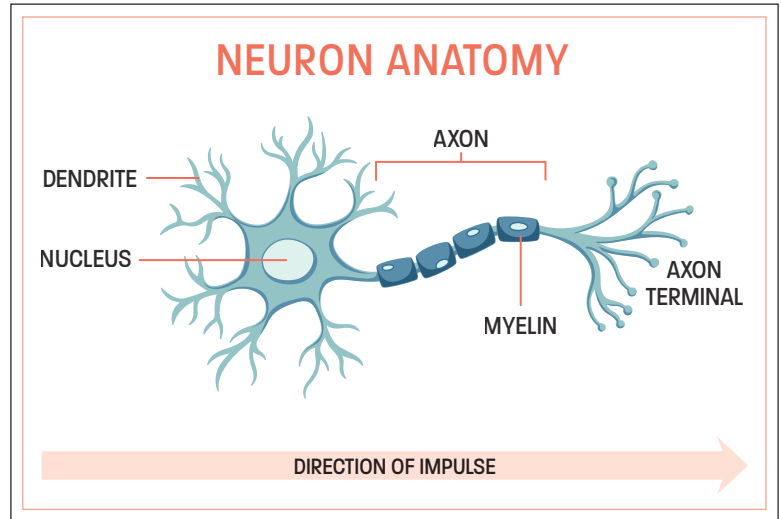


THE NERVOUS SYSTEM PART 1

Read the text below. Then, answer the questions on pages 2 and 3.

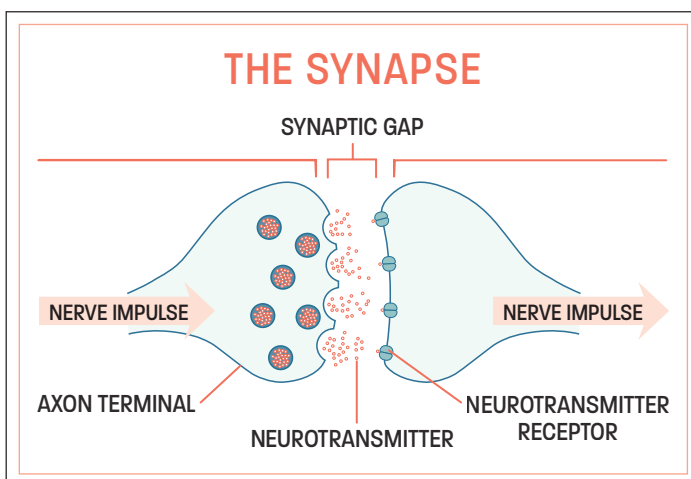
Beep beep beep! An alarm clock sounds at 7:00 a.m. to wake you up. You turn over, check the time on the clock, and hit the snooze button. How does your body know what to do when your alarm rings? The **nervous system** is responsible for coordinating everything you do. It helps you respond and adapt to stimuli, which are changes that occur both outside and inside of the human body. The nervous system also helps maintain the body's internal environment by controlling things like breathing and body temperature.

To understand how your body responds to your alarm clock, we need to understand how the nervous system is structured. Just like other systems in the human body, the nervous system has several levels of organization. **Neurons** are specialized cells that are the basic units of structure and function in the nervous system. A neuron is made up of a cell body, **dendrites**, and an axon. A message, or **impulse**, first reaches a neuron at its dendrites. Dendrites branch out in many directions to receive impulses from neighboring cells and send them to the **cell body**. The cell body contains the nucleus, which is the control center of the neuron. Then the **axon** carries impulses away from the cell body. The axon is coated in **myelin**, a material that allows an impulse to be transmitted as fast as 120 meters per second! At its end, or **terminal**, the axon branches out in many directions to send impulses to other cells.



Neurons are organized into cable-like networks known as **nerves**. Nerves work together in a system to send messages. Every day, billions of nerve impulses are sent through your nervous system. While neurons form a network, they are not actually attached to one another. Instead, messages travel between neurons through a **synapse**, which is a tiny gap between cells. Here, the electrical signal from the axon changes to a chemical signal that crosses the synapse. This chemical signal is called a **neurotransmitter**. When a neurotransmitter binds to the receptor on the next neuron, it stimulates an impulse in that dendrite.

The messages transmitted between neurons in a nerve only travel in one direction. A nerve impulse from a neuron will travel along nerves to the central nervous system, which is made up of the brain and spinal cord. Some responses, like reflexes, are processed directly by the spinal cord. Most responses continue on to the brain, which interprets the incoming signals from the nerves.



THE NERVOUS SYSTEM PART 1

Keep going! Read the text below. Then, answer the questions that follow.

The brain also coordinates the body's responses. A message from the brain will travel through the spinal cord. Then it will travel through nerves in the **peripheral nervous system**. This system includes all of the nerves outside of the central nervous system. The nerves in the peripheral nervous system are the communication pathway between the brain and spinal cord and the other parts of the body.

NEURONS AND RECEPTORS

There are three different types of neurons in the human body. They work together to detect, transmit, and send impulses to coordinate your response to stimuli.

- **Sensory neurons** pick up a stimulus in the environment, convert it into a nerve impulse, and send a message to the brain.
- **Interneurons** make up the majority of the neurons in the body. As the "middle man" of the nervous system, interneurons transmit impulses to and from the central nervous system.
- **Motor neurons** send messages from the brain to the other cells in the body to initiate movement.

Sensory neurons, sometimes called sensory **receptors**, can be further classified by the type of stimuli they detect. **Mechanical** receptors found in the skin and ears detect touch and sound. These receptors detect the sound of your alarm clock ringing. **Electromagnetic** receptors in the eyes detect changes in light, helping you see the time on your alarm clock. **Chemical** receptors in the nose and mouth detect substances and allow you to smell and taste.

Now let's consider what happens when your alarm clock sounds. Sensory neurons detect the sound of your alarm, which is converted to a nerve impulse. This impulse travels from the sensory neurons to interneurons and then to the brain. The brain sends a message via the motor neurons to your eyelids and body, causing you to turn over, open your eyes, and reach out and press the snooze button on the alarm.

Show what you know! Use the reading to answer the questions below.

1. What is the primary function of the nervous system? _____

2. Neurons are made up of three main parts. Describe the function of each part.

a. axon: _____

b. cell body: _____

c. dendrite: _____

THE NERVOUS SYSTEM PART 1

Keep going! Use the reading to answer the questions below.

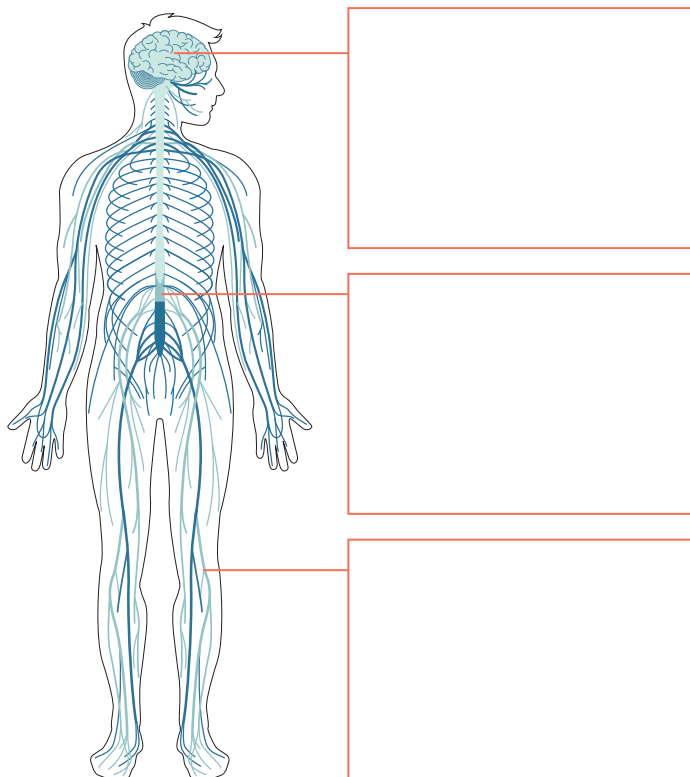
3. What is myelin, and what is its function in the neuron?

4. What is the role of a neurotransmitter in the nervous system? Use the vocabulary words axon, dendrite, and synapse in your answer.

5. List the three main types of sensory receptors in the body. Describe what each receptor does, and provide an example of where the receptor is found in the body.

SENSORY RECEPTOR	FUNCTION	LOCATION IN THE BODY

6. Identify the major components of the nervous system on the diagram below.



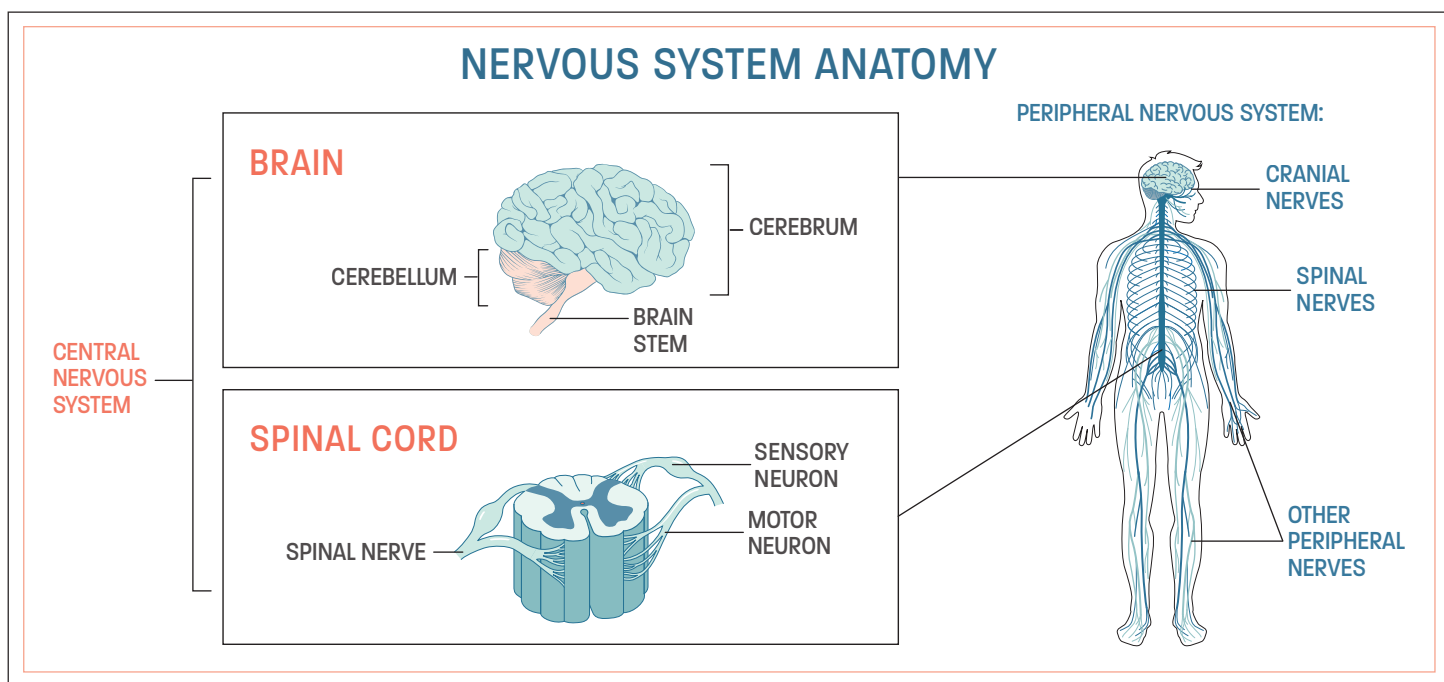
7. Breakfast smells good! You follow the smell and walk to the kitchen. Describe how a nervous impulse, or message, travels along a network of neurons from your nose to your brain and back out to your muscles, causing movement. Identify the types of receptors involved in detecting the stimulus, transmitting the nerve impulse, and generating a response.

THE NERVOUS SYSTEM PART 2

Read the text below. Then, answer the questions on pages 2 and 3.

Have you ever accidentally touched a hot pot on a stove? If you have, you may remember the pain of burning your hand! You probably also learned to be careful around hot objects. Your reactions and memories are examples of your **nervous system** at work. The nervous system coordinates everything you do, including processing stimuli from your internal and external environment. Processing these stimuli may result in an immediate response. It may also result in the storage of new memories. In order to understand how the nervous system works, let's explore the brain, spinal cord, and the peripheral nervous system in more detail.

The **brain** and **spinal cord** are both part of the central nervous system. The human brain has about 100 billion neurons. Working together in networks, these neurons handle thousands of messages every day. The spinal cord relays messages between the brain and the rest of the body.



There are three major components of the brain: the cerebrum, the cerebellum, and the brain stem. The **cerebrum** is the largest region of the brain. It processes input from the five senses and includes regions for communication and learning. The **cerebellum** coordinates your muscle actions and helps maintain your balance. The **brain stem** controls involuntary actions like breathing and digestion. These actions are known as **autonomic functions**, or functions that you don't have to think about.

The **peripheral nervous system** includes all of the nerves outside of the central nervous system. This includes 31 pairs of symmetrical nerves, called **spinal nerves**, that extend from the spinal cord to the two sides of the body. It also includes 12 pairs of nerves extending from the brain called **cranial nerves** that send signals between the face, neck, torso, and brain. The peripheral nervous system has two major divisions: the **somatic** and **autonomic** systems. The autonomic nervous system transmits messages from the brain stem to control autonomic functions, like increasing your heart rate when you run. The somatic nervous system transmits messages to control all conscious movement, like wiggling your toes or using a fork to eat a meal.

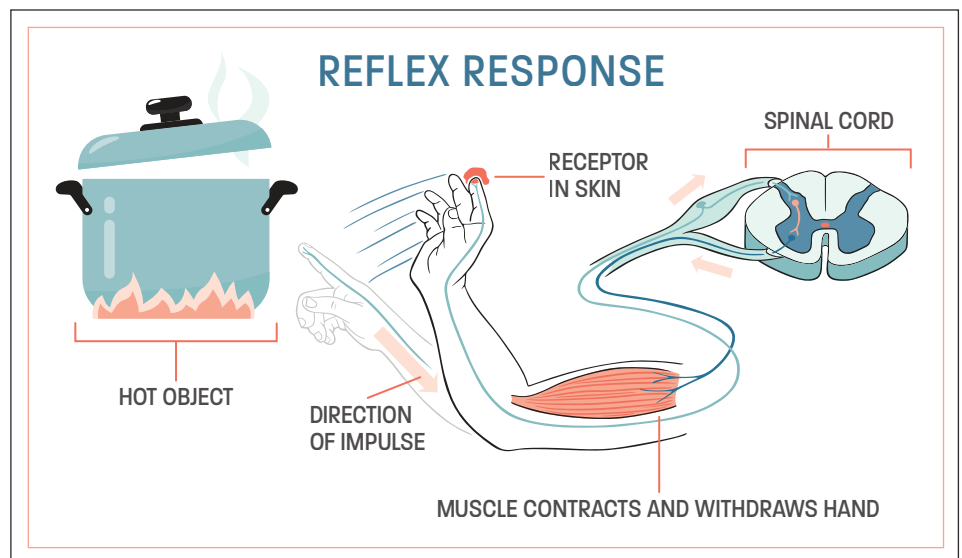
THE NERVOUS SYSTEM PART 2

Keep going! Use the reading to answer the questions below.

Some messages from sensory receptors are processed directly by the spinal cord. Let's consider the example of touching a hot pot on a stove. Ouch! Immediately you pull your hand back. This whole process happens very fast. This is known as a **reflex**. A reflex response doesn't require the brain at all. Instead, when your spinal cord receives nerve impulses from your fingers, your spinal cord sends an impulse directly back. This nerve impulse tells the motor neurons in your hand to pull your hand away from the pot. Reflexes are useful because they allow the body to respond without having to think about what action to take.

Reflex actions are paired with other nervous impulses which travel to the brain for interpretation. This is why your feeling of pain is often delayed. The reflex response happens first, and then the brain registers pain. After the unpleasant experience of touching a hot pot on a stove, most people learn to be careful around hot objects. How do you learn this information? Sensory experiences can generate an

immediate response, like the reflex of pulling your hand away coupled with the feeling of pain. These immediate responses are processed into stored information, or memories, in the brain. So, the next time you encounter a hot pot on the stove, you will be less likely to touch it.



Show what you know! Use the reading to answer the questions below.

1. Match the part of the nervous system with its function in the list below.

- | | |
|------------------------------|---|
| a. Peripheral nervous system | I. Region of the brain that processes smell |
| b. Cranial nerve | II. Controls involuntary actions like your heartbeat |
| c. Spinal cord | III. Helps maintain your balance |
| d. Cerebellum | IV. Includes all of the nerves outside of the brain and spinal cord |
| e. Cerebrum | V. Is made up of the brain and spinal cord |
| f. Brain stem | VI. Sends signals between the brain and the face, neck, and torso |
| g. Central nervous system | VII. Controls reflexes |

THE NERVOUS SYSTEM PART 2

Show what you know! Use the reading to answer the questions below.

2. Why is it useful for humans to have both an autonomic and a somatic system?

3. Jay is walking past the basketball court. His friend Taylor attempts a three-point shot and misses. Taylor yells, "Watch out!" Jay hears Taylor and turns to see the ball flying toward him. Jay instinctively raises his arms to block the ball. Number the nervous system response steps below into the correct order.

- | | |
|---|--|
| _____ Jay's eyes see the ball. | _____ Jay's muscles move to block the ball. |
| _____ Jay's ears hear his friend yelling. | _____ Jay's brain interprets the yell from his friend. |

4. What part of Jay's experience was a reflex? Explain how this reflex was useful for Jay.

5. Explain how memories of this experience would be useful for Jay in the future.

6. Bridget is threading a fishing lure on some fishing line. Her finger accidentally touches one of the sharp hooks on the lure. Bridget immediately pulls her finger away. That hurt! Bridget examines her skin to see if she needs a bandage. Number the nervous system response steps below into the correct order.

- | | |
|--|---|
| _____ Bridget's finger touches the hook. | _____ Bridget's muscles move her finger away. |
| _____ Bridget feels pain in her finger. | _____ Bridget's brain directs her eyes to look at her finger. |

7. What part of Bridget's experience was a reflex? Explain how this reflex was useful for Bridget.

8. Explain how memories of this experience would be useful for Bridget in the future.
