Your Wires are Really Crossed: Communication in the Nervous System

Teacher Pages Activity 1E

Activity Objectives:

In a whole-group simulation, students will be able to:

- Demonstrate an understanding of the anatomy of a neuron
- Explain how neurons must work together to send information through the nervous system
- Investigate neural pathways in the human body
- Demonstrate how information travels between the central nervous system and the peripheral nervous system
- Investigate a stimulus response reaction

Activity Description:

In this engaging, whole-group simulation, your students will have fun developing a common base of experience from which to further investigate how information travels through the nervous system. This activity is a great engagement activity – and it gets students up and moving!

Activity Background:

The brain, like all organs of the body, is made up of cells. In *Activity 1D*, students learned about neurons and their unique structure and function. In this activity, they will apply that understanding as they investigate how neurons work together to send messages between the brain and the body.

Your central nervous system **(CNS)** is made up of the brain and spinal cord. The *peripheral nervous system* **(PNS)** is made up of nerves outside the CNS. Nerves of the PNS connect the CNS to sense organs (touch receptors in skin, nose, eyes, etc.); body organs; muscles; blood vessels; and glands. See ***Figure 1*** **Central Nervous System & Peripheral Nervous System**. Communication between the CNS and PNS is essential to allow us to

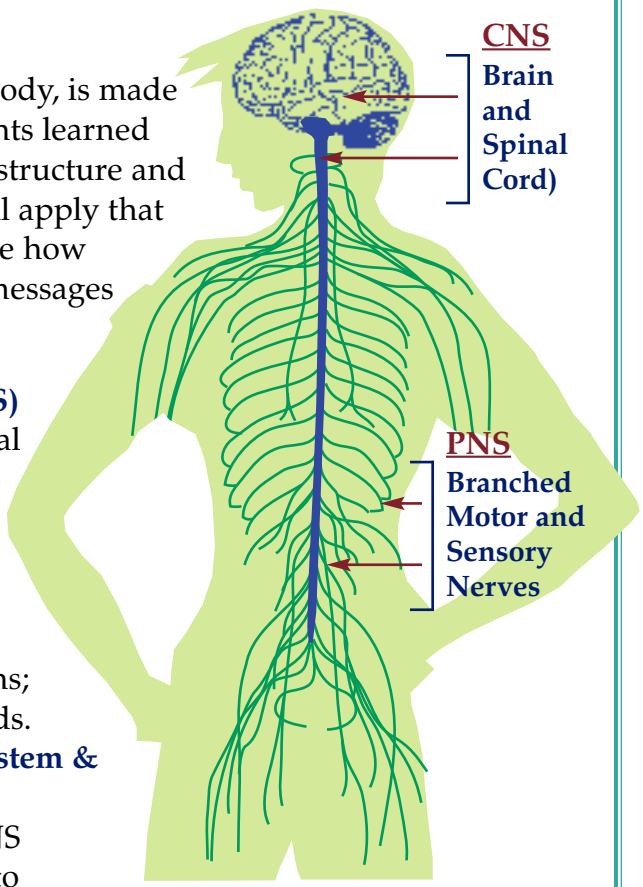

Figure 1 Central and Peripheral Nervous System

Activity Overview

The Brain: It's All In Your Mind

LESSON 1
ACTIVITY 1E

detect, interpret, and respond to ***stimuli***. Stimuli are changes in our environment and can be internal or external.

Neurons relay messages about what you're thinking, feeling, or doing. Neurons are specifically designed for information processing and signaling. They transmit and receive nervous impulses (messages) between the brain and body and within the brain and spinal cord. There are three main types of neurons: ***motor, sensory,*** and ***interneurons*** (also called association neurons). ***Motor neurons*** carry impulses from the brain to muscles, glands, or other neurons in the peripheral nervous system (PNS). ***Sensory neurons*** carry impulses from sensory nerves (receptor cells) to the central nervous system (CNS). ***Interneurons*** are also involved in sending messages but are confined to the CNS. See ***Figure 2*** **Neuron**.

Anatomy of a basic neuron: Neurons are comprised of three major parts – ***Dendrites, Cell Body,*** and ***Axon***.

Most neurons have a series of branching extensions called ***dendrites***. They look something like small tree branches. ***Dendrites*** extend out from the cell body. These dendrites come very close to other neurons, but never actually touch them, forming synapses. At the synapses, dendrites ***receive messages*** from other neurons. The ***synapse*** (which is the space between neurons) contains chemicals called neurotransmitters. These ***neurotransmitters*** assist in sending messages from one neuron to another neuron across synapses.

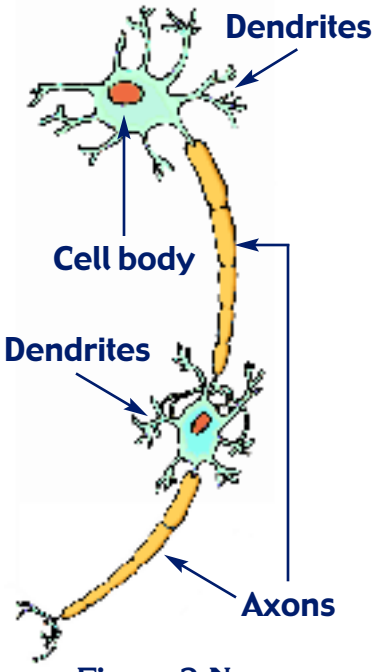

Figure 2 Neuron

All neurons have a ***cell body*** (also known as soma, or perikaryon). The ***cell body*** is the central part of the neuron and contains the cell nucleus, but does not include the axon or dendrite. Cell bodies range from about 5 to 100 μm in diameter.

The neurons conduct signals away from the cell body by a long cylindrical process called an axon. Some axons are insulated with a ***myelin sheath***. This insulation allows electrical messages to travel faster though the neurons. Axons have tiny branches at the end (terminal axons) that form ***synapses*** with other neurons. Some axons are relatively short and are only about a millimeter in length. Other axons in the spinal cord can range up to a meter or more in length.

Neurons have two signaling mechanisms; electrical and chemical. Electrical signals are sent rapidly through the neurons. Chemical messages travel ***between*** the axons of one neuron and receptors on the dendrites of

another at the synapses. Neurons send messages at different speeds ranging from as slow as 0.5 meters/second to as fast as 120 meters/ second (equivalent to 268 miles/hour.) Although all neurons send signals, there is a broad variety in their shapes and sizes. Most neurons are multipolar, where the neuron has multiple dendrites extending from the cell body and almost always has an axon. Some neurons are bipolar where there are two dendrite processes extending from the cell body and they have an axon. And some neurons are unipolar with only one dendrite process extending from the cell body and they have an axon.

Materials:

- Cards *(can be laminated for reuse)*
- Yarn
- Stopwatch
- 1 Copy of the ***Student Pages*** from this activity for each student

Instructions:

1. Ask students to randomly choose cards (included in this activity) that they can wear in the simulation. These cards will establish which student is the Brain, Foot, Sensory Neuron, or Motor Neuron.
2. Have the ***"Brain"*** stand at one end of the classroom and the ***"Foot"*** at the other.
3. Ask the ***"Motor Neurons"*** to stand and line up between the ***"Brain"*** and the ***"Foot"***.
4. Explain that each ***"Motor Neuron"*** has a dendrite, cell body, and axon.
5. Ask students the function of a ***dendrite*** (to carry messages ***toward*** the cell body).
6. Ask students the function of an ***axon*** (to carry messages ***away from*** the cell body).

MOTOR IMPULSES:

1. Explain that ***"Motor Neurons"*** carry messages away from the brain to the muscles and other structures in the body.
2. For the simulation, all ***"Motor Neurons"*** must work together to send a message from the ***"Brain"*** to the ***"Foot"***.
3. Explain to students that their ***left hand = the dendrite, their body=cell body,*** and ***their right hand=the axon***. It helps to write this on the board so students (and you) can refer to it.
4. Ask ***"Motor Neurons"*** to line themselves up so their dendrites (left hands) are towards the ***"Brain"***.
5. Explain that it will take all of the ***"Motor Neurons"*** to get a message from the brain to the foot. They will transmit the message from one neuron to the next as follows:
    a. All ***"Motor Neurons"*** stand with their palms up and arms extended.
    b. The ***"Brain"*** sends a message by "slapping" the dendrite (left hand) of the first ***"Motor Neuron"*** – the message has been received by the dendrite.

c. The message travels through the first *"Motor Neuron"* and is transmitted to the next *"Motor Neuron"* when the axon (right hand) slaps the dendrite (left hand) of the third *"Motor Neuron".*
d. This continues until the message reaches the *"Foot"*.
e. The *"Foot"* kicks in response.

6. Have students repeat one more time for practice and time the *"Nerve Impulse"* with a stopwatch.
7. Tell students their time. Feign surprise when you tell them an impulse travels up to 268 miles per hour. They need to speed it up!
8. Now, what if you step on a nail? How does the brain learn of this development so it can direct a response?

SENSORY IMPULSES

1. Now the *"Sensory Neurons"* need to stand and line up between the *"Brain"* and the *"Foot"* so they are facing the *"Motor Neurons"*.
2. Remind students that ***sensory neurons*** carry information ***from the body to the brain***.
3. Tell them that, just as in the motor neurons, their ***left hand = the dendrite, their body=cell body***, and ***their right hand=the axon***.
4. Their job is to work together to get a message from the injured foot to the brain.
5. The *"Foot"* begins the process by slapping the dendrite (left hand) of the first *"Sensory Neuron"*.
6. The axon (right hand) of the first *"Sensory Neuron"* slaps the dendrite (right hand) of the next *"Sensory Neuron"* and so forth until the message gets all the way to the brain.
7. The brain has the message.
8. Once again, feign surprise at how long it took. Give the *"Sensory Neurons"* a second chance to practice and time them – compare their time to the 268 miles per hour that a real impulse can travel.

MOTOR & SENSORY IMPULSES (STIMULUS RESPONSE)

1. Assume that once again, the *"Foot"* is injured when it steps on a rock.
2. *"Sensory Neurons"* must carry a message to the brain. Ask students to simulate this action as they did before.
3. Explain to students that ***interneurons*** are found in the brain and spinal cord and that they relay messages within the central nervous system.
4. The *"Brain"* processes the message and sends a message back to the foot to move off the rock.
5. The *"Motor Neurons"* must work together to send the message to the *"Foot"*.
6. When the *"Foot"* receives the message, it moves off the rock.
7. Allow students to practice once and then time them the second time. Again, reinforce how quickly this actually happens in the nervous system.

Note: Since this activity is an engagement simulation, for simplicity, the interneurons are not included. Teachers can easily modify the simulation to include interneurons if desired.

Management Suggestions:
All students should participate in the activity and the processing out that follows.

Suggested Modifications: None needed

Suggested Extensions:
1. Investigate how sports-related accidents can cause paralysis due to injuries of the nervous system.
2. Have students develop a simulation for a reflex response.
3. Have students develop a simulation for a specific action, such as picking up a book.
4. Students can also convert the travel time of an impulse into different units. For example, meters/seconds (average 107m/s), centimeters/second.
5. Have students measure the distance from the tip of their finger to their brain in centimeters. Have them calculate the approximate time it takes the impulse to travel. They can do the same type of measurement for other locations of the body.

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Teacher Resource:
Your Wires Are Really Crossed
Slideshow posted online at:
http://teachhealthk-12.uthscsa.edu/curriculum/brain/brain.asp.