Teacher Guide

Virtual Neurons

Lesson Summary: Neurons, or nerve cells, are the basic functional units of the nervous system. Students use the **Virtual Neurons** software to construct neural circuits and visualize how messages travel through the circuits. As an extension, students can design and implement an experiment manipulating circuit components to alter neural communication.

Grade Level 5-8

Lesson Length
1-2 class periods

Standards Alignment

Minnesota Science Standards – Alignment Matrix www.brainu.org/resources/MNSTDS

National Science Standards – Project 2061: Atlas of Science Literacy reference

a) Cells: Cell functions – basic needs and basic functions (p.73, Atlas Vol. 1)

Research on student learning: "Research on student learning: "Preliminary research indicates that it may be easier for students to understand that the cell is the basic unit of structure (which they can observe) than that the cell is the basic unit of function (which has to be inferred from experiments." (p. 72, Atlas Vol. 1)

b) Scientific inquiry: Avoiding bias in science – expectations and explanations (p.23, Atlas Vol. 1)

Research on student learning: "Students tend to look for or accept evidence that is consistent with their prior beliefs and either distort or fail to generate evidence that is inconsistent with these beliefs." (p.22, Atlas Vol. 1)

c) Modeling: uses of models and limitations of models (p.93, Atlas Vol. 2)

Research on student learning: "Prior to instruction, or after traditional instruction, many middle- and high-school students continue to focus on perceptual rather than functional similarities between models and their referents, and think of models predominantly as small copies of real objects. Consequently, students often interpret models they encounter in school science too literally and unshared attributes between models and there referents are a cause of misunderstanding. Some middle- and high-school students view visual representations such as maps or diagrams as models but only a few students view representations of ideas or abstract entities as models. (p.92, Atlas Vol. 2)

Objectives—Students will

- model working neural circuits using three types of neurons (motor, sensory, and inter).
- draw and label a neural circuit using a motor neuron, sensory neuron, and interneuron, indicating the direction on neural communication.
- identify and draw a motor neuron, a sensory neuron, and an interneuron.

Extension Objectives—Students will

- calculate, predict, and test muscle twitch rate.
- test and describe how neuron communication in a circuit is affected by the neuron's threshold.
- design and implement an experiment to test how manipulating a factor in a neural circuit effect neuron communication.

Assessment Options

- Collect and grade Virtual Neuron Student Guide
- Collect and grade Virtual Neuron Experiment Lab Report
- Collect and grade Reflection Paper
- Test students on their understanding of neuron types, neural circuits, and neuron communication.

Terms — important vocabulary that strengthens the lesson. Select terms according to the needs and abilities of your students.

- action potential – an electrical signal that travels along the axon, away from the cell body, to the axon terminal where it triggers the release of neurotransmitters
- excitatory neuron – a neuron whose neurotransmitter excites, stimulates, or depolarizes (cell membrane becomes less negative) another neuron, increasing the probability that the target neuron will fire an action potential
- inhibitory neuron – a neuron whose neurotransmitter inhibits or hyperpolarizes (cell membrane becomes more negative) another neuron, decreasing the probability that the target neuron will fire an action potentialinterneuron – any neuron that is not a sensory or mother neuron; carries information between neurons, for example, between sensory and motor neurons
- motor neuron – a neuron that carries information away from the central nervous system to muscles or glands
- neuromuscular junction – a specialized synapse onto a muscle
- neuron – the principal cell of the nervous system, also called a nerve cell. it is specialized for the transmission of information and characterized by long fibrous projections called axons, and short, branch-like projections called dendrites
- sensory neuron – a neuron that carries information from the body's sensory receptors in the skin, tongue, ear, nose and eyes towards the central nervous system
- threshold – the minimum amount of depolarization (becoming more positive) of the cell membrane potential needed to cause firing of a neuronal action potential

Materials

- computer
- Virtual Neuron software
- Virtual Neuron – Student Guide

Procedures

Engage — Neuron Communication

1. Direct students to pinch their forearms or wiggle their big toes.
2. Ask students to describe how their body detected the pain of the pinch or movement of the big toe.
3. Discuss how the message is sent from the forearm or big toe to the brain via neurons.

Explore — Neurons and Neuron Communication

1. Ask students to draw a neuron and label the parts.
2. Review with students the parts and functions of neurons.
3. Ask students to draw one neuron sending a message to another neuron.
4. Review with students the synapse, electrical signals (action potential), and chemical signals (neurotransmitters) to illustrate neuron communication.

Questioning — Introducing New Concepts

1. Write the following terms on the board or overhead: Motor Neuron, Sensory Neuron, and Interneuron.
    - Use cues in the words (motor, sense, inter) to help students guess the functions of the different neurons.
    - Tell students to write in their notebooks the functions of the three types of neurons.
2. Ask students to think about a time when they were excited and to describe what the word “Excitatory” means.
3. Discuss how some neurons are excitatory, meaning that they excite or stimulate other neurons.
4. Ask students to think about a time when they were inhibited and ask them to describe what the word “Inhibitory” means.
5. Discuss how some neurons are inhibitory, meaning that they inhibit or inactivate another neuron.

Explore — Virtual Neuron software

1. Working in pairs, ask students to open the Virtual Neuron software.
2. Allow students to explore how to move neurons, along with starting and stopping neuron signal sending.
3. Provide students with a copy of the Virtual Neuron – Student Guide.

Explain

1. Invite three students to come to the board and draw a motor neuron, interneuron, and sensory neuron, respectively.
2. Ask the class to share how they figured out which neurons were the sensory neuron, interneuron, and motor neuron.
3. Ask students to describe how they knew which neurons were excitatory and inhibitory.
4. Ask students to write a reflection paragraph that describes how working with the Virtual Neuron software helped them learn about neurons and neuron communication.
5. Ask for volunteers to share their reflections on using the Virtual Neuron software.

Expand

1. Direct students to design an experiment to test how manipulating a factor in a neuron circuit effects neuron communication.
2. Before conducting the experiment, have each student or group describe their experiment to the class and receive feedback about their experimental plan.
3. Give students time to write a lab report on their experimental results.
4. Allow students to discuss their results and compare their results to the rest of the class.