



Chapter 15

Skeletal, Muscular, and Nervous Systems

Lesson 1

The Skeletal System

Lesson 2

Care and Problems of the Skeletal System

Lesson 3

The Muscular System

Lesson 4

The Nervous System

Lesson 5

Care and Problems of the Nervous System





Quick Write

Using Visuals. The skeletal, muscular, and nervous systems are fine-tuned to work together, allowing the body to perform a variety of coordinated actions. What steps do you take in your day-to-day activities to keep these systems functioning and to protect them from injury?

FOLDABLES™

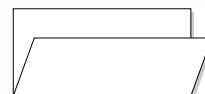
Study Organizer

Before You Read

Use this Foldable to help you organize your notes on the structure and function of the skeletal system, muscular system, and nervous system. Begin with three sheets of $8\frac{1}{2}$ " x 11" paper.

Step 1

Fold the sheets of paper along the long axis so that one edge is about 1" from the other.



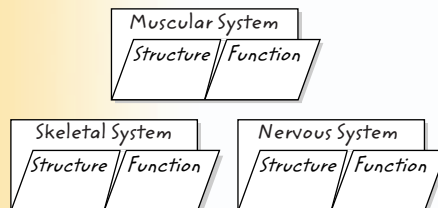
Step 2

Fold the paper in half. Unfold and cut along the inside fold line.



Step 3

Repeat with the other two sheets of paper. Label as shown. Staple the sheets together.



As You Read

As you read and discuss the material in the chapter, use your Foldable to record what you learn.



Lesson 1

The Skeletal System

VOCABULARY

axial skeleton
appendicular skeleton
cartilage
ossification
ligament
tendon

YOU'LL LEARN TO

- Identify the functions of the skeletal system.
- Describe the main divisions and types of bones of the skeletal system.
- Recognize how understanding the functions of the skeletal system is important for maintaining personal health.



List three health behaviors that you think are important for keeping your skeletal system healthy. How do these behaviors help maintain strong bones?



The interaction of bones and muscles allows you to perform all kinds of motions. **List three functions of the skeletal system.**

You reach out your arm and hit the snooze button; it's 6:00 a.m.—time to rise and shine. As you roll out of bed, you reach your arms above your head, stretching your arms and back and rolling your shoulders. You are able to start your day thanks to the interrelationships of your skeletal, muscular, and nervous systems. In this lesson you'll learn about the system that provides the basic framework for your body, your skeletal system.

Functions of the Skeletal System

Your skeletal system provides a living structure for your body. Strong bones, including the vertebrae of your spine, support your upper body and head. The skeleton plays a crucial role in movement by providing a strong, stable, and mobile framework on which muscles can act. Your skeletal system also protects your internal tissues and organs from trauma. The skull, vertebrae, and ribs create protective cavities for the brain, the spinal cord, and the heart and lungs, respectively. Bones store minerals such as calcium and phosphorus, which are important to the health and strength of the skeleton and to various essential processes in your body. Bone marrow, a connective tissue within bones, produces new red blood cells and white blood cells.



Structure of the Skeleton

Your skeletal system consists of 206 bones that can be classified in two main groups. The **axial skeleton** consists of the 80 bones of the skull, spine, ribs, vertebrae, and sternum, or breastbone. The **appendicular skeleton** is composed of the remaining 126 bones of the upper and lower limbs, shoulders, and hips. The bones of these two groups are shown in Figure 15.1 on page 388.

Types of Bones


All bones are covered with an outer layer of hard, densely packed, compact bone. Beneath the compact bone is spongy bone, a less dense bone with a network of cavities filled with red bone marrow. Almost every bone in the body can be placed in the following categories by shape, as shown in the illustration:

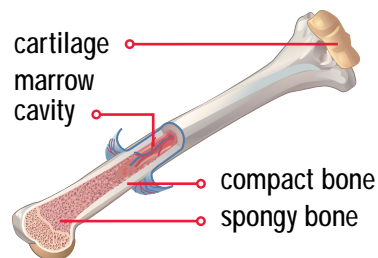
- ▶ **Long Bones.** Examples of long bones include the bones in your legs and arms. The *humerus* is the bone in your upper arm. The *diaphysis*, or main column of a long bone, is composed of compact bone. Within the diaphysis is a narrow cavity that contains yellow bone marrow, a type of connective tissue that stores fat. The end of a long bone is called the *epiphysis*. The epiphyses form joints with other bones and contain red bone marrow, where new blood cells are produced.
- ▶ **Short Bones.** Short bones are almost equal in length and width. Examples include the small bones in the wrists and ankles.
- ▶ **Flat Bones.** Flat bones are somewhat thinner and much flatter than other bones. Flat bones, such as those in the skull, protect organs. The scapula, or shoulder blade, is another example of a flat bone.
- ▶ **Irregular Bones.** Irregularly shaped bones, such as some facial bones or the vertebrae, have unusual shapes and do not fit into the other categories.


Cartilage

Cartilage, a strong, flexible connective tissue, is another component of your skeletal system. Cartilage can be found in many areas of the body: at the ends of long bones, at the end of the nose, and within the outer ear. In some joints, such as the knee, cartilage acts as a cushion, reducing friction and allowing smooth motion.

An embryo's skeleton consists mostly of cartilage that serves as a template from which bones will form. Early in embryonic development, the cartilage hardens. This **ossification** (ah-suh-fuh-CAY-shun) is the process by which bone is formed, renewed, and repaired.

 Bone tissue consists of living cells embedded in a hard matrix of calcium, phosphate, and other calcium minerals.



 Bones are shaped according to their function: long, short, flat, or irregular. Give an example of each of these types of bones.

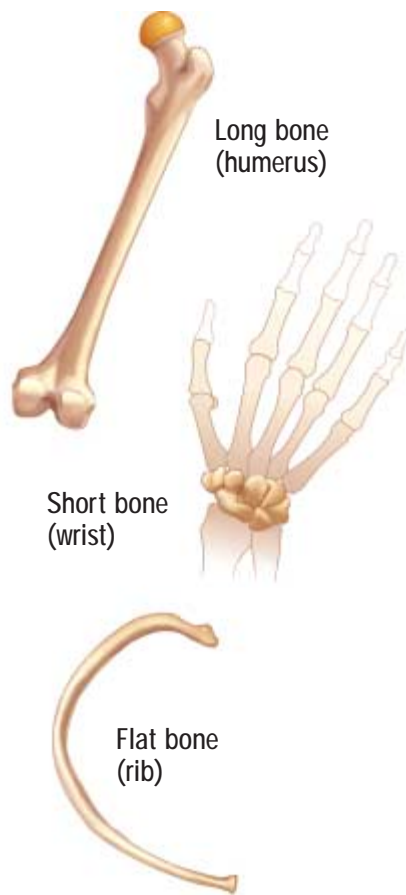




FIGURE 15.1

THE SKELETAL SYSTEM

Your bones continue to grow both in length and in thickness until you are about 25 years old. At this age bones usually stop growing, but may continue to thicken.

Axial Skeleton

atlas (1st vertebra)

axis (2nd vertebra)

cervical vertebrae (neck)

Appendicular Skeleton (shoulders, arms, hips, legs)

thoracic vertebrae
(upper back)

lumbar vertebrae
(lower back)

Pelvis

ilium

sacrum

coccyx

pubis

ischium

occipital bone

parietal bone

frontal bone

nasal bone

cheek bones

temporal bones

mandible (jaw)

clavicle (collar bone)

scapula (shoulder blade)

sternum

ribs (flat bones)

humerus

radius

ulna

carpal bones (wrist)

metacarpal bones (hands)

phalanges (fingers)

femur (long bone)

patella (knee cap)

tibia (long bone)

fibula (long bone)

tarsal bones (ankle)

calcaneus (heel)

metatarsal bones (foot)

phalanges (toes)



Joints

Joints are points at which bones meet. Some joints, such as those between the bones of the skull, do not move. Others, including the joints between vertebrae, have limited movement.

More flexible joints are classified by type:

- ▶ Ball-and-socket joints are formed when the rounded head of one bone fits into the rounded cavity of an adjoining bone, as in a hip or shoulder joint. These joints allow the widest range of movement in all directions.
- ▶ Hinge joints, found at the elbow, knee, ankle, and fingers, allow a joint to bend and straighten, promoting rotation.
- ▶ Pivot joints allow limited rotation or turning of the head.
- ▶ Ellipsoidal joints, such as the one in your wrist, have an oval-shaped part that fits into a curved space. Gliding joints allow bones to slide over one another.

A **ligament** is a band of fibrous, slightly elastic connective tissue that attaches bone to bone. Ligaments help stabilize the movements of bones at a joint. A **tendon** is a fibrous cord that attaches muscle to the bone. Movement is produced because muscles are attached to bones by tendons and ligaments.



Joints allow a wide range of motions. *What is another example of a ball-and-socket joint?*



Hip
(ball-and-socket joint)



Knee
(hinge joint)



Lesson 1 Review

Reviewing Facts and Vocabulary

1. What are the functions of the skeletal system?
2. Define the terms *cartilage* and *ossification*.
3. Name and give examples of each type of joint.

Thinking Critically

4. **Analyzing.** The ligament that holds the bones in your forearm together and helps form the pivot joint there has been torn. How might this affect your ability to move your hand and arm? What movements might be affected?
5. **Comparing and Contrasting.** Recognize how knowledge of the skeletal system is important for maintaining personal health. How are the bones in the axial skeleton similar to those in the appendicular skeleton?

Applying Health Skills

Decision Making. Hector's friends have invited him to go mountain biking. He is hesitant because he thinks this activity would pose some risks to his bones or joints. Using the decision-making steps, role-play with a friend the process of Hector's decision.



WORD PROCESSING Use a word-processing program to list options for Hector's decision. See health.glencoe.com for tips.





Lesson 2

Care and Problems of the Skeletal System

VOCABULARY

osteoporosis
scoliosis
repetitive motion injury

YOU'LL LEARN TO

- Examine strategies to prevent injuries that damage the skeletal system.
- Analyze the relationship between health promotion and prevention of bone disorders.
- Identify different types of joint injuries and situations requiring professional health services.



Write a paragraph describing a situation that could cause a bone or joint injury. List ways of preventing the injury.



Getting enough calcium during your teen years is essential for a lifetime of healthy bones. **Name two foods you enjoy that provide calcium, phosphorus, and vitamin D.**

The overall health of your body very much depends on the health of your skeletal system. If your skeletal system cannot perform its functions properly, your freedom of movement may be limited and other areas of your health and lifestyle may also be affected.

Care of the Skeletal System

Caring for your skeletal system is something you can do every day. Eating foods that contain calcium, vitamin D, and phosphorus can help prevent the development of certain skeletal disorders. Phosphorus can be found in dairy products, beans, whole grains, and liver. Dark green, leafy vegetables are a source of calcium. Milk is fortified with vitamin D and also provides calcium. Regular physical activity, including weight-bearing exercise, helps keep bones strong. Wearing protective gear such as a helmet and padding when you participate in sporting or recreational activities reduces the risk of bone fractures.



Problems of the Skeletal System

Skeletal system disorders and bone injuries can be the result of many factors, including poor nutrition, infections, sports and recreational injuries, and poor posture. The skeletal system is also affected by degenerative disorders such as osteoporosis.

Fractures


A fracture is any type of break in a bone. Fractures can be either compound or simple. A compound fracture is one in which the broken end of the bone protrudes through the skin. A simple fracture is one in which the broken bone does not protrude. Fractures are also classified by the pattern of the break:

- ▶ Hairline fracture. The fracture is incomplete, and the two parts of the bone do not separate.
- ▶ Transverse fracture. The fracture is completely across the bone. A transverse fracture may result from a sharp, direct blow or from stress caused by prolonged running on an already damaged bone.
- ▶ Comminuted fracture. The bone shatters into more than two pieces, usually as a result of severe force.



Osteoporosis

You can build bone mass only during the time you are growing. Health behaviors that you practice now, during your teen years, can reduce your risk of developing osteoporosis later in life. **Osteoporosis** is a condition in which progressive loss of bone tissue occurs. It is a very serious bone disease that affects millions of older Americans and has no warning signs in its early stages. Bones are weakened and become brittle, causing them to break easily. Adequate amounts of calcium, vitamin D, and phosphorus help bones remain strong and healthy. Regular weight-bearing physical activities, such as walking and weight training, stimulate bone cells to increase bone mass, thereby reducing the risk of osteoporosis. Early detection is essential to treatment and to slowing loss of bone tissue. A bone scan (in which X rays measure bone density) can be performed at regular intervals later in life.

 A break like the comminuted fracture shown here might be avoided by keeping bones strong through good nutrition and following safety precautions. **What health promotion steps do you take to prevent diseases of the bones and joints?**

Scoliosis

Scoliosis is a lateral, or side-to-side, curvature of the spine. Scoliosis may exist at the time of birth, or it can develop during childhood. The curvature of the spine worsens as growth continues and may proceed even after growth stops. Early detection is important in the treatment of scoliosis. Treatment includes wearing a brace to help straighten the spine and, in more severe cases, surgery.



Real-Life Application

Are You Getting Enough Calcium?

During the teen years it is very important to choose calcium-rich foods to build maximum bone density. Building strong bones during adolescence will help prevent osteoporosis and bone fractures later in life. You should have at least 3 servings of milk, cheese, or yogurt daily to meet your calcium needs. If you don't drink milk, then choose other foods high in calcium, such as yogurt, kale, or fortified fruit juices. The Recommended Dietary Allowance of calcium for teens between the ages of 11 and 18 is 1,300 milligrams (mg). The following table shows the approximate calcium content in a single serving of some common calcium-rich foods.

Food	Serving size	Mg of Calcium per Serving
Milk	1 cup	300
White beans	$\frac{1}{2}$ cup	113
Broccoli cooked	$\frac{1}{2}$ cup	35
Broccoli raw	1 cup	35
Cheddar cheese	1.5 oz	300
Low-fat yogurt	8 oz	300-415
Kale cooked	1 cup	67
Calcium-fortified orange juice	1 cup	300
Orange	1 medium	50
Sardines or salmon with bones	20 sardines	50
Sweet potatoes	$\frac{1}{2}$ cup	44

ACTIVITY

List all the calcium-rich foods you eat over the next 24 hours, and record the amount or serving size you eat. Compare your calcium intake to the amounts of calcium shown on the chart to see whether you are getting at least 1,300 mg of calcium daily. Create a written plan describing how you will maintain or increase your calcium intake. Include specific actions you will take.

Injuries to Joints

Injuries to joints can occur due to overuse, strain, or disease. The following are joint injuries that may require professional health services.

- **Dislocation** results when the ligaments that attach the bone at the joint are torn as the bone slips out of place. Never attempt to replace a dislocated joint; get immediate medical help. Treatment includes having the joint reset and immobilized while the ligaments heal.
- **Torn cartilage** can result from a sharp blow or the twisting of a joint. Injuries are treated with arthroscopic surgery.



- ▶ Bursitis results from the inflammation of a fluid-filled sac called the bursa. Certain joints, such as the elbow, have bursae that help reduce friction between their movable parts. When the bursa becomes inflamed, pain and swelling can occur at the joint.
- ▶ A bunion is a painful swelling of the bursa in the first joint of the big toe. Wearing ill-fitting shoes can make bunions worse. Large bunions may require surgery.
- ▶ Arthritis is the inflammation of a joint. The condition can result from an injury, natural wear and tear, or autoimmune disease. The most common form of arthritis, osteoarthritis, results from wear and tear on the joints.

Repetitive Motion Injury

A **repetitive motion injury** is damage to tissues caused by prolonged, repeated movements such as in computer work, sewing, or assembly line work. One of the most common repetitive motion injuries is carpal tunnel syndrome. This condition occurs when swollen ligaments and tendons in the wrist cause numbness, a burning or tingling sensation in the thumb and forefinger, pain, and weakness in the hand. Treatment includes wearing a splint to reduce wrist movements, medication to reduce swelling and, in a small percentage of cases, surgery.



Reduce the Risk of Carpal Tunnel Syndrome

Use these tips to reduce your risk of developing repetitive motion injuries.

While using a computer:

- ▶ Rest your hands and wrists from repetitive motion by taking frequent breaks.
- ▶ Use a keyboard or other equipment designed to reduce strain and pressure.
- ▶ Adjust chair height, so that your forearms are level with your wrists. This will reduce the angle of your bent wrists when you are typing.

Lesson 2 Review

Reviewing Facts and Vocabulary

1. Name three behaviors that help keep your bones and joints healthy.
2. What should you do if you think someone has a fractured bone or dislocated joint?
3. Define the term *repetitive motion injury*. Explain how to prevent this type of injury.

Thinking Critically

4. **Analyzing.** A dislocated or injured joint is often immobilized by putting a rigid cast around the affected area. How might this procedure affect the health of the surrounding muscle tissue?
5. **Evaluating.** Analyze the relationship between health promotion during your teen years and the prevention of osteoporosis later in life.

Applying Health Skills

Accessing Information. Research more about keeping the skeletal system healthy. Choose a category such as injury prevention, nutritional needs, or building bone mass to focus your research. Then prepare a pamphlet of step-by-step strategies you and your peers can use to promote the health of bones during the teen years.



SPREADSHEETS Use spreadsheet software to organize your lists. See health.glencoe.com for tips on how to use spreadsheets to build tables.



Lesson 3

The Muscular System

VOCABULARY

smooth muscles
skeletal muscles
flexors
extensors
cardiac muscle
muscle tone
tendonitis
hernia

YOU'LL LEARN TO

- Explain the functions of the muscular system.
- Describe the different types of muscles in the body.
- Examine the effects of health behaviors on the muscular system.
- Identify problems of the muscular system.



List five benefits of having good muscle tone. Next to each benefit, list a problem that might be caused by not having good muscle tone.



Proper warm-up and stretching before and cool-down after any physical activity keeps your muscles flexible and strong.

The action of a slingshot is the result of two interdependent parts—a forked stick and a rubber band or other elastic material. The same is true of the human body. The role of the stick is played by the skeleton. The role of the rubber band is played by the muscular system. Muscles are elastic; they stretch to allow a wide range of motion.

Functions of the Muscular System

Certain muscles in your body are always at work. Even when you sleep, muscles help you breathe, make your heart beat, and move food through your digestive system. These involuntary processes happen without your consciously controlling them. At other times, such as when you play the piano or a video game, make a dash toward first base, or throw a ball, you are using muscles that are under conscious, or voluntary, control. Without the use of both voluntary and involuntary muscles, you would be unable to perform any of these activities.



Structure of the Muscular System

A muscle is made up of hundreds of long cells called fibers. Major muscles in the body are made up of hundreds of bundles of these fibers. Muscles work by means of two complementary, or opposing, actions. These are contraction, the shortening of a muscle, and extension, the stretching of a muscle. Muscle contraction is triggered by nerve impulses. Some nerves provide impulses for many muscle fibers, especially to large muscles such as the calf muscle or biceps. In other areas, such as your eyes, a single nerve may provide impulses to only two or three muscle fibers.

Types of Muscles

The body contains three types of muscle tissue: smooth muscle, skeletal muscle, and cardiac muscle.

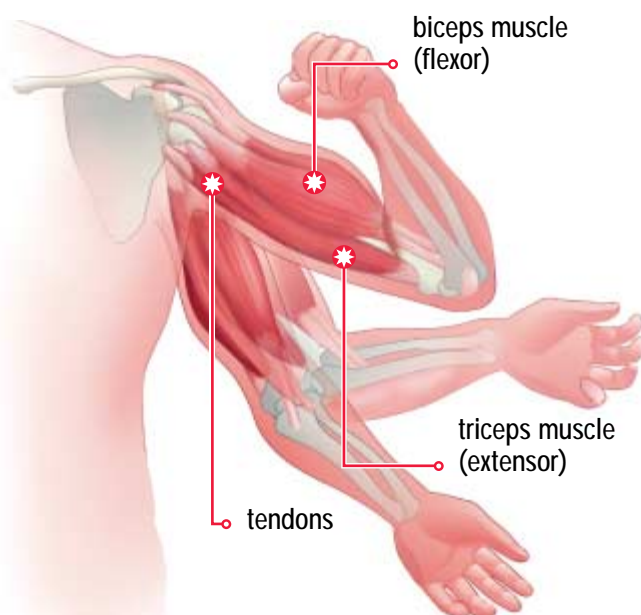
► **Smooth muscles** *act on the lining of passageways and internal organs.* These muscles can be found in the lining of the blood vessels, the digestive tract, the passageways that lead into the lungs, and the bladder. Smooth muscles are under involuntary control.

► **Skeletal muscles** *are attached to bone and cause body movements.* Skeletal muscle tissue has a striated, or striped, appearance under a microscope. Most of your muscle tissue is made up of skeletal muscle, and almost all skeletal muscles are under voluntary control. Skeletal muscles often work together, undergoing opposing actions to produce movement. One muscle contracts while the other muscle extends. An example of this can be seen in the diagram at the right, which shows the biceps and triceps muscles of the upper arm. To bend and straighten your arm at the elbow, these muscles oppose each other's action. The **flexor** is the muscle that closes a joint. In this example the biceps is the flexor. The **extensor** is the muscle that opens a joint. In this case the triceps is the extensor. Identify other opposing skeletal muscles that appear in Figure 15.2 on page 396.

► **Cardiac muscle** is a type of striated muscle that forms the wall of the heart. The involuntary cardiac muscles are responsible for the contraction of your heart, the most important part of the cardiovascular system. The heart contracts rhythmically about 100,000 times each day to pump blood throughout your body.

▼ Skeletal muscles produce movement by working in pairs. One muscle contracts while the other extends. *Try holding your thigh as you bend your leg at the knee. Identify the flexor and the extensor muscles as you perform this action.*

Muscle Movement





hotlink

physical activity For more information about the benefits of physical activity, see Chapter 4, page 75.

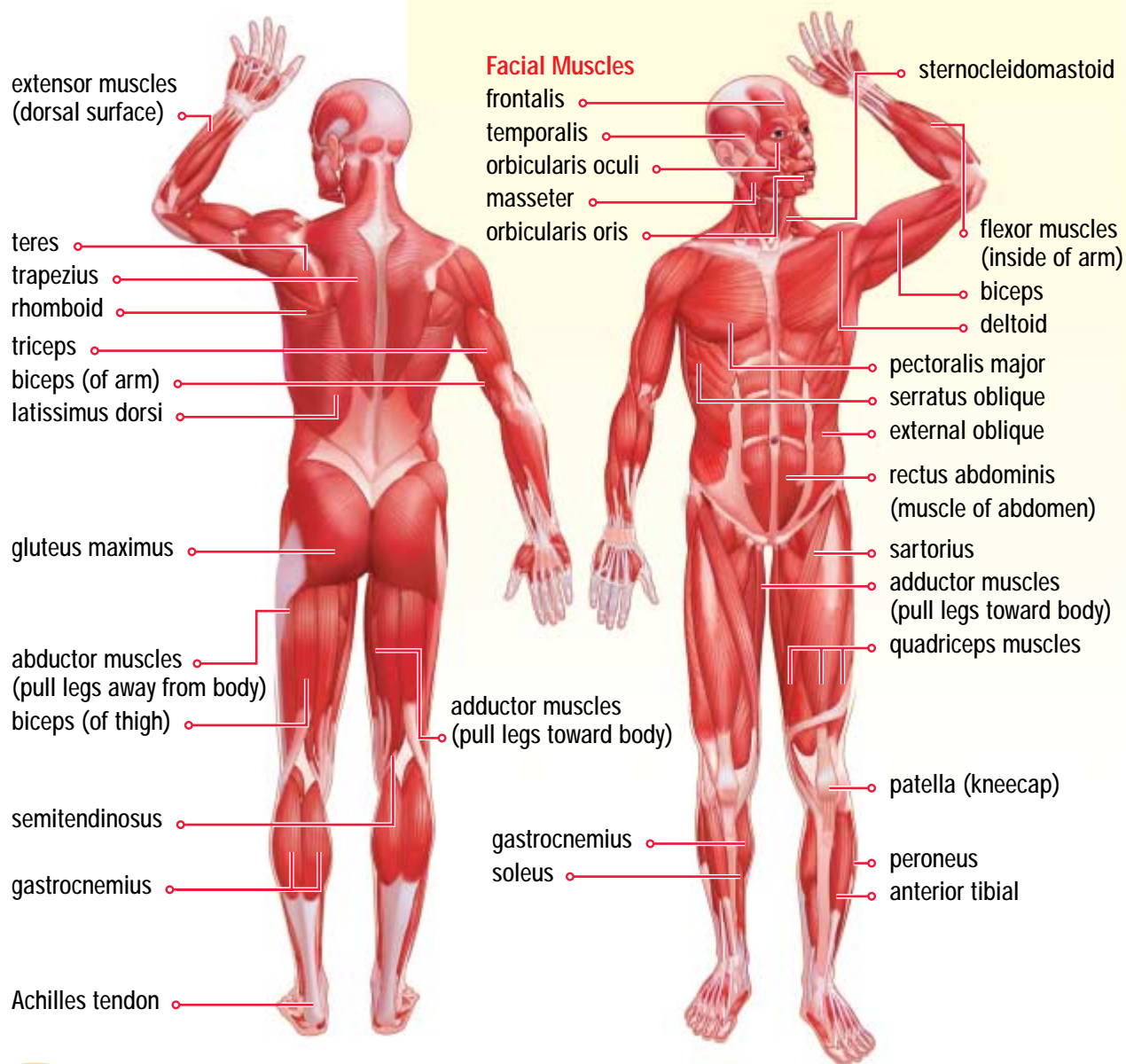
Care of the Muscular System

Regular physical activity is the best way to keep your muscles strong and healthy. Muscles that remain unused for long periods of time will *atrophy*, or decrease in size and strength. **Muscle tone** is the natural tension in the fibers of a muscle. Regular physical activity helps keeps muscles toned and healthy. Practicing good posture strengthens back muscles. Wearing safety equipment and appropriate clothing can protect muscles during physical activity.

FIGURE 15.2

THE SKELETAL MUSCLES

Major muscle groups include the arms, legs, back, abdomen, shoulders, and chest.





Hands-On Health **ACTIVITY**

Training Safety Checklist

Participating in weight-bearing exercise throughout life is important to maintain muscle tone and to keep bones strong and healthy. As with any physical activity, however, safety comes first. In this activity you will create safety checklists for teens doing weight or resistance training.

What You'll Need

- paper and pen or pencil
- textbook and other sources of information

What You'll Do

1. In your group, identify at least one weight-bearing exercise for every major muscle group.
2. Use a separate sheet of paper for each exercise. Describe the exercise, and then list the following: appropriate clothing, when and where to work out, safe exercise procedures, and how to

use equipment properly. Refer to your textbook and other reliable sources to develop your checklist.

3. For each exercise, include at least five easy-to-remember tips for practicing safe weight training. Create an acronym that teens can recall easily.
4. Staple the pages together to make a guide. If your classroom has a computer, input the text and print copies. Place the guides in the gymnasium and in other areas around the school.

Apply and Conclude

Write a paragraph explaining what you have learned about the benefits of weight-bearing exercise. Note the importance of following safety procedures while keeping your muscles healthy.

Problems of the Muscular System

When you are exercising, your muscles are working very hard. They might be sore after strenuous activity, such as going for an all-day hike or bike ride. Although it can be painful, muscle soreness is usually temporary. However, other problems of the muscular system are far more serious and can affect a person's overall health and lifestyle. The recovery time for injury-related muscle problems varies with the type and severity of the injury.



Did You Know?



Muscles produce heat when they contract. Shivering is an involuntary contraction of skeletal muscles in an effort to warm the body.

- Smooth muscles located in the skin at the base of hairs contract involuntarily, raising the hair and producing “goose bumps” in response to cold or fear.
- A muscle spasm occurs when a single muscle involuntarily contracts. A tic is the twitching that results when muscles involuntarily contract in a repeated spasm.

- ▶ **Bruise.** A bruise is an area of discolored skin that appears after an injury causes the blood vessels beneath the skin to rupture and leak. Swelling can be reduced with an ice pack.
- ▶ **Muscle strain or sprain.** A strained muscle results when a muscle is stretched or partially torn as a result of overexertion. Strains are usually treated by using the R.I.C.E. (rest, ice, compression, elevation) procedure. A sprain is an injury to the ligament in a joint, and it requires medical treatment.
- ▶ **Tendonitis.** **Tendonitis**, or *the inflammation of a tendon*, can be caused by injury, overuse, or aging. Signs of tendonitis include joint pain or swelling that worsens with activity. Treatment includes rest, anti-inflammatory medication, or ultrasound.
- ▶ **Hernia.** A **hernia** occurs *when an organ or tissue protrudes through an area of weak muscle*. This condition can result from straining to lift a heavy object. Hernia repair usually requires surgery.
- ▶ **Muscular dystrophy.** Muscular dystrophy is an inherited disorder in which skeletal muscle fibers are progressively destroyed. There is no cure, but with early detection muscle



Lesson 3 Review

Reviewing Facts and Vocabulary

1. Give examples of how muscles work together with other body systems.
2. Describe *cardiac muscle*.
3. What is *tendonitis*? Why does it occur?

Thinking Critically

4. **Applying.** Examine the effects of health behaviors on the muscular system. Which muscles are most involved in your favorite physical activities? What behaviors can help you protect the health of these and other muscles?
5. **Analyzing.** Describe two types of muscle injury, and suggest strategies that can prevent them.

Applying Health Skills

Goal Setting. Set a goal to begin a program of strengthening your muscles. Decide on a weight-training program or another physical activity that will increase muscle strength. On which muscle groups will you focus? Use the steps of goal setting to develop your plan.



SPREADSHEETS Design a table with spreadsheet software to help you organize your training plan. See health.glencoe.com for information on how to use a spreadsheet.





Lesson 4

The Nervous System

VOCABULARY

neurons
cerebrum
cerebellum
brain stem
reflex

YOU'LL LEARN TO

- Differentiate between the central nervous system and the peripheral nervous system.
- Identify the structure and function of neurons.
- Describe the areas of the brain and the function of each.
- Demonstrate knowledge and research more about personal health concerns related to the nervous system.



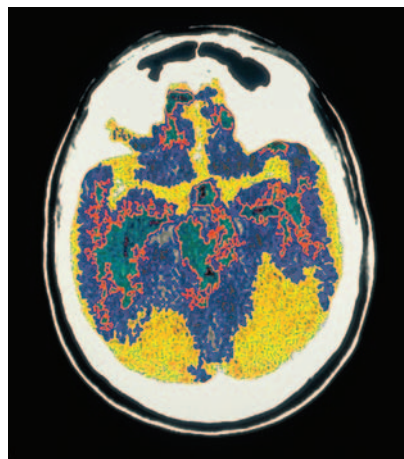
Compare the nervous system with a technology we use today, for example, the telephone system. How are the two systems similar?


Your nervous system is a complex network that allows communication between the brain and all other areas of the body. It also enables you to remember your part in a play or the time to meet your friends for a movie on Friday night.

Function and Structure of the Nervous System

Your nervous system coordinates all of the activities in your body—from breathing or digesting food to sensing pain or feeling fear. The brain, spinal cord, and nerves work together. Nerves transmit messages back and forth to every organ, tissue, and cell.

The nervous system has two main divisions. The *central nervous system (CNS)* consists of the brain and spinal cord. The *peripheral nervous system (PNS)* gathers information from inside and outside your body. It includes nerves that extend from the brain, spinal cord, and sensory receptors, such as those in the skin that sense pressure, temperature, or pain. The central nervous system receives messages from the nerves in the peripheral nervous system, interprets them, and sends out a response. Impulses can be carried at speeds of up to 280 miles per hour, which means, for example, that you can let go of a hot pan before you are badly burned.



 A computed tomography (CT) scan is used to diagnose problems that can affect the function of the nervous system. **Name a type of injury that can cause damage to the brain.**



Neurons

Messages are transmitted to and from the spinal cord and brain by **neurons**, or *nerve cells*. Neurons are classified by their function: sensory neurons, motor neurons, and interneurons. Interneurons communicate with and are found between other neurons. Figure 15.3 illustrates the nerve impulse.

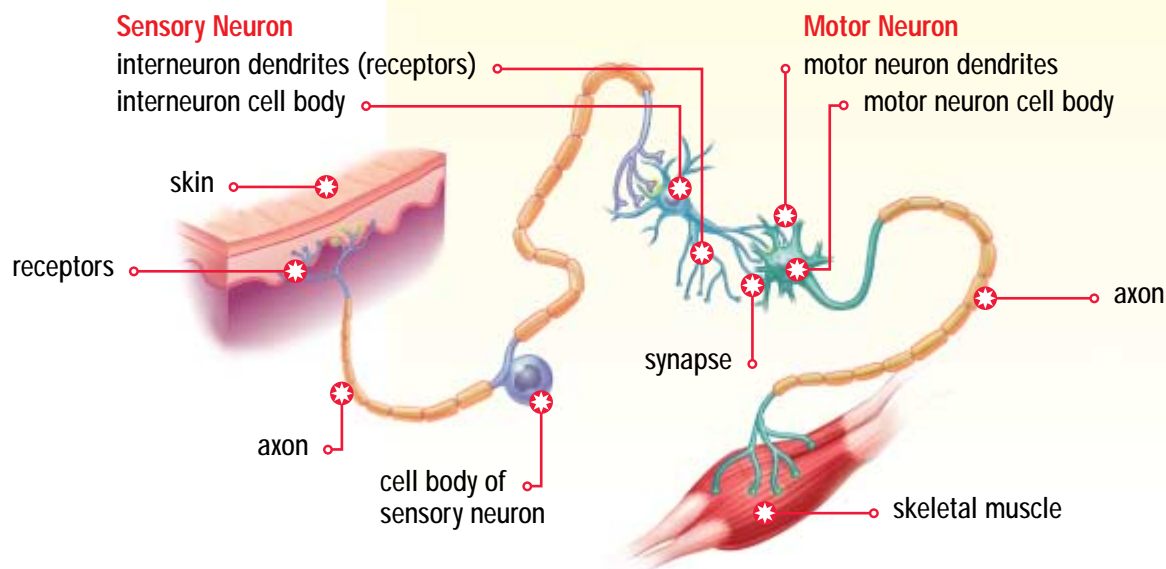
A neuron consists of three main parts:

- ▶ **Cell body.** The cell body of a neuron contains the nucleus, the control center of the cell. The nucleus regulates the production of proteins within the cell. Unlike other cells in the body, neurons have limited ability to repair damage or replace destroyed cells.
- ▶ **Dendrites.** Dendrites are branched structures that extend from the cell body in most neurons. Dendrites receive information from other neurons or sensory receptors and transmit impulses toward the cell body.
- ▶ **Axons.** Axons transmit impulses away from the cell body and toward another neuron, muscle cell, or gland. Some axons are surrounded by a covering called a myelin sheath and can transmit impulses more quickly than axons without coverings.

FIGURE 15.3

THE NERVE IMPULSE

A nerve impulse begins when a sensory receptor is stimulated. The impulse travels to the CNS and is interpreted with the help of an interneuron. Then a motor neuron carries the message to a muscle cell or gland in response to the stimulus.





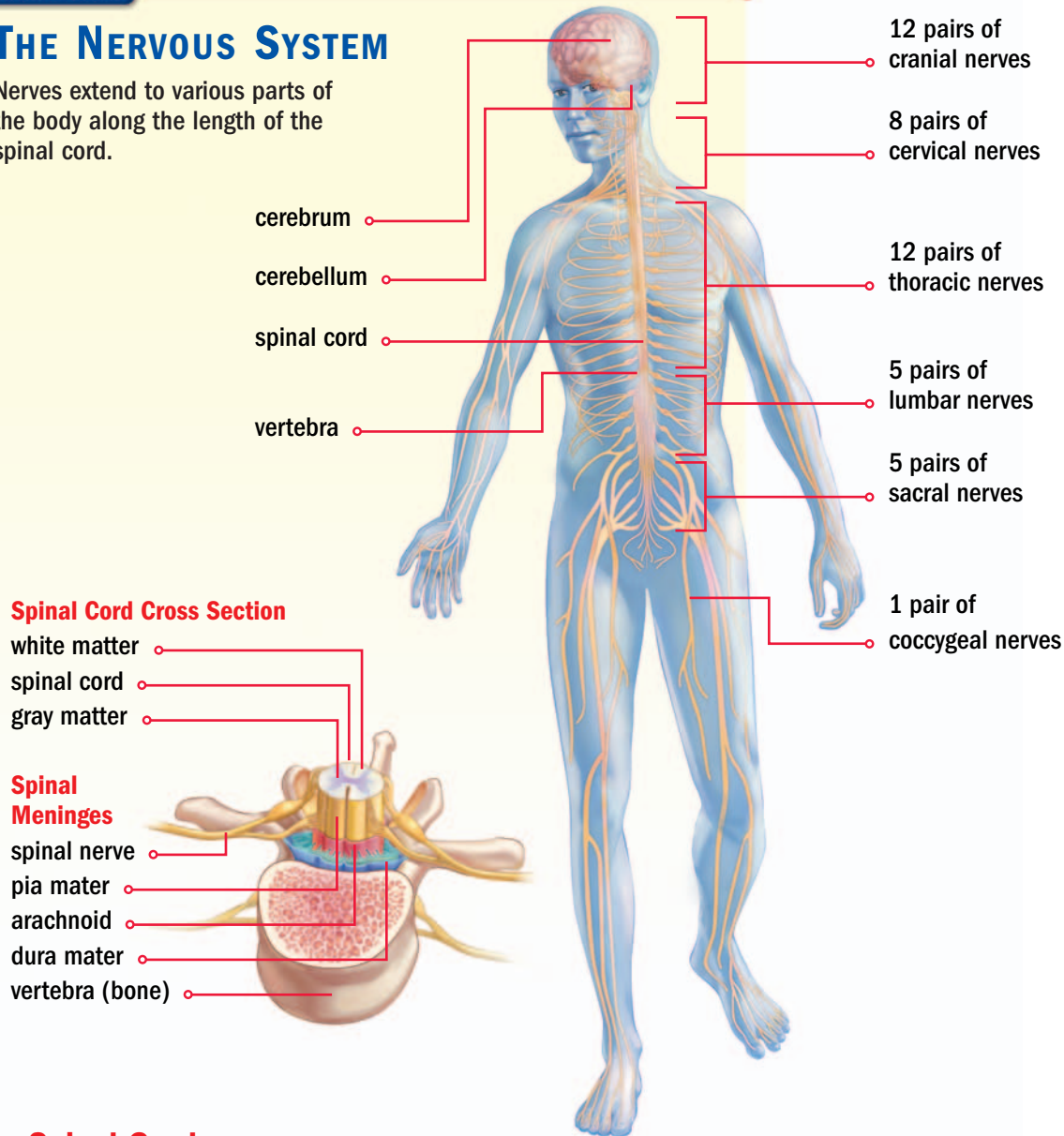
The Central Nervous System

Impulses in the body are carried to and from the spinal cord and the brain, the two organs that make up the central nervous system, as shown in **Figure 15.4**.

FIGURE 15.4

THE NERVOUS SYSTEM

Nerves extend to various parts of the body along the length of the spinal cord.



The Spinal Cord

The spinal cord is a long column of nerve tissue about the thickness of your index finger, extending about 18 inches down your back. Vertebrae are the bones that make up your spine. Connective tissue called the spinal meninges, along with the vertebrae, help protect the spinal cord. The spinal cord is also bathed in cerebrospinal fluid that absorbs shock and nourishes nerve tissue.

**TOPIC Brain Activity**

Go to health.glencoe.com for links to more information about current research into brain activity.

ACTIVITY Using the information provided at these links, write a short paragraph about current methods scientists use to trace activity in the brain.

The Brain

The brain, shown in the illustration, integrates and controls the activities of the nervous system. Your brain helps you receive and process messages; think, remember, and reason; and coordinate muscle movements. Breathing, digesting food, learning math, running a race, and remembering a family vacation are all processes accomplished by the brain. It is involved in emotions and all of your senses.

An adult human brain weighs up to three pounds and sits in the protective cavity formed by the bones of the skull. Like the spinal cord, the brain is covered with layers of cranial meninges and surrounded by cerebrospinal fluid. Both help protect the tissues of the brain from injury. Although the brain makes up only about 2 percent of a person's total body weight, it uses more than 20 percent of the oxygen inhaled. Without oxygen, the brain can last for only four to five minutes before suffering serious and irreversible damage.


The brain has three main divisions: the cerebrum, the cerebellum, and the brain stem.

THE CEREBRUM

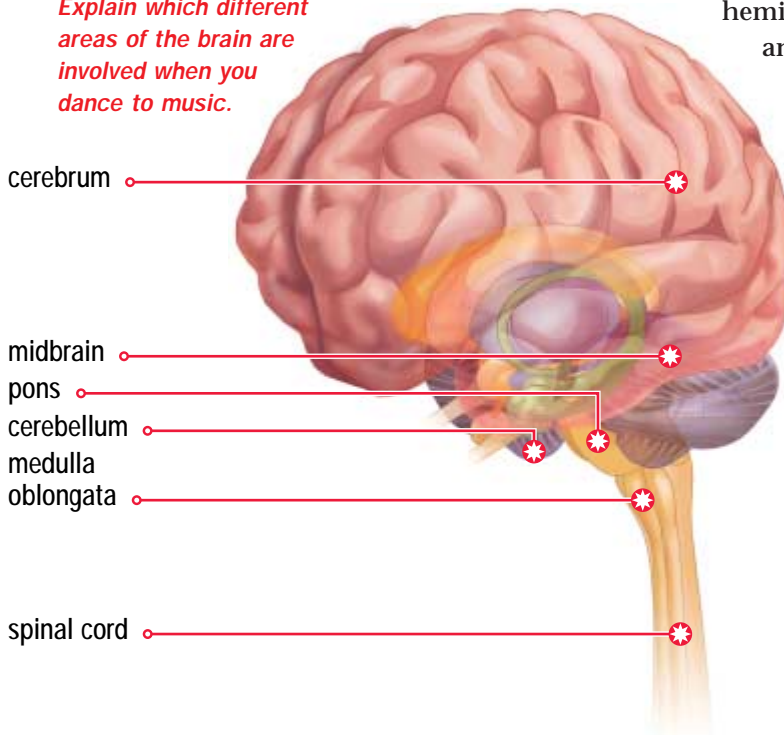
The **cerebrum** is *the largest and most complex part of the brain*. It is covered with a thin layer of gray matter. The billions of neurons in the cerebrum are the center for conscious thought, learning, and memory. Learning how to use language, creating art and music, remembering the past, and dreaming about the future all take place in the cerebrum. The cerebrum is divided into two hemispheres

that communicate with each other. The right hemisphere controls the left side of the body, and the left hemisphere controls the right side of the body. Both hemispheres contain centers for different processes that take place in the brain. The left hemisphere is the center for language, reasoning, and the ability to analyze and think critically about mathematical or scientific problems. The right hemisphere is the center for processing music and art and comprehending spatial relationships.

Each hemisphere has four lobes, and each lobe is named after the skull bone that protects it:

 The brain, like a powerful computer, coordinates all activities of the body.

Explain which different areas of the brain are involved when you dance to music.



cerebrum

midbrain

pons

cerebellum

medulla

oblongata

spinal cord





- ▶ The frontal lobe controls voluntary movements and has a role in the use of language. The prefrontal areas are thought to be involved with intellect and personality.
- ▶ The parietal lobe is involved with sensory information such as heat, cold, pain, touch, and body position in space.
- ▶ The occipital lobe controls the sense of vision.
- ▶ The temporal lobe controls the senses of hearing and smell; it is also involved with memory, thought, and judgment.

THE CEREBELLUM

The **cerebellum** is *the second largest part of the brain*. Its principal function is to coordinate the movement of skeletal muscles. This area of the brain continually receives messages from sensory neurons in the inner ear and muscles, and it uses this information to maintain the body's posture and balance. Being able to complete a complex series of muscle movements, such as serving a volleyball, dancing, or playing the violin, is made possible by the cerebellum.

THE BRAIN STEM

The **brain stem** is *a three-inch stalk of nerve cells and fibers that connects the spinal cord to the rest of the brain*. Incoming sensory impulses and outgoing motor impulses pass through the brain stem. It consists of three main parts—the medulla oblongata, the pons, and the midbrain—and two smaller regions—the thalamus and the hypothalamus.

- ▶ Medulla oblongata. Rising from the top portion of the spinal cord, the medulla oblongata is the lowest part of the brain stem. Within the medulla are centers that regulate heartbeat and respiratory rates as well as reflexes such as coughing, sneezing, and vomiting. The medulla also receives input and sends motor impulses to the cochlea of the inner ear for hearing and to the tongue for movement during speech and swallowing.
- ▶ Pons. Approximately one inch in length, the pons is just above the medulla. The pons is the pathway connecting nerve impulses to other areas of the brain; it also helps regulate breathing. The pons controls the muscles of the eyes and face.
- ▶ Midbrain. The highest portion of the brain stem, the midbrain is involved in such functions as controlling eyeball movement and pupil size. The reflexive response of turning your head when you hear an unexpected loud noise is also initiated by the midbrain.
- ▶ Thalamus. The thalamus is an important relay center for incoming sensory impulses. Nerve cells within the thalamus



How do scientists learn about the brain?

Recent advances in technology have enabled scientists to “see” inside a living brain. Brain imaging techniques help scientists understand the functions of the brain, locate areas affected by neurological disorders, and develop new strategies to treat brain disorders. These techniques include:

- CT, or “CAT” scans, in which a series of X rays are beamed through the head, producing an image that shows the structure of the brain.
- PET scans, in which a machine detects and images radioactive material that is either injected into or inhaled by the patient. This type of scan provides information on brain function.
- MRI, which uses radio waves and magnetic fields to produce an anatomical view of the brain.





hotlink

pituitary gland For more information about the work of the pituitary gland, see Chapter 18, page 465.



When you are nervous about taking a big test, increased heart rate and sweaty palms are signs that your sympathetic nervous system is at work. *Name another situation that will cause a response from your sympathetic nervous system.*



receive information from different sense organs such as the eyes and ears. Through the spine the thalamus also receives information from touch and pressure receptors in the skin.

- **Hypothalamus.** The hypothalamus controls and balances various body processes to regulate body temperature, stimulate appetite for food and drink, and regulate sleep. The hypothalamus also controls secretions from the pituitary gland that control metabolism, sexual development, and emotional responses.

The Peripheral Nervous System

The peripheral nervous system (PNS) consists of all of the nerves that are not part of the CNS. The PNS carries messages between the CNS and the rest of the body. The PNS can be divided into two categories, the autonomic nervous system and the somatic nervous system.

The Autonomic Nervous System

The autonomic nervous system (ANS) controls such involuntary functions as digestion and heart rate. The ANS consists of a network of nerves divided into two smaller networks: the sympathetic nervous system and the parasympathetic nervous system.

THE SYMPATHETIC NERVOUS SYSTEM

You may have felt the effects of the sympathetic nervous system the last time you were startled. Messages from the sympathetic nervous system cause your heart rate to increase and the blood vessels leading to your muscles to dilate, allowing greater blood flow. This is the “fight or flight” response that prepares your body to react to what may be a dangerous situation. You also have experienced a **reflex**, a *spontaneous response of the body to a stimulus*, as when a doctor tests the knee-jerk reflex by tapping the ligament below the knee. Figure 15.5 on page 405 shows the steps of a reflex action.

THE PARASYMPATHETIC NERVOUS SYSTEM

During periods of rest and relaxation, the parasympathetic system opposes the action of the sympathetic system by slowing body functions. It slows down the heartbeat, opens blood vessels, and lowers blood pressure.

Somatic Nervous System

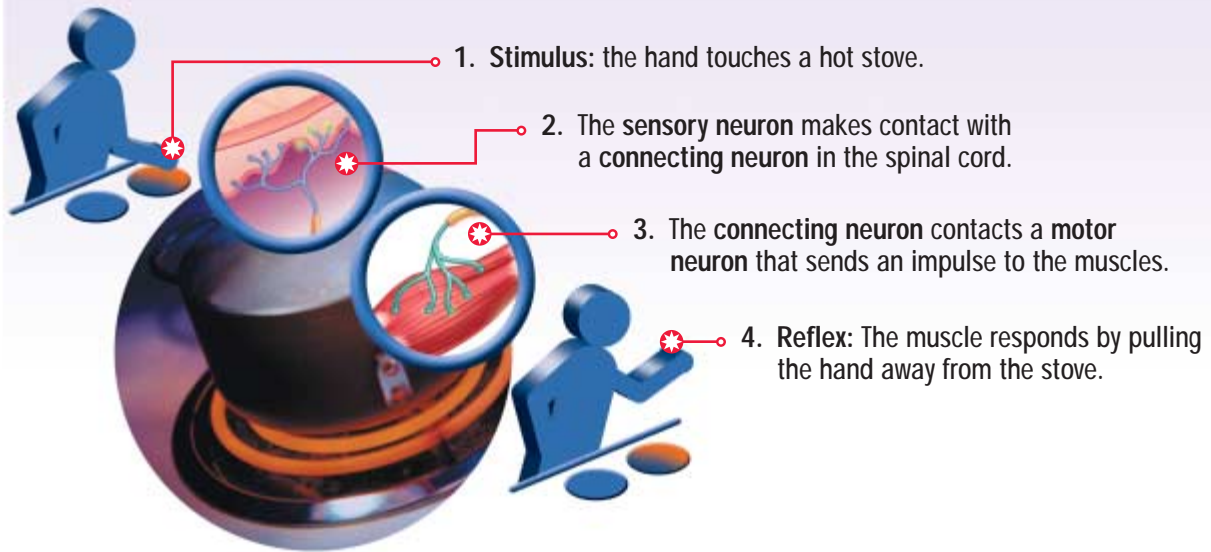
The somatic nervous system consists of sensory neurons that relay messages from receptors in the eyes, ears, nose, tongue, and skin to the CNS and motor neurons that carry impulses from the CNS to skeletal muscles.



FIGURE 15.5

STEPS OF A REFLEX ACTION

Reflexes can prevent injuries. For example, when you touch something hot, your hand jerks away before you feel your finger being burned.



Lesson 4 Review

Reviewing Facts and Vocabulary

1. What is the main function of the brain?
2. Define the term *neuron*. What are the parts of a neuron?
3. What is a *reflex*? How does having quick reflexes benefit your health?

Thinking Critically

4. **Analyzing.** After sustaining a head injury, a patient is having trouble understanding language and controlling movement on the right side of his or her body. What parts of the brain might be damaged?
5. **Evaluating.** Why is an injury to the brain stem considered critical?

Applying Health Skills

Advocacy. Research the benefits of wearing a helmet when biking, skating, or skateboarding. Make an informative pamphlet that outlines helmet laws and explains the importance of protecting the brain from injury. Make your pamphlet available to your classmates to demonstrate your knowledge about this personal health concern.



PRESENTATION SOFTWARE Use presentation software to illustrate your pamphlet. See health.glencoe.com for tips on using presentation software.



Lesson 5

Care and Problems of the Nervous System

VOCABULARY

epilepsy
cerebral palsy

YOU'LL LEARN TO

- Examine the effects of health behavior on the nervous system.
- Identify different types of head and spinal cord injuries.
- Describe different diseases and disorders of the nervous system.



QUICK START Make a list of how often you engage in activities in which there is a risk of head or spinal injury. What do you do to protect these areas during the activity?



Take care of your nervous system by protecting your head. Wear an approved helmet when participating in outdoor activities and certain sports.

Proper use of helmets and safety belts protects the brain and spinal column from injury. Your nervous system interacts and coordinates with all other body systems so that your body will remain internally balanced and functioning properly. Any injury to the nervous system affects the immediate tissues and may lead to dysfunction in other areas of the body.

Care of the Nervous System

Your health behaviors, such as eating a well-balanced diet, exercising regularly, and getting enough sleep, affect the health of your nervous system. Keep your nervous system healthy by protecting it from injury. To protect your head and spine, wear a helmet and protective gear while riding a bike, motorcycle, or other open vehicle or when playing a contact sport or engaging in activities such as skateboarding. Before diving, always check water depth and look along the bottom for protruding logs or rocks. Wear a safety belt when driving or riding in a motor vehicle. Avoid the use of alcohol and drugs, which can cause permanent damage.





Problems of the Nervous System

Problems of the nervous system can result from damage to nerve cells or injury to the head or spinal cord. Nerve tissue can also be damaged by degenerative diseases. Using **drugs** and **alcohol** can destroy brain cells and cause nervous system disorders.

Head and Spinal Cord Injuries

In the United States each year, over one million people sustain head injuries and an estimated 11,000 new cases of spinal cord injury occur. These injuries may result from falls, sports or recreational activities, motor vehicle crashes, physical assaults, or gunshot wounds.

HEAD INJURIES

Although the brain is protected by the bones of the skull, any direct blow to the head can cause injury. A concussion, the mildest

hotlink

drugs For more information on how drugs damage the nervous system, see Chapter 23, page 604.

alcohol For more information on the effects of alcohol, see Chapter 22, page 569.

Health Skills Activity

Decision Making: Riding Smart

When Alfonso's friend Noah wants to give him a ride home from school on his motorcycle, Alfonso hesitates. An avid dirt bike rider, Alfonso knows the importance of wearing a helmet. Unfortunately, Noah doesn't have a spare one.

"Hop on, Alfonso," Noah says, "there's a thunderstorm coming. The sooner we get home, the better."

"I'd really like to," Alfonso replies, "but you don't have an extra helmet. I never ride without one."

"Don't worry," Noah says. "We're going only a couple of miles and I know a short cut. Nothing can happen in that short distance."

As the thunderstorm nears, Alfonso wonders what he should do.



What Would You Do?

Apply the six steps of the decision-making process to help Alfonso make a health-enhancing decision.

1. State the situation.
2. List the options.
3. Weigh the possible outcomes.
4. Consider values.
5. Make a decision and act.
6. Evaluate the decision.



CHARACTER CHECK

Caring. When you understand the effects a nervous system disease can have, you can find ways to help others through a difficult time. **Offering your companionship; reading aloud; or helping with small tasks such as letter writing, watering plants, grocery shopping, or meal delivery are meaningful ways to help those who are disabled.**



Bicycle tours and races are often held to fund research on degenerative diseases such as multiple sclerosis. **Participating in a fund-raising event can be a rewarding experience. Find out more about such opportunities in your community.**



and most common type of brain injury, results in a temporary loss of consciousness, sometimes lasting only a few seconds. A more serious brain injury is a contusion, a bruising of the brain tissues that can result in dangerous swelling. A major trauma to the brain can result in a coma, a state of unconsciousness from which a person cannot be roused.

SPINAL INJURIES

Any injury to the spine must be considered serious and should be evaluated by a health care professional. Some spinal injuries are mild, and full recovery is possible. Swelling of the spinal cord or the tissue around it in response to trauma can result in temporary loss of nerve function. Without treatment, this can lead to permanent nerve damage. If the spinal cord has been severed or damaged beyond repair, paralysis usually results. An injury to the upper part of the spinal cord may result in *quadriplegia*, or paralysis of both upper and lower limbs. *Paraplegia*, paralysis of both lower limbs, can be caused by an injury that occurs at a lower point in the spinal column.

Degenerative Diseases

Degenerative diseases cause affected cells and tissues to break down or deteriorate over time. Common degenerative ailments of the nervous system are listed below.

- ▶ **Parkinson's disease** results in the destruction of nerve cells in an area of the brain that helps coordinate skeletal muscle movement. Parkinson's is a progressive disorder, meaning that it gradually involves more and more nerves. As the cells are destroyed, muscle function is impaired. Symptoms include uncontrolled muscle tremors and increased muscle rigidity. There is no known cause or cure at present.
- ▶ **Multiple sclerosis** involves the destruction of the myelin sheath that surrounds the axons of neurons in the CNS. The scar tissue that remains on the neuron interferes with the conduction of nerve impulses, and voluntary control of muscles gradually decreases. With each attack, loss of nerve function increases. Multiple sclerosis is an autoimmune disease in which the body attacks its own tissues.
- ▶ **Alzheimer's disease** results when neurons in the brain are destroyed. If neurons become clogged with protein deposits, they are unable to transmit impulses. The result is confusion, loss of memory, and gradual mental deterioration. Currently, the cause of Alzheimer's disease is unknown, but the search to find prevention methods continues.



Other Disorders and Problems

Other disorders of the nervous system may not be progressive or degenerative. In some cases a cause may never be identified. These disorders include the following:

- ▶ **Epilepsy** is a disorder of the nervous system that is characterized by recurrent seizures—sudden episodes of uncontrolled electrical activity in the brain. Epilepsy can be caused by several different factors, including brain damage before or during birth, infections, head injury, withdrawal from drugs or alcohol, or exposure to toxins. Seizures may be small and brief, involving little body movement; or they may be quite severe, involving muscle contractions throughout the entire body. Medications can help control seizures so that a person with epilepsy can lead a normal, healthy life.
- ▶ **Cerebral palsy** refers to a group of nonprogressive neurological disorders that are the result of damage to the brain before, during, or just after birth or in early childhood. Causes of cerebral palsy may include infections such as encephalitis or meningitis, head injury, or exposure to radiation before birth. Physical therapy, braces to enable walking, and medication can help cerebral palsy patients be independent and participate in everyday activities.



Many people lead full, independent lives in spite of nervous system disorders. *How would you encourage a close friend or family member who is coping with a nervous system disorder?*



Lesson 5 Review

Reviewing Facts and Vocabulary

1. What precautions should you take before diving into water?
2. Explain the difference between a concussion and a coma.
3. How does multiple sclerosis affect the nervous system?

Thinking Critically

4. **Analyzing.** Examine the effects of health behaviors you can practice to prevent injury to the nervous system. Give a specific example.
5. **Evaluating.** Most states have enacted laws requiring that children under a certain age be restrained by car seats, booster seats, or safety belts. How do such laws benefit the health of small children?

Applying Health Skills

Accessing Information. Write a one-page report on research that is being done to treat spinal cord injuries. Which treatments have had the most success? Why is it so difficult to restore function to the spinal cord after it has been injured?



INTERNET RESOURCES Find more information about spinal cord injuries in Web Links at health.glencoe.com.



health.glencoe.com





Some **Schooling** on Backpacks

Doctors are concerned that looking cool could be hurting you. Here are some ways to avoid injury.

According to the U.S. Consumer Product Safety Commission, 5,900 kids were treated at hospital emergency rooms, clinics, and doctors' offices last year for sprains and strains caused by backpacks. Such injuries are so widespread that more than 70 percent of physicians surveyed by the American Academy of Orthopedic Surgeons listed backpacks as a potential clinical problem for children.

How do you avoid such problems? Choose bags that have wide, padded straps and a belt. That will help transfer some of the weight from the back and shoulders to the hips. You should also tighten both straps firmly, so the pack rests about 2 inches above your waist. Also, remember to pack your bag with the heaviest items closest to your back and to bend both knees when you pick it up.

Try to Lighten Your Load!

How much should you stuff into your pack? That depends on your size and strength, but a general rule is not to exceed 20 percent of your body weight. So if a child weighs 100 pounds, the backpack and its load should not be more

than 20 pounds. One hint: Make frequent trips to your locker to exchange books between classes.

Trendy backpacks with wheels let you pull the weight along the ground, but they have problems too. Many are larger than the average shoulder bag, so students are tempted to carry more than they would in a conventional pack. Roller bags often don't fit into a locker. They can also lead to tripping and falls in crowded halls.

Whatever you use, 10 or 15 minutes of stretching and back strengthening (stomach crunches and holding the pushup position for 10 seconds, for example) is a good idea. ■

TIME
to **THINK...**

**About
Backpacks**

According to the article, the total weight of your backpack and its cargo shouldn't be more than 20 percent of your body weight. With the class, create an easy-to-use formula (where X = YOU and Y = BACKPACK AND ITS CARGO) to help your fellow students determine how much weight they should be carrying.



Health Skills Application



1. Communicating. Your younger brother loves to in-line skate. However, he never wears protective gear while skating. List some strategies you can use to teach him about the importance of preventing injury and encourage him to change his behavior. (LESSON 1)



2. Advocacy. Find out how often screening for scoliosis is offered in your community. To which age groups does it apply? Is there a cost? Raise community awareness by making and displaying a poster that advertises the next screening and demonstrates knowledge about this personal health concern. (LESSON 2)



3. Analyzing Influences. A healthy muscular system depends on physical activity. Even when people are aware of this connection, they may fail to get the physical activity they need. List factors that may positively influence someone's decision to engage in physical activity. (LESSON 3)



4. Accessing Information. Use the Internet to find brain images made with positron-emission tomography (PET) scanners. Compare images of drug users' brains to those of individuals who have never used drugs. How could you use these images to explain the effects of drug use on the nervous system? (LESSON 4)



5. Refusal Skills. Alicia and her friends are exploring a lake in which they have not swum before. Someone spots a rock beneath the water's surface but suggests that it is probably safe to dive anyway. Write a dialogue between Alicia and her friends, demonstrating how she refuses to take this unnecessary risk. (LESSON 5)

CAREER Corner

Physical Therapy Assistant

Do you enjoy seeing people make progress and reach goals? Physical therapy assistants work with people to help them recover mobility after an injury or reduce the impact of a progressive condition such as multiple sclerosis.

To become a physical therapy assistant, you need a high school diploma or its equivalent. After high school, physical therapy assistants complete a two-year program and receive an associate's degree. Find out more by clicking on Career Corner at health.glencoe.com.





Chapter 15 Review

After You Read

Use your Foldable to review what you have learned about the structure and function of the skeletal, muscular, and nervous systems.



▶ EXPLORING HEALTH TERMS *Answer the following questions on a sheet of paper.*

Lesson 1 *Match each definition with the correct term.*

appendicular skeleton	ligament
axial skeleton	ossification
cartilage	tendon

1. A division of the skeletal system that includes the bones of the skull and face, the vertebrae, and the ribs.
2. A division of the skeletal system that includes the bones of the upper and lower limbs and the shoulders and hips.
3. A band of fibrous, slightly elastic connective tissue that attaches bone to bone.
4. A fibrous cord that attaches muscle to bone.

Lesson 2 *Identify each statement as True or False. If false, replace the underlined term with the correct term.*

osteoporosis	scoliosis
repetitive motion injury	

5. A condition in which there is a progressive loss of bone tissue is called scoliosis.
6. Osteoporosis is a lateral or side-to-side curvature of the spine.

Lesson 3 *Match each definition with the correct term.*

smooth muscles	skeletal muscles
flexors	extensors
cardiac muscle	muscle tone
tendonitis	hernia

7. The muscles that act on the lining of passageways in the body and on internal organs.
8. A type of striated muscle that forms the wall of the heart.

9. The natural tension in the fibers of a muscle.
10. A condition created when an organ or tissue protrudes through an area of weak muscle.

Lesson 4 *Fill in the blanks with the correct term.*

brain stem	cerebrum	reflex
cerebellum	neurons	

The (11) is a stalk of nerve cells and fibers that connects the spinal cord to the rest of the brain. The second largest part of the brain is the (12). The (13) is the largest and most complex part of the brain.

Lesson 5 *Replace the underlined words with the correct term.*

epilepsy	cerebral palsy
-----------------	-----------------------

14. A disorder of the nervous system that is characterized by recurrent seizures is cerebral palsy.
15. Epilepsy is a group of nonprogressive neurological disorders that are the result of damage to the brain before, during, or just after birth.

▶ RECALLING THE FACTS *Use complete sentences to answer the following questions.*

1. Compare and contrast the axial and appendicular skeletons.
2. Describe and give examples of each type of bone.
3. Explain how tendons are involved in movement.
4. Why is the early detection of scoliosis important?
5. Explain the association between dislocated joints and torn ligaments. Identify situations that may require professional health services.
6. Explain the difference between bursitis and arthritis.
7. Describe the functions of the muscular system.
8. Examine the effects of health behaviors on the muscular system. Why is good posture important to the health of your muscles?



9. What is muscular dystrophy?
10. What natural protective mechanisms exist in the body for the brain and spinal cord?
11. Identify and describe the three parts of the brain stem.
12. Explain the difference between the autonomic nervous system and the somatic nervous system.
13. Examine the effects of health behaviors, and name three ways to prevent spinal cord injury.
14. What are some symptoms that result from neuron damage caused by Alzheimer's disease?
15. What is quadriplegia? What is paraplegia?
16. What is a degenerative disease?
17. Compare and contrast Parkinson's disease and Alzheimer's disease.

► THINKING CRITICALLY

1. **Evaluating.** Describe what lifestyle choices you can make to protect your bones and skeletal system from damage or injury.
2. **Analyzing.** Although some bone and joint problems, such as osteoporosis and arthritis, seldom occur until later in life, why is it important to think about these conditions now?
3. **Applying.** What advantage is involuntary muscle control to processes such as the contraction of the heart and the movement of food through the digestive tract?
4. **Synthesizing.** After you run, your heart rate slows. Which parts of your nervous system are involved in this function?
5. **Evaluating.** How can swelling of the brain or spinal cord result in damage to these tissues?

Standardized Test Practice



Read the paragraphs below and then answer the questions.

We spend a third of our lives sleeping, but no one really knows why. During sleep, muscles relax and heart-beat and breathing rates slow. Brain waves become larger and slower during certain periods of sleep. Later, brain waves become faster and more frequent. This is when we have dreams we can remember.

Sleep is essential for our health. Without sleep, we lose energy. After two days without sleep, concentration becomes difficult and we make mistakes. We experience difficulty thinking, seeing, or hearing. By the fourth day, hallucinations begin, and we see things that do not really exist. Human beings have been known to go without sleep for as long as 10 or 11 days, but they suffer terrible bouts of near insanity, which go away with a return to sleeping.

1. The author develops the passage by
 - A** explaining what happens when people sleep.
 - B** comparing the effects of sleep and lack of sleep.
 - C** describing sleep and explaining hallucinations.
 - D** describing sleep and explaining why it is essential.
2. Which phrase from the second paragraph helps the reader understand the meaning of the word **hallucinations**?
 - A** terrible bouts of near insanity
 - B** difficulty thinking, seeing, or hearing
 - C** see things that do not really exist
 - D** short-tempered
3. Write a paragraph describing how you feel when you don't get enough sleep.