

How the Nervous System Works

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Discover Activity

Reading Preview

Key Concepts

- 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

How Simple Is a Simple Task?

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, beginning with 1 and ending with 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. What organ system coordinated all the different processes involved in this task?

Target Reading Skill

Previewing Visuals Before you read, preview Figure 3. Then, write two questions that you have about the diagram in a graphic organizer like the one below. As you read, answer your questions.

The Path of a Nerve Impulse

Q. What is a sensory neuron?

A.

Q.

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 glucose in your blood.

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 heart rate, 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 are hungry, your nervous system prompts you to eat. This action maintains homeostasis by supplying your body with the nutrients and energy it needs.

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?



What is a stimulus?

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.

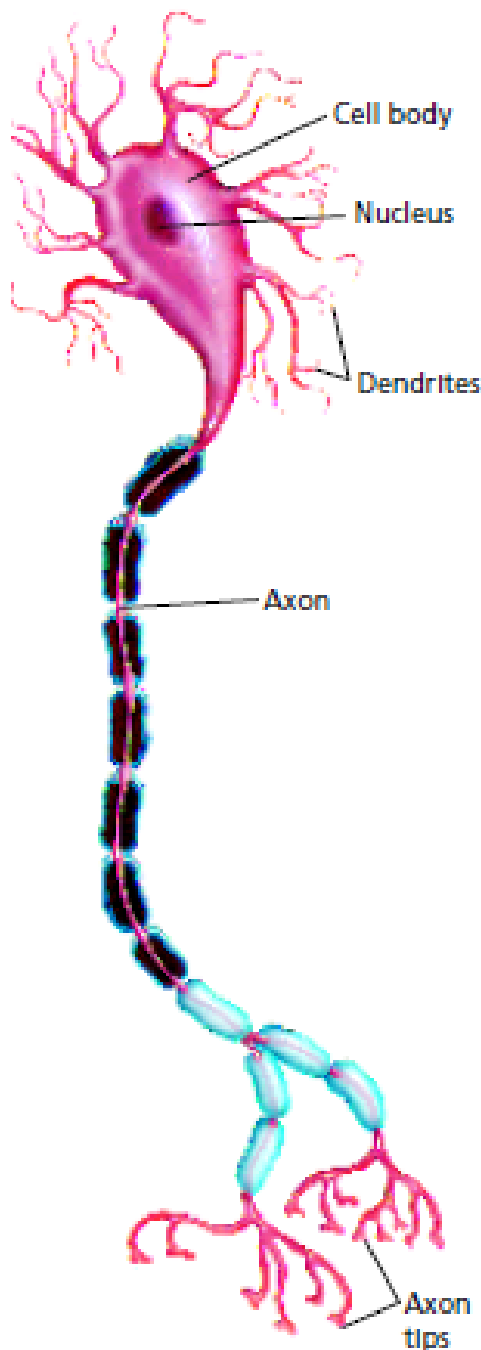
Responding to Information
The nervous system causes a response, and the goalie reaches out to block the shot.



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. Nerve impulses begin in a dendrite, 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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For: More on nerve impulses
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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?



Receptors
in ear

1 Sensory Neuron

Nerve impulses begin when receptors pick up stimuli from the environment. Receptors in the ear pick up the sound of the phone ringing. The receptors trigger nerve impulses in sensory neurons.

2 Interneuron

From the sensory neurons, the nerve impulse passes to interneurons in the brain. Your brain interprets the impulses from many interneurons and makes you realize that the phone is ringing. Your brain also decides that you should answer the phone.

3 Motor neuron

Impulses then travel along thousands of motor neurons. The motor neurons send the impulses to muscles. The muscles carry out the response, and you reach for the phone.

Muscle in hand

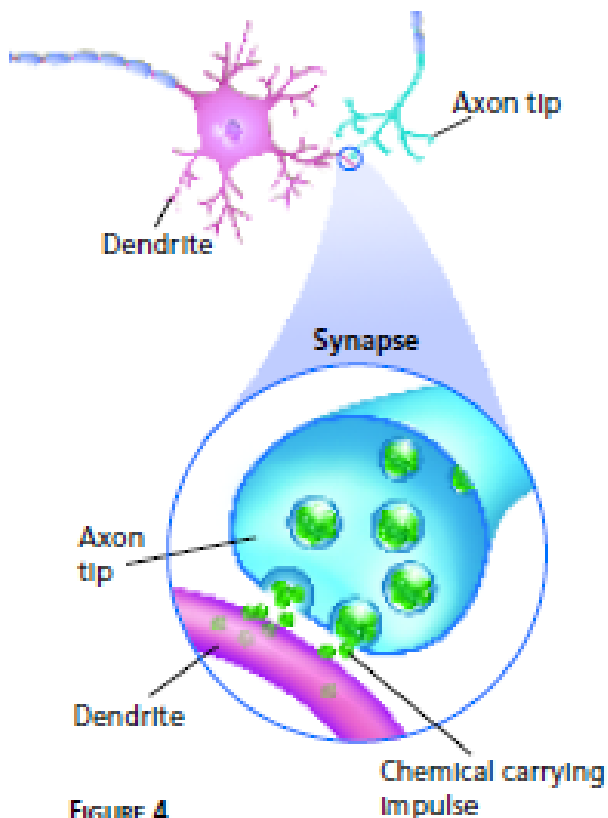


FIGURE 4

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

Target Reading Skill Previewing Visuals Refer to your questions and answers about Figure 3 to help you answer Question 2 below.

Reviewing Key Concepts

- Listing** What are three functions of the nervous system?
 - Describing** Give an example of a stimulus and describe how the nervous system produces a response.
 - 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?
- Identifying** Identify the three kinds of neurons that are found in the nervous system.
 - Explaining** How do the three kinds of neurons interact to carry nerve impulses?

- Comparing and Contrasting** How do sensory neurons and motor neurons differ?

- Reviewing** What is a synapse?
 - Sequencing** Outline the steps by which a nerve impulse reaches and then crosses the gap at a synapse.

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At-Home Activity

Pass the Salt, Please During dinner, ask a family member to pass the salt and pepper 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. Discuss other examples of stimuli and responses with your family.