

## CALIFORNIA

## Standards Preview

**S 7.5** The anatomy and physiology of plants and animals illustrate the complementary nature of structure and function. As a basis for understanding this concept:

- b.** Students know organ systems function because of the contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system.
- g.** Students know how to relate the structures of the eye and ear to their functions.

**S 7.6** Physical principles underlie biological structures and functions. As a basis for understanding this concept:

- b.** Students know that for an object to be seen, light emitted by or scattered from it must be detected by the eye.

**S 7.7** Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

- c.** Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from scientific evidence.



Without your nervous system, a sport like windsurfing would be impossible! ►





## Video Preview

Discovery Channel School

*The Nervous System*



Focus on the  
**BIG Idea**



S 7.5.b

## How do organs and other structures enable the nervous system to function?

### Check What You Know

You smell a delicious aroma. You walk into the kitchen and see a bag of popcorn in the microwave. You hear some kernels still popping. Then you think to yourself, "Snack time!" Which body systems enabled you to smell, walk, see, hear, and think? How did each system play a part in your response?





# Build Science Vocabulary

The images shown here represent some of the Key Terms in this chapter. You can use this vocabulary skill to help you understand the meaning of some key terms in this chapter.

## Vocabulary Skill

### Suffixes

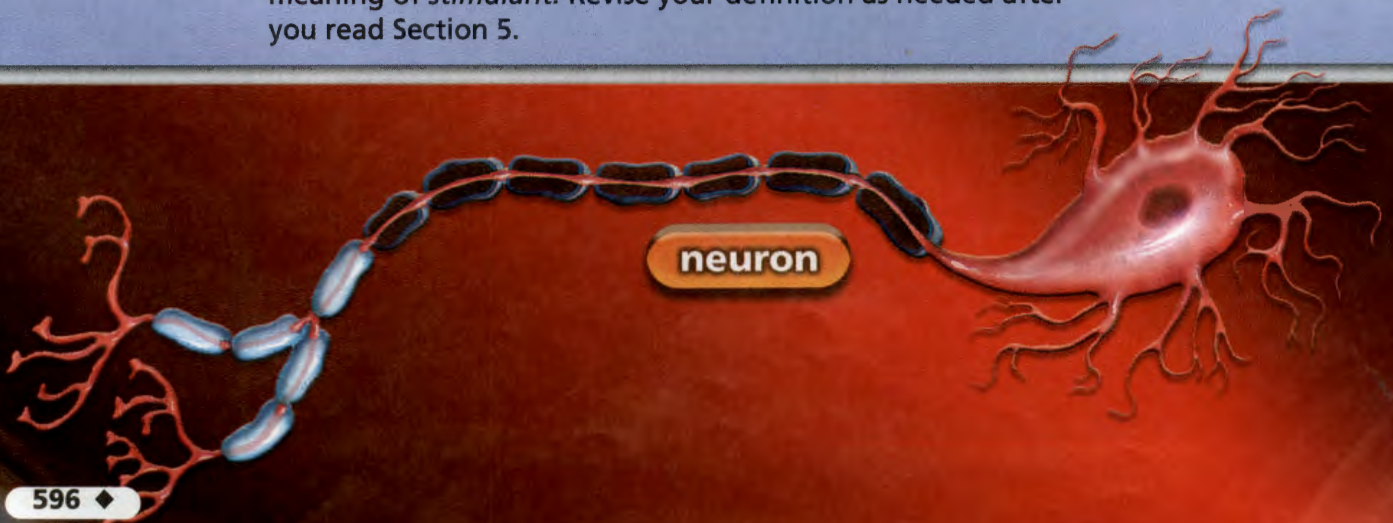
A suffix is a word part that is added to the end of a word to change its meaning. For example, the Anglo-Saxon suffix *-ness* means "state of." When this suffix is added to the adjective *dark*, it forms the noun *darkness*. Darkness means "the state of being dark."

The table below lists some common suffixes and explains their meanings. The table also gives you an example that uses the suffix. You can use the meanings of these suffixes to help understand the meanings of some key terms.

Suffix	Meaning of Suffix	Example and Meaning of Example
-ant	A person or thing that	<b>Pollutant</b> Something that pollutes or makes dirty
-ism	Action or practice of	<b>Criticism</b> Action of judging the value of something
-ness	Condition of; state of	<b>Sickness</b> Condition of being sick
-ous	Having; full of	<b>Disastrous</b> Full of disaster

### Apply It!

1. Alcohol is a drug found in certain beverages. Predict the meaning of *alcoholism*. Revise your definition as needed after you read Section 5.
2. The word *stimulate* means "to increase activity." Predict the meaning of *stimulant*. Revise your definition as needed after you read Section 5.





# Chapter 15 Vocabulary

## Section 1 (page 600)

stimulus	nerve
response	sensory neuron
neuron	interneuron
nerve impulse	motor neuron
dendrite	synapse
axon	

## Section 2 (page 606)

brain	brain stem
spinal cord	reflex
cerebrum	concussion
cerebellum	
central nervous system	
peripheral nervous system	
somatic nervous system	
autonomic nervous system	

## Section 3 (page 614)

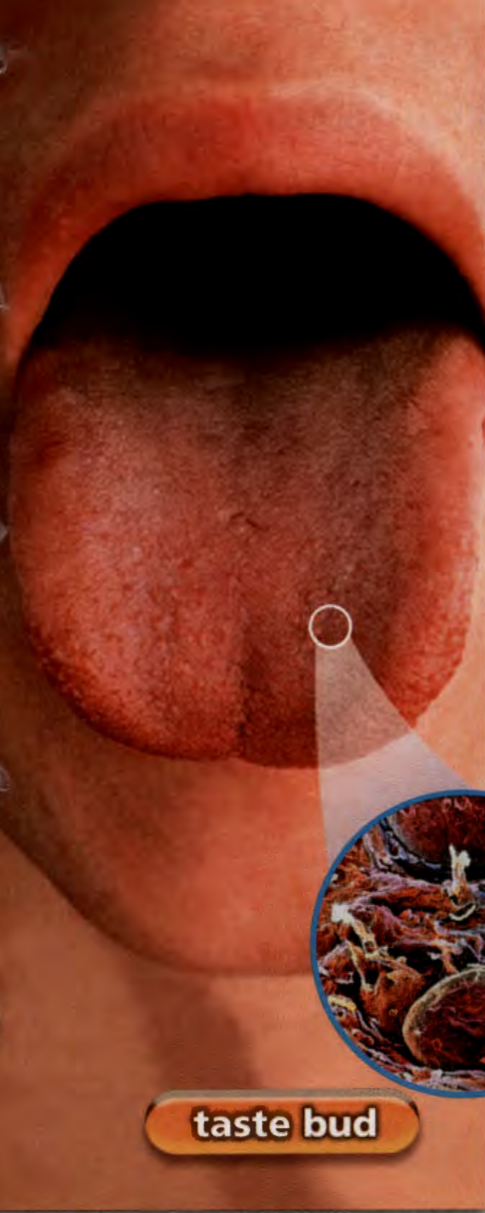
cornea	optic nerve
pupil	eardrum
iris	hammer
lens	anvil
retina	stirrup
rods	cochlea
cones	semicircular canal

## Section 4 (page 621)

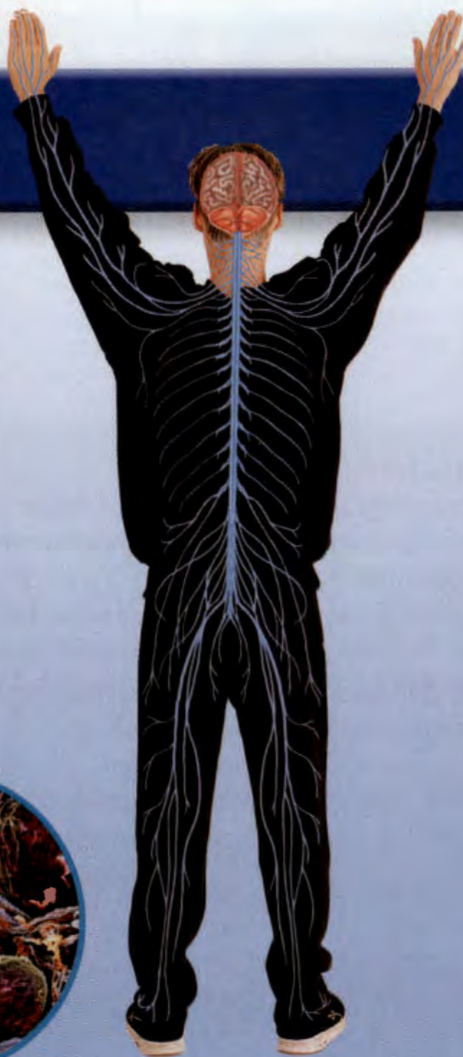
taste bud

## Section 5 (page 624)

drug	withdrawal
drug abuse	depressant
tolerance	stimulant
addiction	alcoholism



taste bud

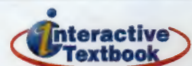
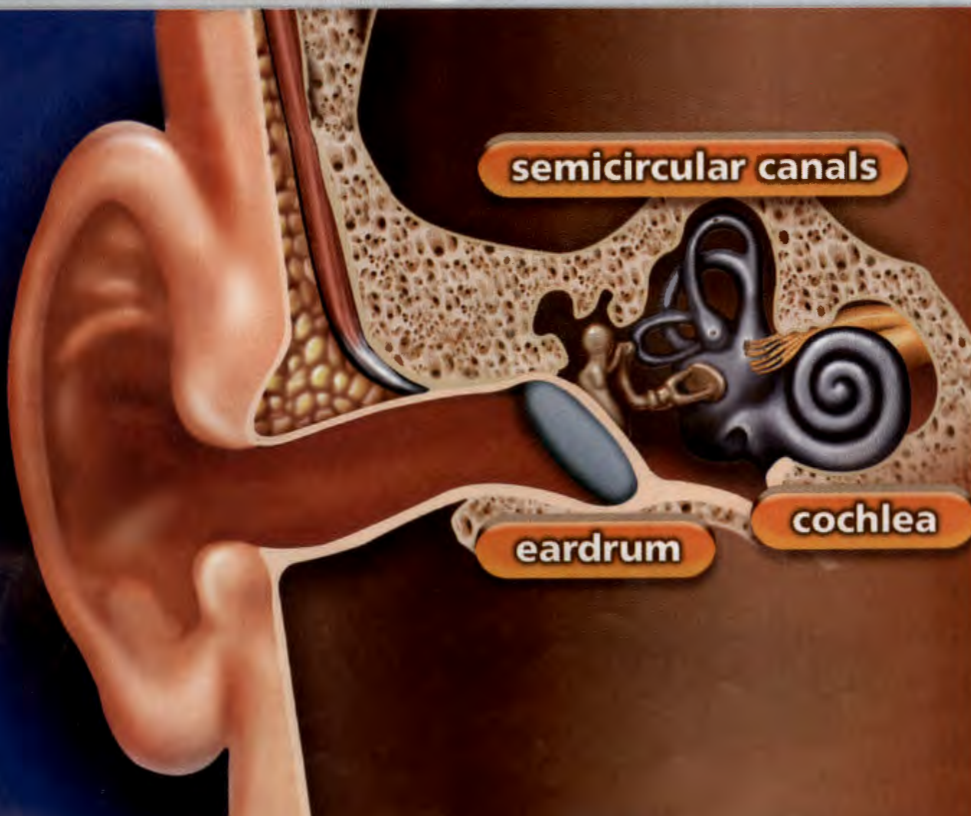


central nervous system

semicircular canals

eardrum

cochlea



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# How to Read Science

## Reading Skill

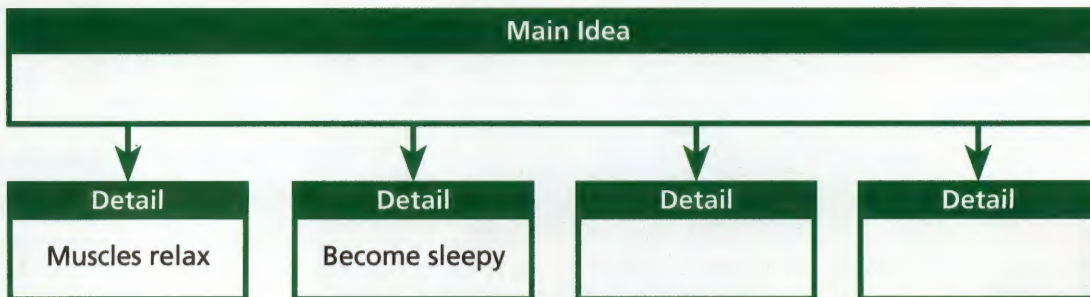


### Identify Main Ideas

The main idea in a paragraph or section is the most important idea. Headings and the boldface key concept statements can often help you identify main ideas. The details in a paragraph or section support the main idea. Details are usually specific facts and examples that help readers understand the main idea.

Look for the main idea and details in the paragraph below. Then copy the graphic organizer in your notebook and complete it.

**Depressants** Depressants are drugs that slow down the activity of the central nervous system. When people take depressants, their muscles relax and they may feel sleepy. They may fail to respond normally. For example, depressants may prevent people from responding quickly to the danger of an onrushing car.



### Apply It!

1. What is the heading of the paragraph? What does it tell you about the main idea?
2. Choose one detail. Explain how it supports the main idea.

In this chapter, look for the main ideas in paragraphs. Also try to identify the main ideas for the text following each heading.



## Sense and Nonsense

An optical illusion is a picture or other visual effect that tricks you into seeing something incorrectly. In this investigation, you'll discover how your senses sometimes can be fooled by illusions.

### Your Goal

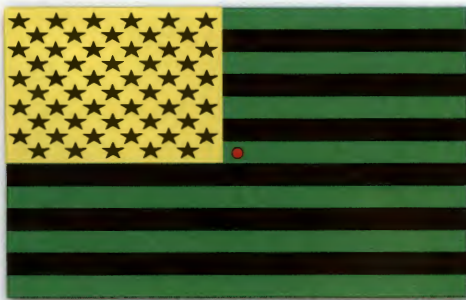
To demonstrate how different people respond to illusions

To complete this investigation you must

- try out a variety of optical illusions as well as some illusions that involve the senses of hearing or touch
- select one or more illusions and set up an experiment to monitor people's responses to the illusions
- learn why the illusions fool the senses
- follow the safety guidelines in Appendix A

### Plan It!

In a small group, discuss illusions that you know about. Look in books to learn about others. Which illusions would make an interesting experiment? How could you set up such an experiment at a science fair? Find out how your nervous system allows you to sense your environment. For example, which structures are involved in observing the optical illusion below? Use this chapter and other print or electronic resources to learn how these structures function when people are fooled by illusions.



Stare for 30 seconds at the red dot in the center of the flag. Then stare at the dot in the white box for a few seconds. Did you see an illusion?



# How the Nervous System Works

CALIFORNIA

## Standards Focus

**S 7.5.b** Students know organ systems function because of the contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system.

- What are the functions of the nervous system?
- What is the structure of a neuron and what kinds of neurons are found in the body?
- How do nerve impulses travel from one neuron to another?

## Key Terms

- stimulus
- response
- neuron
- nerve impulse
- dendrite
- axon
- nerve
- sensory neuron
- interneuron
- motor neuron
- synapse

Lab  
zone

-Up

## How May Systems Work Together?

1. Trace the outline of a penny in twelve different places on a piece of paper.
2. Number the circles 1 through 12. Write the numbers randomly, in no particular order.
3. Now, pick up the penny again. Put it in each circle, one after another, in numerical order, starting at 1 and ending at 12.

### Think It Over

**Inferring** Make a list of all the sense organs, muscle movements, and thought processes used in this activity. Compare your list with your classmates' lists. Which organ systems were working together? What organ system coordinated all the different processes involved in this task?

The ball whizzes toward the soccer goalie. She lunges for the ball, and in one swift movement blocks it from entering the net. To tend goal, soccer players need excellent coordination and keen vision. In addition, they must remember what they have learned from years of practice.

Whether or not you play soccer, you too need coordination, memory, and the ability to learn. Your nervous system carries out all these functions. The nervous system includes the brain, spinal cord, and nerves that run throughout the body. It also includes sense organs, such as the eyes and ears.

## Functions of the Nervous System

The Internet lets people gather information from anywhere in the world with the click of a button. Like the Internet, your nervous system is a communications network. But it is much more efficient than the Internet.

➤ The nervous system receives information about what is happening both inside and outside your body. It also directs the way in which your body responds to this information. In addition, your nervous system helps maintain homeostasis. Without your nervous system, you could not move, think, feel pain, or taste a spicy taco.

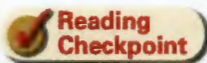


**Receiving Information** Because of your nervous system, you are aware of what is happening in the environment around you. For example, you know that a fly is buzzing around your head, that the wind is blowing, or that a friend is telling a funny joke. Your nervous system also checks conditions inside your body, such as the level of your blood pressure.

**Responding to Information** Any change or signal in the environment that can make an organism react is called a **stimulus** (STIM yoo lus) (plural: *stimuli*). A buzzing fly is a stimulus. After your nervous system analyzes the stimulus, it causes a response. A **response** is what your body does in reaction to a stimulus—you swat at the fly.

Some nervous system responses, such as swatting a fly, are voluntary, or under your control. However, many processes necessary for life, such as the beating of your heart, are controlled by involuntary actions of the nervous system.

**Maintaining Homeostasis** The nervous system helps maintain homeostasis by directing the body to respond appropriately to the information it receives. For example, when you need energy, your nervous system prompts you to feel hungry and then eat. This action maintains homeostasis by supplying your body with the nutrients and energy it needs.



**Reading Checkpoint**

What is a stimulus?

**FIGURE 1**

**The Nervous System at Work**  
The zooming soccer ball is a stimulus. The goalie responds by lunging toward the ball and blocking the shot.

**Interpreting Diagrams** How does the goalie's nervous system help her body maintain homeostasis?

**Receiving Information**

The goalie's eyes receive information that a soccer ball is zooming toward her.

**Maintaining Homeostasis**

The goalie's nervous system adjusts her breathing and heart rate to meet her energy needs throughout the game.

**Responding to Information**

The nervous system causes a response, and the goalie reaches out to block the shot.

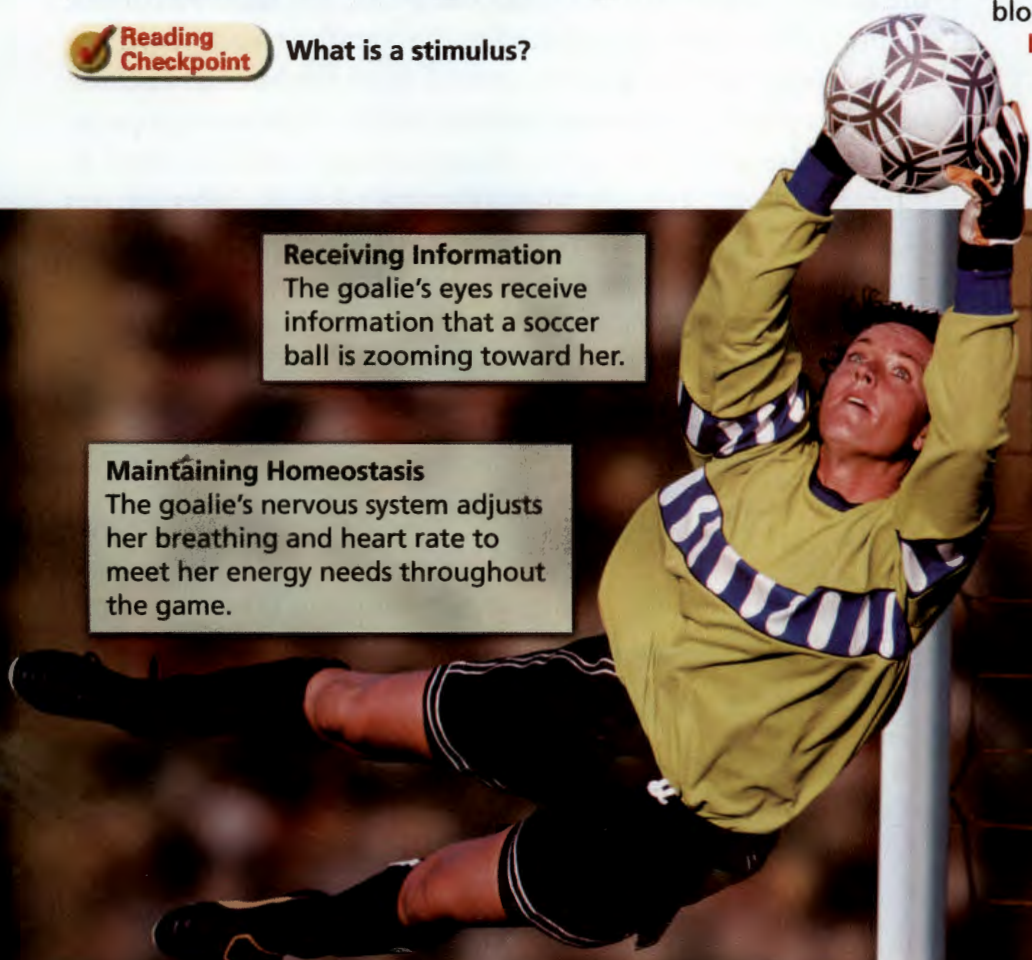
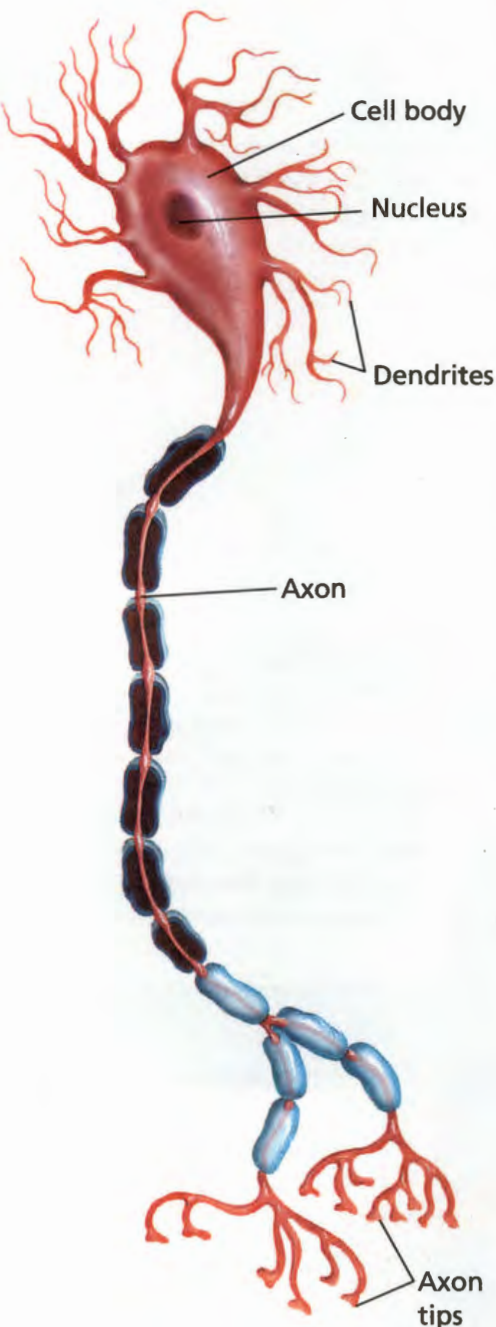




FIGURE 2

### Structure of a Neuron

A neuron has one axon and many dendrites that extend from the cell body.



## The Neuron

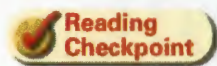
Your nervous system includes various organs, tissues, and cells. For example, your brain is an organ, and the nerves running throughout your body are tissues. The cells that carry information through your nervous system are called **neurons** (NOO rahnz), or nerve cells. The message that a neuron carries is called a **nerve impulse**.

**The Structure of a Neuron** The structure of a neuron enables it to carry nerve impulses. ➡ A neuron has a large cell body that contains the nucleus, threadlike extensions called dendrites, and an axon. The **dendrites** carry impulses toward the neuron's cell body. The **axon** carries impulses away from the cell body. Find the dendrites and axon in Figure 2. Nerve impulses begin in a dendrite, next move toward the cell body, and then move down the axon. A neuron can have many dendrites, but it has only one axon. An axon, however, can have more than one tip, so the impulse can go to more than one other cell.

Axons and dendrites are sometimes called nerve fibers. Nerve fibers are often arranged in parallel bundles covered with connective tissue, something like a package of uncooked spaghetti wrapped in cellophane. A bundle of nerve fibers is called a **nerve**.

**Kinds of Neurons** ➡ Three kinds of neurons are found in the body—sensory neurons, interneurons, and motor neurons. Figure 3 shows how these three kinds of neurons work together.

A **sensory neuron** picks up stimuli from the internal or external environment and converts each stimulus into a nerve impulse. The impulse travels along the sensory neuron until it reaches an interneuron, usually in the brain or spinal cord. An **interneuron** is a neuron that carries nerve impulses from one neuron to another. Some interneurons pass impulses from sensory neurons to motor neurons. A **motor neuron** sends an impulse to a muscle or gland, and the muscle or gland reacts in response.



What is the function of an axon?

## How a Nerve Impulse Travels

Every day of your life, billions of nerve impulses travel through your nervous system. Each of those nerve impulses begins in the dendrites of a neuron. The impulse moves rapidly toward the neuron's cell body and then down the axon until it reaches the axon tip. A nerve impulse travels along the neuron in the form of electrical and chemical signals. Nerve impulses can travel as fast as 120 meters per second!

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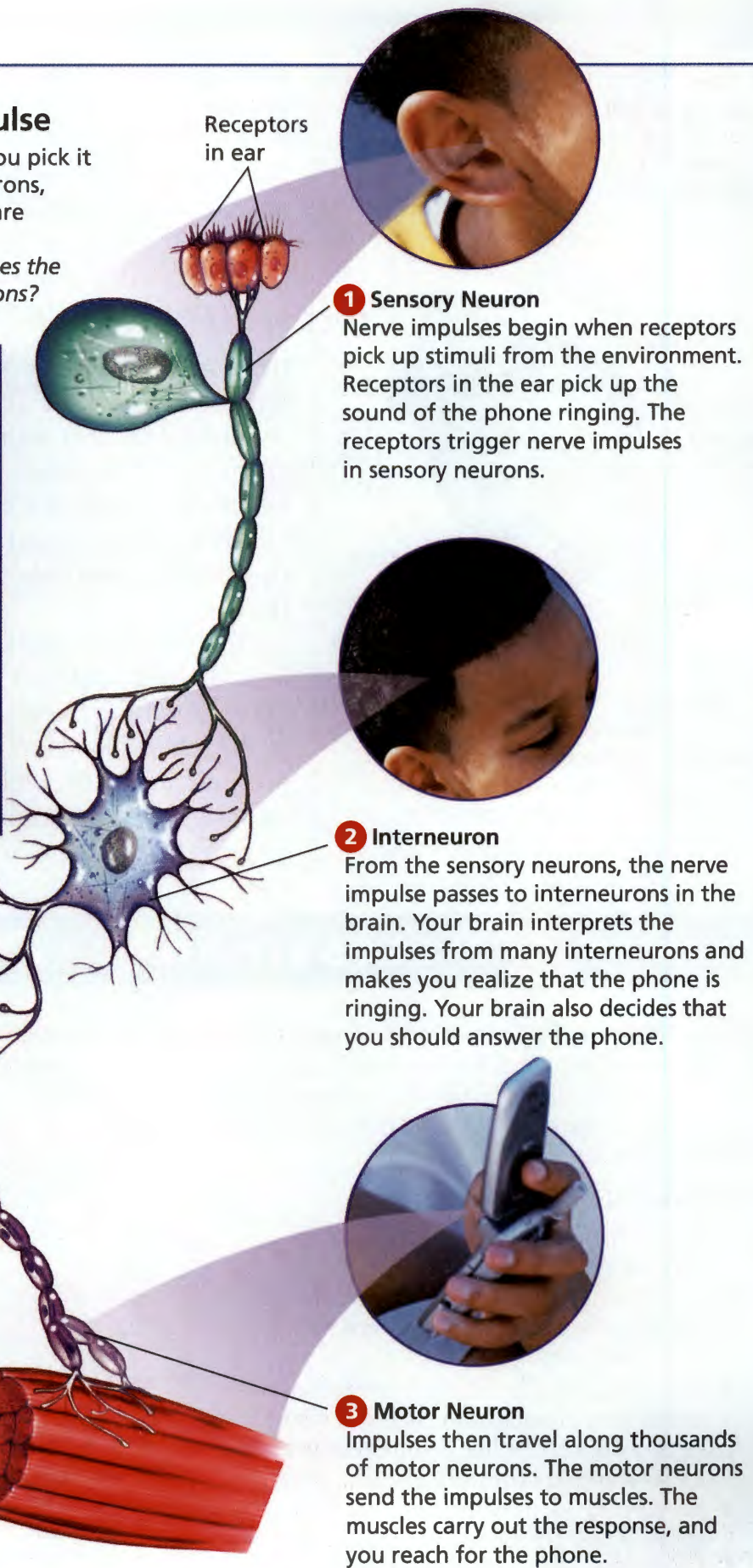


FIGURE 3

## The Path of a Nerve Impulse

When you hear your phone ring, you pick it up to answer it. Many sensory neurons, interneurons, and motor neurons are involved in this action.

**Interpreting Diagrams** To where does the impulse pass from the sensory neurons?





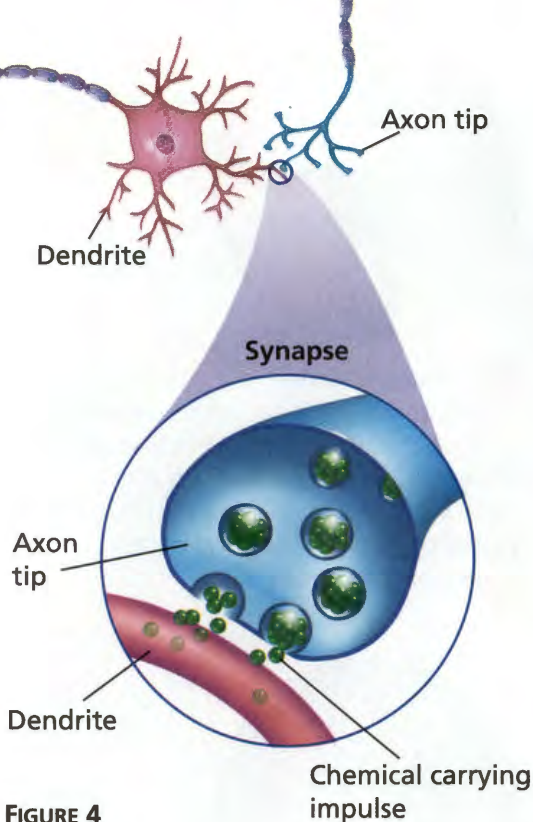



FIGURE 4

### The Synapse

When a nerve impulse reaches the tip of an axon, chemicals are released into the gap at the synapse. The chemicals carry the nerve impulse across the gap.

**The Synapse** What happens when a nerve impulse reaches the axon tip at the end of a neuron? At that point, the impulse can pass to the next structure. Sometimes the structure is the dendrite of another neuron. Other times, the structure is a muscle or a cell in another organ, such as a sweat gland. The junction where one neuron can transfer an impulse to another structure is called a **synapse** (SIN aps).

**How an Impulse Is Transferred** Figure 4 shows a synapse between the axon tip of one neuron and the dendrite of another neuron. Notice that a small gap separates these two structures.  For a nerve impulse to be carried along at a synapse, it must cross the gap between the axon and the next structure. The axon tips release chemicals that carry the impulse across the gap.

You can think of the gap at a synapse as a river, and an axon as a road that leads up to the riverbank. The nerve impulse is like a car traveling on the road. To get to the other side, the car has to cross the river. The car gets on a ferry boat, which carries it across the river. The chemicals that the axon tips release are like the ferry, carrying the nerve impulse across the gap.

## Section 1 Assessment

S 7.5.b, E-LA: Reading: 7.2.0

### Target Reading Skill Identify Main Ideas

Reread the text following the heading Functions of the Nervous System (pages 600–601). Note that the Key Concept is the main idea. List three details that support this main idea.

### Reviewing Key Concepts

1. a. **Listing** What are three functions of the nervous system?
- b. **Describing** Give an example of a stimulus and describe how the nervous system produces a response.
- c. **Predicting** Your heart rate is controlled by involuntary actions of the nervous system. What would life be like if your heartbeat were under voluntary control?
2. a. **Identifying** Identify the three kinds of neurons that are found in the nervous system.
- b. **Explaining** How do the three kinds of neurons interact to carry nerve impulses?

c. **Comparing and Contrasting** How do sensory neurons and motor neurons differ?

3. a. **Reviewing** What is a synapse?

b. **Sequencing** Outline the steps by which a nerve impulse reaches and then crosses the gap at a synapse.

Lab zone

### At-Home Activity

**Pass the Salt, Please** During dinner, ask a family member to pass the salt to you. Observe what your family member then does. Explain that the words you spoke were a stimulus and that the family member's reaction was a response. Describe which structures of the nervous system detect stimuli and enable a response.



## Ready or Not!

S 7.5.b, 7.7.c

### Problem

Do people's reaction times vary at different times of the day?

### Skills Focus

developing hypotheses, controlling variables, drawing conclusions

### Material

- meter stick

### Procedure

#### **PART 1** Observing a Response to a Stimulus

1. Have your partner hold a meter stick with the zero end about 50 cm above a table.
2. Get ready to catch the meter stick by positioning the top of your thumb and forefinger just at the zero position, as shown in the photograph.
3. Your partner should drop the meter stick without any warning. Using your thumb and forefinger only (no other part of your hand), catch the meter stick as soon as you can. Record the distance in centimeters that the meter stick fell. This distance is a measure of your reaction time.

#### **PART 2** Designing Your Experiment

4. With your partner, discuss how you can use the activity from Part 1 to find out whether people's reaction times vary at different times of day. Consider the questions below. Then, write up your experimental plan.
  - What hypothesis will you test?
  - What variables do you need to control?
  - How many people will you test? How many times will you test each person?



5. Submit your plan for your teacher's review. Make any changes your teacher recommends. Create a data table to record your results. Then, perform your experiment.

### Analyze and Conclude

1. **Inferring** In this lab, what is the stimulus? What is the response? Is the response voluntary or involuntary? Explain.
2. **Drawing Conclusions** Which body systems were involved in people's reactions?
3. **Developing Hypotheses** What hypothesis did you test in Part 2?
4. **Controlling Variables** In Part 2, why was it important to control all variables except the time of day?
5. **Drawing Conclusions** Based on your results in Part 2, do people's reaction times vary at different times of the day? Explain.
6. **Communicating** Write a paragraph to explain why you can use the distance on the meter stick as a measure of reaction time.

### More to Explore

Do you think people can do arithmetic problems more quickly and accurately at certain times of the day? Design an experiment to investigate this question. *Obtain your teacher's permission before carrying out your investigation.*



# Divisions of the Nervous System

## CALIFORNIA

## Standards Focus

**S 7.5.b** Students know organ systems function because of the contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system.

- What are the structures and functions of the central nervous system?
- What are the structures and functions of the peripheral nervous system?
- What is a reflex?
- What are two ways in which the nervous system can be injured?


## Key Terms

- central nervous system
- peripheral nervous system
- brain
- spinal cord
- cerebrum
- cerebellum
- brain stem
- somatic nervous system
- autonomic nervous system
- reflex
- concussion

## Lab zone

## Standards Warm-Up

## How Does Your Knee React?

1. Sit on a table or counter so that your legs dangle freely. Make sure that your partner is not directly in front of your legs.
2.  Have your partner use the side of his or her hand to tap one of your knees gently just below the kneecap. Observe what happens to your leg. Note whether you have any control over your reaction.
3. Change places with your partner. Repeat Steps 1 and 2.



### Think It Over

**Inferring** When might it be an advantage for your body to react very quickly and without your conscious control?

You are standing at a busy street corner, waiting to cross the street. A traffic cop blows his whistle and waves his arms energetically. For the heavy traffic to move smoothly, there needs to be a traffic cop and responsive drivers. The traffic cop coordinates the movements of the drivers, and they steer the cars safely through the intersection.

Similarly, your nervous system has two divisions that work together. The **central nervous system** consists of the brain and spinal cord. The **peripheral nervous system** (puh RIF uh rul) includes all the nerves located outside of the central nervous system. The central nervous system is like a traffic cop. The peripheral nervous system is like the drivers and pedestrians.

The traffic cop keeps everybody moving.



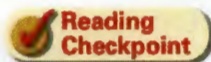


## Central Nervous System

You can see the central and peripheral nervous systems in Figure 5. 🗑️ **The central nervous system is the control center of the body. It includes the brain and spinal cord.** All information about what is happening in the world inside or outside your body is brought to the central nervous system. The **brain**, located in the skull, is the part of the central nervous system that controls most functions in the body. The **spinal cord** is the thick column of nervous tissue that links the brain to most of the nerves in the peripheral nervous system.

Most impulses from the peripheral nervous system travel through the spinal cord to get to the brain. Your brain then directs a response. The response usually travels from the brain, through the spinal cord, and then to the peripheral nervous system.

For example, here is what happens when you reach under the sofa to find a lost quarter. Your fingers move over the floor, searching for the quarter. When your fingers finally touch the quarter, the stimulus of the touch triggers nerve impulses in sensory neurons in your fingers. These impulses travel through nerves of the peripheral nervous system to your spinal cord. Then the impulses race up to your brain. Your brain interprets the impulses, telling you that you've found the quarter. Your brain starts nerve impulses that move down the spinal cord. From the spinal cord, the impulses travel through motor neurons in your arm and hand. The impulses in the motor neurons cause your fingers to grasp the quarter.



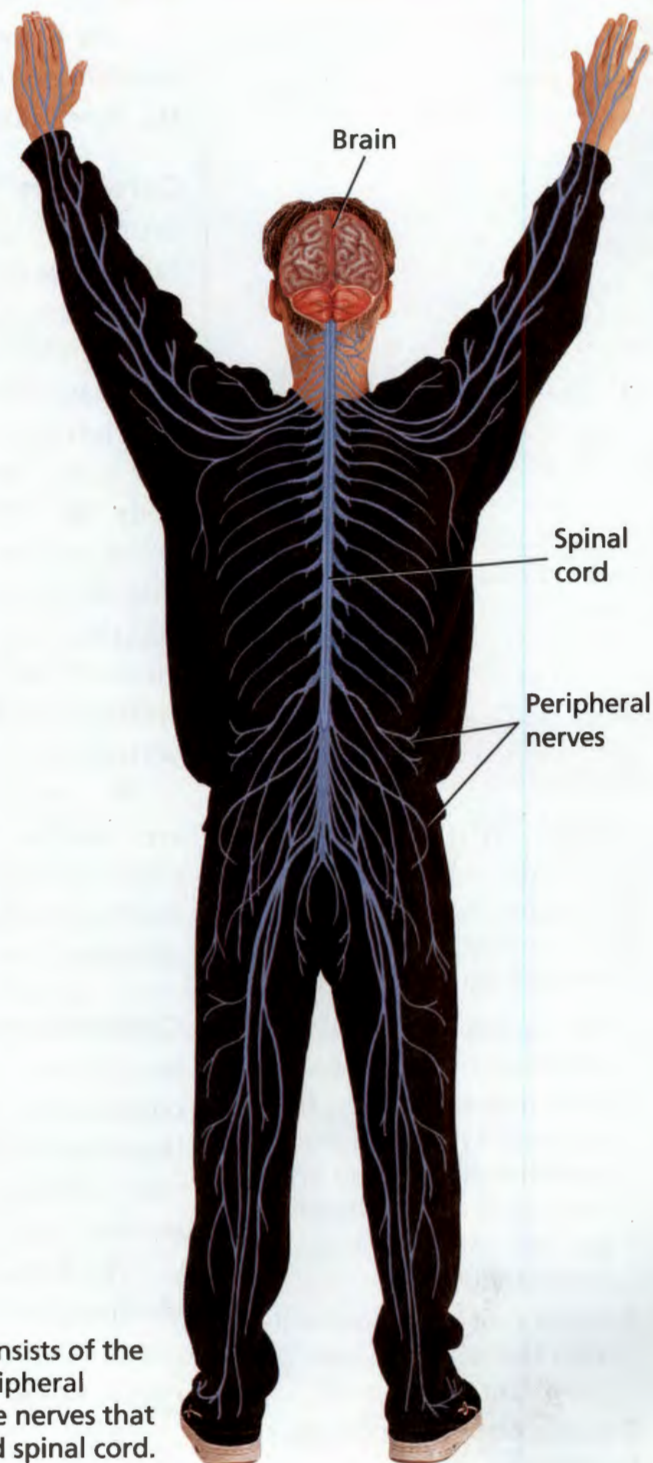
**Reading  
Checkpoint**

**What are the parts of the central nervous system?**

**FIGURE 5**

### **The Nervous System**

The central nervous system consists of the brain and spinal cord. The peripheral nervous system includes all the nerves that branch out from the brain and spinal cord.



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## The Brain and Spinal Cord

Your brain contains about 100 billion neurons, all of which are interneurons. Each of those neurons may receive messages from up to 10,000 other neurons and may send messages to about 1,000 more! Three layers of connective tissue cover the brain. The space between the middle layer and innermost layer is filled with a watery fluid. The skull, the layers of connective tissue, and the fluid all help protect the brain from injury.

➡ There are three main regions of the brain that receive and process information. These are the cerebrum, the cerebellum, and the brain stem. Find each in Figure 6.

**Cerebrum** The largest part of the brain is called the cerebrum. The **cerebrum** (suh REE brum) interprets input from the senses, controls movement, and carries out complex mental processes such as learning and remembering. Because of your cerebrum, you can locate your favorite comic strip in the newspaper, read it, and laugh at its funny characters.

The cerebrum is divided into a right and a left half. The right half sends impulses to skeletal muscles on the left side of the body. In contrast, the left half controls the right side of the body. When you reach with your right hand for a pencil, the messages that tell you to do so come from the left half of the cerebrum. In addition, each half of the cerebrum controls slightly different kinds of mental activity. The right half is usually associated with creativity and artistic ability. The left half is usually associated with mathematical skills, language, and logical thinking.

As you can see in Figure 6, certain areas of the cerebrum are associated with smell, touch, taste, hearing, and vision. Other areas control movement, speech, written language, and abstract thought. Different tissues in the cerebrum carry out different functions.

**Cerebellum and Brain Stem** The second largest part of your brain is the cerebellum. The **cerebellum** (sehr uh BEL um) coordinates muscle action and balance. When you walk, the impulses that move your feet start in your cerebrum. However, your cerebellum gives you the muscular coordination and sense of balance that keep you from falling down.

The **brain stem**, which lies beneath the cerebrum and cerebellum, controls your body's involuntary actions—those that occur automatically. For example, neurons in the brain stem regulate your breathing and help control your heartbeat.

Lab  
zone

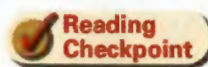
### Skills Activity

#### Controlling Variables

Are people better able to memorize a list of words in a quiet room or in a room where soft music is playing?

1. Write a hypothesis that addresses this question.
2. Design an experiment to test your hypothesis. Make sure that all variables are controlled except the one you are testing—music versus quiet.
3. Check your procedure with your teacher. Then perform your experiment.

Did your results support your hypothesis?



What actions does the brain stem control?

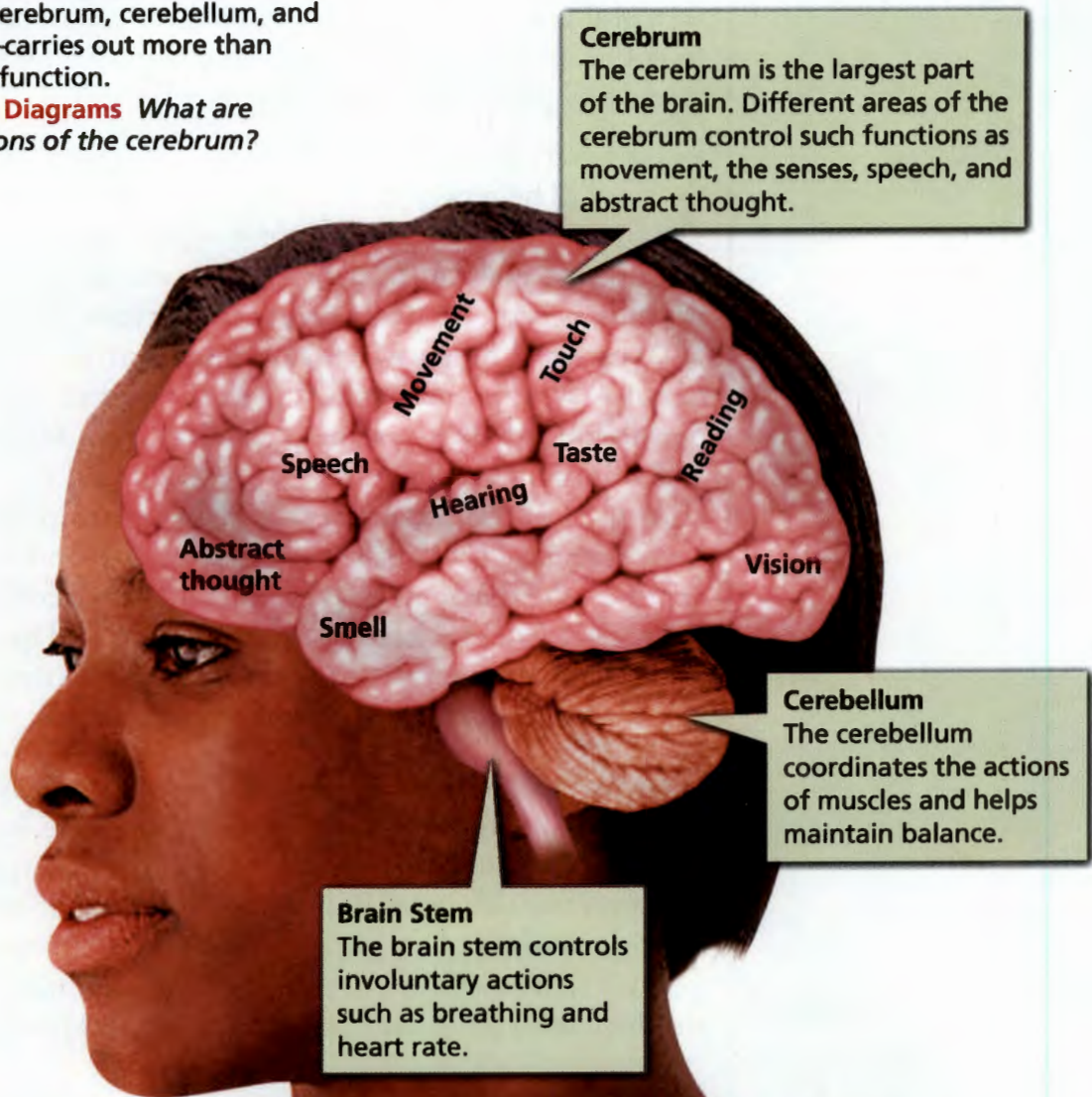


FIGURE 6

## The Brain

Each of the three main parts of the brain—the cerebrum, cerebellum, and brain stem—carries out more than one specific function.

**Interpreting Diagrams** What are three functions of the cerebrum?



### Top View of Cerebrum

**Left Half**  
The left half of the cerebrum is associated with mathematical and logical thinking.



**Right Half**  
The right half of the cerebrum is associated with creativity and artistic ability.



**The Spinal Cord** 🗝️ The spinal cord is the link between your brain and the peripheral nervous system. Run your fingers down the center of your back to feel the bones of the vertebral column. The vertebral column surrounds and protects the spinal cord. The layers of connective tissue that surround and protect the brain also cover the spinal cord. Like the brain, the spinal cord is further protected by a watery fluid.

## Peripheral Nervous System

The second division of the nervous system is the peripheral nervous system. 🗝️ The peripheral nervous system consists of a network of nerves that branch out from the central nervous system and connect it to the rest of the body. The peripheral nervous system is involved in both involuntary and voluntary actions.

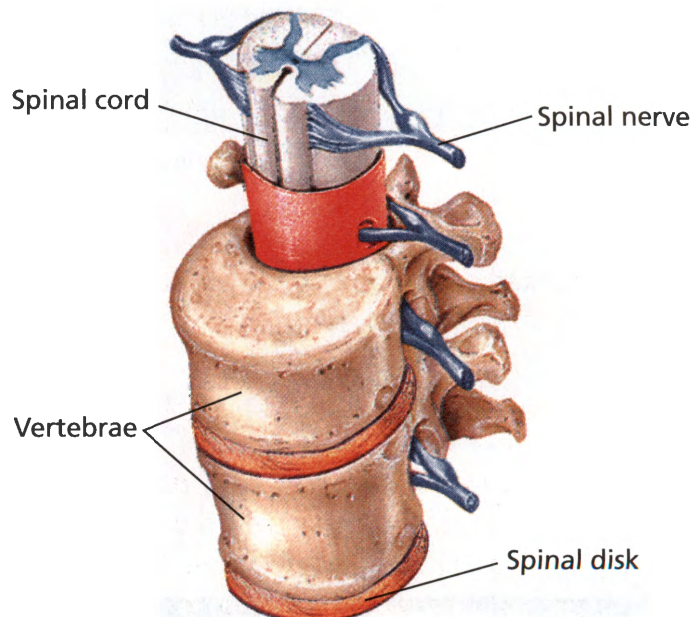
A total of 43 pairs of nerves make up the peripheral nervous system. Twelve pairs originate in the brain. The other 31 pairs—the spinal nerves—begin in the spinal cord. One nerve in each pair goes to the left side of the body, and the other goes to the right. As you can see in Figure 7, spinal nerves leave the spinal cord through spaces between the vertebrae.

**How Spinal Nerves Function** A spinal nerve is like a two-lane highway. Impulses travel on a spinal nerve in two directions—both to and from the central nervous system. Each spinal nerve contains axons of both sensory and motor neurons. The sensory neurons carry impulses from the body to the central nervous system. The motor neurons carry impulses in the opposite direction—from the central nervous system to the body.

FIGURE 7

### The Spinal Nerves

The spinal nerves, which connect to the spinal cord, emerge from spaces between the vertebrae. Each spinal nerve consists of both sensory and motor neurons.







**FIGURE 8**  
**Somatic and Autonomic Nervous Systems**

The somatic nervous system controls voluntary actions. The autonomic nervous system controls involuntary actions. **Classifying** Which system helps regulate the artist's heartbeat?

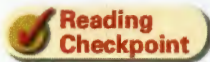
**Actions Controlled by the Somatic Nervous System**

- Hands shape the clay.
- Foot turns the wheel.
- Mouth smiles.

**Actions Controlled by the Autonomic Nervous System**

- Heartbeat is regulated.
- Breathing rate is kept steady.
- Body temperature remains constant.

**Somatic and Autonomic Systems** The nerves of the peripheral nervous system can be divided into two groups, the somatic (soh MAT ik) and autonomic (awt uh NAHM ik) nervous systems. The nerves of the **somatic nervous system** control voluntary actions such as using a fork or tying your shoes. In contrast, nerves of the **autonomic nervous system** control involuntary actions. For example, the autonomic nervous system regulates the contractions of the smooth muscles that adjust the diameter of blood vessels.



**Reading Checkpoint**

What kinds of actions are controlled by the autonomic nervous system?

## Reflexes

Imagine that you are watching an adventure movie. The movie is so thrilling that you don't notice a fly circling above your head. When the fly zooms right in front of your eyes, however, your eyelids immediately blink shut. You didn't decide to close your eyes. The blink, which is a **reflex**, is a response that happened automatically. 🔄 **A reflex is an automatic response that occurs very rapidly and without conscious control. Reflexes help to protect the body.** If you did the Standards Warm-Up on page 606, you observed another reflex.

**Lab zone**

## Try This Activity

### You Blinked!

Can you make yourself *not* blink? Find out in this activity.

1. Put on safety goggles.
2. Have your partner stand across from you and gently toss ten cotton balls, one at a time, toward your goggles. Your partner should not give you any warning before a toss.
3. Count the number of times you blink and the number of times you don't blink.

**Interpreting Data** Compare the two numbers. Why is blinking considered a reflex? What structure protects your eye when you blink?

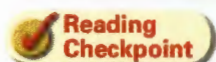


**A Reflex Pathway** As you have learned, the contraction of skeletal muscles is usually controlled by the brain. However, in some reflex actions, skeletal muscles contract with the involvement of the spinal cord only—not the brain.

Figure 9 shows the reflex action that occurs when you touch a sharp object. When your finger touches the object, sensory neurons send impulses to the spinal cord. The impulses may then pass to interneurons in the spinal cord. From there the impulses pass directly to motor neurons in your arm and hand. The muscles then contract, and your hand jerks up and away from the sharp object. By removing your hand quickly, this reflex protects you from getting badly cut.

**Signaling the Brain** At the same time that some nerve impulses make your arm muscles contract, other nerve impulses travel up your spinal cord to your brain. When these impulses reach your brain, your brain interprets them. You then feel a sharp pain in your finger.

It takes longer for the pain impulses to get to the brain and be interpreted than it does for the reflex action to occur. By the time you feel the pain, you have already moved your hand away.



What is an example of a reflex?



FIGURE 9

### A Reflex Action

If you touch a sharp object, your hand immediately jerks away. This action, which is known as a reflex, happens automatically. Follow the numbered steps to understand how a reflex happens.

**Sequencing** Do you pull your hand away before or after you feel the pain? Explain.

- 1 Sensory neurons in your fingertip detect a pain stimulus.
- 2 Nerve impulses travel to your spinal cord.
- 3 Nerve impulses return to motor neurons in your hand, and you pull your hand away.
- 4 As you pull your hand away, nerve impulses travel to your brain. You feel the pain.



## Nervous System Injuries

The nervous system can suffer injuries that interfere with its functioning. 🗝️ **Concussions and spinal cord injuries are two ways in which the central nervous system can be damaged.**

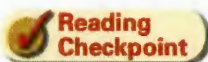
**Concussions** A **concussion** is a bruise-like injury of the brain. A concussion occurs when the soft tissue of the brain collides against the skull. Concussions can happen when you bump your head in a hard fall, in an automobile crash, or during a contact sport such as football.

With most concussions, you may have a headache for a short time, but the injured tissue heals by itself. However, with more serious concussions, you may lose consciousness, experience confusion, or feel drowsy after the injury. To decrease your chances of getting a brain injury, wear a helmet during activities in which you risk bumping your head.

**Spinal Cord Injuries** Spinal cord injuries occur when the spinal cord is cut or crushed. As a result, axons in the injured region are damaged, so they fail to carry impulses. This type of injury usually results in paralysis, which is the loss of movement in some part of the body. Car crashes are the most common cause of spinal cord injuries.



**FIGURE 10**  
**Protecting the Nervous System**  
You can help protect yourself from a spinal cord injury by wearing a seatbelt when you travel in a car.



What is paralysis?

## Section 2 Assessment

S 7.5.b, E-LA: Reading: 7.1.2  
Writing: 7.2.0

**Vocabulary Skill Suffixes** In the term *nervous system*, the word *nervous* contains the suffix *-ous*. What does this suffix mean? How does it relate to the meaning of *nervous system*?

### 🗝️ Reviewing Key Concepts

- Listing** What two structures are part of the central nervous system?
  - Describing** Describe the functions of the three main regions of the brain.
  - Relating Cause and Effect** What symptoms might indicate that a person's cerebellum has been injured?
- Identifying** What are the two groups of nerves into which the peripheral nervous system is divided?
  - Comparing and Contrasting** How do the functions of the two groups of peripheral nerves differ?
- Defining** What is a reflex?
  - Sequencing** Trace the pathway of a reflex in the nervous system.
  - Inferring** How do reflexes help protect the body from injury?
- Reviewing** What is a concussion?
  - Applying Concepts** How can you reduce your risk of concussion?

## Writing in Science

**Comparison Paragraph** Write two paragraphs in which you compare the functions of the left and right halves of the cerebrum. Discuss what kinds of mental activities each half controls as well as which side of the body it controls.



# Sight and Hearing

## CALIFORNIA

## Standards Focus

**S 7.5.g** Students know how to relate the structures of the eye and ear to their functions.

**S 7.6.b** Students know that for an object to be seen, light emitted by or scattered from it must be detected by the eye.

How do your eyes enable you to see?

How do you hear and maintain your sense of balance?

## Key Terms

- cornea • pupil • iris • lens
- retina • rods • cones • optic nerve • eardrum • hammer • anvil • stirrup • cochlea
- semicircular canals

## Lab zone

## Standards Warm-Up

## Can You See Everything With One Eye?

1. Write an X and an O on a sheet of paper. The O should be about 5 cm to the right of the X.
2. Hold the sheet of paper at arm's length.
3. Close or cover your left eye. Stare at the X with your right eye.
4. Slowly move the paper toward your face while staring at the X. What do you notice?
5. Repeat the activity, keeping both eyes open. What difference do you notice?

### Think It Over

**Posing Questions** Write two questions about vision that you could investigate using the X and the O.

The pitcher goes into her windup, keeping her eye on the strike zone. The batter watches the pitcher release the ball and then swings. Crack! She drops the bat and sprints toward first base. From your seat, you watch the ball travel toward the outfield. Will it be a base hit? The left fielder watches the ball speed toward her. It's over her head for a double!

Players and spectators alike followed the first rule of baseball: Keep your eye on the ball. As the ball moves near and far, your eyes must adjust continuously to keep it in focus. Fortunately, this change in focus happens automatically.

## Video Field Trip

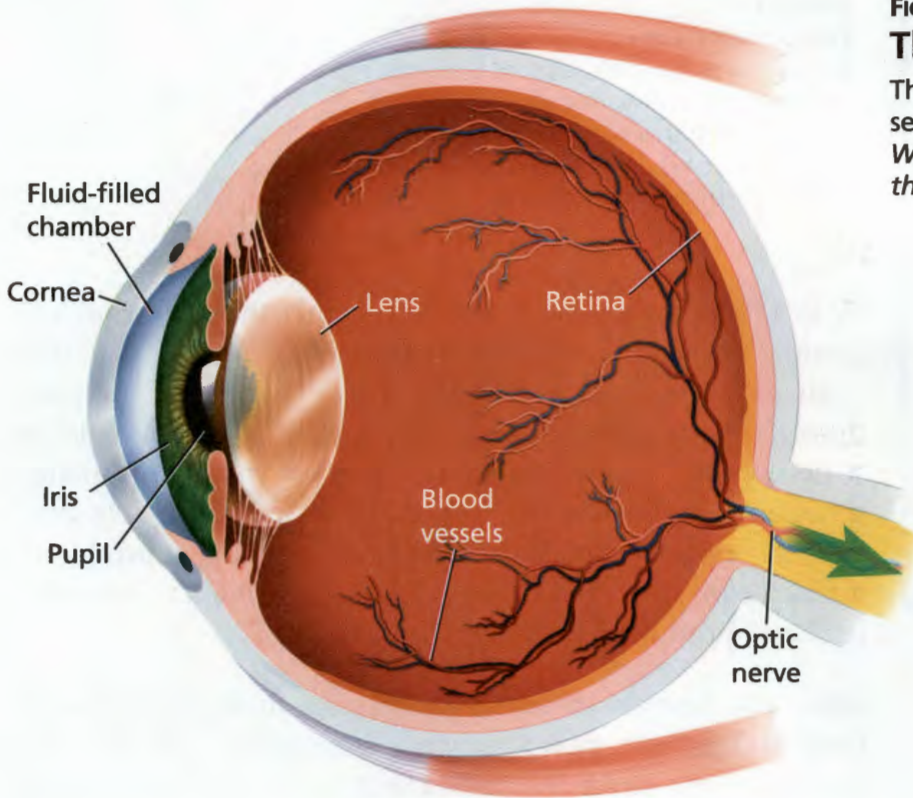
Discovery Channel School

*The Nervous System*



Keep your eye on the ball! ▶





**FIGURE 11**  
**The Eye**

The eye is a complex organ that senses light. **Interpreting Diagrams**  
What structure adjusts the size of the pupil?

**Pupil in Bright Light**



**Pupil in Dim Light**

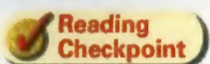


## Vision

Your eyes are the sense organs that enable you to see the objects in your environment. 🗣️ **Your eyes respond to the stimulus of light. They convert that stimulus into impulses that your brain interprets, enabling you to see.**

**How Light Enters Your Eye** Light rays from an object enter the eye through the structures shown in Figure 11. First, the light strikes the **cornea** (KAWR nee uh), the clear tissue that covers the front of the eye. The light then passes through a fluid-filled chamber behind the cornea and reaches the pupil. The **pupil** is the opening through which light enters the eye.

You may have noticed that people's pupils change size when they go from a dark room into bright sunshine. In bright light, the pupil becomes smaller. In dim light, the pupil becomes larger. The size of the pupil is adjusted by muscles in the iris. The **iris** is a circular structure that surrounds the pupil and regulates the amount of light entering the eye. Together, the iris and the pupil act much like the aperture of a camera. The iris also gives the eye its color.



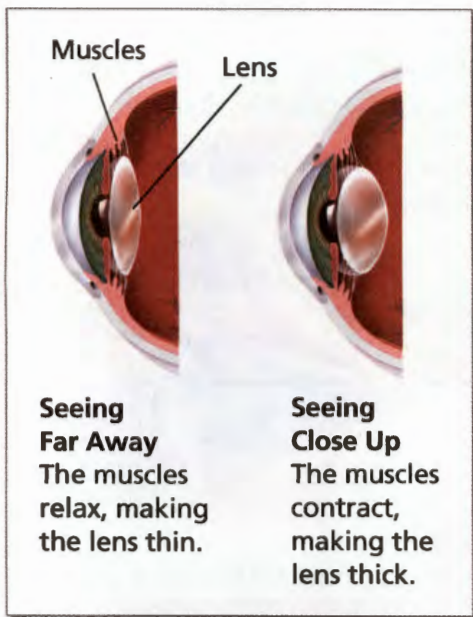
**Reading  
Checkpoint**

What is the function of the iris?

**Go Online**  
**active art**

For: Virtual Dissection of the Eye activity  
Visit: PHSchool.com  
Web Code: cvp-4153





**FIGURE 12**

### Focusing the Lens

Muscles change the shape of the lens, allowing the eye to focus on objects at different distances.

**Applying Concepts** *What structures does light pass through before it reaches the lens?*

**How Light Is Focused** Light rays enter the eye through the cornea. The cornea transforms the diverging rays that come from an object into converging rays. Then the light passes through the pupil and strikes the lens. The **lens** is a flexible structure that focuses light. The lens of your eye functions something like the lens of a camera. Because of the way in which the lens of the eye bends the light rays, the image it produces is upside down and reversed. Muscles that attach to the lens adjust its shape, producing an image that is in focus.

**How You See an Image** After passing through the lens, the focused light rays pass through a transparent, jellylike fluid. Then the rays strike the **retina** (RET 'n uh), a sheet of light-sensitive cells that lines the back of the eye. The retina, which has the same job as a film or video chip in a camera, contains about 130 million receptor cells. These cells respond to light. There are two types of receptors: rods and cones. **Rod cells** work best in dim light and enable you to see black, white, and shades of gray. In contrast, **cone cells** work best in bright light and enable you to see colors. This difference between rods and cones explains why you see colors best in bright light, but you see only shadowy gray images in dim light.

The rods and cones send electrical impulses to the brain through a short, thick nerve called the **optic nerve**. One optic nerve comes from the left eye and the other one comes from the right eye. The brain interprets the signals. First, it turns the reversed image right-side up. Then the brain combines the images from each eye. You see a single image.

**Seeing in Depth** Unlike many animals, humans have both eyes in the front of the head. Both your eyes look forward. However, you see a slightly different image with your right eye than you do with your left eye. Your brain compares the images from your two eyes. This comparison gives you three-dimensional vision. That is, you can judge how close or how far away an object is.

**Lab zone**

### Try This Activity

#### Working Together

Discover how your two eyes work together.

1. With your arms fully extended, hold a drinking straw in one hand and a pipe cleaner in the other.
2. With both eyes open, try to insert the pipe cleaner into the straw.
3. Now close your right eye. Try to insert the pipe cleaner into the straw.
4. Repeat Step 3 with your left eye closed.

**Inferring** How does closing one eye affect your ability to judge distances?



**Reading Checkpoint**

What enables humans to see in three dimensions?



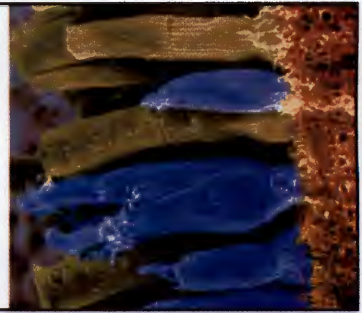
FIGURE 13

## How You See

Light coming from an object enters your eye and is focused by the cornea and lens. An upside-down image forms on your retina. Receptors in your retina then send impulses to your cerebrum, which turns the image right-side up.

**Comparing and Contrasting** Which receptors work best in dim light?

**Rods and Cones**  
Receptors in the retina include rods (shown in green) and cones (shown in blue).



Object

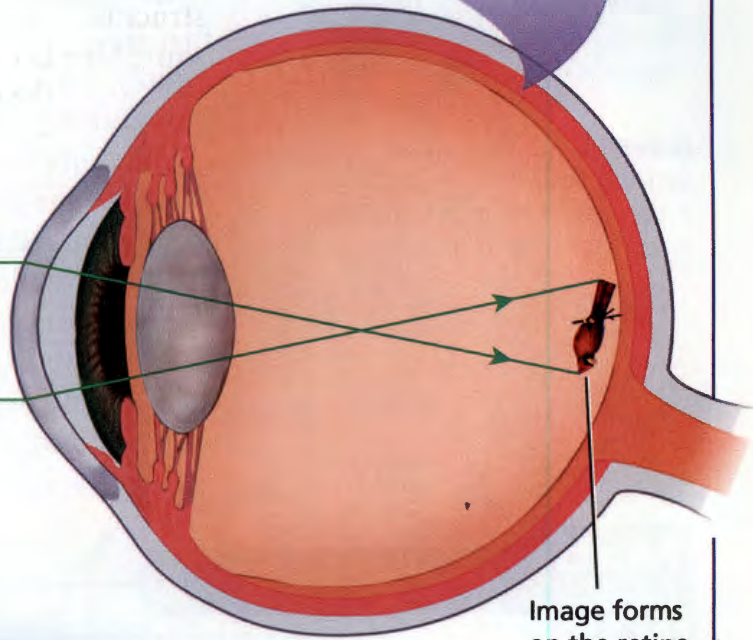
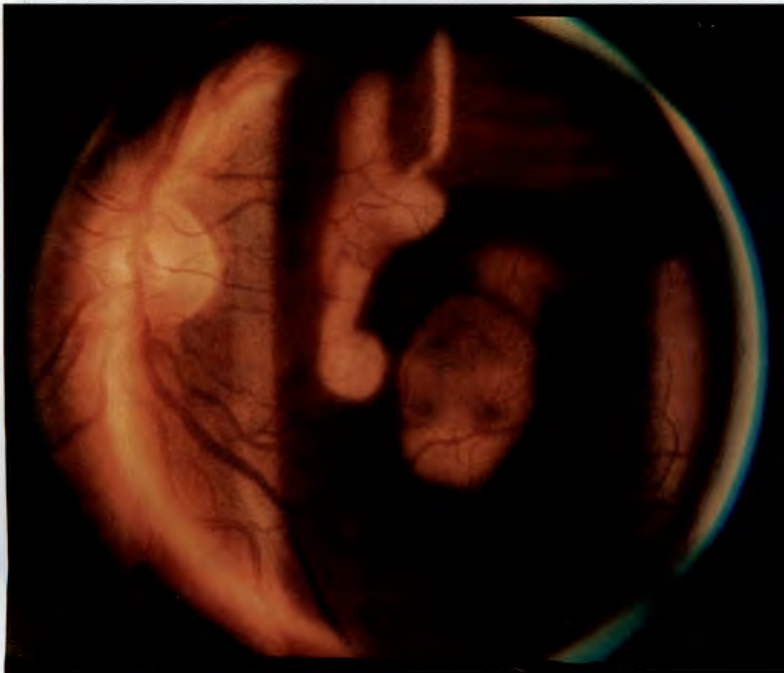


Image forms on the retina



◀ An image is focused on the retina. Notice that the image is upside down.





**FIGURE 14**  
**Sensing Sound**  
 A dog can cock its external ear when listening to sounds.

## Hearing and Balance

Have you ever watched a dog listen for its owner's voice? Dogs and other mammals have muscles that enable their external ears to move. This movement helps the animals detect faint sounds and identify where the sounds come from. Though your ears don't move like those of a dog, they do detect sound.

👉 **Your ears are the sense organs that respond to the stimulus of sound. The ears convert sound to nerve impulses that your brain interprets.** So when you hear an alarm clock, your brain tells you that it's time to wake up.

**How Sound Is Produced** Sound is produced by vibrations that travel as waves. The material that is vibrating, or moving rapidly back and forth, may be almost anything—a guitar string, an insect's wings, or a stereo speaker.

The vibrations, or sound waves, move outward from the source of the sound, something like ripples moving out from a stone dropped in water. The sound waves cause particles, such as the gas molecules that make up air, to vibrate. In this way, sound is carried. When you hear a friend's voice, for example, sound waves have traveled from your friend's larynx to your ears. Sound waves can also travel through liquids, such as water, and solids, such as wood.

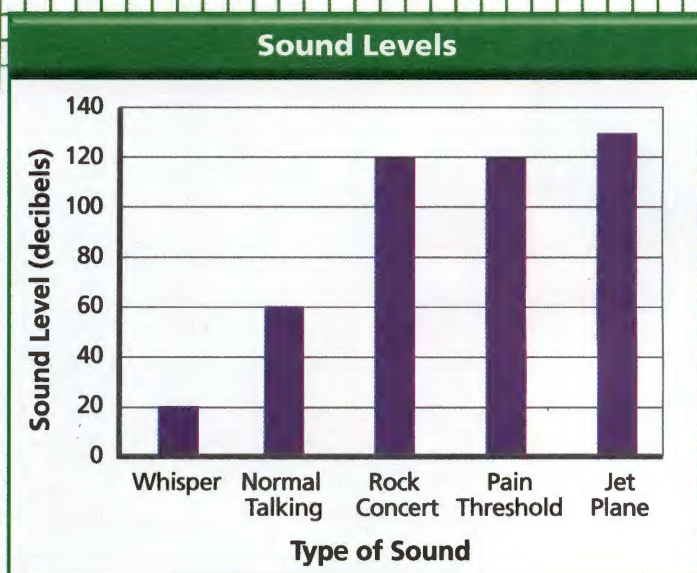
## Math

### Analyzing Data

Math: Number Sense 7.1.1

### Sound Intensity

Sound intensity, or loudness, is measured in units called decibels. The threshold of hearing for the human ear is 0 decibels. For every 10-decibel increase, the sound intensity increases ten times. Thus, a 20-decibel sound is ten times more intense than a 10-decibel sound, not twice as intense. A 30-decibel sound is 100 times more intense than a 10-decibel sound. Sound levels for several sound sources are shown in the bar graph.

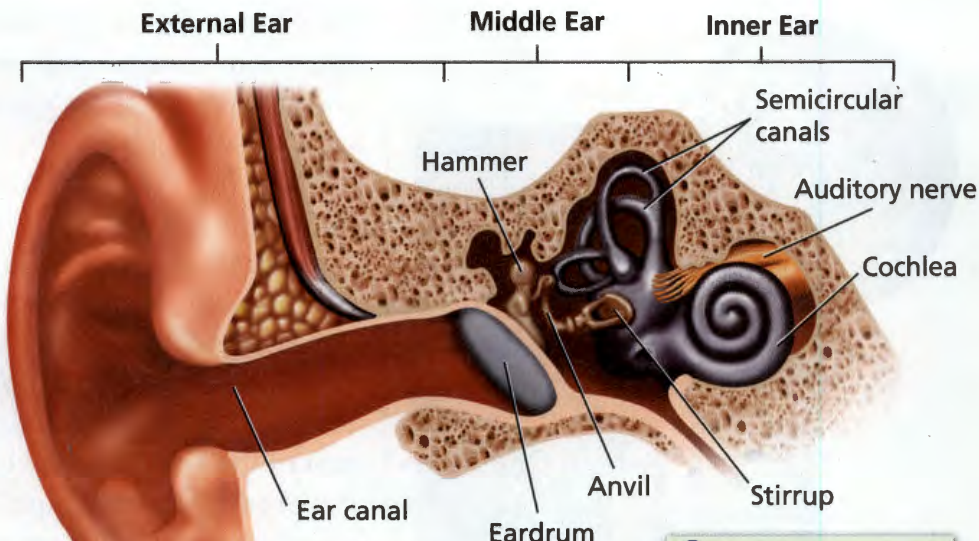


- Interpreting Data** What is the sound intensity in decibels of a whisper? Normal talking? A rock concert?
- Calculating** How much more intense is normal talking than a whisper? Explain.
- Predicting** Based on the graph, what sounds could be painful if you were exposed to them?



FIGURE 15  
The Ear

Sound waves enter the outer ear and make structures in the middle ear vibrate. When the vibrations reach the inner ear, nerve impulses travel to the cerebrum through the auditory nerve. **Predicting** What would happen if the bones of the middle ear could not move?



**1 External Ear**  
Sound waves enter the external ear and reach the eardrum.

**2 Middle Ear**  
Vibrations pass from the hammer to the anvil and stirrup.

**3 Inner Ear**  
Vibrations in the cochlea cause nerve cells to transmit signals to the brain.

**The External Ear** The three regions of the ear—the external ear, middle ear, and inner ear—are shown in Figure 15. Notice that the visible part of the external ear is shaped like a funnel. This funnel-like shape enables the external ear to collect sound waves, which then travel down the ear canal.

**The Middle Ear** The ear canal directs sound waves to the middle ear, where they strike the eardrum. The **eardrum**, or tympanic membrane, vibrates when struck by sound waves. Your eardrum vibrates much as a drum does when it is struck. Within the middle ear are three small bones called the **hammer** (or malleus), **anvil** (or incus), and **stirrup** (or stapes). These tiny bones act as a series of levers that transfer vibrations from one place to another. Vibrations pass first from the eardrum to the hammer. Then they pass to the anvil, and next to the stirrup. Muscles adjust the tension on the eardrum and the three bones in response to the loudness of the sound.

**The Inner Ear** The stirrup vibrates against a thin membrane that covers the opening of the inner ear, also called the labyrinth. This membrane channels the vibrations into fluid in the cochlea. The **cochlea** (KAHK le uh) is a snail-shaped tube that is lined with receptor cells that respond to sound. When the fluid in the cochlea vibrates, it stimulates these receptors. Sensory neurons then send nerve impulses to the cerebrum through the auditory nerve. These impulses are interpreted as sounds that you hear.

**Lab zone Skills Activity**

**Making Models**

Use simple materials to build a model of the ear. Items such as a funnel, clay, pipe cleaners, and a piece of balloon may be used to model different parts of the ear. Make a sketch of your model and label each structure. Then write a brief paragraph that explains how the parts of the ear work together to transmit sound to the brain.





FIGURE 16

### Balancing Act

This tightrope walker is able to keep his balance due to the functioning of his semicircular canals.

**Relating Cause and Effect** How do the semicircular canals help you to maintain balance?

**The Inner Ear and Balance** ➡ Structures in your inner ear control your sense of balance. Above the cochlea in your inner ear are the **semicircular canals**, which are the structures in the ear that are responsible for your sense of balance. You can see how these structures got their name if you look at Figure 16. These canals, as well as the two tiny sacs located behind them, are full of fluid. The canals and sacs are also lined with tiny cells that have hairlike extensions.

When your head moves, the fluid in the semicircular canals is set in motion. The moving fluid makes the cells' hairlike extensions bend. This bending produces nerve impulses in sensory neurons. The impulses travel to the cerebellum. The cerebellum then analyzes the impulses to determine the way your head is moving and the position of your body. If the cerebellum senses that you are losing your balance, it sends impulses to muscles that help you restore your balance.

Have you ever spun around and then stopped suddenly? You probably felt dizzy afterward. Dizziness happens because the fluid in the semicircular canals keeps moving for a while after your body stops moving.



**Reading Checkpoint**

Where in the ear are the semicircular canals located?

## Section 3 Assessment

S 7.5.g, 7.6.b, E-LA:  
Reading: 7.1.2, Writing 7.2.5

**Vocabulary Skill Suffixes** Use the meaning of the suffix *-ness* to explain the meaning of *dizziness*.

### Reviewing Key Concepts

1. a. **Listing** What are the parts of the eye?  
b. **Sequencing** Describe the process by which the eye produces an image. Begin at the point at which light is focused by the lens.  
c. **Predicting** If you closed one eye, could you thread a needle easily? Explain your answer.
2. a. **Identifying** What are the three regions of the ear?  
b. **Describing** Describe how sound is transmitted from the eardrum to the cochlea.  
c. **Relating Cause and Effect** Why may an infection of the inner ear cause you to lose your balance?

### Writing in Science

**Summary Paragraph** Write a summary paragraph that describes what happens to your eyes when you walk from a dark movie theater into bright sunshine. Include the main ideas and important details about the structures in the eye and how they change.



# Smell, Taste, and Touch

**CALIFORNIA**
**Standards Focus**

**S 7.5.b** Students know organ systems function because of the contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system.

- How do your senses of smell and taste work together?
- How is your skin related to your sense of touch?

**Key Terms**

- taste bud

**Lab zone**
**Standards Warm-Up**
**What's in the Bag?**

1. Your teacher will give you a paper bag that contains several objects. Your challenge is to use only your sense of touch to identify each object. You will not look inside the bag.
2. Put your hand in the bag and carefully touch each object. Observe the shape of each object. Note whether its surface is rough or smooth. Also note other characteristics, such as its size, what it seems to be made of, and whether it can be bent.
3. After you have finished touching each object, write your observations on a sheet of paper. Then, write your inference about what each object is.

**Think It Over**

**Interpreting Data** What did your sense of touch help you learn? What could you not determine?

You grip the steering wheel as the bumper car jerks into motion. The wheel's surface feels smooth. Next, you are zipping around and bumping into other cars. You feel air rush past your face and the jolt of another car hitting yours. As you zoom to a far corner of the floor, you smell the aromas of the snack bar.

Like your other senses, your senses of smell, taste, and touch get information from your environment. This information travels by nerve impulses to your brain. Then you can decide how to act on the information. For example, you can choose which way to move the bumper car or when to eat.



For: Links on the senses  
 Visit: [www.SciLinks.org](http://www.SciLinks.org)  
 Web Code: scn-0463

Enjoy the ride, and  
 thank your senses! ▶






## Designing Experiments

Can people tell one food from another if they can taste the foods but not smell them? Design an experiment to find out. Use these foods: a peeled pear, a peeled apple, and a peeled raw potato. Be sure to control all variables except the one you are testing. Write your hypothesis and a description of your procedure. Obtain your teacher's approval before carrying out your experiment.

## Smell and Taste

You walk into the house and smell the aroma of freshly baked cookies. You bite into one and taste its rich chocolate flavor. When you smelled the cookies, receptors in your nose reacted to chemicals carried by the air from the cookies to your nose. When you took a bite of a cookie, your taste buds were stimulated. **Taste buds** are organs on your tongue that respond to chemicals in food. These chemicals were dissolved in saliva, which came in contact with your taste buds.

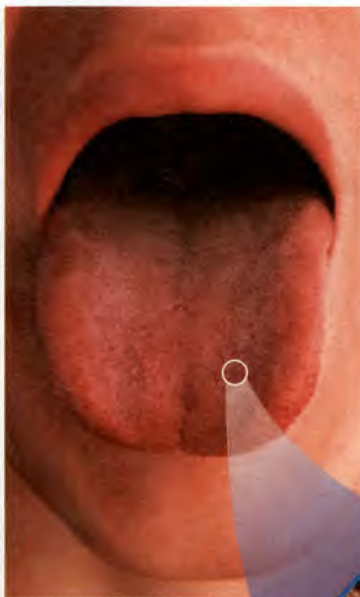
 **The senses of smell and taste work closely together. Both depend on chemicals in food or in the air. The chemicals trigger responses in receptors in the nose and mouth.** Nerve impulses then travel to the brain, where they are interpreted as smells or tastes.

The nose can distinguish at least 50 basic odors. In contrast, there are only five main taste sensations—sweet, sour, salty, bitter, and a meatlike taste called *umami*. When you eat, however, you experience a much wider variety of tastes. The flavor of food is influenced by both smell and taste. When you have a cold, foods may not seem very flavorful. That is because a stuffy nose decreases your ability to smell food.



**Reading Checkpoint**

What basic tastes can the tongue detect?



Magnified image of the tongue's surface ▶

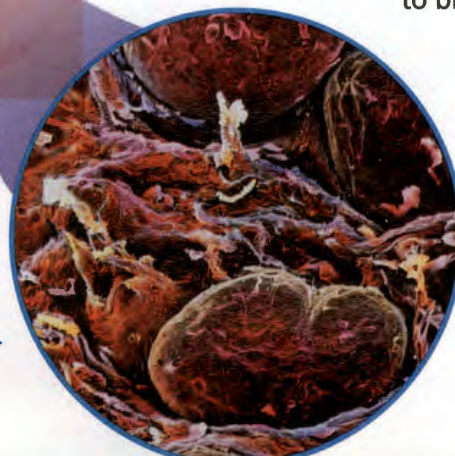
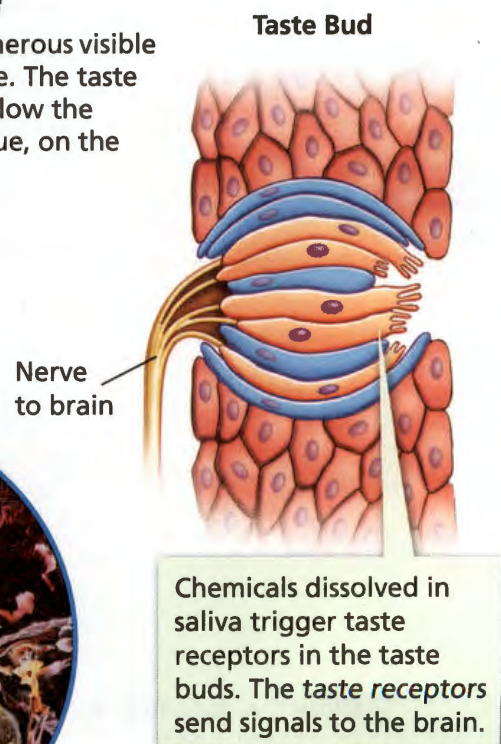


FIGURE 17

### Sense of Taste

The tongue has numerous visible bumps on its surface. The taste buds are located below the surface of the tongue, on the sides of the bumps.





## Touch

Unlike vision, hearing, balance, smell, and taste, the sense of touch is not found in one specific place. Instead, the sense of touch is found in all areas of your skin. Your skin is your largest sense organ! 🗝️ **Your skin contains different kinds of touch receptors that respond to a number of stimuli.** Some of these receptors respond to light touch and others to heavy pressure. Still other receptors pick up sensations of pain and temperature change.

The receptors that respond to a light touch are close to the surface of your skin. They tell you when something brushes against your skin. These receptors also let you feel the textures of objects, such as smooth glass and rough sandpaper. Receptors deeper in the skin pick up the feeling of pressure. Press down hard on the top of your desk, for example, and you will feel pressure in your fingertips.

The skin also contains receptors that respond to temperature and pain. Pain is unpleasant, but it can be one of the body's most important feelings because it alerts the body to possible danger. Have you ever stepped into a bathtub of very hot water and then immediately pulled your foot out? If so, you can appreciate how pain can trigger an important response in your body.



FIGURE 18

### Reading by Touch

People who are blind use their sense of touch to read. To do this, they run their fingers over words written in Braille. Braille uses raised dots to represent letters and numbers. Here, a teacher shows a blind child how to read Braille.

## Section 4 Assessment

S 7.5.b, E-LA: Reading: 7.2.0

🌀 **Target Reading Skill Identify Main Ideas**  
Reread the text following the heading Touch. Which sentence states the main idea?

c. **Drawing Conclusions** The brain itself has no pain receptors. What can you conclude about the brain from this information?

### 🗝️ Reviewing Key Concepts

- a. **Reviewing** What two senses work together to influence the flavor of food?

b. **Comparing and Contrasting** How are the senses of taste and smell similar? How are they different?

c. **Sequencing** Describe the process by which you are able to taste food. Begin at the point when you put a piece of food into your mouth. Identify each of the key structures involved.
- a. **Identifying** What kinds of touch receptors are found in the skin?

b. **Relating Cause and Effect** What happens in the skin when you accidentally touch a hot stove?

Lab  
zone

### At-Home Activity

**Light Touch** Ask family members to keep their eyes closed while you help them touch simple objects from around your home. Choose different items, such as a metal spoon, fuzzy fabric, a nailbrush, a warm mug, and a chilled apple. Explain to your family that they can feel the differences in texture and temperature of the objects because of the different receptors present in skin.



# Alcohol and Other Drugs

## CALIFORNIA

## Standards Focus

**S 7.5.b** Students know organ systems function because of the contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system.

Which body system is immediately endangered by drug abuse?

What are some commonly abused drugs and how does each affect the body?

How does alcohol abuse harm the body?

## Key Terms

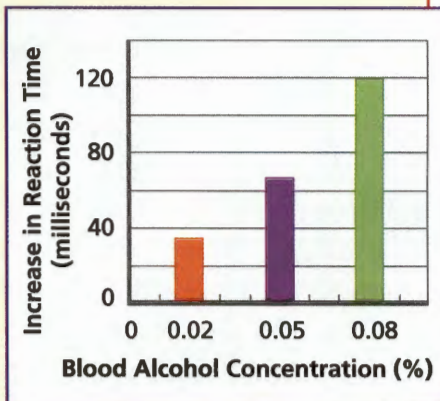
- drug
- drug abuse
- tolerance
- addiction
- withdrawal
- depressant
- stimulant
- alcoholism

## Lab zone

## Standards Warm-Up

## What Is Alcohol's Effect?

1. Look at the graph to the right. It relates the percent of alcohol in the blood to changes in reaction time. Reaction time is the time it takes someone to respond to a stimulus.
2. How does the percent of alcohol in the blood change from left to right in the graph?
3. Describe how reaction time changes as the alcohol level in the blood changes. What is the difference between the least and greatest change in reaction time?



## Think It Over

**Inferring** How might alcohol affect a person's ability to drive safely? Explain your answer.

Drugs! You probably hear and see that word in a lot of places. Drugstores sell drugs to relieve headaches, soothe upset stomachs, and stop coughs. Radio and television programs and magazine articles explore drug-related problems. Your school probably has a program to educate students about drugs. When people talk about drugs, what do they mean? To a scientist, a **drug** is any chemical taken into the body that causes changes in a person's body or behavior. Many drugs affect the functioning of the central nervous system.

## Drug Abuse

The deliberate misuse of drugs for purposes other than medical ones is called **drug abuse**. Even medicines can be abused drugs if they are used in a way for which they were not intended. Many abused drugs, however, such as cocaine and heroin, are illegal under any circumstances. The use of these drugs is against the law because their effects on the body are almost always dangerous.



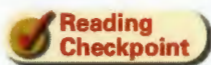
**Effects of Abused Drugs** 🚫 Most abused drugs, such as marijuana, alcohol, and cocaine, are especially dangerous because of their immediate effects on the brain and other parts of the nervous system. In addition, long-term drug abuse can lead to addiction and other health and social problems.

Different drugs have different effects. Some drugs cause nausea and a fast, irregular heartbeat. Others can cause sleepiness. Drug abusers may also experience headaches, dizziness, and trembling. Alcohol can cause confusion, poor muscle coordination, and blurred vision. These effects are especially dangerous in situations in which an alert mind is essential, such as driving a car.

Most abused drugs can alter, or change, a person's mood and feelings. For example, alcohol can sometimes make a person angry and even violent. Mood-altering drugs also affect of thinking and interpretation information from the senses.

**Tolerance and Addiction** If a person takes a drug regularly, the body may develop a tolerance to the drug. **Tolerance** is a state in which a drug user needs larger and larger amounts of the drug to produce the same effect on the body. Tolerance can cause people to take too much, or an overdose, of a drug. People who take an overdose may become unconscious or even die.

Repeated use of some abused drugs can lead to **addiction**, a condition in which the body becomes physically dependent on a drug. If a person stops using a drug suddenly, headaches, dizziness, fever, vomiting, and muscle cramps may result. These symptoms are signs of **withdrawal**, a period of adjustment that occurs when a person stops taking a drug on which the body is dependent. Some drugs may also cause a person to become emotionally dependent on them.



**What is addiction?**

## Lab zone Skills Activity

### Communicating

Plan a 30-second television commercial aimed at teenagers to help them avoid the pressure to try drugs. Your commercial should reveal some harmful effects of drugs and give strategies for avoiding drugs. Create several storyboards to show what the commercial will look like. Then, write a script for your commercial.

**FIGURE 19**

#### Drug Abuse

Drug abuse can have serious consequences. However, if someone is abusing drugs, there are ways to help that person.

**Interpreting Diagrams** What are two ways you can help if someone you know is abusing drugs?

#### How to Help If Someone Is Abusing Drugs

- Seek adult or professional help.
- Stop covering up for the person and making excuses.
- Talk to the person and express your concern.
- Ask another friend to help.





**FIGURE 20**  
**Making a Statement About Drug Abuse**  
Many teens are becoming active in antidrug campaigns.



## Kinds of Abused Drugs

There are many kinds of drugs, with a wide range of effects on the body. Some are legitimate medicines that a doctor prescribes to help the body fight disease and injury. However, many kinds of drugs are frequently abused. ➡ **Commonly abused drugs include depressants, stimulants, inhalants, hallucinogens, anabolic steroids, and alcohol.** Many drugs affect the central nervous system, while others affect the overall chemical balance in the body. Figure 21 lists and describes characteristics of some commonly abused drugs.

**Depressants** Notice in Figure 21 that some drugs are classified as depressants. **Depressants** are drugs that slow down the activity of the central nervous system. When people take depressants, their muscles relax and they may become sleepy. They may fail to respond to stimuli in a normal amount of time. For example, depressants may prevent people from reacting quickly to the danger of a car rushing toward them. Alcohol and narcotics, such as heroin, are depressants.

**Stimulants** In contrast to depressants, **stimulants** speed up body processes. They make the heart beat faster and make the breathing rate increase. Cocaine and nicotine are stimulants, as are amphetamines (am FET uh meenz). Amphetamines are prescription drugs that are sometimes sold illegally.

**Inhalants and Hallucinogens** Some substances, called inhalants, produce mood-altering effects when they are inhaled, or breathed in. Inhalants include paint thinner, nail polish remover, and some kinds of cleaning fluids. Hallucinogens, such as LSD and mescaline, can make people see or hear things that do not really exist.

**Steroids** Some athletes try to improve their performance by taking drugs known as steroids. Anabolic steroids (an uh BAH lik STEER oydz) are synthetic chemicals that are similar to hormones produced in the body.

Anabolic steroids may increase muscle size and strength. However, steroids can cause mood changes that lead to violence. In addition, steroid abuse can cause serious health problems, such as heart damage, liver damage, and increased blood pressure. Steroid use is especially dangerous for teenagers, whose growing bodies can be permanently damaged.



What kinds of drugs are classified as stimulants?



**FIGURE 21**

Abused drugs can have many serious effects on the body. Most of the drugs listed below cause addiction and emotional dependence. **Interpreting Tables** What are the long-term effects of using methamphetamines?

Some Effects of Commonly Abused Drugs		
Drug Type	Short-Term Effects	Long-Term Effects
Marijuana (including hashish)	Unclear thinking, loss of coordination, increased heart rate	Difficulty with concentration and memory; respiratory disease and lung cancer
Nicotine (in cigarettes, cigars, chewing tobacco)	Stimulant; nausea, loss of appetite, headache	From tobacco smoke: heart and lung disease, difficulty breathing, heavy coughing
Alcohol	Depressant; decreased alertness, poor reflexes, nausea, emotional depression	Liver and brain damage, heart disease, digestive problems, inadequate nutrition
Inhalants (glue, household cleaners)	Sleepiness, nausea, headaches, loss of consciousness, death	Damage to liver, kidneys, and brain; loss of bladder control
Cocaine (including crack)	Stimulant; nervousness, disturbed sleep, loss of appetite	Mental illness, damage to lining of nose, irregular heartbeat, heart or breathing failure, liver damage
Amphetamines	Stimulant; restlessness, rapid speech, dizziness	Restlessness, irritability, irregular heartbeat, liver damage
Methamphetamine (crystal meth)	Increased respiration, elevated body temperature, stroke	Psychotic behavior, memory loss, aggression, damage to brain and heart, severe tooth and gum disease, stroke
Hallucinogens (LSD, mescaline, PCP)	Hallucinations, anxiety, panic; thoughts and actions not connected to reality	Mental illness; fearfulness; behavioral changes, including violence
Barbiturates (Phenobarbital, Nembutal, Seconal)	Depressant; decreased alertness, slowed thought processes, poor muscle coordination	Sleepiness, irritability, confusion
Tranquilizers (Valium, Xanax)	Depressant; blurred vision, sleepiness, unclear speech, headache, skin rash	Blood and liver disease
Opiates (opium, codeine, morphine, heroin)	Depressant; sleepiness, nausea, reduced respiration	Constipation, convulsion, coma, death
Anabolic steroids	Mood swings	Heart, liver, and kidney damage; hypertension; overgrowth of skull and facial bones; aggression



## Alcohol

Alcohol is a drug found in many beverages, including beer, wine, cocktails, and hard liquor. Alcohol is a powerful depressant. In all states, it is illegal for people under the age of 21 to buy or possess alcohol. In spite of this fact, alcohol is the most commonly abused legal drug in people aged 12 to 17.

**How Alcohol Affects the Body** Alcohol is absorbed by the digestive system quickly. If a person drinks alcohol on an empty stomach, the alcohol enters the blood and gets to the brain and other organs almost immediately. If alcohol is drunk with a meal, it takes longer to get into the blood.

The chart in Figure 22 describes what alcohol does to the body. The more alcohol in the blood, the more serious the effects. The amount of alcohol in the blood is usually expressed as blood alcohol concentration, or BAC. A BAC value of 0.1 percent means that one tenth of one percent of the fluid in the blood is alcohol. In some states, if car drivers have a BAC of 0.08 percent or more, they are legally drunk. In other states, drivers with a BAC of 0.1 are considered legally drunk.

Alcohol produces serious negative effects, including loss of normal judgment, at a BAC of less than 0.08 percent. This loss of judgment can have serious consequences. People who have been drinking may not realize that they cannot drive a car safely. About every two minutes, a person in the United States is injured in a car crash related to alcohol.

FIGURE 22

### Alcohol's Effects

Alcohol affects every system of the body. It also impacts a person's thought processes, judgment, and reaction time. In the bottom photo, a police officer tests the blood alcohol concentration of a driver suspected of drinking.



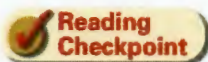
### Short-Term Effects of Alcohol

Body System	Effect
Cardiovascular system	First, heartbeat rate and blood pressure increase. Later, they may decrease.
Digestive system	Alcohol is absorbed directly from the stomach and small intestine, which allows it to enter the bloodstream quickly.
Excretory system	The kidneys produce more urine, causing the drinker to excrete more water than usual.
Nervous system	Vision blurs. Speech becomes unclear. Control of behavior is reduced. Judgment becomes poor.
Skin	Blood flow to the skin increases, causing rapid loss of body heat.



**Long-Term Alcohol Abuse** Many adults drink occasionally and in moderation, without serious safety or health problems. However, heavy drinking, especially over a long period, can result in significant health problems. ➔ **Alcohol abuse can cause the destruction of cells in the brain and liver, and can lead to addiction and emotional dependence.** Damage to the brain can cause mental disturbances, such as hallucinations and loss of consciousness. The liver, which breaks down alcohol for elimination from the body, can become so scarred that it fails to function properly. Liver failure affects body systems and processes. For example, without certain chemicals produced by the liver, blood may not clot properly. In addition to liver and brain damage, long-term alcohol abuse can increase the risk of getting certain kinds of cancer.

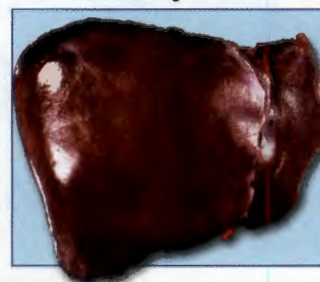
Abuse of alcohol can result in **alcoholism**, a disease in which a person is both physically addicted to and emotionally dependent on alcohol. To give up alcohol, as with any addictive drug, alcoholics must go through withdrawal. To give up drinking, alcoholics need both medical and emotional help. Medical professionals, psychologists, and organizations such as Alcoholics Anonymous can help a person stop drinking.



**Reading Checkpoint**

What organs are affected by alcohol abuse?

Healthy Liver



Alcohol-damaged Liver



FIGURE 23

**Alcohol's Effect on the Liver**

Long-term alcohol abuse can cause serious damage to the liver.

**Relating Cause and Effect** What other effects can alcohol abuse have on the body?

## Section 5 Assessment

S 7.5.b, E-LA: Reading: 7.1.2

**Vocabulary Skill Suffixes** One meaning of the verb *depress* is “to decrease the force or activity of.” If you add the suffix *-ant* to the verb *depress*, what Key Term do you get? What is the meaning of this Key Term?

➔ **Reviewing Key Concepts**

1. a. **Identifying** Which major organ of the body is quickly affected by commonly abused drugs?  
b. **Applying Concepts** What reasons would you give to discourage someone from abusing drugs?
2. a. **Listing** Name two commonly abused depressants and two commonly abused stimulants.  
b. **Comparing and Contrasting** Contrast the effects that depressants and stimulants have on the body.

- c. **Inferring** Why might a person's risk of a heart attack increase with the use of stimulants?
3. a. **Reviewing** What type of drug is alcohol?  
b. **Explaining** What immediate effects does alcohol have on the body?  
c. **Relating Cause and Effect** Based on alcohol's effect on the nervous system, explain why drinking and driving is extremely dangerous.

Lab zone

### At-Home Activity

**Medicine Labels** With a family member, collect several medicine bottles found in your home. Read the warning labels and then discuss them with your family. Identify which body systems could be placed at risk by use of these medicines. Why do you think medicines provide warnings?



The **BIG Idea**

Structures that enable the nervous system to function include the brain, spinal cord, neurons, and sense organs, such as the eye and ear.

**1 How the Nervous System Works****Key Concepts**

S 7.5.b

- The nervous system directs how your body responds to information about what is happening inside and outside your body. Your nervous system also helps maintain homeostasis.
- The three kinds of neurons found in the body are sensory neurons, interneurons, and motor neurons.
- For a nerve impulse to be carried along at a synapse, it must cross the gap between an axon and the next structure.

**Key Terms**

- stimulus • response • neuron
- nerve impulse • dendrite • axon • nerve
- sensory neuron • interneuron
- motor neuron • synapse

**2 Divisions of the Nervous System****Key Concepts**

S 7.5.b

- The central nervous system is the control center of the body. It includes the brain and spinal cord.
- The three main regions of the brain are the cerebrum, cerebellum, and brain stem.
- The peripheral nervous system consists of a network of nerves that branch out from the central nervous system and connect it to the rest of the body.
- A reflex is an automatic response that occurs very rapidly and without conscious control.
- Concussions and spinal cord injuries are two ways the central nervous system can be damaged.

**Key Terms**

- central nervous system
- peripheral nervous system • brain
- spinal cord • cerebrum • cerebellum
- brain stem • somatic nervous system
- autonomic nervous system • reflex
- concussion

**3 Sight and Hearing****Key Concepts**

S 7.5.g, 7.6.b

- The eyes convert light into nerve impulses that your brain interprets, enabling you to see.
- The ears convert sound into nerve impulses that your brain interprets, enabling you to hear.
- Structures in your inner ear control your sense of balance.

**Key Terms**

- cornea • pupil • iris • lens • retina • rods
- cones • optic nerve • eardrum • hammer
- anvil • stirrup • cochlea • semicircular canal

**4 Smell, Taste, and Touch****Key Concepts**

S 7.5.b

- The senses of smell and taste work together when chemicals in food or in the air trigger receptors in the nose and mouth.
- The skin contains touch receptors that respond to a number of stimuli.

**Key Terms**

- taste bud

**5 Alcohol and Other Drugs****Key Concepts**

S 7.5.b

- Most abused drugs are dangerous because of their immediate effects on the nervous system.
- Commonly abused drugs include depressants, stimulants, inhalants, steroids, and alcohol.
- Alcohol use can destroy cells in the brain and liver, and lead to addiction.

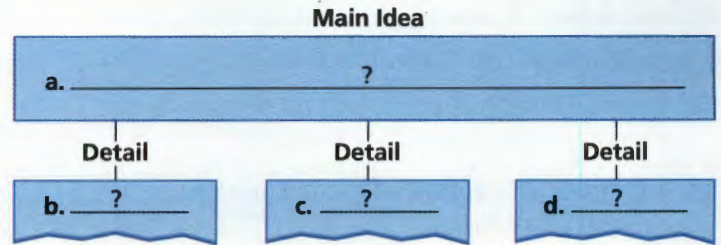
**Key Terms**

- drug • drug abuse • tolerance • addiction
- withdrawal • depressant • stimulant
- alcoholism



## Target Reading Skill

**Identifying Main Ideas** Review the two paragraphs following the heading Concussions on page 613. Use a graphic organizer like the one to the right to identify the main idea and three details.



## Reviewing Key Terms

Choose the letter of the best answer.

- The structures that carry messages toward a neuron's cell body are
  - axons.
  - dendrites.
  - nerves.
  - nerve impulses.
- Which structure links the brain to most of the nerves of the peripheral nervous system?
  - the cerebrum
  - the cerebellum
  - the cochlea
  - the spinal cord
- Which structure focuses light as it passes through the eye?
  - the pupil
  - the retina
  - the lens
  - the iris
- Taste buds contain sensory receptors that detect
  - odors.
  - flavors.
  - textures.
  - heat.
- Physical dependence on a drug is called
  - withdrawal.
  - response.
  - addiction.
  - tolerance.

Complete the following sentences so that your answers clearly explain the key term.

- Answering the door when the bell rings is an example of a **response**, which is \_\_\_\_\_.
- Your understanding of the words on this page occurs in your **cerebrum**, which is \_\_\_\_\_.
- The **cornea** in your eye plays an important role in seeing because it \_\_\_\_\_.
- Sound waves strike the **eardrum**, which then \_\_\_\_\_.
- Alcohol is classified as a **depressant** because \_\_\_\_\_.

## Writing in Science

**Descriptive Paragraph** Draw a diagram of the human eye, and label the key parts. Then, write a paragraph that describes how each part helps a person "see" an image.

### Video Assessment

Discovery Channel School

*The Nervous System*



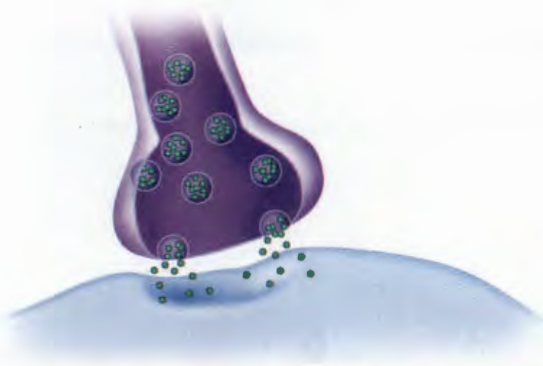
# Review and Assessment

## Checking Concepts

11. Compare the functions of axons and dendrites.
12. How do the cerebrum and cerebellum work together when you ride a bicycle?
13. What is the function of the autonomic nervous system?
14. What is the result if the spinal cord is cut?
15. What enables a person to see depth?
16. What type of stimuli trigger receptors that enable you to taste food?
17. How do anabolic steroids affect the body?

## Thinking Critically

18. **Interpreting Diagrams** The diagram below shows a synapse. Explain how a nerve impulse crosses the gap.



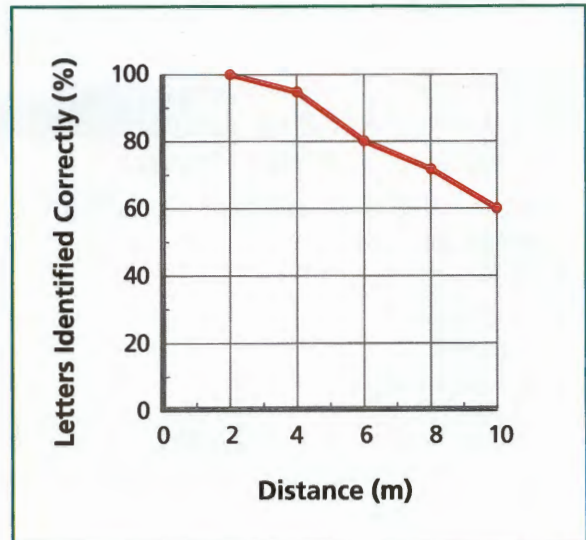
19. **Relating Cause and Effect** When a person has a stroke, blood flow to part of the brain is reduced, and some brain cells die. Suppose that after a stroke, a woman is unable to move her right arm and right leg. In which side of her brain did the stroke occur? Explain.
20. **Applying Concepts** As a man walks barefoot along a beach, he steps on a sharp shell. His foot automatically jerks upward, even before he feels pain. What process is this an example of? How does it help protect the man?
21. **Inferring** Suppose a person has an injury that results in a torn eardrum. Explain how you think the person's hearing would be affected.

## Applying Skills

Use the graph to answer Questions 22–25.

A person with normal vision stood at different distances from an eye chart and tried to identify the letters on the chart. The line graph gives the results.

Eye Chart Results



22. **Reading Graphs** What variable is plotted on the  $x$ -axis? On the  $y$ -axis?
23. **Interpreting Data** As the distance from the eye chart increases, what happens to the percentage of letters identified correctly?
24. **Controlling Variables** What was the manipulated variable in this experiment? What was the responding variable?
25. **Predicting** Based on the graph, what would you expect the percent of correctly identified letters to be when the distance is 12 meters?

## Lab zone Standards Investigation

**Performance Assessment** Explain to your classmates how you set up your experiment, which illusions you used, which senses were involved in the illusions, and why the illusions worked. Include information on how the nervous system was involved in your illusions.



Choose the letter of the best answer.

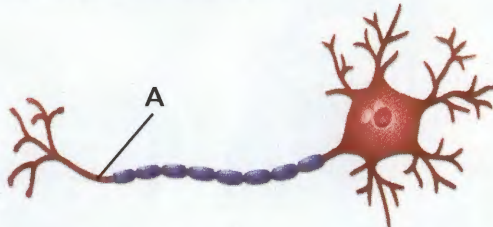
1. A scientist studying the brain is studying part of the
- A peripheral nervous system.
  - B somatic nervous system.
  - C autonomic nervous system.
  - D central nervous system.

**S 7.5.b**

2. Suppose you step on a tack. Which of the following choices represents the order of response of your nervous system?
- A Sensory neuron stimulated; impulse to spinal cord; impulse to brain; impulse to motor neuron; foot moves
  - B Sensory neuron stimulated; impulse to spinal cord; impulse to motor neuron; foot moves; message to brain
  - C Impulse to motor neuron; foot moves; impulse to sensory neuron; impulse to spinal cord; impulse to brain
  - D Foot moves; sensory neuron stimulated; impulse to brain; impulse to motor neuron

**S 7.5.b**

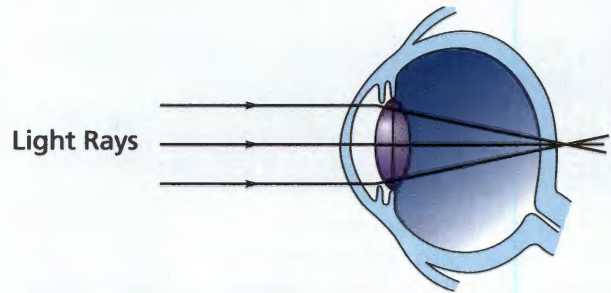
3. What is the function of the part labeled A on the neuron shown below?



- A It carries the nerve impulse toward the cell body.
- B It protects the neuron from damage.
- C It carries the nerve impulse away from the cell body.
- D It picks up stimuli from the environment.

**S 7.5.b**

Use the diagram below and your knowledge of science to answer Question 4.



4. The person with this eye probably has trouble seeing because the light rays focus
- A behind the retina.
  - B on the eye's lens.
  - C on the cornea.
  - D on the iris.

**S 7.5.g**

5. A disease damages a person's semicircular canals. That person will most likely have difficulty

- A seeing.
- B hearing.
- C maintaining balance.
- D tasting food.

**S 7.5.g**

6. Which of the following structures in the ear changes sound waves into nerve impulses that go to the brain?

- A hammer
- B cochlea
- C eardrum
- D anvil

**S 7.5.g**

7. You can infer that a person who has lost his or her sense of smell is also likely to have a poor

- A sense of balance.
- B sense of touch.
- C sense of taste.
- D sense of hearing.

**S 7.5.b**

Apply the **BIG Idea**

8. Identify the structures of the eye and other parts of the nervous system that allow you to read and understand this sentence. Explain the order in which the structures are involved and how each one functions.

**S 7.5.g**