



UNIVERSITY OF
NEW ENGLAND

Center for Excellence
in the Neurosciences

Human Neuroanatomy

Grades 9-12

Driving Question: How did the evolution of the human brain impact the structure and function it has today?

Objectives: Students will be able to...

- Describe the basic parts and functions of the brain.
- Explain the structure and function of a neuron.
- Explain the structure of the brain.
- Describe the evolutionary theory behind brain development.

Next Generation Science Standards:

- HS-LS1-2 Develop and use model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- HS-LS-4 Communicate through scientific information that multiple lines of empirical evidence support common ancestry and biological evolution.

Materials:

- Animal brain specimens
- Brain diagrams
- Paper and pens/pencils
- Human brain

Procedure:

Engage: Ask the students the following questions and have them record their responses.

- Brainstorm the most important brain functions. What are the things your body does to keep you alive?
- What are the basic functions of human life?

Explore:

- Compare and contrast the animal brain and human brain.
- Discussion of brain parts and functions.
- Discussion of neurons and their function.

Explain:

- Compare and contrast animal and human brain
 - Observe the human brain and animal brain.
 - What is similar and what is different?
 - Surface Area Activity
 - Observe the animal brains and the human brain. Pay close attention to the sulci and gyri. The rat brain does not have the bumps and bulges (sulci and gyri) like the human brain does. That is because the human brain has allows for more surface area, which can fit more neurons!
 - Use a piece of paper: have the students try to fit the sheet of paper into a cup. The paper will need to be crumpled up in order to fit. That is the same way our brain works. We have so much surface area that needs to fit inside our skull, that our brain ends up with sulci and gyri by folding itself in the head. The rat brain has much less surface area than the human brain.
- Discussion of brain parts and functions

Forebrain	
Consists of cerebral hemispheres. For higher levels of functioning such as storage of memories, emotions, thinking, and understanding language.	
Cerebral Hemispheres: Consist of the frontal, parietal, temporal, and occipital lobe.	Frontal Lobe: 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.
Parietal Lobe: 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. It is known as the somatosensory cortex.	Temporal Lobe: This lobe controls the sense of sound. It also processes complex stimuli like faces. It is important in processing of semantics in both speech and vision. Also houses language and speech.
Occipital Lobe: This lobe is responsible for the sense of sight. Damage to this lobe can produce hallucinations and blindness.	Limbic System: Amygdala and hippocampus are the main structures. Stores and forms memories and contributes to emotional responses.
Hypothalamus: 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.	Thalamus: Relays information regarding senses and pain to other parts of the brain. Commonly known as the “gateway in and out of cortex”.

Midbrain	
Consists of tectum and tegmentum. For sensory and motor needs such as the fight or flight response, reflexes, and hunger needs. Connects the hindbrain to the forebrain.	
Tectum: Responsible for auditory and visual reflexes.	Tegmentum: Responsible for emotional responding, motor and automatic

	behaviors, also the source of many neurotransmitters.
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Hindbrain	
Consists of brainstem and cerebellum. For survival mechanisms such as heartbeat, breathing, and sleep/wake cycle.	
Medulla: The point at which the spinal cord becomes the brain. Controls heart rate, blood pressure, and respiration.	Pons: Situated above the medulla. The <i>reticular formation</i> runs through the pons and mediates consciousness.
Cerebellum: Structure located toward the back of the brain. For balance and coordination.	

- First discuss the hindbrain. The hindbrain supports vital body processes such as breathing and sleep.
- Draw the brainstem and cerebellum or point it out on a poster. Allow the students to draw their own on a piece of paper. Label and discuss the functions of the parts listed above.
- Second, discuss the midbrain. The midbrain supports reflexes and other vital functions such as hunger.
- Draw the midbrain and label and discuss the parts above. Allow the students to draw it on their own paper.
- Lastly, discuss the forebrain. The forebrain is for higher executive functions such as emotions, language, and memories. This part is what makes humans different from other species.
- Draw the forebrain and label the parts above with the students.
 - Forebrain: compare forebrain function in animals to humans. The forebrain gives humans the abilities to conduct decision-making and learning. Tadpoles, for example, move away from harm but then return to the same place when the stimulus is taken away. They do not have the forebrain function to learn that they should relocate if there is consistent danger. They have the hindbrain and midbrain function to swim away from immediate danger but cannot problem solve to stay away from the dangerous area.
 - Different animals have different levels of function.

- Neuron Discussion:
 - Discussion of neurons and their function:
 - Draw and label the parts of the neuron with the students. Allow them to draw the neuron a sheet of paper and follow along with the discussion.
 - Explain how the neurons receive and send information. The neuron receives an electrical signal at the beginning of the dendrite. It travels toward the soma and through the axon. At the end of the axon (axon terminal) the signal “jumps” to the next neuron’s dendrite.

Axon	A long, slender projection of a nerve cell, it conducts electrical impulses away from the soma
Soma	The cell body
Dendrite	The branching process of a neuron that conducts the signal toward the cell.
Schwann Cell/Oligodendrocytes	A cell of the peripheral nervous system that wraps around a nerve fiber, forming the <i>myelin sheath</i>
Node of Ranvier	A gap occurring at regular intervals between segments of myelin sheath along the nerve axon
Axon Terminal	Endings by which the axons make synaptic contacts with other nerve cells

Elaborate:

- Compare and contrast the animal and human brain.
 - Concept Check: Why does our brain have sulci and gyri?
 - What are sulci and gyri?
 - Sulci: A groove or crevasse on the surface of the brain, creating the gyri.
 - Gyri: A fold or curve on the surface of the brain.
- Other Brain Structures

Meninges: three layers that cover your

Corpus Callosum: Connects the right

brain and protect it. Protects the brain from physical damage, such as a concussion.	and left hemispheres of the brain
Optic Chiasm: The point at which information from each eye crosses to the other side of the brain.	Ventricles: Empty spaces throughout the brain filled with cerebrospinal fluid. CSF is produced in the ventricles and washes out unwanted things in the brain and nourishes it as well.
Pituitary/Pineal Gland: Produces many of the hormones needed to live such a melatonin for sleep.	Olfactory Bulb: The point at which smell receptors bring information to the brain to process what you smell.

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?

NGSS Description:

- HS-LS1-2 Develop and use model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Students demonstrate HS-LS1-2 when they draw and label the sections of the brain. They learn how neurons work together to create central nervous system function.

- HS-LS-4 Communicate through scientific information that multiple lines of empirical evidence support common ancestry and biological evolution.

Students demonstrate HS-LS1-4 when they discuss the biological evolution of the brain and evaluate the animal brains.