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Teacher Resources from the
Center for Educational Outreach at
Baylor College of Medicine

What Are Neurons?

Activity from *Brain Chemistry: Teacher's Guide*

by

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"The brain is the last and grandest biological frontier, the most complex thing we have yet discovered in our universe. It contains hundreds of billions of cells interlinked through trillions of connections. The brain boggles the mind."

James D. Watson
from Discovering the Brain
National Academy Press, 1992

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What Are Neurons?

The human brain is the most complex structure in the known universe. Consisting of close to 100 billion cells, the brain is the center of our thoughts and emotions. It receives and processes information from the world around us, directs our movements and controls automatic functions of our bodies. Amazingly, all functions of the brain and nervous system are based on communication among nerve cells, also known as **neurons**.

Unit Links

LEGACY OF LOST CANYON
Story, Chapter 4; Science box, p. 11.

EXPLORATIONS
Brain Busters!, p. 7; Neuron photograph, p. 2.

In many ways, a neuron is like any other cell in the body. Each neuron is surrounded by a membrane, is filled with liquid and has a nucleus containing its genetic material. However, just as many other cells within the body are specialized to do a particular job, neurons are specialized to receive and transmit information. Even though they may differ in appearance, all neurons collect information either from the environment (information detected by the senses) or from other cells of the body. They transmit the information to other neurons and/or other kinds of cells (such as muscle).

A typical neuron has an enlarged area, the **cell body**, which contains the **nucleus**. Neurons typically also have several branches, or nerve fibers. The branches on which information is received are known as **dendrites**. Each neuron usually has many dendrites. Each neuron usually also has a longer taillike structure, or **axon**, which transmits information to other cells. Axons can be branched at the tips. The axons of many kinds of neurons are surrounded by a fatty, segmented covering called the **myelin sheath**. This covering acts as a kind of insulation and improves the ability of axons to carry nervous system signals rapidly.

The end of the axon (or **axon terminal**) of one neuron usually is separated from the next cell by a tiny gap called a synapse. Messages traveling from one neuron to the next must cross this gap in order for the signal to continue along its path. A single neuron may be capable of receiving messages simultaneously on its dendrites and cell body from several thousand different cells.

OVERVIEW

Students are introduced to how messages are sent and received by neurons, and they build a model neuron.

CONCEPTS

- Messages within the brain and nervous system are sent very rapidly.
- Messages are conducted by living cells called neurons.
- Neurons are specialized to receive and transmit messages.
- Neurons are connected in networks.

SCIENCE & MATH SKILLS

Predicting, inferring and modeling

TIME

Preparation: 10 minutes
Class: 45 minutes

MATERIALS

- transparency of Transmitters & Receivers student sheet
- overhead projector

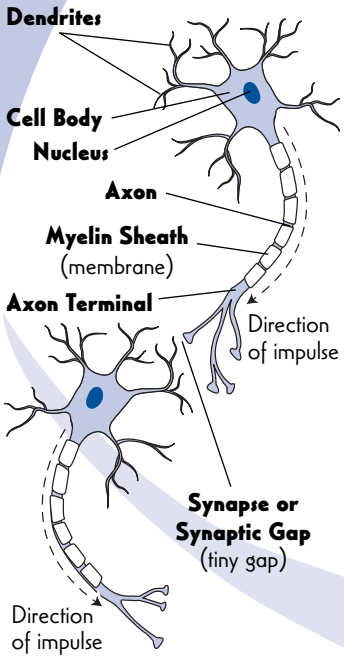
Each group will need:

- resealable plastic bag, approx. 12 x 15 in. (or gal size, see SETUP)
- roll of masking tape, 0.75 in.

Each student will need:

- modeling clay (or small styrofoam ball)
- 4 pipe cleaners
- copy of Transmitters & Receivers student sheet

Typical Structure of Neurons



A typical neuron has an enlarged cell body which contains the nucleus. Most neurons have branches, known as dendrites. Each neuron typically also has a longer taillike branch, called an axon. Information is received on the dendrites or on the cell body and is transmitted down the axon to other cells. (The myelin sheath, as shown on the two motor neurons above, has been enlarged for viewing its location on the axon.)

Neurons vary greatly in size, shape, and number and length of branches. On average, most neurons have 100–1,000 dendrites.

This activity provides students with a general introduction to neurons and to their role as message carriers within the body.

SETUP

Organize materials in one plastic bag for each group and place in a central location. Conduct the initial portion of this activity with the entire class. Then divide the class into groups of four students to build their neuron models.

PROCEDURE

1. Begin by asking students how they react to touching something hot. Ask, *What happens when you accidentally touch a hot dish or iron?* Students might mention that they jerk their hands away quickly from the hot items. Ask, *Why might it be important for you to react quickly?*
2. Point out to students that components of the nervous system work together to conduct signals very rapidly. Reflex responses (which can be essential for survival) are especially fast, because the signal from sensors can be routed directly to muscles through the spinal cord without first passing through the brain.
3. Next ask students as a group to respond to some simple arithmetic questions. Ask, *What is two times four? Three times three? Three times nine? Ten times ten?* Follow by asking, *Did it take a long time for your brain to figure out the answers? Did it take long for your brain to send messages to your lips and tongue to form the words?* Reiterate that components of the brain and nervous system work together very rapidly.
4. Display a transparency of the Transmitters & Receivers student page. Mention that there are many different kinds of neurons (about 10,000!) but that all of them are designed to carry messages. Point out the "message-receiving" parts (dendrites and cell bodies) and "message transporting" parts (axons) on the two neurons. Mention the myelin sheath that surrounds the axons of some neurons and helps them conduct signals more rapidly (not unlike the insulation on an electrical wire).
5. You also may want students to look at the photograph of a neuron network on page 2 of the *Explorations* that accompanies this unit. In the photograph, students can easily observe the cell bodies of neurons. They also can observe that axons and dendrites form complicated networks.
6. Distribute copies of the student sheet and have students

complete it. Make sure students understand that messages flow in only one direction on each neuron.

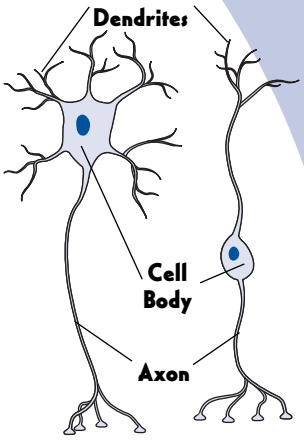
7. Challenge students to use a variety of materials to create their own neurons (see Typical Student Model, sidebar). Use modeling clay or small styrofoam balls to create cell bodies, and pipe cleaners to create axons and dendrites. Remind students that, even though printed images give neurons (and other cells) a flat appearance, these structures actually have a variety of shapes in three dimensions.
8. Provide masking tape for students to create short myelin sheath segments on the axons of their nerve cells.
9. After students have made their neurons, ask them to identify on their models where incoming messages would be received from other neurons and from where their models would be able to transmit messages to other neurons.
10. Display the completed neuron models on a board or table. Or encourage students to work together to create networks of interconnected nerve cells using the neuron models they have created and display these constructions.

BRAIN JOGGING

Here are more ideas for you and your students to explore.

- Obtain prepared slides of neurons and other cells in the nervous system from a biological supply company (see p. vi for contact information on Carolina Biological Supply Company). Or find photographs of neurons on the Internet. Help students find the cell bodies, dendrites and axons on the neurons. Students will observe that actual neurons are much more complex than their models, but still have the same basic parts.
- Try envisioning the following. If the cell body of a typical motor neuron (a neuron that sends messages to muscles) were the size a tennis ball, its dendrites would extend the length of a normal room and its axon would be about the size of a garden hose nearly 1/2-mile long.
- Neurons are not the only cells in the nervous system. They are assisted by other cells. Some types of cells even wrap around the axon to form the myelin sheath (see Typical Structure of Neurons, sidebar, p. 8). Challenge students to use the Internet or library resources to find out more about these helpers, called **glial cells**.

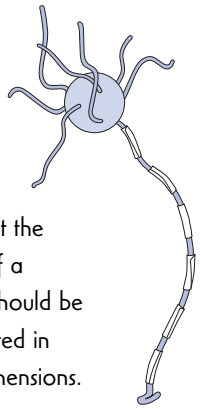
A Variety of Neurons



Neurons come in different shapes and sizes. On the left is a motor neuron. On the right is a typical neuron from the eye.

Most neurons receive signals from many other neurons. The combined effects of these signals determine the response of the receiving neuron.

Typical Student Model



Note that the model of a neuron should be constructed in three dimensions.

Transmitters & Receivers

Neurons are special cells that pass messages throughout the body.

1. Find the **axons** (long branches) that lead from one neuron to the next.

2. Locate the **dendrites** (short branches) on the neurons.

3. Find the **myelin sheath** that covers each axon.

4. Locate the **cell body** and the **nucleus** of each neuron.

5. Locate the ends of each axon (or **axon terminals**). Notice the slightly rounded shapes.

6. Find the **synapse** (tiny gap between the neurons through which messages must pass). Draw a circle around the synapse.

7. Label the parts of the neurons.

8. Notice the arrows on the drawing. What do you think they mean?

   _____

   _____

9. A single neuron may receive messages from several other neurons at one time. Think about how messages are passed between neurons. Add another neuron to this image and circle the synapse.