Unit: Designing Circuits for Neurodevices

Lesson 1: The Nervous System

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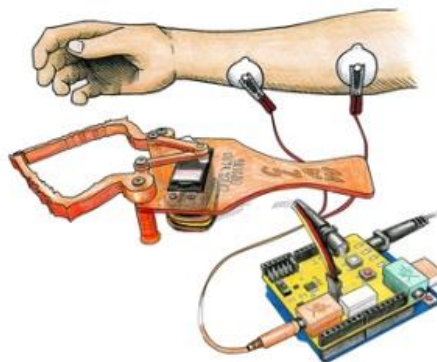

Image credit: BackyardBrains.com

LESSON OVERVIEW

Activity Time:
One 55 minute class period.

Lesson Plan Summary:
In this lesson, students will view a demo of a robotic gripper hand that can be controlled by their own muscles and they will have time to discuss this phenomena with each other. Students will then learn about the basics of the nervous system by watching videos and will teach each other what they have learned.

STUDENT UNDERSTANDINGS

Big Idea & Enduring Understanding:

- **The Nervous System:** The basics on how the nervous system works
- **The Brain**: The brain can be thought of similarly to an electric circuit, where sensory neurons receive input, the brain processes this, and motor neurons instigate a response.

Investigative Phenomenon: A robotic gripper arm translates EMG biosignals from the human body to control a simple machine.

Driving Question:

- How does the robotic gripper work with the nervous system?

Learning Objectives:

Students will know…
- Basic features of the nervous system and how they work.

Students will be able to…
- Explain to another student the basics of the nervous system.

Vocabulary:
- **Demo:** A demonstration of something, such as a technology, for others to see.
- **Nervous System:** Consists of the central nervous system (brain and spinal cord) and peripheral nervous system (all nerves throughout the body not part of the brain or spinal cord).
- **Population:** A specific group of people, distinguishable based on specific characteristics (e.g., gender, age, income level, ability).
- **Technology:** Equipment, machinery, devices, or computer programs that are developed through a knowledge of science and/or engineering.

Next Generation Science Standards:

This lesson builds toward the following Performance Expectation (PE) and its integrated three dimensions of learning. Additional dimensions are denoted with an asterisk (*).

High School Performance Expectations		
HS-LS1-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. (Grades 9-12).		
Science and Engineering Practices (SEPs)	**Disciplinary Core Idea(s)**	**Crosscutting Concepts (CCCs)**
Developing and Using Models *Asking Questions and Defining Problems	LS1.A: Structure and Function	Systems and System Models

TEACHER PREPARATION

Materials

Material	Description	Quantity
Computers	Students will need internet-enabled computers, laptops, or tablets to watch a video.	1/student
Backyard Brains Claw Bundle	EMG robotic gripper/claw that works through a brain computer interface when hooked up to an arm (comes with 50 EMG electrode patches and 2 9v batteries). Source: https://backyardbrains.com/products/clawBundle	1 per class
Backyard Brains EMG Large Muscle Electrode Patches	Extra EMG electrode patches to use with the claw bundle. Source: https://backyardbrains.com/experiments/MuscleSpikerShield_GripperHand	As needed
9v Battery	Extra battery for use with claw bundle	As needed
Student Handouts	*Student Handout 1.1: Gripper Demo Questions*	1 per class/ group/ student
Student Handouts	*Student Handout 1.2: The Nervous System Jigsaw*	1 per student
Teacher Resource	*Teacher Resource 1.2: The Nervous System Jigsaw Answer Key*	1

Preparation

1. Set up the Backyard Brains claw bundle before class begins. Make sure to troubleshoot any issues. See the *Resources* section of this lesson.
2. Prepare entry task and exit tickets in a way that works for your classroom. For example you could print, post on board, or post online.
3. Have questions for Engage section ready to post on board or present to students in some way. Student Handout 1.1 can be used if you would like physical copies.
4. Make copies of Student Handout 1.2: Jigsaw Questions for Crash Course Videos, one per student.
5. Have the *Teacher Handout 1.2* ready to go after the jigsaw activity.

PROCEDURE

Engage: Robotic Gripper Hand Demo (5-10 min)
1. Post the following entry task on the board or in whatever format you use in your classroom.
   a. *What types of technologies exist that could be considered useful for people? List as many as you can think of.*

2. Show students the Backyard Brains claw/gripper. Have student volunteers come up and try it on their own arms as time allows.
   a. Students may want to try this for longer than time allows for. Consider allowing students to come up in staggered times during the Jigsaw portion of this lesson.

Explore: Group Discussion (5-10 min)
3. Have students, in table groups, discuss the following (this is also on *Student Handout 1.1*):
   a. *How did you think it worked?*
   b. *Have you seen anything like this before? Where? When?*
   c. *What is the importance of this type of technology and what population do you think would benefit from it?*
   d. *How does this relate to your life? Or someone close to you?*
   e. *What did you like most about it? What would you change about it?*
   f. *Do you have any further questions or anything else you want to know about it?*

4. Have each table representative share with the class what they have written down for each question on *Student Handout 1.1.*

Explain: Jigsaw of Nervous System Videos (10 min)
5. Number all students off by 1s, 2s, and 3s. Each number will watch and fill out a worksheet for a different Crash Course Nervous System video.

6. Each student will watch their video independently, while filling out the appropriate section of the *Student Handout 1.2: The Nervous System Jigsaw*. Close captioning is available by turning on the CC option on the bottom of the video viewer.
   a. **Group 1:** The Nervous System: Part 1 (10:35 min) (https://www.youtube.com/watch?v=qPix_X-9t7E)
   b. **Group 2:** The Central Nervous System (10:07 min) (https://www.youtube.com/watch?v=q8NtmDrb_qo)
   c. **Group 3:** Peripheral Nervous System (10:01 min) (https://www.youtube.com/watch?v=QY9NTVh-Awo)

Elaborate: Jigsaw Activity (10-15 min)

7. Have each student create a group that includes students who are numbered 1, 2, and 3. Make sure to help with this process if needed.

8. Each student will then be tasked with teaching their other group members about what they learned so that everyone can fill out their own worksheet. This will be done in order based on what video they watched.

Evaluate: Checking answers and exit ticket (5-10 min)

9. Go over answers to the *Student Handout 1.2: The Nervous System Jigsaw* with students using *Teacher Handout 1.2: The Nervous System Jigsaw Answer Key* so that students have the correct answers.
    a. Alternatively, you can collect and grade yourself and return to students.

10. Have students keep both handouts in their journal or using whatever organization you use in your classroom so that they may reference it as the unit continues.

11. Post the following exit ticket on the board or in whatever format you use in your classroom.
    a. *Write a one sentence summary of the nervous system and what you think the most important function is. Explain your reasoning.*

STUDENT ASSESSMENT

Assessment Opportunities:
- Teachers can check in with groups during the jigsaw discussion, as well as during the whole group summary.
- Students will go over the answers to the jigsaw activity to ensure that they are on the right track and have the correct information. *Student Handout 1.2* can be collected by the teacher if needed for assessment purposes. Example answers are provided on *Teacher Resource 1.2.*

Student Metacognition: Students will go over their answers and have ample opportunity to discuss the lesson with their table groups. Afterwards, they will keep both handouts in their journal or notebook to look back on and use as the unit goes on.

Scoring Guide: Students will be successful if they have filled out both of the student handouts and have all of the correct information. This information will be important for understanding the underlying concepts in the rest of the unit. *Teacher Resource 1.2* provides example answers for *Student Handout 1.2.*

EXTENSION ACTIVITIES

Extension Activities: Students could draw a diagram or create a model of the nervous system based on what they have learned through the jigsaw activity.

Adaptations: The jigsaw activity can be modified with different resources of varied levels (higher or lower) and it can be modified to be a partner activity before a group one (for example, students can be paired together to watch the video they are assigned and work together to determine the answers on the handout). All videos linked in this lesson have closed captioning and transcripts available.

TEACHER BACKGROUND & RESOURCES

Background Information: Teachers need to understand how the Backyard Brains claw bundle works, so they should visit the website and watch the videos (see Resources below). If the claw is not working well, try using fresh 9v batteries.

Teachers also need to have a good background on the nervous system and at least a general understanding of how it works. They should also watch the videos before having the students do so.

Resources:
Backyard Brains: The Claw https://backyardbrains.com/products/clawbundle

Backyard Brains Experiment: Controlling the Claw with your Muscles, https://backyardbrains.com/experiments/MuscleSpikerShield_GripperHand

Crash Course: The Nervous System, Part 1: Crash Course A&P #8
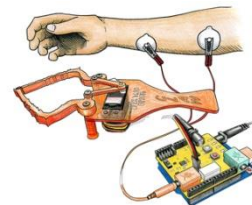YouTube, 2015, 10min 35sec, https://www.youtube.com/watch?v=qPix_X-9t7E

Crash Course: Central Nervous System: Crash Course A&P #11
YouTube, 2015, 10min 7sec, https://www.youtube.com/watch?v=q8NtmDrb_qo

Crash Course: Peripheral Nervous System: Crash Course A&P #12
YouTube, 2015, 10min 1sec, https://www.youtube.com/watch?v=QY9NTVh-Awo

Unit: Designing Circuits for Neurodevices
Student Handout 1.1: Gripper Demo Questions

Name:_____ Date:_____ Period:_____

After viewing the demo, please answer the following questions:
1. How did you think it worked?

2. Have you seen anything like this before? Where? When?

3. What is the importance of this type of technology and what population do you think would benefit from it?

4. How does this relate to your life? Or someone close to you?

5. What did you like most about it? What would you change about it?

6. Do you have any further questions or anything else you want to know about it?

Image credit: BackyardBrains.com

Unit: Designing Circuits for Neurodevices
Student Handout 1.2: The Nervous System Jigsaw

Name:_____ Date:_____ Period:_____

Video 1: The Nervous System

1. What kind of signals do nerve cells use?

2. What are the three principal functions?

3. Define each of the following:
   a. Integration

   b. Motor output

   c. Central Nervous System

   d. Peripheral Nervous System

   e. Neurons

4. Describe and/or draw the main parts of a neuron.

5. List at least 2 other things you learned that you found interesting.

Video 2: The Central Nervous System

1. What are the two main parts of the nervous system?

2. What is the brain's purpose?

3. What is the spinal cord's purpose?

4. Define what is meant by "specialized regions".

5. What do each of the following control and/or do:

   a. Cerebellum

   b. Brain stem

   c. Cerebrum

   d. Frontal Lobe

   e. Occipital Lobe

   f. Parietal Lobe

6. List at least 2 other things you learned that you found interesting.
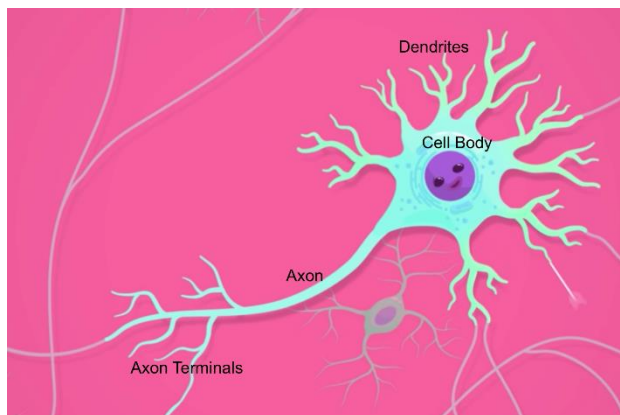
Video 3: The Peripheral Nervous System

1. Why is your peripheral nervous system important?

2. What is the function of the sensory nerve receptors?

3. What input do each of the following receptors respond to?

    a. Thermoreceptors

    b. Photoreceptors

    c. Chemoreceptors

    d. Mechanoreceptors

    e. Nociceptors

4. Draw and/or describe a generic pathway in your peripheral nervous system in response to a stimuli.

5. What is the difference between an innate reflex action and a learned reflex?

6. List at least 2 other things you learned that you found interesting.

Unit: Designing Circuits for Neurodevices
Teacher Handout 1.2: The Nervous System Jigsaw ANSWER KEYS

Video 1: The Nervous System

1. What kind of signals do nerve cells use?
   Electrical and chemical

2. What are the three principal functions?
   Sensory input, integration, motor output

3. Define each of the following:
   a. Integration: The processing of an input and deciding what needs to be done by the nervous system.

   b. Motor output: The response that occurs when your nervous system activates certain parts of your body.

   c. Central Nervous System: The brain and spinal cord.

   d. Peripheral Nervous System: All nerves that branch from the brain to the rest of the body.

   e. Neurons: Nerve cells that respond to stimuli and transmit signals.

4. Describe and/or draw the main parts of a neuron.

5. List at least 2 other things you learned that you found interesting.
   Varies by student.

Video 2: The Central Nervous System

1. What are the two main parts of the nervous system?
    Central nervous system and peripheral nervous system

2. What is the brain's purpose?
    Sorts out all sensory information and gives orders. Carries out complex functions.

3. What is the spinal cord's purpose?
    Two-way signaling between brain and body. Controls muscle reflexes and activities not controlled by the brain.

4. Define what is meant by "specialized regions".
    Parts of the brain that control different functions.

5. What do each of the following control and/or do:

    a. Cerebellum: Coordinate muscle activity

    b. Brain stem: Relays info from body to brain

    c. Cerebrum: Controls voluntary movement and higher thinking

    d. Frontal Lobe: Governs muscle control and cognitive functions

    e. Occipital Lobe: Processes visual cues

    f. Parietal Lobe: Processes touch, pain, and pressure

6. List at least 2 other things you learned that you found interesting.
    Varies by students.

Video 3: The Peripheral Nervous System

1. Why is your peripheral nervous system important?
   Keeps your brain in touch with the physical environment and allowing it to respond.

2. What is the function of the sensory nerve receptors?
   To see what is going on in the world for the central nervous system.

3. What input do each of the following receptors respond to?

   a. Thermoreceptors: Changes in temperature

   b. Photoreceptors: Light

   c. Chemoreceptors: Chemicals

   d. Mechanoreceptors: Pressure

   e. Nociceptors: Pain

4. Draw and/or describe a generic pathway in your peripheral nervous system in response to a stimuli.
   Change in environment (stimulus activates sensory receptors), receptors provide sensation, spinal cord, brain

5. What is the difference between an innate reflex action and a learned reflex?
   Innate-super fast and not voluntary, learned-from experience and with time, can be fast

6. List at least 2 other things you learned that you found interesting.
   Varies by students.