Unit 1:
The Brain and Skull

"The children really enjoyed the lessons and learned a lot. The 'hands-on' elements really help them to stay focused and have a clearer understanding of the information presented. ***Thank you!"***

3rd Grade Teacher

GRADE 3

The Brain and Skull: Background Information

The first unit of the third grade lessons introduces the students to the skull, the part of the skeleton that houses and protects the brain. By comparing the human skull to that of other mammals, the students gain an awareness of the similarities and differences between themselves and other animals. The comparatively larger human brain allows them to perceive and change the world in which they live. The uniqueness of the human brain is explored in the following lessons, as the students learn about basic brain structures and their functions. The miracles of sight, movement, sound, and touch all stem from intricate interactions between mind and body.

Lesson 1: Name That Skull

When the students are looking at the skulls, draw their attention to specific features that can give important clues as to the animal's identity. An examination of the teeth can reveal if the animal was an herbivore, a carnivore, or an omnivore. Are the teeth sharp and pointed, flat and smooth, or a combination of the two? Which one(s) would be the meat eater? Which one(s) probably ate grass and plants? Are there any that look like they could eat anything? Are the eyeholes side-by-side, facing towards the front, or more on the side of the head? Both the baboon and the human eyeholes face towards the front, indicating binocular vision (the ability to focus on an object directly in front, with depth perception). The other animal skulls have eyes more on the side of the head, indicating a wider range of vision, but less of an ability to focus on a close object. An animal that uses its hands or paws more would need depth perception and the ability to focus on nearby objects, while other animals would not.

The foramen magnum is the hole in the base of the skull that allows the brain to connect to the spinal cord. The space inside the skull where the brain sits is called the cranium. In a fifth grade version of this class, the students measured the volume of the animal's brain by pouring material into the cranium, then measuring the amount of material needed to fill it.

Finally, raise the issue of proportion. How large would the brain be in proportion to the body? The cranial area of the human is comparatively quite large, followed in area by that of the baboon.

The small dog and the wolf skulls are different in size, but proportionally, they are very similar. Ask the students to consider the size of the animal. If the small dog skull were about the same size as the wolf skull, would the cranial area be similar? An elephant's brain weighs about 13 pounds, compared to about 3 pounds for a human. Are elephants smarter than people? How big would your brain be if you were as big as an elephant? This will no doubt stimulate some interesting student observations.

Lesson 2: Wonders of the Human Brain
Notes on the Brain Models

The models of the human brain are divided into two separate pieces called hemispheres. The left hemisphere controls the right side of the body, while the right hemisphere controls the left side. The hemispheres are connected together by a band of nerve connections called the corpus callosum. The hemispheres send messages back and forth through this connection. On the models, the corpus callosum is the white 'c' shaped structure in the middle of the inside surfaces. The round circular structures that appear to contain a root system on the lower back of the hemispheres make up the cerebellum. The cerebellum also consists of two connected hemispheres, much like the brain.

The stick-like structure that protrudes from the bottom of the brain is called the brain stem, and connects the brain to the spinal cord. The brain stem is actually a collection of different structures, although we will not be discussing these with the students. The pyramids are the large fibrous material on the brain stem. These carry messages from the brain to the muscles in the body, controlling skilled movement. The structure in front of the pyramids is called the pons, which links the brain with the cerebellum and controls sleep and dreams. The lower part of the brain stem is called the medulla, which controls heartbeat, breathing, blinking, and blood pressure.

While the models give the impression that the corpus callosum, the cerebellum, and the brain stem are each split into two pieces, they are not in an actual brain. This point should be stressed to the students.

The structures beneath the cortex and above the brain stem area will not be discussed in the third grade except in the most general terms. The sub-cortical structures visible on the models include the thalamus, the basal ganglia, the hippocampus, and the fornix. The thalamus is the round spot visible in the center of the brain model. It acts as a message center, relaying information between the brain, the cerebellum, and the spinal cord. Around the thalamus are the basal ganglia, a large collection of nerve cell bodies that help the cerebellum keep body movement smooth and coordinated. The hippocampus is the pink structure draped over the basal ganglia; it is involved in learning and memory. The fornix, the bluish-purple structure above the hippocampus, is a bundle of nerve fibers that carry messages to and from the hippocampus.

The red button-like structure extending from the mid-brain is the pituitary gland. This controls secretion of growth hormones. The white string-like structures extending from the mid-brain are some of the cranial nerves. Detailed brain diagrams will be provided to the teachers for this lesson. The students will be full of questions.

Lesson 3: Making Clay Brains

This lesson introduces the basic parts of brain anatomy and exposes the students to scientists' penchant for using Greek and Latin words to name different structures and discoveries. The Greek term hemisphere, literally half (hemi) a circle (sphere), should be familiar to students from their studies of Earth geography. Comparing the human brain to a globe helps students understand how the word 'hemisphere' can be used to describe any half of a spherical object.

The Latin term corpus callosum describes the 'bridge' between the two hemispheres. This term, which means 'body of hardness', refers to the millions of nerve connections that allows the two hemispheres to communicate with one another. Surgically severing the corpus callosum does not result in a person having two brains; rather, it interferes with the individual's ability to see or identify objects in the right or left fields of vision. This surgery is performed in cases of recurring severe epileptic seizures.

Another Latin word, cortex, is used to describe the outer layer of the hemispheres. Cortex means 'bark', like the bark of a tree. The cortex controls all of our movements, sensory experience, and is critically involved in learning and memory. The terms gyrus (plural, gyri) and sulcus (plural, sulci {pronounced sul-sigh}) are also Latin words that describe the convolutions and furrows that cover the two hemispheres. The gyri are the folds in the cortex, which is precisely what the term means: 'roll' or 'fold'. The sulci are the grooves between the gyri; the word means 'furrow'. If the students are familiar with the furrows of a farmer's field, this may help them learn this word.

The term cerebellum means 'little brain' in Latin, and describes the structure that is situated at the lower back of the cortex. The cerebellum is very much like a little brain, consisting of two hemispheres that communicate with each other through a structure called the vermis. The cerebellum controls balance and coordination of the body. Again, unlike the model brains, the actual cerebellum is not divided into two separate pieces. It is one piece, not literally connected by a single structure, as the hemispheres are by the corpus callosum. The final structure introduced in today's lesson is the brain stem. As you read in the previous notes, the brain stem is actually made up of a number of different structures. For the purposes of this unit, we will refer to these structures collectively as the brain stem, which will be described as the automatic pilot of the body, controlling things we don't have to think about like breathing, heartbeat, and blinking. Again, the students will find the model brains deceptive. Remind them that the brain stem is one piece, not two separate pieces.

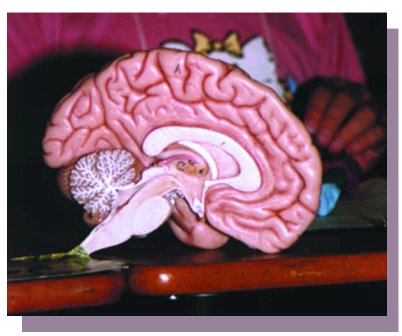
Lesson 4: The Magic Wand

Localization of function in the cerebral cortex is a concept that scientists have only begun to understand in the last 60 or 70 years. The roots of this concept are found in the 19th century 'science' of phrenology. Bumps and protuberances of the skull were thought to correspond to specific emotional and intellectual characteristics. Scientists who studied patients with head injuries refuted this theory, and found specific areas of the brain corresponded with specific motor and sensory activities. Advances in surgical techniques during the 20th century allowed doctors to actually stimulate areas of an exposed human brain, and carefully chart the corresponding motor and sensory responses. Dr. Wilder Penfield (1891-1976) was a pioneer in neurosurgical research, performing hundreds of operations during the 30's, 40's and 50's. His research laid the groundwork for our current understanding of localization of function in the human body.

Dr. Penfield mapped the localization of function in the human brain by stimulating different areas with small amounts of electrical current, and carefully documenting the resulting reaction. His patients were conscious during the operations, and their observations were an important part of the procedure.

The cortices mentioned in the magic wand lesson are the primary motor cortex, the somato-sensory cortex, the primary visual cortex, and the auditory (hearing) cortex. These functional parts of the cortex are found predominantly on individual gyri. The primary motor cortex is responsible for simple muscular movement. More complex movements are controlled by the associative motor cortex, which is located directly in front of the primary cortex. Both the primary motor and the somato-sensory cortex are connected to the body inversely; the movement and sensory areas for the toes and feet are located at the top of the motor and sensory gyri, while the corresponding portions controlling the face and head are found toward the bottom. The visual cortex is located at the back of the brain, where the optic nerves carry the information gleaned by the eyes. The hearing cortices are situated near the ears; like the primary motor and somato-sensory cortices, the right hemisphere serves the left side of the body, while the left hemisphere serves the right. The magic wand lesson is an effective way to reinforce the students' understanding of the 'cross-wired' nature of the brain.

Today, doctors and scientists can use diagnostic tools such as fMRI's (functional magnetic resonance imagery), CAT scans (computerized axial tomography), and PET scans (positronic emission tomography) to observe the inner workings of the brain. Actual brain incisions and removal of tissue such as the prefrontal lobotomy are rarely used, except in extreme cases of epilepsy or the appearance of tumors.



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