



ACTIVITY 2 A NEURON PLAY

Messages travel through the nervous system by means of an electrochemical process called neurotransmission. A key component in this process is the neuron, a nerve cell that is specialized to transmit and receive information. In this activity the students will model a neuron circuit to learn how it functions.

Background

Neurons are nerve cells that are specialized to communicate with other cells. A typical neuron has a cell body that contains the nucleus and other cell organelles. Extending from the cell body are projections called dendrites that bring messages or signals into the cell from other neurons. A neuron also has a long extension called an axon that carries signals away from the cell.

The process by which signals in the nervous system move from neuron to neuron is called neurotransmission. In neurotransmission, a signal received by a neuron's dendrites can cause an electrical impulse known as an action potential to travel down the axon of the cell. Some neurons have a fatty covering on the axon called a myelin sheath. This sheath helps the action potential travel faster.

An action potential is an all-or-none event. If the difference in charge between the inside of the cell and the outside of the cell reaches a critical level (threshold), the action potential is initiated. Furthermore, the magnitude of the action potential of a specific neuron is always the same.

Neurons are separated by a gap (synapse) that the action potential cannot cross. Once the action potential reaches the end of an axon (its terminal), it stimulates the release of chemicals called neurotransmitters. The neurotransmitters exit the terminal, cross the synapse, and relay the signal to a neighboring neuron by binding to specific protein receptors. Once the signal has been received, the neurotransmitters are released back into the synapse. They are either destroyed by enzymes or taken up by the neuron that released them (reuptake).

Two different types of neurons are sensory neurons and motor neurons. Sensory neurons receive input from the environment. Motor neurons communicate with muscles and make them contract.

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Ecstasy alters neurotransmission by causing an increase in three neurotransmitters in the brain: serotonin, dopamine, and norepinephrine (noradrenaline). This change is responsible for the short-term effects produced by the drug.

Learning Objectives

The student will:

1. name two different types of neurons.
2. demonstrate the process of neurotransmission.

Materials

- signs with string to go around students' necks
 - Neuron 1 (Sensory Neuron)
 - Neuron 2 (Sensory Neuron)
 - Neuron 3 (Motor Neuron)
 - Neuron 4 (Motor Neuron)
- brain model (or brain sign)
- roll of toilet paper
- lightning bolt-shaped sign (for electrical signal)
- basketball
- two bags with small objects such as marbles or eyedroppers (preferably two different objects)
- empty trash can to catch basketball at end

Procedure

Prior to class:

1. Make the signs.
2. Read through the Neuron Play script and insert your school's and a rival school's name in the appropriate blanks.

During class

1. Recruit students to take on the roles of the basketball player, neurons 1-4, the brain, and two neurotransmitters.
2. Give each neuron his/her appropriate sign. Wrap one arm of each "neuron" student in toilet paper to simulate the myelin sheath.
3. Hand the brain model to the brain person.
4. Give a bag of neurotransmitter to each neurotransmitter person.
5. Give the trash can to one student.
6. Line the students up at the front of the class with the sports player at one end of the line and the brain at the other. Put Neurons 1 and 2 between the sports player and the brain. Have the dendrites of Neuron 1 touch the player, and the axon close to but not touching the dendrites of Neuron 2. Let the other students sit down until needed.
7. Point out to the students that their unwrapped arm is the dendrite, their body is the cell body, and the wrapped arm is the axon.
8. Read the script, calling up the other players as they are mentioned in the script.

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Neuron Play

“Once upon a time, a student was playing in a basketball game. The game was very close and everyone was tense. It was the final game for the coveted league championship title - _____ (your school) vs _____ (rival). One student found himself/herself out on the court in the final seconds of the game. His/her team was behind by one point. They needed a basket to win. Suddenly the student found that the basketball had somehow ended up in his/her hands. The whole world went into slow motion. Despite what some might say, this is what REALLY happened (*put ball in hands of player*).

The dendrites in the sensory neurons of his/her hands were triggered by the touch of the ball in his/her hand. An electrical signal passed from the dendrites to the cell body of the neuron (*move the lightning bolt along Neuron 1*). From there the signal traveled at up to 250 miles per hour, down the axon carrying signals away from the cell body and on to other places. Suddenly, the signal reached a synapse (*have first neurotransmitter person come up*). This was it. There was a gap and the electrical signal could not go across it. All of a sudden though, some chemicals, neurotransmitters, went across the gap and on to the dendrites of the second neuron (*have neurotransmitter person put some objects into the axon hand of Neuron 1, then Neuron 1 hands them to the dendrite hand of Neuron 2*). The electrical signal quickly moved along the second neuron towards the brain (*move lightning bolt along Neuron 2*). When it reached the brain stem, it traveled up to the thalamus. From there it was sent to the correct part of the brain. The brain sorted out all the information and in an instant, made the decision that the player must shoot the ball if the team would have any chance of winning the game.

But wait a minute. It’s not that easy (*move lightning bolt through brain*). The brain had to get the message back to the player’s hands. Surely the game would be lost. But then, suddenly, from nowhere the motor neuron was located (*have Neurons 3 and 4 come up - Neuron 3’s dendrites should touch the brain, and Neuron 4 is in line behind Neuron 3*). Thank goodness for the many hours the player had spent shooting and going over just such a situation in the mind. The pathways in the brain were well connected and that made a quick response possible.

The electrical signal traveled from the brain on its way to give the message to the distant body parts (*move lightning bolt along Neuron 3*). Oh no, another synapse! (*Have second neurotransmitter person come up and put neurotransmitter into the axon hand of Neuron 3. Neuron 3 then hands the objects to the dendrite hand of Neuron 4*). Fortunately, the electrical message was once again quickly translated into a chemical message and carried on to the next neuron where it changed back to an electrical signal and passed through the dendrites, a cell body, and axon (*move lightning bolt along Neuron 4*). This axon was a very long axon that went clear back to the arm muscle was sent. The message to tell the muscles to contract and the player’s arm to shoot the ball. The player released the ball just as the buzzer sounded. It swished through the hoop (*have student with trashcan come up to catch the ball*). What a great moment! _____ (Your school) won the championship.”

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Extension Activities

- *Science*: Compare and contrast the different types of neurons in the nervous system.
- *History*: Examine the history of the discovery of the neuron.
- *Science*: Investigate the chemical process that induces neurotransmitter release.

Standards

National Science Education Standards, Grades 5-8

- Science Content Standard C: All students should develop understanding of structure and function in living systems.

Books

- LeVert, Suzanne. 2002. The Brain New York: Benchmark Books/Marshall Cavendish.
- Parker, Steve. 1998. Brain and Nerves. Brookfield, Conn.: Copper Beech Books.

Web Sites

The starred sites are particularly appropriate for students:

- Understanding Addiction: Basic Science Information*
<http://www.utexas.edu/research/asrec/addiction.html>
- Neuroscience for Kids*
<http://faculty.washington.edu/chudler/neurok.html>