Neuron Structure

By: Natalie Frederick, Xiaoqing Hu, Carmen Lin, Daniel Ohm, Shoai Hattori
Updated: 1/10/25 Claire Cho

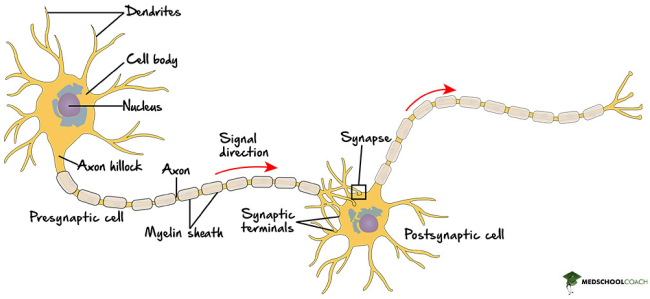
Objectives

1. Explore the overall structure and function of a neuron
2. Understand how the neuron's structure allows it to communicate with other neurons

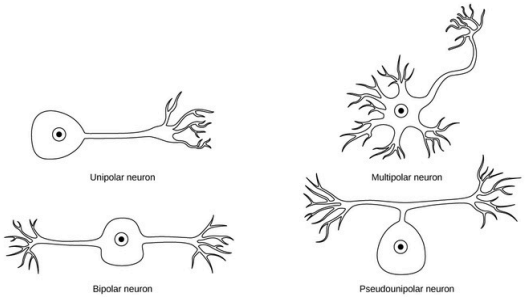
Background Information

Neurons are the fundamental units of the brain and the nervous system. They receive and send messages throughout the brain and to the rest of the body to allow us to do everything, from breathing to eating to thinking. They are able to accomplish this through their unique structure.

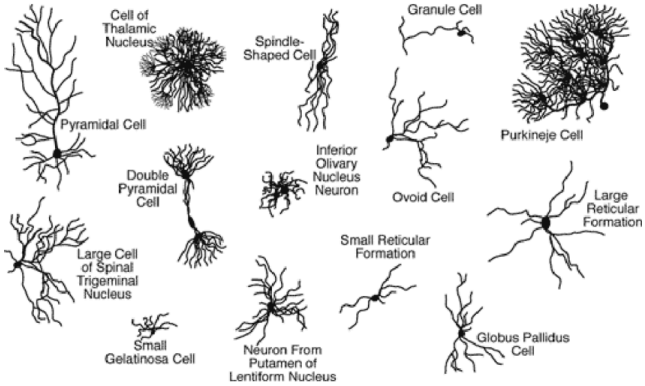
Neurons are made up of three main components: the soma, axon, and dendrites. The soma is the cell body, and it houses the neuron's nucleus, DNA, and other organelles to maintain the cell. The axon sends signals (called action potentials) in the form of electricity to other neurons. Some axons are wrapped in a special protein called myelin, allowing the action potential to travel at faster velocities. Axons terminate in synaptic boutons that contain synaptic vesicles filled with neurotransmitters. When an action potential reaches the bouton, the vesicles release their neurotransmitters into the synaptic cleft. On the other side of the synaptic cleft is the dendrite of another neuron that contains a high concentration of neurotransmitter receptors. Activating these receptors allows the next cell to fire (or not fire) an action potential and continue this signal propagation.



Neurons are broadly divided into four basic types: unipolar, bipolar, multipolar, and pseudounipolar. Unipolar neurons have only one process that extends from the soma. Bipolar neurons have one axon and one dendrite extending from the soma. Multipolar neurons are the most common type of neuron and contain one axon and multiple dendrites. Lastly, pseudounipolar neurons have a single process that extends from the soma that later branches into the axon and dendrites.



There is a large diversity in neurons! They can vary in terms of size, shape, and complexity of their branching patterns. Each neuron's structure is directly related to their specific function.



Materials

Item	**Quantity**	**Notes**
Pipe cleaners	Lots!	- Can be bought at any craft store (i.e. Michaels, Hobby Lobby) or on Amazon - Have different colors - ~$8 for 200 pack on Amazon - Used to make the soma, axons, and dendrites
Pony beads	Lots	- Can be bought at any craft store or on Amazon - ~$7 for 1000 pack on Amazon - Used to make myelin
Scissors	At least 2	- Used to cut the pipe cleaners
Pom pom balls	Lots	- Optional - Can be bought at any craft store or on Amazon - ~$7 for 1500 pack on Amazon - Used to make synaptic vesicles
Glitter glue	At least 2 containers	- Optional - Can be bought at any craft store or on Amazon - ~$10 for pack of four - Used to represent neurotransmitters

In the Class

1. Begin by asking the students what a neuron does
2. Discuss the different parts of a neuron and how these structures allow the neuron to “talk” to each other. Discuss how the parts of the neuron can vary to serve different functions (i.e. axons can have longer/shorter lengths to allow signal to travel further/shorter distances)
3. Build the neuron

a. Make a spiral at one end of the pipe cleaner, and leave the rest of the pipe cleaner straight. The spiral represents the soma, and the straight part represents the axon
b. Add beads to the axon to represent the myelin sheath
c. Cut smaller pieces of pipe cleaner. Wrap these pieces around the soma and at the end of the axon to represent dendrites and branched axons respectively
d. Optional: use pom pom balls to represent synaptic vesicles. Roll them around in glitter glue, where the small glitter pieces represent neurotransmitters

Additional information

Helpful figure showing different neuron sizes drawn to scale. Blue arrows point to axons, and green arrows point to dendrites. A. Cerebellar Purkinje cell, B. Cerebellar granule cell, C. Inferior olive cell, D. Ventral horn motor neuron, E. Cortical pyramidal neuron, F. Retinal bipolar cell, G. Dorsal root ganglion cell.

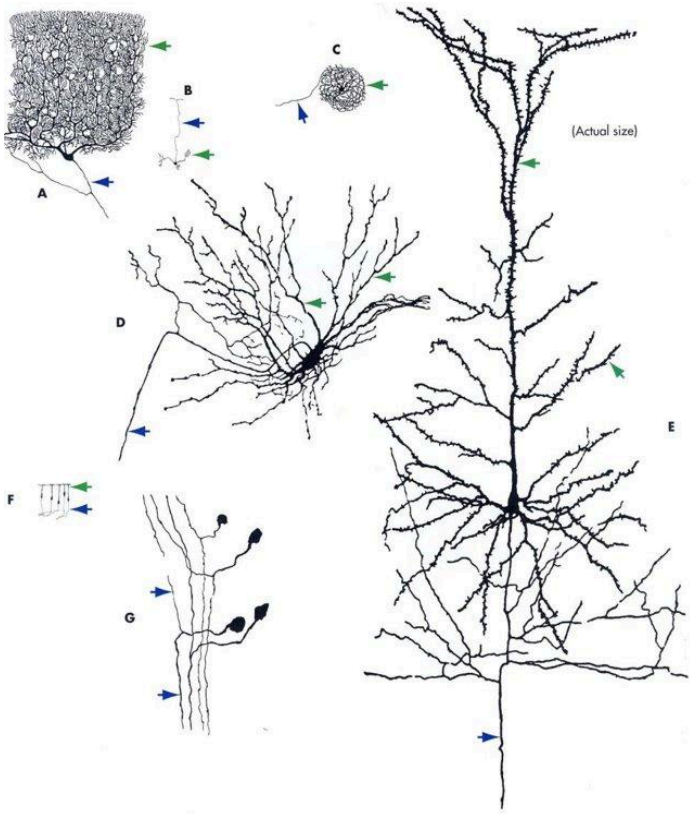


Image Credits (in order of appearance)

1. https://www.medschoolcoach.com/neuron-structure-mcat-biology/
2. https://rotel.pressbooks.pub/biologicalpsychology/chapter/types-of-cells-in-the-brain/
3. Braini, C. (2016). Biophysical approach of neuronal shapes
4. http://www.multiculturalmotherhood.com/2017/07/learning-about-brain.html
5. Nolte's the Human Brain 8th edition. Figure 1.4