body hair appears, and menstruation begins.

During adulthood, a person reaches physical and emotional maturity. A person is considered a young adult from about age 20 to age 40. Beginning around age 30, changes associated with aging begin. The aging process continues into middle age (between 40 and 65 years old). During this time, hair may turn gray, athletic abilities will decline, and skin may wrinkle. A person more than 65 years old is considered an older adult. Exercising and eating well-balanced diets help people stay healthy as they grow older.

Do the Math

Everyone grows as they age, but does the amount you grow change as you get older?

Sample Problem

To calculate growth rate, divide the difference in height by the difference in age. For example, the growth rate between the ages of one and five for the girl shown below is:

$(102\ \text{cm} - 71\ \text{cm}) \div (5\ \text{years} - 1\ \text{year}) = 8\ \text{cm/year}$

You Try It

13 Calculate Determine the growth rate for the girl between the ages of 14 and 19. Is the amount of growth greater between ages 1 and 5 or between ages 14 and 19?

Think Outside the Book

14 Research Learning a new language can be easier for young children. This phenomenon is known as a "critical period." Research critical periods for language and write a short report describing what you learned.

Infections

What causes STIs?

Sexually transmitted infections (STIs) are infections that are passed from one person to another during sexual contact. STIs can be caused by viruses, bacteria, or parasites.

Active Reading **15 Identify** As you read, underline the symptoms of each STI listed below.

Viruses

Acquired immunodeficiency syndrome (AIDS) is caused by the human immunodeficiency virus (HIV). This virus infects and destroys immune system cells. As a result, people with AIDS usually show symptoms of many other illnesses that the immune system of a healthy person usually can fight. Most HIV infections are transmitted through sexual contact.

A much more common, but less deadly, viral STI is genital herpes. Most people with herpes do not have symptoms, but some individuals develop painful sores.

The human papillomavirus (paa•puh•LOH•muh•vy•russ) (HPV) and hepatitis B are two other common viral STIs that are often symptomless. Because some people do not have symptoms, they do not know they are spreading the virus. In the case of hepatitis B, the virus attacks the liver. This can lead to death.

Bacteria and Parasites

A common bacterial STI in the United States is chlamydia. Symptoms include a burning sensation when urinating or a discharge from the vagina or penis. The symptoms for gonorrhea, another bacterial STI, are similar to the symptoms of chlamydia. Both of these infections can be treated with antibiotics. Another STI, syphilis, is caused by the bacterium *Treponema pallidum*. Its symptoms, such as swollen glands, rash and fever, are hard to distinguish from those of other diseases.

Some STIs are caused by parasites. For example, the STI trichomoniasis is caused by the protozoan *Trichomonas vaginalis*. It is the most common curable STI for young women. Symptoms are more common in women and may include a genital discharge and pain during urination. Another parasitic STI is a pubic lice infestation. Pubic lice are tiny insects that feed on blood. The most common symptom of a pubic lice infection is genital itching.

16 Label For each photo below, label the type of infection as a virus, a bacterium, or a parasite.

Chlamydia cell

Herpes-infected immune cells

Syphilis cell

Why It Matters

Seeing Double

HEALTH WATCH

Multiple births occur when two or more babies are carried during the same pregnancy. In humans, the most common type of multiple births occurs when the mother gives birth to two children, or twins. About 3% of all births in the United States result in twins.

Identical Twins

Identical twins form when a single sperm fertilizes a single egg. The developing embryo then divides in two. Identical twins are always the same gender and are genetically identical.

Fraternal Siblings

Fraternal siblings form when two sperm fertilize two or more separate eggs. Fraternal siblings can be the same gender or different genders and are as different genetically as any ordinary siblings.

Triplets

While twinning is the most common type of multiple birth, other multiples still occur. About 0.1% of all births are triplets.

Extend

Inquiry

17 Infer Based on how identical twins form, infer how identical triplets could develop. Explain your reasoning.

18 Research Describe some shared behavioral traits or language between twins and give an example.

19 Create Illustrate how fertilized eggs develop into fraternal triplets. You may choose to make a poster, make a model, or write a short story.

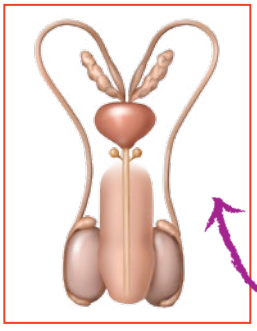
Visual Summary

To complete this summary, circle the correct word. Then, use the key below to check your answers. You can use this page to review the main concepts of the lesson.

Reproduction and Development

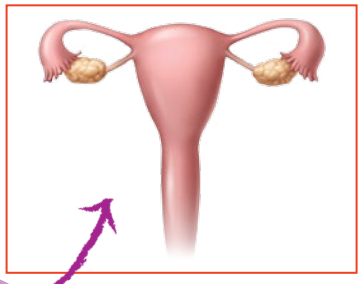
The male reproductive system makes hormones and sperm cells.

20 Sperm are produced in the penis / testes.



The female reproductive system makes hormones and egg cells, and protects a developing baby if fertilization occurs.

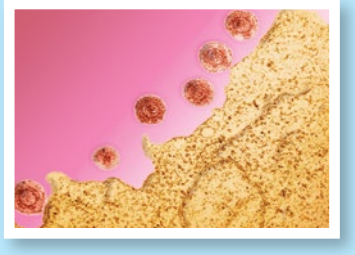
21 Eggs are produced in the ovary / vagina.



A baby goes through many changes as it develops into an adult.

22 During pregnancy, a growing baby gets oxygen and nourishment from an organ called the embryo / placenta.

Sexually transmitted infections (STIs) are caused by viruses, bacteria, and parasites.



23 STIs are spread through the air / sexual contact.

Answers: 20 testes; 21 ovary; 22 placenta; 23 sexual contact

24 Apply Concepts Why does the egg's covering change after a sperm has entered the egg? Support your claim with evidence.

Lesson Review

Vocabulary

1 Use *uterus* and *vagina* in the same sentence.

2 Use *sperm* and *egg* in the same sentence.

Key Concepts

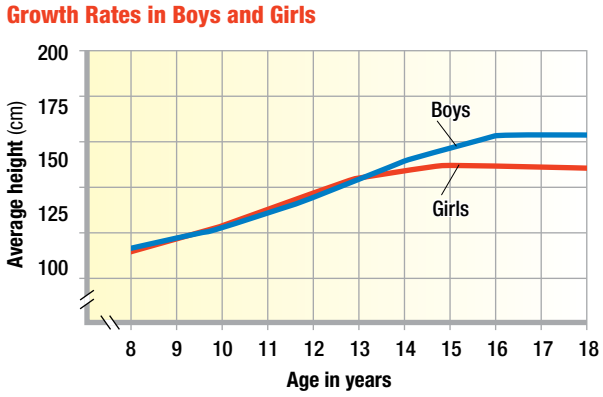
3 Compare Compare the functions of the male and female reproductive systems.

4 Summarize Summarize the processes of fertilization and implantation.

5 Identify Explain what causes STIs and how they are transmitted.

6 Explain How does a fetus get nourishment up until the time it is born?

Use the graph to answer the following question.



Source: Centers for Disease Control and Prevention

7 Interpret At what age is the difference between the average height of boys and girls greatest? Estimate this difference to the nearest centimeter.

Critical Thinking

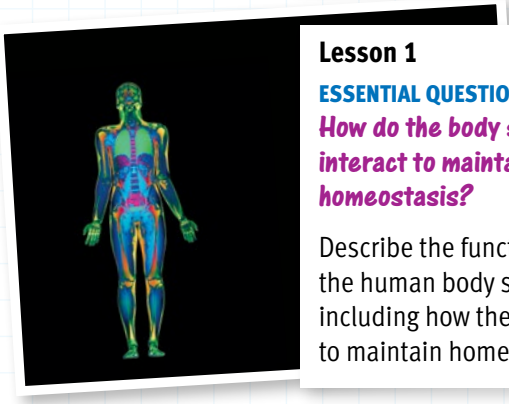
8 Claims • Evidence • Reasoning How might cancer of the testes affect a man's ability to make sperm? State your claim. Summarize evidence to support your claim and explain your reasoning.

9 Apply Explain the difference between identical twins and fraternal twins. Include in your answer how they form and their genetic makeup.

My Notes

Unit 4

Big Idea The human body is made up of systems that have different functions, and these systems interact to carry out life processes.

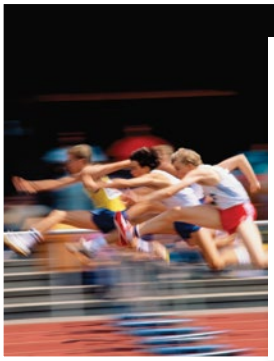


Lesson 1

ESSENTIAL QUESTION

How do the body systems interact to maintain homeostasis?

Describe the functions of the human body systems, including how they interact to maintain homeostasis.



Lesson 2

ESSENTIAL QUESTION

How do your skeletal and muscular systems work?

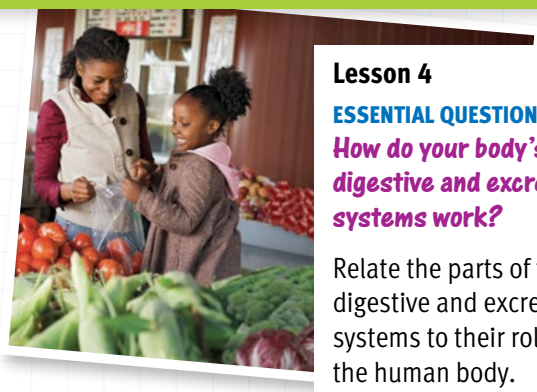
Explain how the skeletal and muscular systems interact to allow movement of the body.

Lesson 3

ESSENTIAL QUESTION

How do the circulatory and respiratory systems work?

Relate the structures of the circulatory and respiratory systems to their functions in the human body.

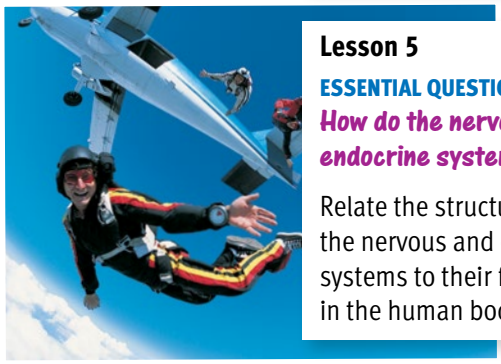


Lesson 4

ESSENTIAL QUESTION

How do your body's digestive and excretory systems work?

Relate the parts of the digestive and excretory systems to their roles in the human body.

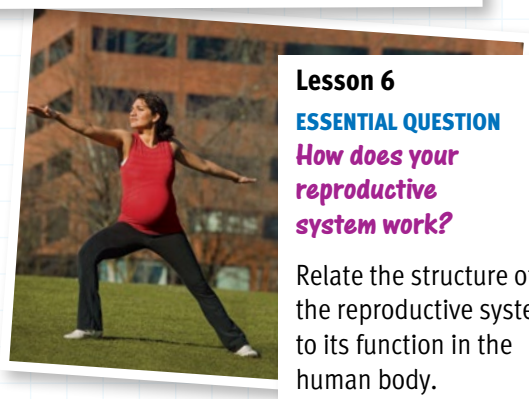


Lesson 5

ESSENTIAL QUESTION

How do the nervous and endocrine systems work?

Relate the structures of the nervous and endocrine systems to their functions in the human body.



Lesson 6

ESSENTIAL QUESTION

How does your reproductive system work?

Relate the structure of the reproductive system to its function in the human body.

Connect ESSENTIAL QUESTIONS

Lessons 5 and 6

1 Explain How does the endocrine system regulate the function of the reproductive system in males and females?

Think Outside the Book

2 Synthesize Choose one of these activities to help synthesize what you have learned in this unit.

- ☐ Using what you learned in lessons 1 through 6, choose a human body system and create a poster presentation to explain its structures and functions.
- ☐ Using what you learned in lessons 2, 3, 4, and 5, write a short story that explains which body systems are involved when a person eats an apple.

Unit 4 Review

Name _____

Vocabulary

Fill in each blank with the term that best completes the following sentences.

1 _____ is the maintenance of a stable environment inside the body.

2 The _____ are the specialized tubes in the kidneys in which waste is collected from the blood.

3 A place where two or more bones are connected is called a(n) _____.

4 The _____ is the body system that controls growth, metabolism, and regulates reproduction through hormones.

5 The _____ is the female reproductive organ that produces egg cells.

Key Concepts

Read each question below, and circle the best answer.

6 Which of these statements correctly describes a key difference between aerobic activity and anaerobic activity?

A Aerobic activity is intense and of short duration, while anaerobic activity involves moderate effort over a long period of time.

B Muscles do not use oxygen during aerobic activity, but they do during anaerobic activity.

C Aerobic activity increases muscle endurance, while anaerobic activity increases muscle strength.

D Lifting weights is an aerobic activity, while jogging is an anaerobic activity.

7 Which of these body systems is made up of the tissues and organs responsible for collecting fluid that leaks from the blood and returning it to the blood?

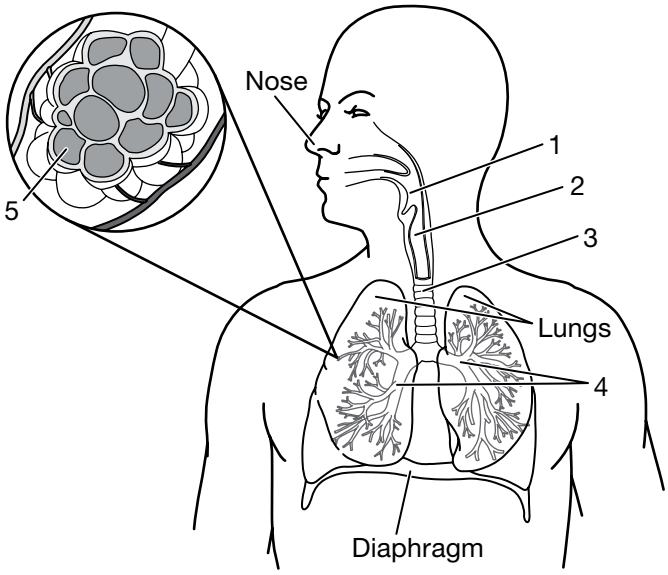
A excretory system

B cardiovascular system

C endocrine system

D lymphatic system

8 The diagram below shows the main parts of the respiratory system.



Which of these correctly names the parts of the respiratory system numbered 1 through 5 in the diagram above?

A 1. larynx, 2. pharynx, 3. trachea, 4. bronchi, 5. alveoli

B 1. pharynx, 2. larynx, 3. trachea, 4. bronchi, 5. alveoli

C 1. pharynx, 2. larynx, 3. bronchi, 4. trachea, 5. alveoli

D 1. larynx, 2. trachea, 3. pharynx, 4. alveoli, 5. bronchi

9 Which of these correctly maps the circulation of blood from the heart through the blood vessels and back to the heart?

A heart → arteries → capillaries → veins → heart

B heart → veins → capillaries → arteries → heart

C heart → capillaries → arteries → veins → capillaries → heart

D heart → arteries → capillaries → veins → capillaries → heart

10 Which of the following sentences best describes the esophagus?

A It produces bile that helps the digestive system break down fats.

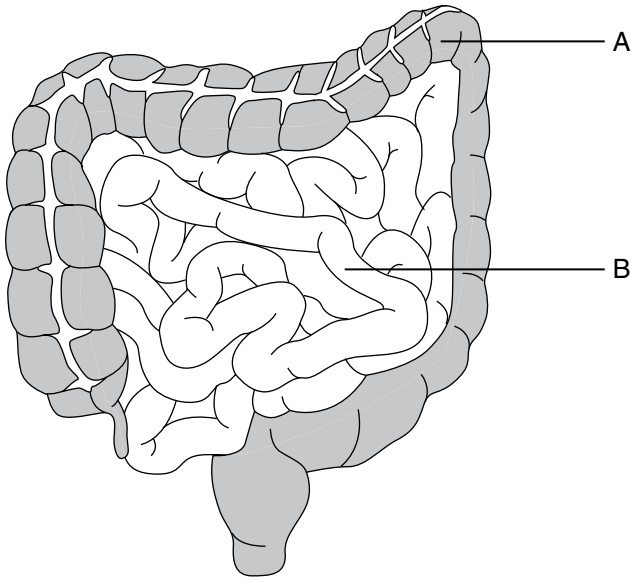
B It is a muscular tube that moves food from the mouth to the stomach.

C It releases enzymes into the small intestine that aid in chemical digestion.

D It is a muscular bag that churns food and produces acid and enzymes for chemical digestion.

Name _____

11 The diagram below shows two important parts of the human digestive system.



Which of these statements is correct?

A Part A absorbs most of the nutrients from digested food into the bloodstream.

B The pancreas releases enzymes into part A to aid in chemical digestion.

C As food digests, it moves through part B first, then through part A.

D The inside of part A is covered with finger-like projections called villi.

12 Which of the following is a correct statement about the role of the kidney in homeostasis?

A The kidney helps to keep smooth muscle contracting efficiently.

B The kidney filters wastes, such as sodium, from the blood.

C The kidney stores bile, which breaks down fats in the intestine.

D The kidney interacts with the endocrine system to help the body react to stimuli that occur outside the body.

13 Which of these glands of the endocrine system would you suspect has a problem if someone has an abnormal level of sugar in the blood?

A pineal gland

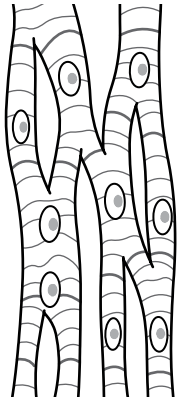
B parathyroid

C pancreas

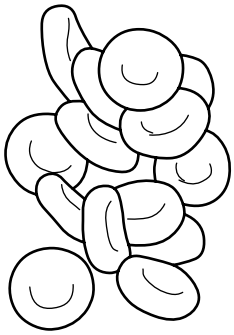
D pituitary gland

14 Which of these pictures shows a nerve cell?

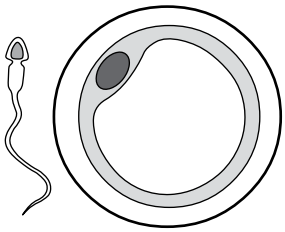
A



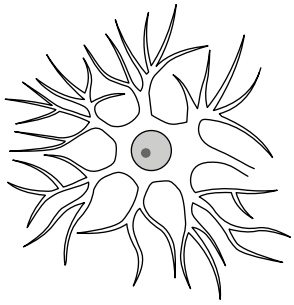
C



B



D



15 Which development occurs in the second trimester of pregnancy?

A The eyes of the fetus first open and blink.

B The embryo becomes a fetus.

C The embryo moves from the fallopian tube to the uterus.

D Contractions in the uterus move the fetus from the uterus through the vaginal canal.

16 Which of these is a function of the testes?

A to produce egg cells

B to produce a hormone that causes facial hair to grow

C to produce a hormone that causes growth of wider hips

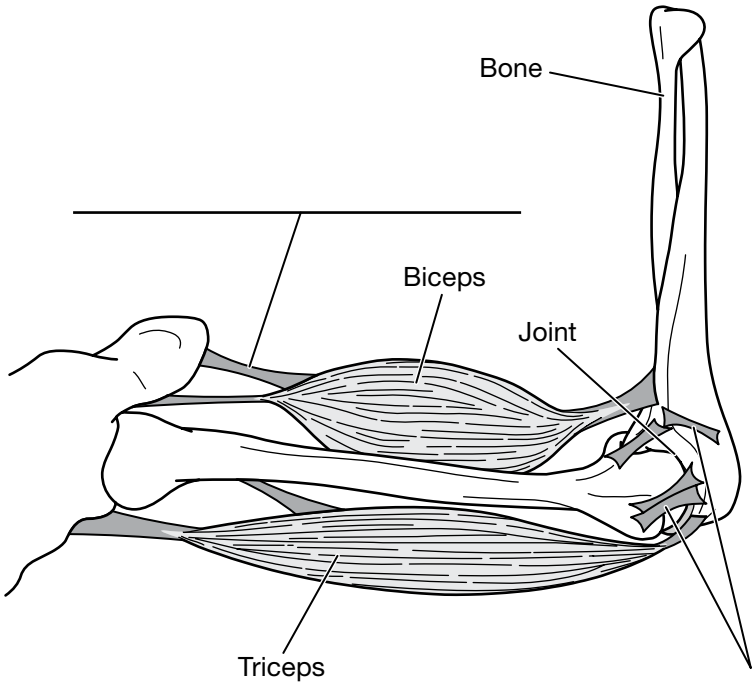
D to deliver semen into the female reproductive system

Name _____

Critical Thinking

Answer the following questions in the space provided.

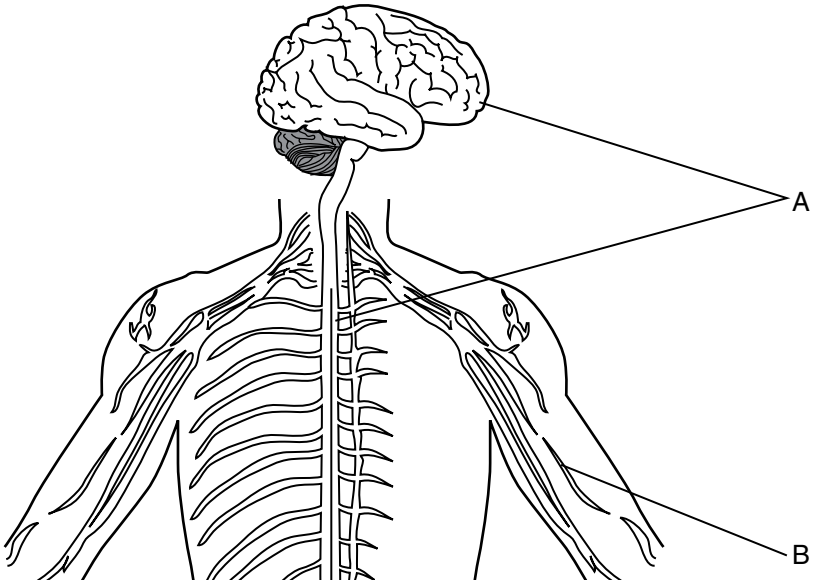
17 The diagram below shows some of the muscles and bones of the arm.



Fill in the blank lines in the diagram above to label the two types of connective tissue shown, then describe the function of each below.

18 What is the difference between pulmonary circulation and systemic circulation? Use evidence to support your claim and explain your reasoning.

19 The diagram below shows the two main parts of the human nervous system.



Write the names for the two parts of the nervous system labeled A and B. Then describe the main functions of each part.

A Name: _____

Function: _____

B Name: _____

Function: _____

Connect ESSENTIAL QUESTIONS

Lessons 1, 2, 3, and 5

Answer the following question in the space provided.

20 When you burn yourself after touching something hot, you pull your hand away quickly. How do your skeletal, muscular, circulatory, endocrine, and nervous systems interact to make you react and to start healing your burn? Use evidence that you learned in lessons 1, 2, 3, and 5 to support your claim.