



The Peripheral Nervous System

Key Questions

 How does the central nervous system receive sensory information?

 How do muscles and glands receive commands from the central nervous system?

Vocabulary

somatic nervous system
reflex arc
autonomic nervous system

Taking Notes

Flowchart As you read, make a flowchart that shows the flow of information between the divisions of the peripheral nervous system and the central nervous system.

FIGURE 31-10 Sensory Receptors

Sensory receptors react to a specific stimulus such as light or sound by sending impulses to sensory neurons.

Apply Concepts List three types of sensory receptors that are activated when you walk into a busy flower shop.




THINK ABOUT IT It's all about input and output. No computer is worth much unless it can accept input from the world around it. And, no matter how quickly it calculates, no result is of any meaning unless there's a way to output it. The central nervous system faces the same issues. Can you guess what it uses for input and output devices?

The Sensory Division

 How does the central nervous system receive sensory information?

The peripheral nervous system consists of all the nerves and associated cells that are not part of the brain or spinal cord. Cranial nerves go through openings in the skull and stimulate regions of the head and neck. Spinal nerves stimulate the rest of the body. The cell bodies of cranial and spinal nerves are arranged in clusters called ganglia.

The peripheral nervous system, our link with the outside world, consists of two major divisions—the sensory division and the motor division.  **The sensory division of the peripheral nervous system transmits impulses from sense organs to the central nervous system.** The motor division transmits impulses from the central nervous system to the muscles and glands.

Sensory receptors are cells that transmit information about changes in the environment—both internal and external. These changes are called stimuli. Sensory receptors can be categorized by the type of stimuli to which they respond. **Figure 31-10** shows the functions and locations of several types of sensory receptors. When stimulated, sensory receptors transmit impulses to sensory neurons. Sensory neurons then transmit impulses to the central nervous system.

Sensory Receptors

Type	Responds to	Some Locations
Chemoreceptor	Chemicals	Mouth, nose, blood vessels
Photoreceptor	Light	Eyes
Mechanoreceptor	Touch, pressure, vibrations, and stretch	Skin, hair follicles, ears, ligaments, tendons
Thermoreceptor	Temperature changes	Skin, hypothalamus
Pain receptor	Tissue injury	Throughout the body

The Motor Division

How do muscles and glands receive commands from the central nervous system?

The nervous system plays a key role in maintaining homeostasis by coordinating the activities of other systems and organs. Once it has gathered and processed sensory information, the nervous system sends commands to the rest of the body. The motor division of the peripheral nervous system transmits impulses from the central nervous system to muscles or glands. These messages are relayed through one of two divisions, the somatic nervous system or the autonomic nervous system.

Somatic Nervous System The somatic nervous system regulates body activities that are under conscious control, such as the movement of skeletal muscles. Most of the time you have control over skeletal muscle movement, but when your body is in danger the central nervous system may take over.

► **Voluntary Control** Every time you lift your finger or wiggle your toes, you are using motor neurons of the somatic nervous system. Impulses originating in the brain are carried through the spinal cord where they synapse with the dendrites of motor neurons. The axons from these motor neurons extend from the spinal cord carrying impulses directly to muscles, causing the contractions that produce voluntary movements.

► **Reflex Arcs** Although the somatic nervous system is generally considered to be under conscious control, some actions of the system occur automatically. If you accidentally step on a tack with your bare foot, your leg may recoil before you are even aware of the pain.

This rapid response (a reflex) is caused by impulses that travel a pathway known as a **reflex arc**, as shown in Figure 31-11. 1 In this example, sensory receptors react to the sensation of the tack and send an impulse to sensory neurons. 2 Sensory neurons relay the information to the spinal cord. 3 An interneuron in the spinal cord processes the information and forms a response. 4 A motor neuron carries impulses to its effector, a muscle that it stimulates. 5 The muscle contracts and your leg moves. Meanwhile, impulses carrying information about the injury are sent to your brain. By the time your brain interprets the pain, however, your leg and foot have already moved. The spinal cord does not control all reflexes. Many reflexes that involve structures in your head, such as blinking or sneezing, are controlled by the brain.

MYSTERY CLUE

Based on Captain Cook's symptoms of weakness, what part of the nervous system is most affected by the consumption of even small amounts of this fish?

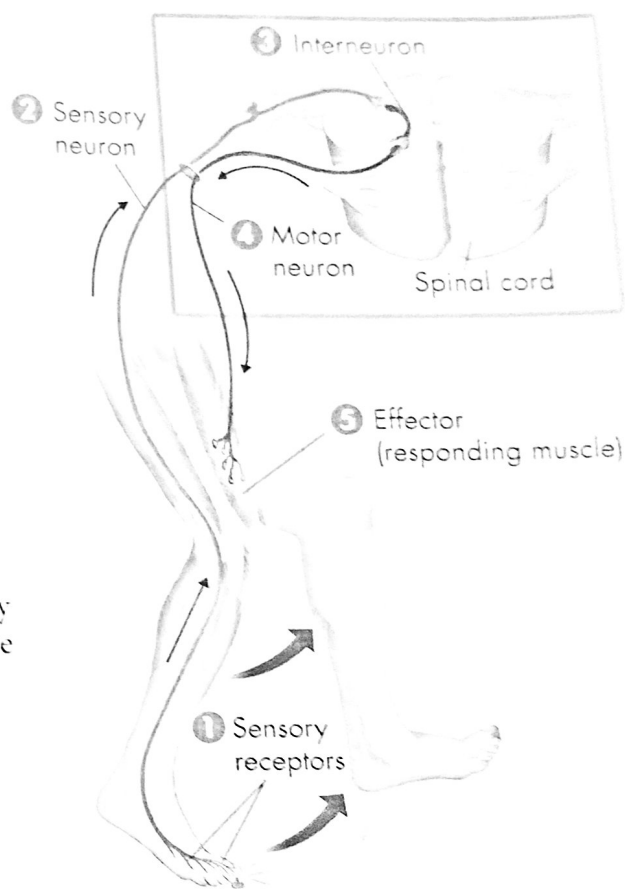
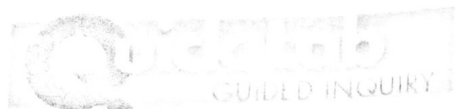


FIGURE 31-11 Reflex Arc When you step on a tack, sensory receptors stimulate a sensory neuron, which relays the signal to an interneuron within the spinal cord. The signal is then sent to a motor neuron, which in turn stimulates a muscle that lifts your leg.

In Your Notebook In your own words, describe how a reflex arc works. Include the role of the three types of neurons in your description.



How Do You Respond To an External Stimulus?

- ❶ Have your partner put on safety goggles.
- ❷ Crumple up a sheet of scrap paper into a ball.
- ❸ Watch your partner's eyes carefully as you toss the paper ball toward his or her face.
- ❹ Repeat step 3, three times.
- ❺ Exchange roles and repeat steps 1, 3, and 4.

Analyze and Conclude

1. **Observe** Describe your partner's reaction to step 3.
2. **Compare and Contrast** Did you see any change in behavior as you repeated step 3? Explain.
3. **Infer** What is the function of the blink reflex?

Autonomic Nervous System The autonomic nervous system regulates activities that are involuntary, or not under conscious control. For instance, when you start to run, the autonomic nervous system speeds up your heart rate and blood flow to the skeletal muscles, stimulates the sweat glands, and slows down the contractions of smooth muscles in the digestive system. You may not be aware of any of these activities, but all of them enable you to run faster and farther.

The autonomic nervous system consists of two equally important parts, the sympathetic nervous system and the parasympathetic nervous system. Why two systems? In general, the sympathetic and parasympathetic systems have opposite effects on each organ they influence. In the same way that a driver must be able to turn the steering wheel both left and right to keep a car on the road, the two systems produce a level of fine control that coordinates organs throughout the body.

For example, heart rate is increased by the sympathetic nervous system but decreased by the parasympathetic nervous system. In general, the sympathetic system prepares the body for intense activity. Its stimulation causes an increase in blood pressure, the release of energy-rich sugar into the blood, and shutting down of activities not related to the body's preparation to "fight or flee" in response to stress. In contrast, the parasympathetic system causes what might be called the "rest and digest" response. It lowers heart rate and blood pressure, activates digestion, and activates pathways that store food molecules in the tissues of the body.

31.3 Assessment

Review Key Concepts

1. **a. Review** Describe the role of the sensory division.
b. Explain Give three examples of stimuli that your sensory receptors are responding to right now.
c. Infer Which type of sensory receptors most likely responds to a change in blood pressure that causes more force to be exerted on your blood vessels? Explain.
2. **a. Review** Describe the function of the two parts of the motor division of the peripheral nervous system.
b. Explain Is a reflex part of the central nervous system, the peripheral nervous system, or both?
c. Apply Concepts Describe a situation in which you would expect your sympathetic nervous system to be more active than your parasympathetic nervous system.

Apply the Big Idea

Structure and Function

3. Which part of the peripheral nervous system is involved in both innate behaviors and learned behaviors? Explain.
(Hint: See Lesson 29.1.)