Lesson One: Introduction to Neuroscience
Center for Sensorimotor Neural Engineering
Lesson Plan Author: Phelana Pang

LESSON OVERVIEW

Activity Time: 50+ minutes.

Lesson Plan Summary:
In this lesson, students will be introduced to the parts of the nervous system and neurons.

STUDENT UNDERSTANDINGS

Big Idea & Enduring Understanding:

- The nervous system senses information, processes that information, and responds using different neurons.
- Neurons have a specialized structure that is related to their function.

Essential Question:

- How does the structure of the nervous system relate to its function?

Learning Objectives:
Students will know…

- The parts of a neuron: dendrites receive information, electrical signal runs through the axon, chemical signal is released through the axon terminal.
- Divisions of the nervous system: the central nervous system is composed of the brain and spinal cord, and the peripheral nervous system carries information to and from the central nervous system through sensory and motor neurons.

Students will be able to…

- Describe through words and diagrams the parts of a neuron and the divisions of the nervous system.

Vocabulary:

- **Parts of neuron**: dendrite, cell body, axon, axon terminal, synapse, neurotransmitter
- **Divisions of the nervous system**: central nervous system (brain and spinal cord), peripheral nervous system (sensory/afferent neurons, motor/efferent neurons)

- **Types of communication**: electrical signal, chemical signal, *(action potential, ion channels, voltage difference, threshold)
  *more advanced

Standards Alignment: This lesson addresses the following middle school Next Generation Science Standards (NGSS).

NGSS High School Disciplinary Core Ideas

- **MS-LS1.A**: **Structure and Function**: Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.
- **MS-LS1.D**: **Information Processing**: Each sense receptor responds to different inputs, transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.

NGSS Cross-Cutting Concepts

- **Systems and Systems Models**
- **Structure and Function**

NGSS Science & Engineering Practices

- **SEP**: Developing and Using Models

MATERIALS

Material	Description	Quantity
Student Handout 1.1: The Problem	chart for students to brainstorm what might be challenging for someone with an impaired sense	1 per student
Student Handout 1.2: Nervous System Diagrams	diagrams for students to discuss relationship between PNS, CNS, parts of neuron	1 per student

Neuron Model	model using rope, buckets, pool float, and ping pong balls to simulate nerve impulse (from *Neuroscience 101* - lesson in Teacher Preparation section)	1
Student Handout 1.3: Neurons and Synapse Review	reviews parts of neuron through description and analogy	1 copy per student

TEACHER PREPARATION

1. Acquire/make neuron model (See the lesson plan *Neuroscience 101* at http://www.neuroseeds.org/Lessons/neuroscience101).
2. Copy handouts as listed in the materials section above.

PROCEDURE

Engage: Loss of a Sense (15 minutes)

1. *Student Handout 1.1: The Problem.* Have students brainstorm about the prompt: "If you lost or damaged your sense of _____, what might your world be like? Why?" Students can be assigned one sense to focus on, or students can brainstorm ideas for all senses.

2. Students can pair, then share their thoughts. Discuss as a class: Is this a "problem" to be solved? If this is a problem that can be solved, how do we engineer solutions and pick the best one?

3. Lead into the overview of the curriculum unit by discussing how we'll learn about the nervous system and how it processes inputs. Without a certain sense, how might we design a device to substitute the sense to get similar information? We will also be learning about circuits and engaging in the engineering design process.

Explore and Explain: Parts of the Nervous System (30 minutes)

4. *Student Handout 1.2: Diagrams of Nervous System.* In small groups, come up with a sentence for each diagram (A-E); discuss and review as a whole class (see *Teacher Resource 1.2*)

5. Conduct a class demo of the neuron model designed by Eric Chudler and described in the Sowing the Seeds of Neuroscience curriculum (See http://www.neuroseeds.org/Lessons/neuroscience101). This demo will help students to learn about the structure of neurons with a focus on the electric impulse along the axon versus the chemical signal between neurons. You will make/use your own model or alternatively, you may show the model in use in the following video: http://uwtv.org/series/brainworks/watch/CAKscnzkhHg/ (starting at 10:20 minutes).

Evaluate: Students Begin Homework in Class (5 minutes)

6. *Handout 1.3: Neuron and Synapse Review*. Ask students to label parts of a neuron and create an analogy for different parts of the neuron. *Teacher Resource 1.3* provides a key for this handout.

7. *Homework option:* students can draw/write/create some representation of the difference between the peripheral nervous system (PNS) and central nervous system (CNS), and between sensory and motor neurons in their lab notebooks.

STUDENT ASSESSMENT

Assessment Opportunities: Student knowledge, skills, and concepts for this lesson will be assessed in a number of ways.

- Class discussions can be used to check for general understanding.
- The *Neuron and Synapse Review* handout can be used to check for understanding; students can develop an analogy.

Student Metacognition:

- Provide students opportunities to come up with questions, reflect on their initial ideas about what they know and understand, and write them down in their lab notebook. They can add new/changing ideas to their lab notebook.

Scoring Guide:

- If students are successful, they will meet learning objectives stated above. Evidence needed would be from student answers during the group and class discussions and from homework assignment. See the provided keys in *Teacher Resources 1.2* and *1.3*.

EXTENSION ACTIVITIES

Extension Activities:

- Students can learn in greater depth about the structure of the neuron and/or the nervous system. With neurons, they can explore action potentials, ion channels (chemical-gated versus voltage-gated). With the nervous system, they can learn about more divisions of the nervous system and compare sensory input between internal and external environments.

Adaptations:

- Kinesthetic adaptions:
    - Act out a neural pathway with students playing the part of individual neurons. Have students stand in a line. Left hand is dendrite holding a cup. Right hand contains neurotransmitter (coin, token, marble). When pathway is activated, student releases neurotransmitter into next student's dendrite. Following students cannot release neurotransmitter unless they receive one first. See a description of this activity within the lesson plan *Neuroscience 101* at http://www.neuroseeds.org/Lessons/neuroscience101).
    - Students can create their own model of a neuron using everyday supplies (pipe cleaners, straws, cups, glue, beads, etc.). For examples, see http://faculty.washington.edu/chudler/chmodel.html.
- For gifted or older students:
    - Students can explore how ion channels work to understand the chemical basis for the electrical signal along the axon.

TEACHER BACKGROUND & RESOURCES

Resources:

For introductory lessons and activities on neurons and nervous system, see the lesson plan *Neuroscience 101* at Sowing the Seeds of Neuroscience (http://www.neuroseeds.org/Lessons/neuroscience101) and visit the resources at Neuroscience for Kids (http://faculty.washington.edu/chudler/neurok.html).

Citations:

Sowing the Seeds of Neuroscience. Available: http://www.neuroseeds.org/.
Brainworks. UW TV. Available: http://uwtv.org/series/brainworks/watch/CAKscnzkhHg/

Student Handout 1.1: What is the problem we are trying to solve?

Name:_____ Date:_____

Period:_____

If you lost or damaged your sense of _____….

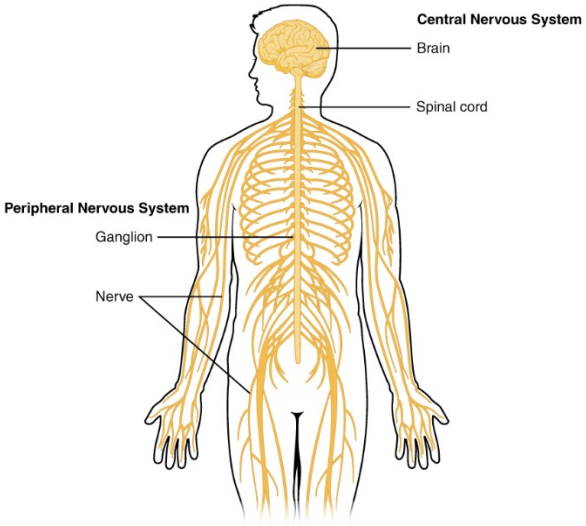
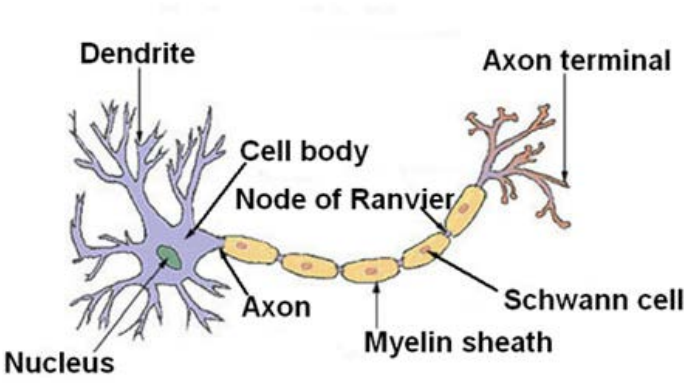
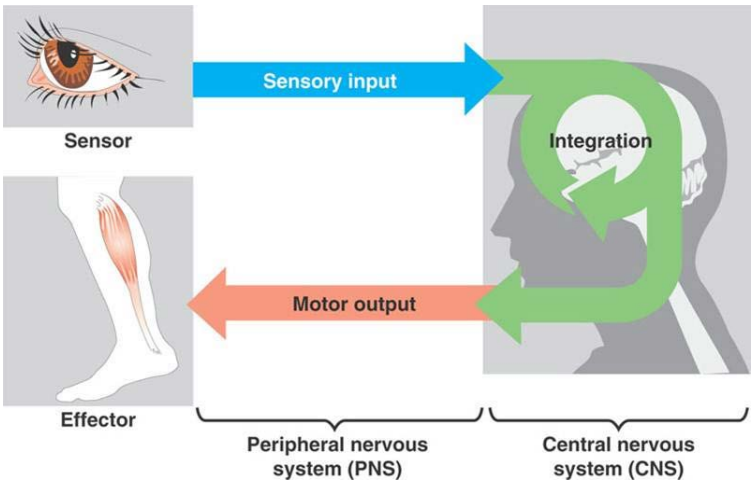
	Sight	Hearing	Touch
….what would you be able to do well or better?			
….what would be more challenging for you to do (but you could still do)?			
….what would be very hard to do?			

What assumptions are we making about what people need to function daily?

Student Handout 1.2: Nervous System Diagrams

Name:_____ Date:_____

Period:_____

A.	 By OpenStax - https://cnx.org/contents/FPtK1zmh@8.25:fEI3C8Ot@10/Preface, CC BY 4.0,
B.	 https://upload.wikimedia.org/wikipedia/commons/b/bd/Neuron.jpg
C.	

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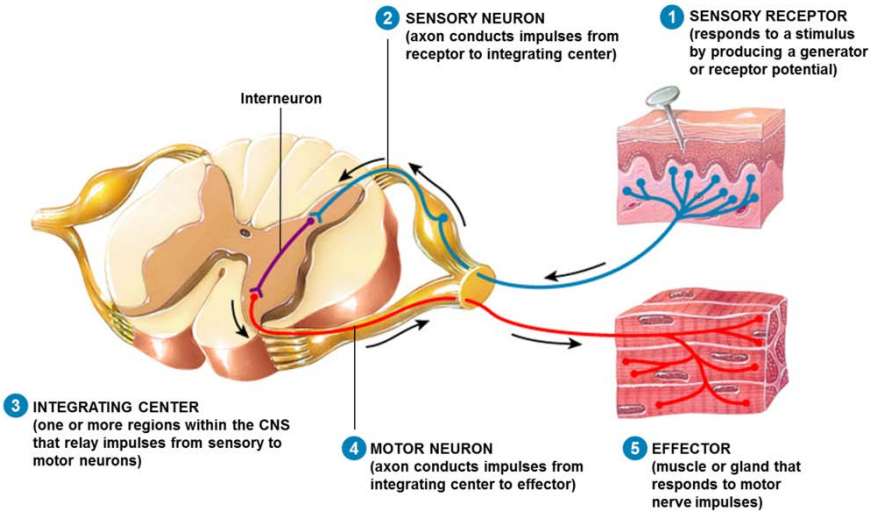
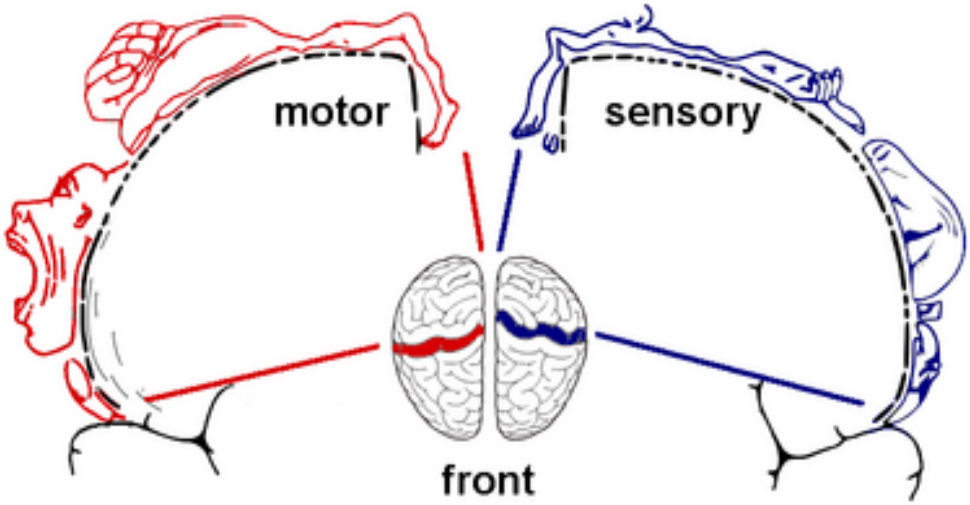
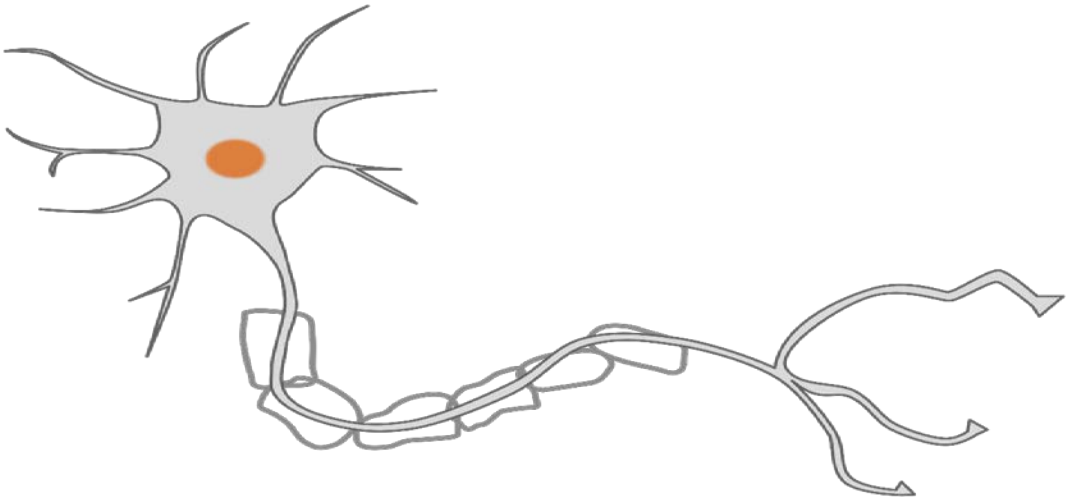
D.	 http://images.rapgenius.com/15bbff4d8aca800d8f495444dbcee8c8.1000x594x1.png
E.	 https://neuwritesd.files.wordpress.com/2013/08/homunculi.png

Main Take-Aways:

Student Handout 1.3: The Neuron

Name:_____ Date:_____

Period:_____



Part of Neuron	Why it's important	How you'll remember where it is and what it's for
Dendrites		
Cell Body		
Nucleus		
Axon		
Myelin		
Axon Terminal		

The Synapse

https://pixabay.com/en/science-neuron-synapse-biology-305773/

The **synapse** is the _____ between two _____ (or between a neuron and a muscle/gland).

When the _____ signal that traveled through the _____ reaches the axon terminal, _____ are released. These neurotransmitters are a _____ signal that travels across the _____. Receptors for the neurotransmitters are located on the _____ of the next neuron (or muscle or gland)

To summarize:

- _____ signals travel _____ a neuron.
- _____ signals (neurotransmitters) travel _____ neurons.

Word Bank:	Electrical	Chemical	Space	Between	Across
	Dendrites	Axon	Synapse	Neurons	Neurotransmitters

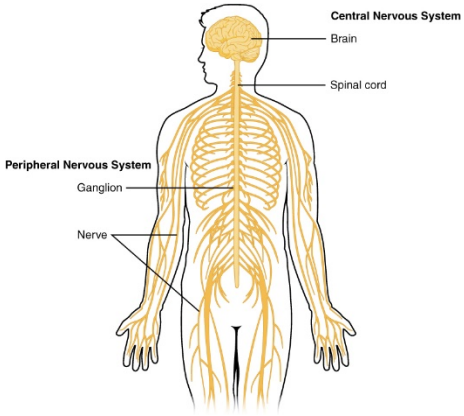
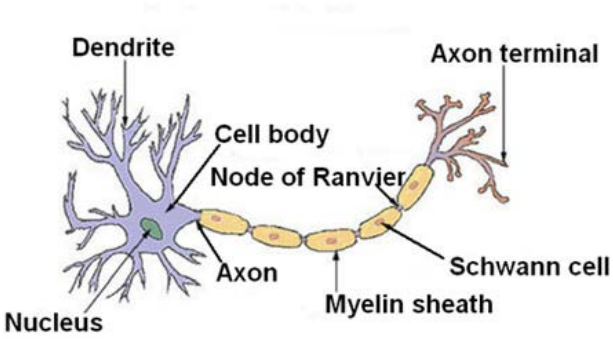
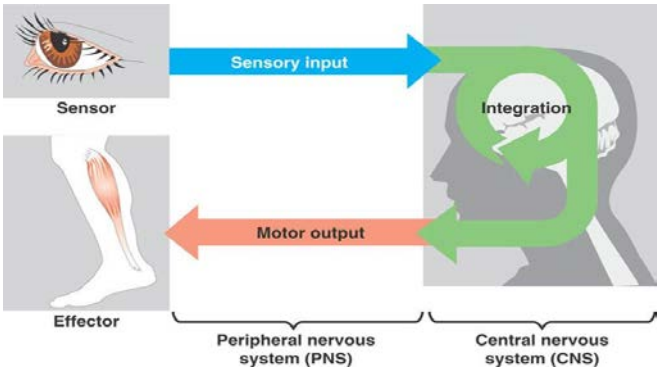
Teacher Resource 1.1: What is the problem we are trying to solve? Answer Key

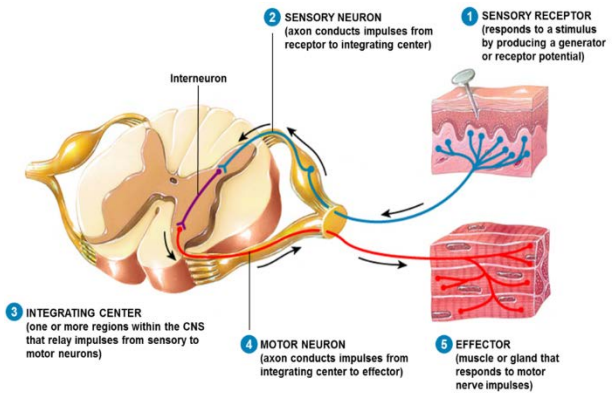
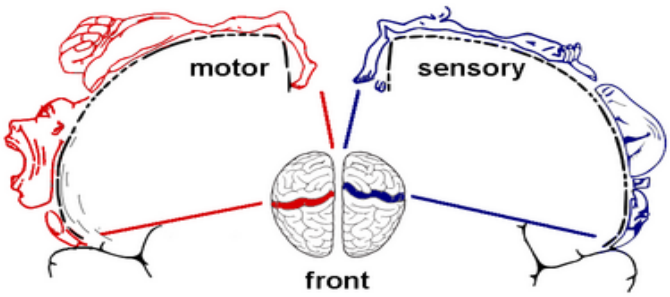
If you lost or damaged your sense of _____….

	Sight	Hearing	Touch
….what would you be able to do well or better?	Possible answers: Listen to conversations Type your thoughts	Possible answers: Lip read what someone is saying across the room	Possible answers:
….what would be more challenging for you to do (but you could still do)?	Possible answers: Cross the street Read Cook	Possible answers: Talk on the phone Play an instrument well	Possible answers: Grip an egg or ball without cracking it or dropping it
….what would be very hard to do?	Possible answers: Drive See facial expressions Choose matching clothes	Possible answers: Hear emergency sirens behind you	Possible answers: Sense temperature Sense pain/injury

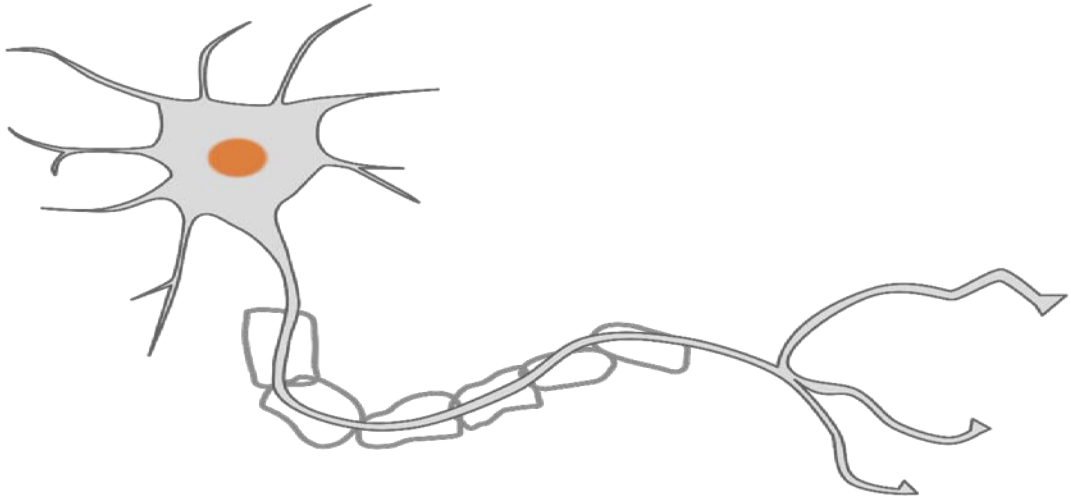
What assumptions are we making about what people need to function daily?

Teacher Resource 1.2: Nervous System Diagrams Answer Key

A. CNS is made of brain and spinal cord; PNS is made of nerves that bring information to and away from CNS	 By OpenStax - https://cnx.org/contents/FPtK1zmh@8.25:fEI3C8Ot@10/Preface, CC BY 4.0,
B. Neuron has many parts: dendrites receive chemical messages, electrical impulse travels down axon	 https://upload.wikimedia.org/wikipedia/commons/b/bd/Neuron.jpg
C. Input from senses go to the brain for processing which sends information to the muscles (motor output).	 http://www.proprofs.com/flashcards/upload/a7106439.jpg

D. Sensory receptors receive information, sending to CNS through sensory neurons which cause muscle or gland to respond based on information sent from motor neuron.	 http://images.rapgenius.com/15bbff4d8aca800d8f495444dbcee8c8.1000x594x1.png
E. Sensory and motor cortex are located adjacent to each other in brain, and neurons responsible for sensing and moving different parts of the body can be mapped out on the brain.	 https://neuwritesd.files.wordpress.com/2013/08/homunculi.png

Teacher Resource 1.3: The Neuron Answer Key



Part of Neuron	Why it's important	How you'll remember where it is and what it's for
Dendrites	Receives neurotransmitters from other neurons	Ex: hand that receives a ball
Cell Body	Contains nucleus and other cell organelles	Ex: head that contains the brain
Nucleus	Contains DNA	Ex: brain that controls what rest of body does
Axon	Where electrical signal travels	Ex: blood vessels that transports nutrients
Myelin	Insulates the axon	Ex: insulation surrounding electrical wire
Axon Terminal	Releases neurotransmitters when electric signal reaches here	Ex: shipping dock releasing boxes of goods to another company

The Synapse

https://pixabay.com/en/science-neuron-synapse-biology-305773/

The **synapse** is the space between two neurons (or between a neuron and a muscle/gland).

When the electrical signal that traveled through the axon reaches the axon terminal, neurotransmitters are released. These neurotransmitters are a chemical signal that travels across the synapse. Receptors for the neurotransmitters are located on the dendrite of the next neuron (or muscle or gland).

To summarize:

Electrical signals travel within a neuron.

Chemical signals (neurotransmitters) travel between neurons.