PIPE CLEANER NEURON

LESSON PLAN

Title: Pipe Cleaner Neuron
Setting: In Classroom
Subject: Biology - Neuroscience
Grade Level: 6-8
Time Frame: 40 Minutes
Paired Dana Foundation Fact Sheets: 6th-8th Grade How Does the Brain Work?
Next Generation Science Standards: Meets MS-LS1-1, MS-LS1-3, & MS-LS1-8

STUDENT OBJECTIVES

- Understand the main components of a neuron and their functions.
- Discover how neurons communicate with one another during "neurotransmission."

BACKGROUND

The human brain is made up of approximately 86 billion nerve cells called neurons. Neurons are like other cells in the body in that they have a cell body and a nucleus and contain structures such as mitochondria. However, they also have features that make them unique. It is these specialized structures of a neuron that allow brain cells to communicate with one another in a process called "neurotransmission."

In this hands-on exercise, students will first learn about the structure and components of a neuron and how they facilitate neurotransmission. Then they have the opportunity to create a realistic model neuron out of colorful pipe cleaners.

MATERIALS

- Printed copies of 6th-8th grade Dana Foundation fact sheet, "How Does the Brain Work?" **Downloadable here:** www.dana.org/factsheets/
- Audio and visual capacities for a PowerPoint presentation.
- Pipe cleaners in at least six different colors.

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TEACHER BACKGROUND INFO

WHAT TO KNOW BEFORE YOU TEACH

* Note: This content is primarily for the instructor's reference; the accompanying PowerPoint presentation will be for the students.

What are the different parts of a neuron?

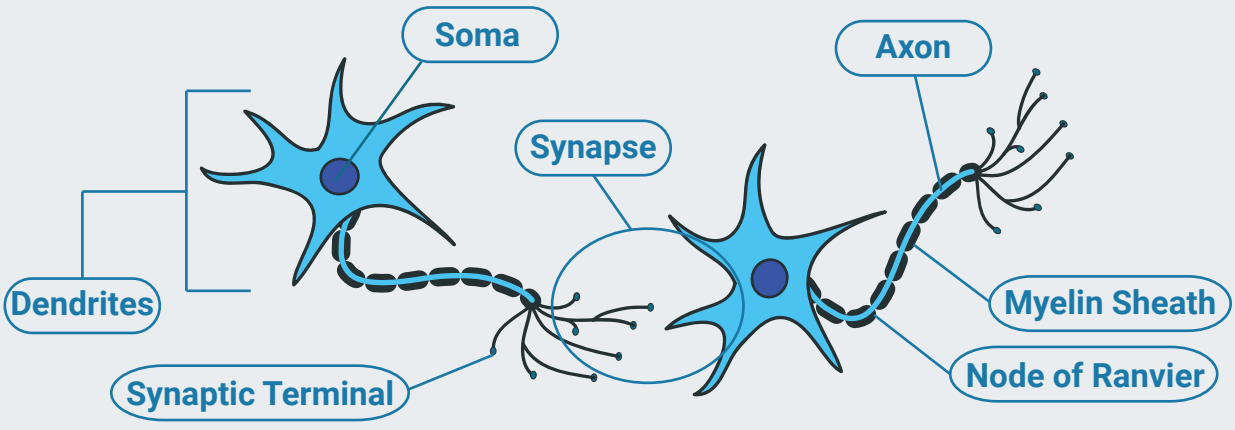
Cell body - also known as the "soma," the cell body contains the neuron's nucleus and is where a lot of proteins are synthesized. The cell body protrudes out into two processes - dendrites and axons.

Dendrites - small, branch-like projections on the soma that receive input signals from neighboring neurons. These signals can be excitatory, which means they make the neuron fire off an electric signal (Action Potential), or they can be inhibitory, which means they prevent the neuron from firing.

Axon - the long, tail-like feature of a neuron that conducts the electric signal down from the soma. The axon is usually covered in a white fatty substance called "myelin," which insulates the axon and helps the signal travel faster.

Nodes of Ranvier - gaps along the axon that are not covered in myelin. These allow the electric signal to jump from one node to another node, a process called "saltatory conduction."

Synaptic terminals - the individual branches that mark the end of an axon. Where the electric signal travels to be converted to a chemical signal that gets released into the space between two neurons, called the "synapse." This chemical signal will talk to the neighboring cell and convey an excitatory or inhibitory message.



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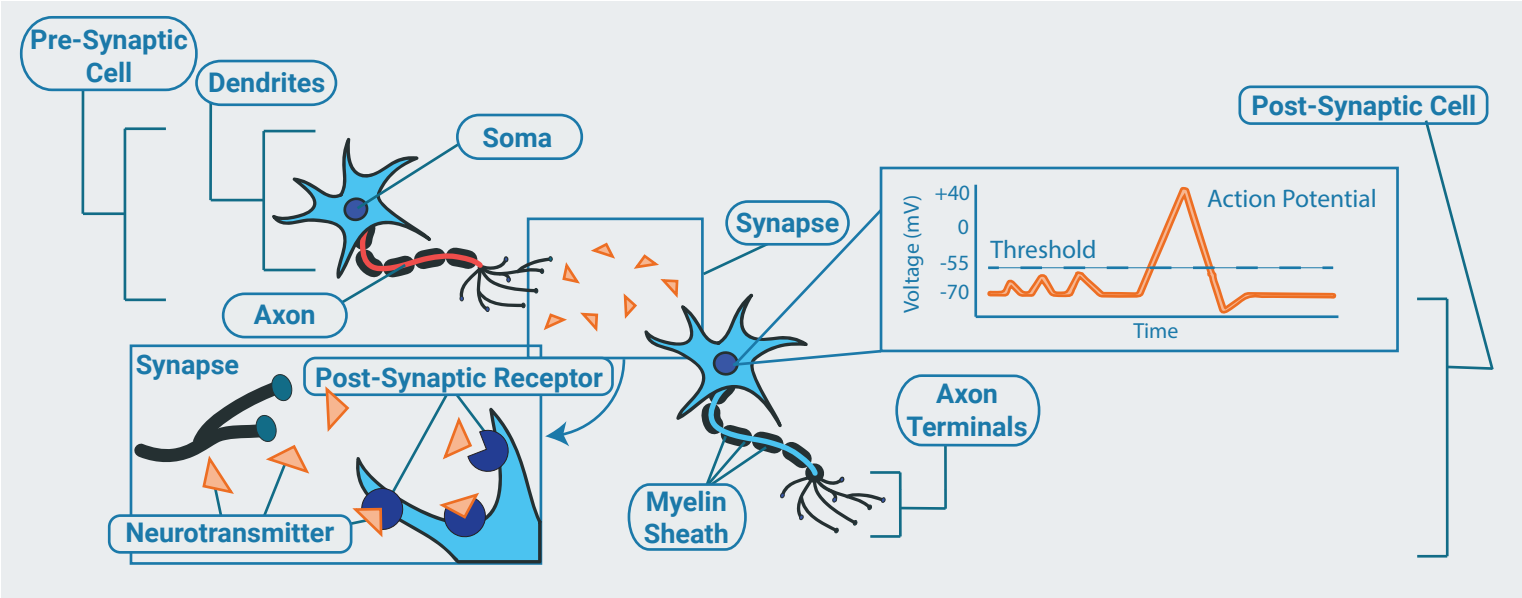
Neurotransmission

Neurotransmission is the mechanism by which neurons communicate. This process requires a combination of electric and chemical signals in the cell. Communication between neurons enables us to think, read, write, speak, and dream. Pretty much everything we do relies on successful neurotransmission! The chemical signal that one neuron (pre-synaptic cell) releases into the synapse between itself and another neuron (post-synaptic cell) is called a "neurotransmitter." Once released, the molecules of neurotransmitter will float across the synapse and bind to proteins called "post-synaptic receptors," where they dock in a lock and key formation. This binding will lead to either excitation or inhibition of this second neuron. Excitation means an electric signal will cause the post-synaptic cell to "fire" off a signal known as an Action Potential. The signal is consequently sent down the axon to be converted into a chemical message. Inhibition means the post-synaptic cell will not fire at all. The type of neurotransmitter and the type of receptor it binds to will dictate what type of response a neuron will generate. Some conventional neurotransmitters are: dopamine, serotonin, GABA, and acetylcholine.



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PROCEDURE

[1] Each student reads 6th-8th grade Dana Foundation fact sheet, "How Does the Brain Work?" **(5 minutes).**

[2] Briefly introduce the exercise and give a short PowerPoint presentation on the neuron and neurotransmission **(10 minutes).**

[3] Hand out at least six different colors of pipe cleaner to each student and provide these instructions **(15 minutes):**

a. Roll one pipe cleaner into a ball; this will be the soma.

b. Take a second (different color) pipe cleaner and push it through the "soma" so that there are two halves sticking out an equal amount. Twist these together to form a single rope that will be the axon.

c. Take two more pipe cleaners and push them through the soma to form the branch-like shape of dendrites.

d. Wrap one pipe cleaner along the entire length of the axon to represent the fatty myelin.

e. Twist one more pipe cleaner into a ball on the axon end opposite from the soma. This will be the synaptic terminal.

f. As a group activity, students can join up in groups of 2-3 after their neurons are made, and act out how neurotransmission works with their individual neuron models **(10 minutes).**

ADDITIONAL RESOURCES

- More information on brain anatomy and function: **www.brainfacts.org/Brain-Anatomy-and-Function/Cells-and-Circuits/2012/Neuron-Conversations**
- A collection of neuroscience puzzles and fact sheets for kids in grades K-12 that are available for download (PDF): **www.dana.org/educators/**

* The "Pipe Cleaner Neuron" activity was originally developed by Eric H. Chudler, Ph.D., University of Washington, and was adapted by Elizabeth Weaver, M.S. and Linda Qi Beach, Ph.D. for the Dana Foundation.