



UNIVERSITY OF  
NEW ENGLAND

Center for Excellence  
in the Neurosciences

## Neuroanatomy

### Grades 6-12

Driving Question: In what ways do parts of the brain and body work together in order to maintain homeostasis?

Objectives: Students will be able to...

- Describe how neurons differ from other types of cells in the human body.
- Compare and contrast different animal brains to the human brain.
- Describe the basic parts of the brain and the function of each.
- Describe general brain organization.

Next Generation Science Standards:

- MS-LS1-1 Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
- MS-LS1-8 Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
- HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Materials:

- Sheep brain
- Dissection pan
- Dissection kit
- Gloves
- Animal brains (mouse, rat, and human brain model)

Procedure:

*Engage:* Ask the students the following questions:

- Working in groups, the students will collaborate their current knowledge of brain/neuron anatomy.
  - Draw a picture of a neuron.
  - What does each part of the neuron do? Label as many as they can, briefly discuss with each other.
  - With a simple brain diagram label as many parts of the brain you know and if you know the function, write that as well.

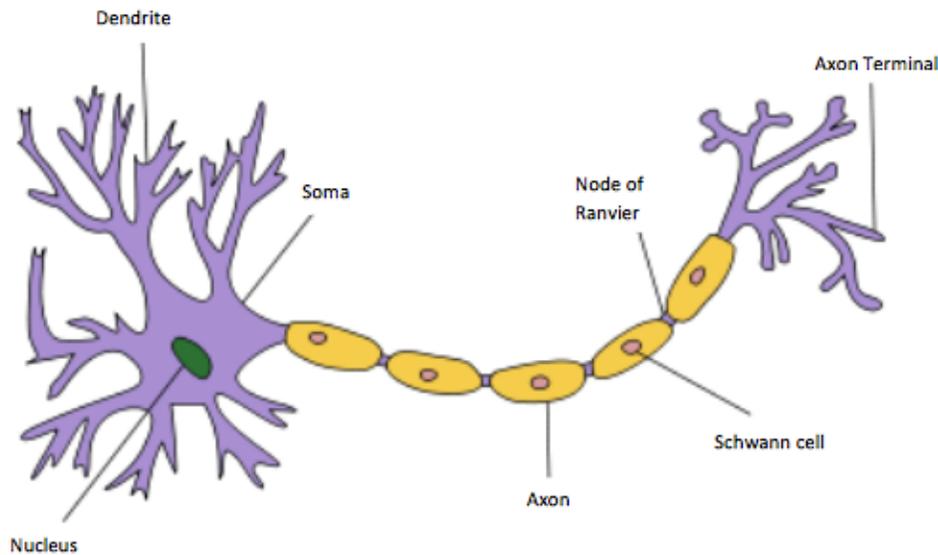
*Explore:*

- Neuron discussion
- Comparative animal anatomy
- Sheep brain dissection

*Explain:*

- Neuron Dissection: discuss the parts of the neuron as you draw it on the board. Allow the students to draw one on a piece of paper as well.

<b>Dendrite</b>	The branching process of a neuron that conducts signals toward the cell.
<b>Soma</b>	The body of an organism, or “cell body”
<b>Nucleus</b>	Oval shaped, membrane bound structure, also contains genetic material in the form of chromosomes
<b>Axon</b>	A long, slender projection of a nerve cell, it conducts electrical impulses away from the soma
<b>Node of Ranvier</b>	A gap occurring at a regular intervals between segments of myelin sheath along the nerve axon
<b>Schwann Cell</b>	A cell of the peripheral nervous system that wraps around a nerve fiber, forming myelin sheath
<b>Oligodendrocytes</b>	A cell of the central nervous system that wraps around a nerve fiber, forming myelin sheath
<b>Axon Terminal</b>	Endings by which the axons make synaptic contacts with other nerve cells



- Comparative Animal Anatomy
  - Using observations, allow the students to describe the visual differences between a rat, mouse, sheep, and human brain.
    - How are the brains alike and different?
  - Use a sheet of paper to describe why we have sulci and gyri on our brain. The sheet of paper represents all the surface of our brain, but it has to fit into our heads so it gets crumpled up and “stuffed” into our skull, creating bumps and creases. Crumple up the sheet of paper to fit it inside your hand, which is representing the head.
  - Compare the sulci and gyri of the rat brain to the human brain. The human brain has the bumps and folds (sulci and gyri) because it has more surface area that needs to fit inside our head. The larger amount of surface area allows for more neurons and a larger brain.
- Sheep Brain Dissection
  - Define the term *homeostasis*.
 

**Homeostasis:** 1) The tendency of an organism or a cell to regulate its internal conditions, usually by a system of feedback controls, so as to stabilize health and functioning, regardless of the outside changing conditions

(2) The ability of the body or a cell to seek and maintain a condition of equilibrium or stability within its internal environment when dealing with external changes
  - Be sure to explain safety precautions and apply gloves.

- Discuss sharp tools, importance of gloves, communication, and to follow directions.
- Explain structures on the outer surface of the brain such as the lobes, sulci and gyri, and brainstem.
- Follow the link for a full sheep brain dissection video:  
<https://www.youtube.com/watch?v=y7gEWzPqm94>

<b>Frontal Lobe</b>	The frontal lobe controls conscious thought, executive thinking, decision-making and movement. This is the most unique to humans and more developed in humans than in animals. If you damage this, you will have trouble working socially and creatively as well as experience impairments with movements, depending on the part of the lobe that is damaged.
<b>Parietal Lobe</b>	This lobe plays important roles in integrating sensory information from various senses (touch, smell, taste, sight, hearing). It is also responsible for visual spatial processing.
<b>Occipital Lobe</b>	This lobe is responsible for the sense of sight. Damage to this lobe can produce hallucinations and blindness.
<b>Temporal Lobe</b>	This lobe controls senses of smell and sound. It also processes complex stimuli like faces. It is important in processing of semantics in both speech and vision.
<b>Cerebellum</b>	This plays an important role in motor control. It may be involved in some cognitive functions such as attention, language and in regulating fear and pleasure responses. It contributes to coordination, precision and accurate timing.
<b>Sulcus</b>	A groove or crevasse on the surface of the brain, creating the gyri.
<b>Gyrus</b>	A fold or curve on the surface of the brain.
<b>Meninges</b>	Three membranes around the brain that provide protection and support. Dura, Arachnoid, and Pia. Dura mater is the outermost and is extremely tough. Arachnoid is between the dura and pia mater. Pia mater is the innermost and delicate layer that lies very tightly to the surface of the brain.
<b>Cerebrospinal Fluid (CSF)</b>	This is the liquid surrounding the brain. It acts as a cushion or buffer for the brain, and allows for the brain to be buoyant. When the brain is suspended in the CSF it is much lighter than it would be without the fluid.

<b>Brain Stem</b>	Controls all things required to live. This includes: respiration rate, change of heart rate, etc.
<b>Optic Chiasm</b>	The point at which the signal for sight is sent to the brain. Where the optic nerves partially cross.
<b>Ventricles</b>	Provide support for the brain, CSF circulates through them. A place with blood turns into cerebrospinal fluid.
<b>Olfactory Bulb</b>	Place where the sense of smell is sent to the brain to be identified.
<b>White Matter</b>	A tissue of the brain consisting of nerve fibers and myelin sheath, allowing it to have the white color.
<b>Grey Matter</b>	A tissue of the brain consisting of nerve cell bodies and branching dendrites.

*Elaborate:*

- Neuron discussion
  - **Myelin Sheath:** The yellow part of the neuron picture. Its main purpose is to increase the speed of signals that travel across the axon. The signal is sent from the dendrite through the nucleus, to the axon, and then goes to the axon terminal.
- Sheep Brain Dissection
  - Explain where the forebrain, midbrain, and hindbrain are located.
  - Discuss other structures of the brain

<b>Corpus Callosum</b>	A thick band of fibers joining the two halves of the brain.
<b>Thalamus</b>	Relays information regarding senses and pain to other parts of the brain. Commonly known as the “gateway in and out of cortex”.
<b>Hypothalamus</b>	Below the thalamus that coordinate the autonomic nervous system and the activity of the pituitary gland. The pituitary gland controls thirst, hunger, and body temperature.
<b>Midbrain</b>	A part of the brainstem that controls visual and auditory systems as well as some body movement. A part of the midbrain called the substantia nigra produces dopamine and the degeneration of it causes Parkinson’s Disease.
<b>Pons</b>	A part of the brainstem that connects the cerebral cortex to the

	medulla. It has several functions including controlling autonomic functions, arousal, and relaying information.
<b>Medulla</b>	A part that is a continuation of the spinal cord to the brainstem. It has several functions such as the control centers for the heart and lungs.

*Evaluate:*

- Did the CEN Outreach volunteer teach the student objectives?
- Did the CEN Outreach program reach the goals of the teacher?
- Did the CEN Outreach program reach it's own goals/objectives?

*Resources:*

- <http://www.biology-online.org/dictionary/Homeostasis>

*NGSS Description:*

- MS-LS1-1 Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

*Students will demonstrate MS-LS1-1 when they learn about neurons. The discussion includes the structure and function of a neuron and how all the neurons in our body work together to send chemical signals.*

- MS-LS1-8 Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

*Students will demonstrate MS-LS1-8 when they learn about various structures of the brain. Structures that respond to stimuli are located and how the brain responds to and sends signals using neurons for behavior and memory is also discussed.*

- HS-LS1-3 Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

*Students will demonstrate HS-LS1-3 when they define homeostasis and learn about the brain structures.*