Anatomy of the Human Brain
Middle School/High School

This guide is for middle and high school students participating in the AIMS Anatomy of the Human Brain. Programs will be presented by an AIMS Anatomy Specialist. During this activity, students will become more familiar with the anatomical structures of the human brain by observing, studying and examining human specimens. The primary focus is on anatomy, function and pathology. Included in this guide, you will find additional resources such as important terminology and pre/post tests for your students.

National Science Education (NSES) Content Standards

Content Standard K-12	Unifying Concepts and Processes: systems order and organization; evidence, models and explanation; form and function (Grades 9-12)
Content Standard A	Science as Inquiry (Grades 9-12; Grades 5-8)
Content Standard C	Life Science: matter, energy and organization of living systems (Grs 9-12) Life Science: structure and function in living systems; diversity and adaptation of organisms (Grades 5-8)
Content Standard F	Science in Personal Health and Social Perspectives: personal and community health (Grades 9-12) Science in Personal Health and Social Perspectives: personal health (Grs 5-8)

Show Me Standards (Science and Health/Physical Education)

Science 3	Characteristics and interactions of living organisms
Health/Physical Education 1	Structures of, functions of and relationships among human body systems
Health/Physical Education 2	Principles and practices of physical and mental health
Health/Physical Education 3	Diseases and methods for prevention, treatment and control
Health/Physical Education 5	Methods used to assess health, reduce risk factors, avoid high-risk behaviors
Health/Physical Education 6	Consumer health issues

Missouri Learning Standards (Grades 9-12)

Life Sciences (9-12.LS1.A.2)	Interacting systems that provide specific functions within multicellular organisms

Missouri Learning Standards (Grades 5-8)

Life Sciences (6-8.LS1.A.1)	Organisms are made of cells; cells carry out all of the basic functions of life.
Life Sciences (6-8.LS1.A.3)	Multicellular organisms are organized by varying levels of complexity: cells, tissue, organs, organ systems.
Life Sciences (6-8.LS1.A.4)	Body systems interact to carry out key body functions.
Life Sciences (6-8.LS1.B.2)	Environmental and genetic factors influence the growth of organisms.

Topics Covered:

- Brain anatomy, including cerebral hemispheres, cerebellum and brainstem
- Protective coverings of the brain
- Central and peripheral nervous systems, organization of the nervous system
- Neurons and supporting cells of the nervous system
- Cranial and spinal nerves
- Spinal cord anatomy

Lesson Objectives:

Students will participate in the use of a cadaver as a learning tool for health science education.
Students will be able to identify the protective structures of the brain.
Students will be able to identify the four lobes of the brain, including their functions.
Students will increase their understanding of the surface area and structures of the brain and spinal cord as well as their functions within the central and peripheral nervous systems.
Students will increase their understanding of common neurological disorders, their symptoms and treatment.
Students will be able to increase their understanding of the effects of drugs and alcohol on the brain.

Prerequisite Knowledge:

Students should be familiar with terms relating to the central and peripheral nervous systems.

Materials:

Review of Terminology/Vocabulary Reference Guide
Pre/Post Test

Anatomy of the Human Brain
Terminology/Vocabulary Reference Guide

Alzheimer's Disease	A progressive form of presenile dementia that is similar to senile dementia except that it usually starts in middle age. Symptoms include a gradual decline in memory, thinking, behavior and social skills which eventually become severe enough to interfere with daily tasks.
Amygdala	Small structure located in temporal lobe that is responsible for the control of emotions and behavior; activates the fight-or-flight response
Aneurysm	A cardiovascular disease characterized by a weakness in the wall of a blood vessel causing it to dilate or bubble. If it ruptures, blood is released causing injury to surrounding tissues.
Arachnoid	Middle meningeal layer located between the pia mater and dura mater. This thin web-like membrane encloses the brain and spinal cord.
Axon	Part of the neuron (nerve cell) that carries impulses away from the cell body; a usually long process that is covered by myelin for insulation and nerve conduction. There is one axon for each neuron, and its distal end forms synapses where impulses are transmitted from one neuron to another. Axons cannot regenerate as the part distal to the damage will degenerate.
Brainstem	Portion of the brain, consisting of the medulla oblongata, pons and midbrain, that connects the spinal cord to the forebrain and cerebrum. Controls involuntary functions such as heartbeat, temperature, breathing, digestion and homeostatic processes.
Central nervous system	In vertebrates, it consists of the brain, spinal cord, nerves, ganglia and parts of the receptor organs. It receives and interprets stimuli and transmits impulses to the effector organs. In the CNS, a group of neuron cell bodies is known as the nucleus or center; a group of axons is known as a tract.
Central sulcus	Separates the frontal lobe from the parietal lobe; also known as the fissure of Rolando or Rolandic fissure
Cerebellum	Tri-lobed structure of the brain posterior to the pons and medulla oblongata and inferior to the occipital lobes; second largest part of the brain. Responsible for regulation and coordination of complex voluntary muscular movement and maintenance of posture and balance.

Anatomy of the Human Brain
Terminology/Vocabulary Reference Guide (Continued)

Cerebral cortex	Outer layer of gray matter of the cerebrum; receives sensory information and controls motor function. Most highly evolved part of the human brain as consciousness and higher functions of learning, thinking and memory occur here.
Cerebrospinal fluid	Clear watery fluid that flows in and around the hollow spaces of the brain and spinal cord and between two of the meninges (arachnoid and pia); acts a shock absorber to protect brain from injury
Cerebrum	Large rounded structure of the brain that occupies most of the cranial cavity. Divided by longitudinal fissure into two hemispheres which are joined at the bottom by the corpus callosum. Controls and integrates motor, sensory and higher level mental functions such as thought, reason, emotion and memory.
Choroid plexus	A network of blood vessels and cells located in the pia mater found in each ventricle of the brain; produces cerebrospinal fluid (CSF)
Corpus callosum	Arched bridge of nervous tissue that connects the two cerebral hemispheres, allowing communication between the right and left sides of the brain
Cranial nerves	Along with the spinal nerves, these comprise the Peripheral Nervous System; includes 12 pairs of nerves that leave the brain
Dendrite	Part of the neuron (nerve cell) that carries impulses toward the cell body. Dendrites have an unmyelinated surface and tend to be short; each neuron may have one or more dendrites.
Diencephalon	Region of brain made up of thalamus and hypothalamus
Dura mater	Outermost meningeal layer; tough fibrous membrane surrounding the brain and spinal cord and lines the inner surface of the skull
Epilepsy	A neurological disorder characterized by sudden recurring attacks of motor, sensory or psychic malfunction with or without loss of consciousness or convulsive seizures
Fontanelle	Any of the soft membranous gaps between the incompletely formed cranial bones of a fetus or an infant; also known as a “soft spot”
Fourth ventricle	Cavity in the brain that is filled with cerebrospinal fluid that connects to the central canal of spinal cord; also connects to third ventricle

Anatomy of the Human Brain
Terminology/Vocabulary Reference Guide (Continued)

Frontal lobe	The largest and most anterior part of each cerebral hemisphere, responsible for executive function
Gray matter	Brownish-gray nerve tissue found in the cerebral cortex and inner portion of the spinal cord; comprised of neurons, their dendrites, some supportive tissue and unmyelinated axons
Gyri	Any of the prominent rounded, elevated convolutions on the surfaces of the cerebral hemispheres; the folds of the cerebral cortex
Hemorrhage	Excessive discharge of blood from the blood vessels; profuse bleeding
Hippocampus	Region below lateral ventricles; involved with emotions and converting short term to long term memory and influences activity of hypothalamus
Hypothalamus	Part of diencephalon and inferior to thalamus; responsible for regulation and maintenance of internal homeostasis (body temperature, certain metabolic processes and other autonomic activities)
Lateral sulcus	Deep fissure in each hemisphere that separates the frontal and parietal lobes from the temporal lobe; also known as the Sylvian fissure
Lateral ventricles	Largest ventricles of the brain (first and second); contain cerebrospinal fluid
Longitudinal fissure	Deep groove that separates the two cerebral hemispheres
Medulla oblongata	Inferior portion of brainstem in the vertebrate brain, continuous with the spinal cord. It is responsible for the control of respiration, circulation (HR/BP) and other bodily functions (coughing, sneezing, hiccupping).
Meninges	Three layers of tissue that enclose the brain and spinal cord in vertebrates to cover and protect
Meningiomas	A slow-growing tumor of the meninges, occurring most often in adults

Anatomy of the Human Brain
Terminology/Vocabulary Reference Guide (Continued)

Midbrain	Topmost part of the brainstem between the pons and the diencephalon; also called “mesencephalon”
Multiple Sclerosis	Demyelinating disease marked by patches of hardened tissue in the brain or spinal cord and associated with partial or complete paralysis and jerking muscle tremor
Myelin	White fatty material, composed chiefly of lipids and lipoproteins, that encloses certain axons and nerve fibers
Nervous System	In vertebrates, it is the bodily system made up of the brain and spinal cord, nerves, ganglia and parts of the receptor organs; receives and interprets stimuli and transmits impulses to the effector organs
Neurons	Functional cell of the nervous system. A typical **neuron** consists of a **cell body**, containing the **nucleus** and the surrounding cytoplasm (**perikaryon**), several short radiating processes (**dendrites**) and one long process (**axon**), which terminates in twig-like branches (**telodendrons**) and may have branches (**collaterals**) projecting along its course. Does not regenerate.
Neuropathy	Abnormal condition characterized by inflammation and degeneration of peripheral nerves
Neurosurgeon	A physician who does surgery on the nervous system
Occipital lobe	Posterior lobe of each cerebral hemisphere; contains the visual center of the brain
Olfactory bulbs	Cell bodies of neurons that synapse with neurons of olfactory nerves to process smell signals
Oligodendrocytes	Cells in the Central Nervous System that produce myelin
Optic chiasma	Crossing point of the optic nerves
Parietal lobe	Middle portion of each cerebral hemisphere, separated from the frontal lobe by the central sulcus, from the temporal lobe by the lateral sulcus; primarily responsible for sensation

Anatomy of the Human Brain
Terminology/Vocabulary Reference Guide (Continued)

Parkinson's Disease	Degenerative disease of the basal ganglia; occurs most often after 50 years of age. Associated with the destruction of brain cells that produce dopamine; characterized by muscle tremors, slowing of movement, partial facial paralysis, peculiarity of gait and posture and weakness.
Peripheral nervous system	In vertebrates, it consists of the nerves outside the central nervous system, including the 12 cranial nerves, 31 spinal nerves and sympathetic and parasympathetic nervous systems. In the PNS, a group of neuron cell bodies is known as a ganglion; a group of axons is known as a nerve.
Pia mater	Innermost meningeal layer; fine vascular membrane that closely envelops the brain and spinal cord under the arachnoid and the dura mater. Binds to the surface of the brain and is made up of many blood vessels which carry food and oxygen to the brain.
Pineal body	Endocrine gland in roof of third ventricle, secretes melatonin
Pituitary gland or Hypophysis	A small oval endocrine gland attached to the vertebrate brain; its secretions control the other endocrine glands and influence growth, metabolism and maturation.
Pons	Anterior to the medulla oblongata; band of nerve fibers of the brainstem that links the medulla and the cerebellum with other parts of the brain and spinal cord
Postcentral gyrus	Anterior convolution of the parietal lobe; location of the primary somatosensory cortex
Precentral gyrus	Posterior convolution of the frontal lobe; location of the primary motor cortex
Schwann cell	Cells in the Peripheral Nervous System that produce myelin; able to regenerate by forming a tube or nerve sprouts to make new connection
Seizures	Abnormal electrical discharge in the cerebral cortex; a sudden attack or convulsion characterized by generalized muscle spasms and loss of consciousness
Skull	Skeleton of the head forming a bony case that encloses and protects the brain and chief sense organs; also supports the jaw

Anatomy of the Human Brain
Terminology/Vocabulary Reference Guide (Continued)

Spinal cord	Thick, whitish cord of nerve tissue that extends from the medulla oblongata down through the spinal column and from which the spinal nerves branch off to various parts of the body
Stroke or Cerebral Vascular Accident (CVA)	Sudden loss of brain function caused by blockage or hemorrhage of a blood vessel to the brain; characterized by loss of muscular control, diminution or loss of sensation or consciousness, dizziness, slurred speech or other symptoms that vary with the extent and severity of the damage to the brain
Subarachnoid space	Area between the arachnoid mater and pia mater that is filled with cerebrospinal fluid
Sulci	Any of the narrow fissures, grooves or depressions separating adjacent convolutions or gyri of the brain. Deeper sulci are often referred to as fissures and used as landmarks to divide the cerebrum into regions.
Suture	Line of junction or an immovable joint between two bones, especially of the skull
Synapse	Surface of separation; point where signal goes from one neuron to another
Temporal lobe	Lower lateral lobe of either cerebral hemisphere, located in the front of the occipital lobe and containing the sensory center of hearing in the brain
Thalamus	Large ovoid mass of gray matter that is part of diencephalon; located in the center of the brain and superior to hypothalamus. Serves as the sensory relay center, sending sensory impulses to the cerebral cortex. All sensory nerves (except olfactory) enter it and impulses are sent to appropriate higher brain centers for interpretation.
Third ventricle	Cavity in the brain that is filled with cerebrospinal fluid that connects the lateral ventricles to the fourth ventricle
Transverse fissure	Separates the cerebrum from the cerebellum
Tumor	Abnormal growth of tissue resulting from uncontrolled, progressive multiplication of cells and serving no physiological function

Anatomy of the Human Brain
Terminology/Vocabulary Reference Guide (Continued)

Ventricle	Small cavity or chamber within a body or organ; any of the interconnecting cavities of the brain. One of the four cavities in the brain that is filled with cerebrospinal fluid.
White Matter	Whitish nerve tissue found in inner portions of the cerebrum and outer regions of the spinal cord; comprised chiefly of myelinated nerve fibers. Allows cerebrum to communicate with the rest of CNS including within the cortex and lower brain centers in the brainstem/spinal cord. Functions include association and information exchange.

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Anatomy of the Human Brain
Pre/Post Test

1. The two main components of the central nervous system are:
   a. _____ b. _____
2. Control of voluntary movements of specific body parts is located in this lobe:
   _____
3. The outer layer of the brain or gray matter that is the highest center of nervous system activity is known as the _____.
4. The middle meningeal layer, which contains the cerebrospinal fluid, is known as the _____.
5. The cerebrospinal fluid (CSF) is produced deep within the ventricles of the brain by specialized vessels called the _____.
6. The convoluted or folded surface of the brain consists of a system of rounded ridges separated by deep grooves. The elevated ridges are called _____ and the grooves are called _____.
7. Name the four main lobes of the brain:
   a. _____
   b. _____
   c. _____
   d. _____
8. The part of the brain involved in the coordination of voluntary motor movements, balance, equilibrium and muscle tone: _____
9. This is the term used to describe brain damage caused by a blocked blood vessel or bleeding in the brain: _____
10. This is the lower portion of the brainstem which deals with autonomic functions including breathing, blood pressure and control of heart rate: _____
11. Axons of the brain are coated with a fatty substance which helps to speed impulses between neurons and gives “white matter” of the brain its color. This coating is called _____.
12. This lobe is responsible for processing sensory stimulation from receptors throughout the body: _____.

Bonus: Are you interested in a career in medicine, science or healthcare?
_____

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Anatomy of the Human Brain
Pre/Post Test Answers

1. brain; spinal cord
2. frontal lobe
3. cerebral cortex
4. arachnoid mater
5. choroid plexus
6. gyri; sulci
7. frontal; parietal; occipital; temporal
8. cerebellum
9. stroke or CVA (cerebrovascular accident)
10. medulla oblongata
11. myelin
12. parietal lobe