

Control and Coordination

The Nervous System

..... Before You Read

What do you think? Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	1. The nervous system contains two parts—the central nervous system and the peripheral nervous system.	
	2. The autonomic nervous system controls voluntary functions.	

..... Read to Learn

Functions of the Nervous System

Have you ever had goose bumps on your arms when you were cold? These bumps form when muscle cells in your skin respond to cold temperatures. These muscle cells contract, or shorten. Then bumps form, and the hairs on your arms rise up. The raised hairs trap air. The trapped air insulates your skin and helps you feel warmer.

How do your muscle cells know to contract? When you first feel the cold, a message is sent to your brain. Your brain then sends a message to your skin's muscle cells, and the goose bumps form.

*The part of an organism that gathers, processes, and responds to information is called the **nervous system**.* Your nervous system gets information from your five senses. These senses are vision, hearing, smell, taste, and touch. You will read more about the senses in Lesson 2. ✓

The nervous system reacts quickly. It can receive information, process it, and respond in less than one second. Signals received by the nervous system can travel as fast as some airplanes. This is around 400 km/h.

Key Concepts

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

Study Coach

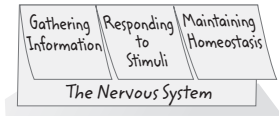
K-W-L Fold a sheet of paper into three columns. Label them (*K*) what you know about the nervous system, (*W*) what you want to learn, and (*L*) the facts that you learned. Fill in the third column after you have read this lesson.

Reading Check

1. Identify What does your nervous system use to gather information?

FOLDABLES®

Make a three-tab book as shown to organize your notes about the functions of the nervous system.



Think it Over

2. Apply Imagine that you duck when you hear a loud noise overhead. What function of the nervous system does ducking show?



Key Concept Check

3. Identify What are some of the tasks performed by the nervous system?

Gathering Information

Imagine a driver stopping a car quickly so it doesn't hit a ball that has rolled into the street. The sight of the ball is a stimulus (STIHM yuh lus) (plural, stimuli). A **stimulus** is a change in an organism's environment that causes a response. The driver's nervous system gathered and interpreted the sight of the ball and caused her body to react by braking.


Responding to Stimuli

How would you react if you were riding your bike and a squirrel ran in front of you? You might quickly put on the brakes. Or you might change direction to avoid the squirrel. These reactions are ways that your nervous system helps you respond to a stimulus from the environment.

Your nervous system receives many stimuli at the same time. The type of response you make often depends on how your nervous system processes the information.

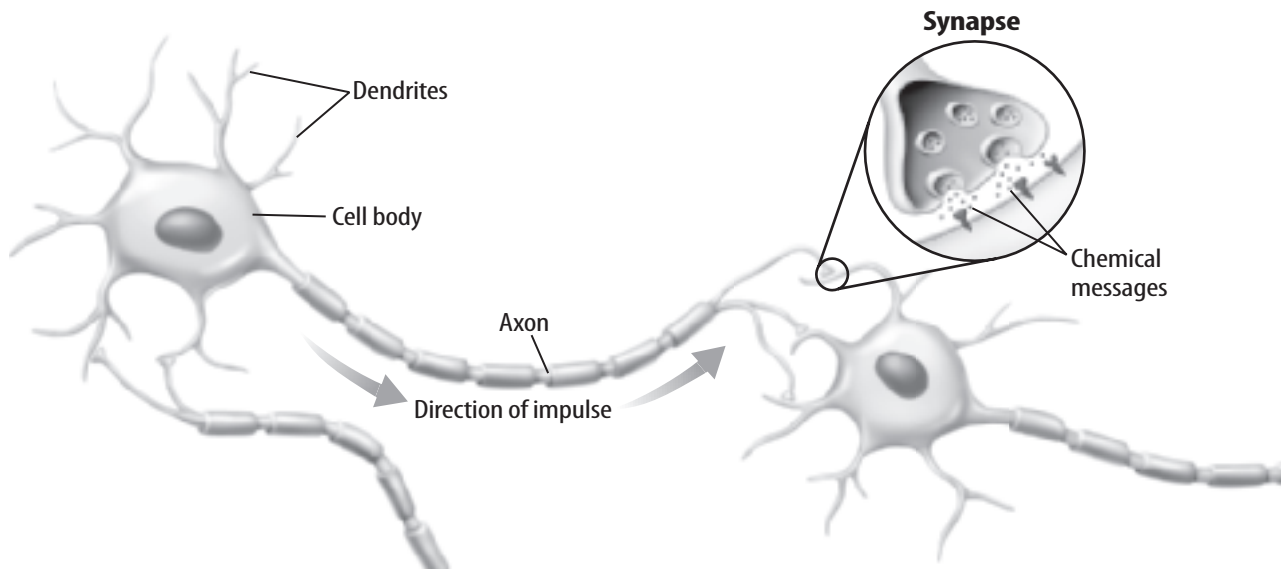
Maintaining Homeostasis

Imagine again the driver who stops her car quickly so she doesn't hit a ball in the street. The driver responds to the stimulus of the moving ball. Her nervous system probably also causes her heart to beat faster and her breathing to speed up. These changes help the driver react quickly.

People are always reacting to changes in their environments. Therefore, their nervous systems help maintain homeostasis, or the regulation of their internal environments. For example, the driver's nervous system must signal her heart to beat slower and her breathing to slow down to restore homeostasis after safely reacting to the ball. 

Neurons

The basic functioning units of the nervous system are called nerve cells, or **neurons** (NOO rahnz). Neurons help different parts of your body communicate with each other. Without looking down, how do you know whether you are walking on sand or on a sidewalk? Neurons in your feet are connected to other neurons. These neurons send information to your brain about the surface you are walking on.



The figure above shows a neuron. A neuron has three parts: dendrites (DEN drites), a cell body, and an axon (AK sahn). A dendrite receives information from another neuron or from another cell in your body. A cell body processes information. An axon sends the information to another neuron or cell in your body.

Types of Neurons

There are three types of neurons that work together. They send and receive information throughout your body. You have sensory neurons, motor neurons, and interneurons. Sensory neurons send information about your environment to your brain or spinal cord. Motor neurons send information from your brain or spinal cord to your tissues and organs. Interneurons make a connection, or bridge, between sensory and motor neurons.

Synapses

The gap between two neurons is called a **synapse** (SIH naps). Look again at the figure above. In the close-up of the synapse, you can see that neurons communicate across synapses by releasing chemicals. These chemicals carry information from the axon of one neuron to a dendrite of another neuron. Most synapses are between an axon of one neuron and a dendrite of another neuron. Information usually goes in just one direction. ✓

Visual Check

4. Label the second neuron in the figure with the following terms: *axon*, *cell body*, and *dendrite*.

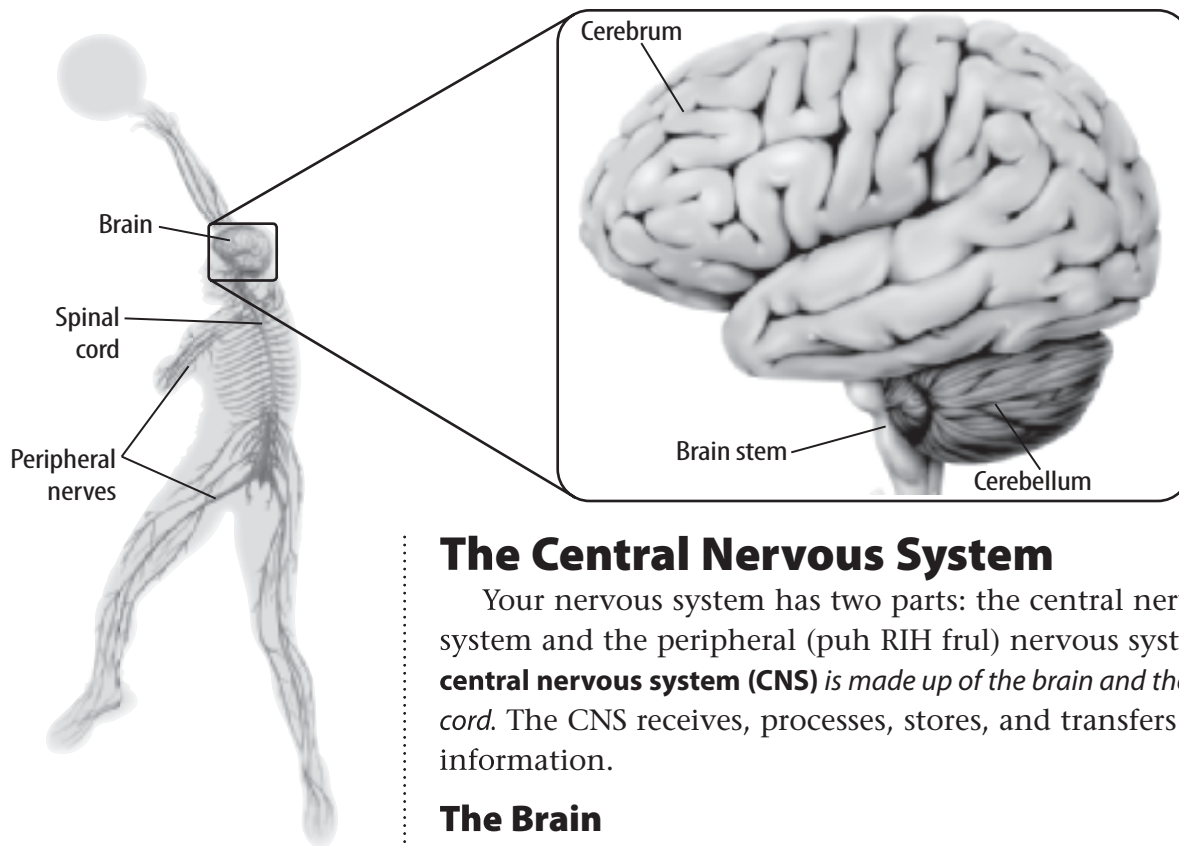
Think it Over

5. Apply Which kind of neuron sends information to your brain after you burn your finger?

Reading Check

6. Recall In a neuron, the message usually goes from which of the following? (Circle the correct answer.)

- a. from an axon to a dendrite
- b. from a dendrite to an axon
- c. from an axon to an axon



Visual Check

7. Identify In the enlarged picture of the brain, highlight in the area that controls memories.

The Central Nervous System

Your nervous system has two parts: the central nervous system and the peripheral (puh RIH frul) nervous system. *The central nervous system (CNS) is made up of the brain and the spinal cord.* The CNS receives, processes, stores, and transfers information.

The Brain

The brain is the control center of your body. Your brain receives information, processes the information, and sends out a response. The brain also stores some information as memories.

The Cerebrum *The part of the brain that controls memory, language, and thought is the **cerebrum** (suh REE brum).* The cerebrum also processes information from the senses of touch and sight. The cerebrum is the largest and most complex part of the brain.

Look at the cerebrum in the figure above. The surface has many folds. The folds make it possible for many neurons to fit into a small space. If you could unfold the cerebrum, you would find that it has as much surface area as a large pillowcase.

Think it Over

8. Generalize If someone had a disease that affected the cerebrum, which of the following would be affected? (Circle the correct answer.)

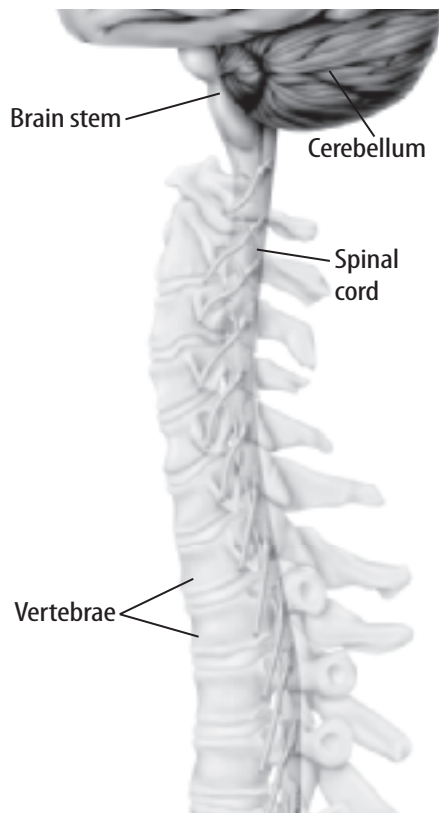
- a. breathing
- b. talking and writing
- c. walking

The Cerebellum *The part of the brain that coordinates voluntary muscle movement and regulates balance and posture is the **cerebellum** (ser uh BEH lum). Voluntary muscle movements are the ones that you control. For example, you tie your shoe or pedal your bike because you make your muscles do what is needed. Locate the cerebellum in the figure on the previous page and in the figure below.*

The cerebellum also stores information about the movements you do often, such as tying your shoe or pedaling a bike. Because your brain stores this information, you can repeat the movements faster and more accurately. For example, the more you tie your shoe or pedal a bike, the faster and better you can do these things.

The Brain Stem Some of your body's functions, such as digestion and the beating of your heart, are involuntary. These functions are called involuntary because they happen without your controlling them.

*The area of the brain that controls involuntary functions is the **brain stem**. Your brain stem also controls sneezing, coughing, and swallowing. The brain stem connects the brain to the spinal cord. Both are shown in the figure below.*



Math Skills

A nerve impulse from your hand travels at about 119 m/s. How long does it take the signal from your hand to reach your spinal cord if the distance is 0.40 m? You can use proportions to solve the problem.

Set up a proportion.

$$\frac{119 \text{ m}}{1 \text{ s}} = \frac{0.40 \text{ m}}{y \text{ s}}$$

Cross multiply.

$$119 \text{ m} \times y \text{ s} = 0.40 \text{ m} \times 1 \text{ s}$$

Solve for y by dividing both sides by 119 m.

$$y = \frac{0.40 \text{ m} \cdot \text{s}}{119 \text{ m}}$$

$$y = 0.003 \text{ s}$$

9. Use Proportions One giraffe neuron has an axon 4.6 m long that extends from its toe to the base of its neck. How long will it take a nerve impulse to travel this distance at a speed of 75 m/s?

Visual Check

10. Recall Circle the two major parts of the central nervous system.

Think it Over

11. Predict Name something else your body does that is involuntary and therefore might be controlled by your brain stem.

 **Key Concept Check**

12. Discuss How does the PNS work with the CNS?

ACADEMIC VOCABULARY

physical
(*adjective*) relating to material things

 **Reading Check**


13. Define What word do we use to refer to the loss of muscle function and sometimes feeling?

The Spinal Cord

The **spinal cord** is a tubelike structure of neurons. You read earlier that a neuron is a nerve cell that sends and receives information in your body. Because the neurons extend to other areas of the body, the brain can send out and get information. The spinal cord can be thought of as an information highway between the brain and the rest of the body. Cars use a highway to move quickly from one city to another. Neurons in the spinal cord send information quickly back and forth between the brain and other body parts. Bones called vertebrae protect the spinal cord.

The Peripheral Nervous System

Recall that the nervous system is made up of both the central nervous system (CNS) and the peripheral nervous system. The **peripheral nervous system (PNS)** has sensory neurons and motor neurons that transmit information between the CNS and the rest of the body.


The PNS has two parts: the somatic system and the autonomic system. The somatic system controls skeletal muscles. Neurons of the somatic system communicate between the CNS and skeletal muscles. They cause voluntary movements such as kicking a ball and picking up a book. The autonomic system controls smooth muscles and cardiac muscles. It regulates involuntary actions, such as the beating of your heart. 

Nervous System Health

A healthy nervous system is necessary to maintain homeostasis. A physical injury is the most common way that the nervous system is damaged. Infections and diseases can also damage the nervous system.

Physical Injuries

There are a number of ways that you can injure and harm the nervous system. Falling, being in an automobile accident, and getting hurt while participating in sports are just a few of them.

Injuries to the nervous system can stop communication between the CNS and the PNS. When this happens, paralysis can occur. Paralysis is the loss of muscle function and sometimes a loss of feeling in the area. Paralysis occurs in the area that can no longer send or receive signals. 

Preventing Injuries

Imagine that you are walking barefoot, and you step on a rock. Without thinking, you quickly lift your foot. You do not think about moving your foot. It just happens. *An automatic movement in response to a stimulus is called a reflex.*

Reflexes are fast because, in most cases, the information goes only to the spinal cord. The information usually does not go to the brain. This fast response protects you because it takes less time to move away from harm.

A reflex often occurs before your brain knows your body is in danger. Once nerve signals travel from your spinal cord to your brain after the response, you feel pain. ✓

Drugs

So far, you have learned that the nervous system can be affected by infections, diseases, and injuries. Drugs can also affect it. Drugs are chemicals that affect the body's functions. Many drugs affect the nervous system by speeding up or slowing down the communication between neurons. ✓

Some pain medicines slow the communication so much that they stop pain stimuli from being sent to the brain. A drug that slows down neuron communication is called a depressant.

Other drugs speed up communication between neurons. A drug that speeds up neuron communication is called a stimulant. Caffeine is a common stimulant.

The Nervous System and Homeostasis

Why do you shiver when you are cold? It is because your nervous system senses the cold temperature. It then signals your muscles to move quickly to warm your body. Doing so maintains homeostasis.

Your body maintains homeostasis by getting information from your environment and responding to it. Your nervous system senses changes in your environment. It then signals other systems, such as the digestive, the endocrine, and the circulatory systems, to make adjustments when needed. ✓

✓ Reading Check

14. Discuss Why are reflexes fast?

✓ Reading Check

15. Identify A chemical that affects how the body works is called which of the following? (Circle the correct answer.)

- a. drug
- b. neuron
- c. cerebral fold

✓ Key Concept Check

16. Explain Give an example of how the nervous system works with another body system to maintain homeostasis.

..... After You Read

Mini Glossary

brain stem: the area of the brain that controls involuntary functions

central nervous system (CNS): the part of the nervous system that is made up of the brain and the spinal cord

cerebellum (ser uh BEH lum): the part of the brain that coordinates voluntary muscle movement and regulates balance and posture

cerebrum (suh REE brum): the part of the brain that controls memory, language, and thought

nervous system: the part of an organism that gathers, processes, and responds to information

neuron (N00 rahn): the basic functioning unit of the nervous system, also called a nerve cell

peripheral (puh RIH frul) nervous system (PNS): the part of the nervous system that has sensory neurons and motor neurons that transmit information between the CNS and the rest of the body

reflex: an automatic movement in response to a stimulus

spinal cord: a tubelike structure of neurons

stimulus (STIHM yuh lus): a change in an organism's environment that causes a response (plural, stimuli)

synapse (SIH naps): the gap between two neurons

- Review the terms and their definitions in the Mini Glossary. Write two or three sentences that compare and contrast the brain stem and the cerebellum.

- Fill in the missing parts of the table to describe the parts of the central nervous system.

Part of the CNS	What It Controls
Cerebrum	memory, language, thought, information from the senses
Cerebellum	
Brain stem	
Spinal cord	movement of information between the brain and other parts of the body

- Look at the K-W-L chart that you made at the beginning of this lesson. Circle two facts you learned about the nervous system that you found interesting.

What do you think **NOW?**

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?



Log on to ConnectED.mcgraw-hill.com and access your textbook to find this lesson's resources.

