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Brain Structure and Function and Disease

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Introduction

The US Congress voted the 1990's the decade of the brain. Thanks to the advent of imaging methods, such as CT (computer tomography), PET (positron emission tomography) and MRI (magnetic resonance imaging), brain mapping flourished. Brain mapping, or the understanding of which regions of the brain are responsible for specific mental processes, has allowed us to better understand the structure-function relationship of this previously mysterious organ. This unit is appropriate for middle school science education and will cover the basic anatomy of the brain and the functions of specific regions of the brain. The mechanism of Parkinson's Disease and the impact of alcohol on the brain are discussed.

There are many divisions made to brain structure for the purpose of understanding all it's functional regions. Like a Russian matryoshka doll, a doll within a doll, the brain has various levels at which structure and function can be detailed, but the most superficial division can be made between the brain's macroanatomy and microanatomy. The macroanatomy is the larger global anatomy, divided into segments that are large enough to see with our eyes, the macro structures of the various parts of the brain. The large convoluted structure of the cerebrum is an example of the brain's macro-anatomy. The cerebrum is the brain's processing powerhouse. The cerebrum is further divided into the right and left hemispheres, with the right hemisphere serving the left side of the body and vice versa. And when we look further within each hemisphere, we find the frontal lobe, parietal lobe, occipital lobe, and temporal lobes (See Diagram 1) providing numerous functions, such as our senses, comprehension, speech and our perceptions of our body's orientation in space. As will be further illustrated, our current descriptions of the brain's structure, is largely based on isolating regions that are functionally related.

The most prominent feature of the brain's microanatomy is its cellular structure, particularly the presence of neurons. Neurons are the brain's functional cells. It is within this microanatomy that we find a network of cells communicating at amazing speeds using electrochemical means. These electrochemical pathways link different regions of the brain. Neurons from one functional region literally reach out to link it to other regions, thus bestowing us with the remarkable ability to both see and understand what is being seen at the same time, for example.

A basic understanding of brain structure and function should be incorporated into the middle school life science curriculum. The brain is largely neglected in the middle school curriculum perhaps because it seems

too complex to be addressed at this grade level. But as our understanding of the brain advances, one can't help but feel this void in middle school curriculum makes it out of date.

In my experience as a 7th grade life science teacher, many students show interest in understanding the brain and ask sincere questions about brain structure and how it functions. Many of these questions seek to understand how other animals' or mammals' brains relate to humans or what is happening in the brain of family members with a neurological disorder. Questions about diseases like Parkinson's Disease and Alzheimer's Disease or the effect of drugs and alcohol on the brain often arise. Without a common technical language and a basic understanding of the brain and how it functions, I am able to answer such questions only in a superficial way.

As a public school life science teacher at Everett Middle School, I try my best to educate my students with texts, journals, videos, labs and field trips. With the learning I've obtained from the Yale Teacher Initiative Seminars and curriculum writing, I will be able to bring a deeper understanding of the brain to my students, which in my opinion must begin with the knowledge of brain structure and how those structures contribute to brain functions.

Everett Middle School serves approximately 600 students in the Castro/Mission District of San Francisco California. The student population is of a low economic class (95% receive free lunch), minority (70% Latino, 15% African American, 5% Asian, 10% Other etc.) and many perform below or far below basic reading and math skills. In addition, many have behavioral problems attributed largely to living in a culture that doesn't address their needs more directly and to being raised in families that struggle to survive. It is important that any topic I teach be presented in a fashion that makes it accessible to this student population.

Most of my lessons are presented in a fashion that encourages conversation, questioning, and exploration using plenty of visual aids and dramatization. This approach to teaching is important to keep the attention of all students learning life science, but also to accommodate the ELL student (English Language Learner), which is a constant consideration for me. I feel it's important to stress that one of my primary teaching goals is to both engage a student and to present materials in a way that makes science accessible to them. Additionally, I attempt to provide them with the opportunity to take ownership of academic knowledge without hesitation to be involved in the learning process and in a fashion that is not degrading. To accomplish these goals, I have designed a unit on brain structure and function with an approach that makes what is seen as a difficult subject more accessible to the student learner. The unit is divided into three sections, which examine the brain at different levels.

Section One of the Brain Structure and Function Unit will discuss brain gross anatomy and its relation to brain function. Several important concepts will be introduced: the subdivisions of the brain, the role of the cerebral cortex, the role of the cerebellum and the brain stem. Projects and labs will be suggested to enforce the concepts of Section One, such as a comparative look at the anatomy of brains across a few chosen species using visual aids to further enforce the knowledge of the regions of the brain.

Section Two will introduce brain microanatomy, particularly the role of neurons. The anatomy of the neuron will be presented, as well as mechanisms that neurons use to relay information to one another. The biology of neurotransmitter-receptor binding (neurotransmission) is covered.

Section Three covers Parkinson's Disease and alcohol. To synthesize the two prior sections on macroanatomy/function and microanatomy/neurotransmission, Parkinson's disease is covered. Parkinson's disease is a good model in that it involves a specific neurotransmitter (dopamine) and receptors, occurs in a

specific region of the brain involved in motor function (midbrain), and has a profound effect on functioning. A discussion of alcohol will further bring together prior learning.

This unit is written in hope that all middle school teachers can implement the unit into their science and health curriculum. I also hope this unit will further foster student engagement in the study of life science and allow for its application to real life situations through knowledge and critical thinking.

Structure and Function

Structure and function relationship of the brain can be more easily understood by dissecting the brain into functional parts. The human brain weighs about 3 pounds and is composed of approximately 100 billion neurons. The neuron is the basic functional building block of the brain. Structurally it is the most complex of organs. Housed within the skull, the brain acts as the controller of the entire nervous system and, therefore, regulates and coordinates many of the body activities.

The brain is divided into three regions: forebrain, midbrain and hindbrain. Part of the hindbrain (medulla oblongata and pons) and the midbrain are collectively known as the brain stem. The brain stem connects the brain to the spinal cord to form the central nervous system.

The Forebrain

The forebrain is the most developed part of the human brain (See Diagram 2). Many structures are contained in the forebrain, but only the cerebrum, thalamus, hypothalamus, and basal ganglia are discussed here. The large cerebrum is divided in two by the great longitudinal fissure into two cerebral hemispheres (right and left brain). The longitudinal fissure is a cleft that runs from the forehead to the back of the head through the cerebrum, dividing it in two. The surface of the cerebrum is highly convoluted and grey in appearance and is specifically known as the cerebral cortex. The gray color is due to the presence of cell types (neuronal cell bodies, neuropil and glial cells) found in the nervous system (the cellular region of the brain is sometimes called). Glial cells are non-neuronal cells that maintain and provide nutrition and support for neurons. Neuropil lie between neuronal cell bodies consisting of axon cell bodies, dendrites, and glial cell bodies. The dense folds of the cerebral cortex extend over two square meters and act to increase the surface area, thus increasing the volume of cells in the forebrain. The more cells of the cerebral cortex, the better the ability to perceive, remember, and perform all higher cognitive functions, including concentration, reasoning and abstract thought, which are all attributed to the cerebral cortex.

Below the gray surface cerebral cortex is white matter, which is composed of myelinated or insulated neurons.

The two hemispheres of the cerebrum are united by the corpus callosum, which can be identified as a white arch-like structure (made of white matter) that links the two cerebral hemispheres. White matter is composed of myelinated or insulated neurons. The white matter nerve fibers of the corpus callosum connect the grey matter of the two cerebral hemispheres to allow the communication between the right and left brain. It has

been suggested that the difference in size of the corpus callosum between men and women (with a women's being larger) may explain the lay belief that woman are more intuitive. The increase in "cross-talk" between the right brain (associated with creativity) and the left brain (associated with linear thinking) may be a basis for some gender differences.

Each of the cerebral hemispheres can further be divided into four lobes: the frontal, parietal, occipital and temporal lobes. The frontal lobe is at the front of the head, parietal lobe is on top of the head, occipital lobe is at the rear of the head, and temporal lobe is on the sides of the head (See Diagram 1).

The organization of functions within the cerebral hemisphere is highly localized. Language functions (speech, reading, writing and calculation) are organized in the frontal, parietal and temporal lobes. Vision is organized in the occipital lobes and the perception or recognition of objects and human faces is found within the temporal lobes. The ability to maneuver the limbs and body in space, known as the visuospatial function, are found within the parietal lobes.

Areas of the frontal lobes are also involved in learned movements of the head, neck, and limbs and other motor functions, problem solving, and goal-directed behavior. The temporal lobes are also involved in learning new information and recollecting from experience (memory).

Regions of brain responsible for the special senses (vision, hearing, taste, touch, and smell) can also be found within the forebrain. Within the parietal lobe is the somatosensory region, which is responsible for touch, temperature, proprioception (recognition of body position), and pain. Sound is processed within the temporal lobe and vision within the occipital lobe.

Three other major structures of the forebrain are the thalamus and hypothalamus. The thalamus functions include relaying sensation and special sense signals to the cerebral cortex, relaying motor signals from the cerebral cortex, and the regulation of consciousness, sleep and alertness. Since the thalamus is centrally located within the brain, it is ideally positioned to relay information to different regions of the brain. The hypothalamus is the smaller structure lying below the thalamus. The hypothalamus controls body temperature, hunger, thirst, fatigue, and circadian cycles. The basal ganglia, which is also found in the forebrain, facilitates useful, purposeful movements and inhibits unwanted movements initiated by the substantia nigra, which will be discussed below. In addition to the structures mentioned, there is a pathway in the forebrain known as the reward pathway that is associated with addiction.

The Midbrain

The region below the forebrain is the midbrain (See Diagram 2). The midbrain is the smallest region of the brain and has three significant parts for voluntary motor functions: tectum, tegmentum, and the substantia nigra. The tectum and tegmentum are also important for vision, hearing, and eye and body movements. The substantia nigra, contains large numbers of dopamine producing cells, which are necessary for controlled body movements; this region of the brain, is directly linked to Parkinson's Disease.

The Hindbrain

The hindbrain is composed of the medulla oblongata, pons and cerebellum (See Diagram 2). The hindbrain collectively controls the involuntary/autonomic nervous system, sensory perception, coordination and movement.

The medulla oblongata is found in the lowest most part of the brainstem. It relays nerves signals between the brain and the spinal cord and controls and regulates the autonomic functions of respiration, blood pressure and heart rate, as well as swallowing, vomiting, defecation, and urination. Interestingly, death by hanging is a result of cervical vertebra piercing the medulla oblongata by the force of the rope, which stops breathing and the heart.

The pons resides above the medulla oblongata. The pons acts to transmit sensory information between the cerebellum and the forebrain/cerebrum, plays a role in sleep and arousal, and also acts to regulate the autonomic nervous system.

The cerebellum (See Diagram 1) contains approximately 50% of the neurons of the brain or 50 billion of the 100 billion neurons in the whole brain. Surprisingly, this is only 10% of the total volume of the whole brain, because the cerebellum is primarily composed of tiny granule cells.

The cerebellum is involved in sensory perception, coordination, and movement. The cerebellum contains many neural pathways connecting it with the cerebral motor cortex and the spinocerebellar tract. Cerebral motor cortex is a region in the forebrain that relays information to muscles. Spinocerebellar tract is a tract of nerve fibers originating in the spinal cord providing feedback on limb and joint position in space. By integrating these two pathways, the cerebellum defines movements based on constant feedback from the spinocerebellar tract.

Microanatomy of the Brain

The neurons of the brain are constantly sending and receiving information between the regions of the brain and the body. These neuron-to-neuron messages transmit information about what is happening in the world, relay vital information about the state of the body, and allow for the appropriate response to changing conditions.

There are many different types of neurons. Neurons vary in shape and size, but all share certain characteristics (See Diagram 3). Each neuron has a single cell body with processes emerging from it known as dendrites and an axon. Dendrites act to receive information from neighboring neurons to the cell body, whereas the axon acts to carry information away from the cell body to the axon terminus. Dendrites have a collection of receptors that bind compounds known as neurotransmitters, which are released at the axon terminus of neighboring neurons. Neurotransmitters act as chemical messengers between neurons. There are many different kinds of neurotransmitters: dopamine, serotonin and gama-aminobutyric acid (GABA) are well known and studied.

The neuron that releases the neurotransmitter (from the axon terminus) is known as the pre-synaptic neuron, while the neuron that binds it (at the dendrite) is known as the post-synaptic neuron (See Diagram 4). Neurons release and bind neurotransmitters in a narrow space known as the synaptic cleft or synapse.

Neurons relay information between each other in a process known as neurotransmission. The process begins with the pre-synaptic cell receiving some form of stimuli. The pre-synaptic cell releases neurotransmitters into the synapse where the post-synaptic cell can bind them. After subsequent binding, an electric signal, an action potential, is generated along in the post-synaptic cell's axon. This electrical signal causes the post-synaptic cell in turn to release neurotransmitters from its axon terminus into another synapse and the cycle continues.

Though not covered in detail here, an action potential is a wave of electrical energy that allows neurons to carry a signal along its length. Changes in permeability of the neuron's axon membrane to sodium (Na+) and potassium (K+) ions drive the propagation of the signal.

Parkinson's Disease

The symptoms of Parkinson's Disease are tremors, muscle rigidity, slowed movements, and/or the inability to move and impaired balance and speech. Tremors are characterized by the uncontrolled shaking of extremities, specifically the hands. Muscle rigidity is the tightening of muscles. The disease is caused by the loss of the dopamine-producing cells within the substantia nigra of the midbrain. The lack of dopamine disables the substantia nigra-basal ganglion connection necessary for controlled movement.

There are two substantia nigra in the brain. One is on the right side and one is on the left side deep in the midbrain. The cells of the substantia nigra produce and use the neurotransmitter dopamine to send signals that coordinate movement. Because of an unknown factor harming the substantia nigra, cells in this region that produce dopamine continue to degenerate and die. The death of these dopamine-generating cells causes a disruption in the process of relaying messages to other important motor regions, such as basal ganglia. The effected substantia nigra slowly reduces the supply of dopamine to the region resulting in symptoms. These severe symptoms do not usually appear until 80% of dopamine-producing cells of the substantia nigra are lost. No cure has been discovered, although the drug L-dopa can elevate dopamine levels in the brain and reduce symptoms for some people suffering from Parkinson's disease.

Alcohol and The Brain

Alcoholism is a psychiatric disease characterized by the excessive drinking of alcohol. Studies have shown biological children from alcoholic parents, who have been placed in non-alcoholic families, have a high occurrence to become alcoholic. Other studies have shown that children of non-alcoholic parents placed into homes of alcoholics did not have an increase risk to become alcoholic. From these studies, many speculate that alcoholism has a strong genetic component.

When alcohol reaches the brain, it depresses or slows down the way the brain works by disrupting some of the messages the brain sends to itself and throughout the body. This is because alcohol is able to bind many different (neurotransmitter) receptors and inhibit or prevent an action potential. One such receptor is called gama-aminobutyric acid (GABA) receptor. GABA, the neurotransmitter, is the body's inhibitory neurotransmitter and thus acts to prevent the transmission of excitatory signals (i.e. pain and anxiety). Many different anesthetic and sedative medications mimic GABA by binding the GABA receptor. Alcohol increases the effect GABA has by acting on the GABA receptor, which is why people often feel more relaxed after consuming alcohol.

In addition to the activations of the GABA receptors, alcohol also increases the release of naturally occurring opiods, which in turn increases the release of dopamine. These naturally occurring opiods cause a flooding of dopamine in the forebrain, specifically in the pathway known as the reward pathway of the forebrain. Besides drinking alcohol, eating, gambling and sex also increase dopamine levels in the reward pathway of the brain by the same means. Hence, people crave these things.

Many alcoholics are clinically depressed and drink as a form of non-medical treatment for their depression (Ironically, because of its action on the GABA receptor, alcohol itself is a depressant). Alcohol also acts to cause the release of serotonin, a neurotransmitter associated with happiness, in the brain. As one continues to drink, one is often encouraged to drink more because of the positive feedback of feeling happier.

Lessons

As an introduction to the unit, I recommend a whole group discussion. Teachers may want to welcome and introduce the unit with an open dialogue. This will safely encourage and include all students to participate, regardless of whether they have the academic knowledge or language skills to do so. Some guiding questions may be, "Do people with larger head having a larger brain?" If so, and are they smarter than people with a smaller head? I trust that teachers will "hook" their students with a list of top topic questions that will capture their interest and open a dialogue on the subject.

In this open dialogic approach, teachers may ask students to assist in generating "best practices for group discussions", which can be written on chart paper. This will best ensure all students have equal representation and importance. Teachers may also chart the list of responses and vocabulary, academic or not. Charting will provide a foundation where students may borrow vocabulary, word phrases, or sentences to properly communicate safely and comfortably in whole class learning. The responses written on chart paper can remain displayed throughout the unit for reference.

This "dialogic approach" was in part my research with the University of California, Berkeley and the Lawrence Hall of Science, Berkeley. The research on this dialogic approach was an attempt to experiment with whole class-group discussions to promote higher critical thinking skills and understanding. As the research suggested, a transformative learning experience was gained through the dialogic approach (for further information on the dialogic approach, read "Opening Dialogue" by Gamoran).

Below are lessons and activities that support the curriculum unit on brain structure and function. Teachers may want to create or alter worksheet materials to best fit their classroom or laboratory needs. Please note

that materials presented may be subjected to availability in your region or district.

Introduction Lesson to Brain Science

This lesson is taught at the beginning of this unit. Students may stay in their normal seating arrangements. This introductory lesson is intended to introduce the brain science in a safe and welcoming learning environment. The introduction to new academic vocabulary on brain structure and function may be more challenging for ELL (English Language Learner) and the disabled. This introductory dialogic approach will encourage and allow all students at all levels of competency to participate safely. In this process, teachers and students will generate and chart common and academic vocabulary for students, so they can relay new information in complete sentences effectively to the class on brain science information.

Materials: markers, scrap paper, and chart paper.

Teacher Task

Teacher should ask students to work on the Due Now. A due now is a sentence that is to be completed immediately when students arrive to the classroom to help set the tone for the lesson. The Due Now is " Is the brain the same as the skull?" Teacher should next ask students to clear their desk and assist in generating a list of guidelines for group participation and discussion. Give each student a piece of scrap paper and marker. Ask students "What is the brain?" Have students write their responses quietly on scrap paper. Allow one minute for each response. Ask them to raise their papers up and record the responses on large chart paper. One sheet of chart paper is dedicated to correct responses and one sheet for questionable responses. It is helpful to ask students to talk about why they think the responses on the "questionable" chart paper aren't accurate.

Brain Size and Intelligence

Concepts of brain size and intelligence, should be introduced after the lessons on the forebrain. This lesson will reinforce the concepts of the macroanatomy or gross anatomy of the cerebral cortex and its role in processing, perception, thinking, and memory. The question of brain size and intelligence is analyzed. Students may stay in their normal seating arrangements. This lesson is intended to introduce brain science in a safe and welcoming learning environment. The introduction to new academic vocabulary on brain structure and function may be more challenging for ELL (English Language Learner) and the disabled. This activity will encourage and allow all students at all levels of competency to participate safely.

Materials: markers, chart paper, LCD projector, and computer.

Teacher Task

Teacher should ask students to work on the Due Now. A Due Now is any general question that is to be completed immediately when students arrive to the classroom to help set the tone for the lesson. The Due

Now is " Is there a relationship between brain size and intelligence?" Select a student to share their answer. Following this question, teach the students that dense convoluted folds in the brain are believed to increase the surface area, thus, increasing perception, memory, and all higher cognitive functions, including the ability to concentrate, reason, and think in abstract form. Teachers may refer to pictures in the Dana Guide to Brain Health and HYPERLINK "http://serendip.brynmawr.edu/bb/kinser/Structure1.html" for images that compare brain images of human, chimpanzee, dolphin, and dog. The serendip website will also show different examples that compare brain size and surface of the cerebrum of different animals. Students will need to turn in an exit ticket demonstrating 2 facts from what they learned. For a writing homework, have students write two paragraphs analyzing the relationship of brain size and intelligence of a cow and a chimpanzee. Students may submit brain images of these two animals for extra credit.

Horrifying Death and The Brain

Horrifying death and the brain, is a fun short discussion that can keep students "hooked" after learning difficult new information. Its serves as an intermission to the brain gross anatomy that will reinforce the concepts of the macroanatomy or gross anatomy of the cortex and its role in processing, perception, thinking, and memory. Students may stay in their normal seating arrangements. This discussion is intended to introduce the brain science in a safe and welcoming learning environment. The introduction to new academic vocabulary on brain structure and function may be more of challenging for ELL (English Language Learner) and the disabled. This activity will encourage and allow all students at all levels of competency to participate safely.

Materials: markers, chart paper, LCD projector, computer, and human skeleton

Teacher Task

In a open dialogic approach, ask students "Is death by hanging a consequence of suffocation or due to a broken vertebrae?" Give the class a few minutes to process with each other and ask them to also consider their knowledge on vertebrate structure and function. After a 5-minute discussion, teach the lesson on midbrain and the hindbrain. Be sure to use visuals showing where each part of the brain is, if possible, to help visual learners. Emphasize how the medulla oblongata is found in the lowest most part of the brainstem. It relays nerve signals between the brain and the spinal cord and controls and regulates the autonomic functions of respiration, blood pressure and heart rate, as well as swallowing, vomiting, defecation, and urination. Revisit this "death" question in a discussion. Then teach students that in this type of death, the medulla oblongata is penetrated by a broken vertebrae that kills the victim and it is not necessarily because of suffocation. Teachers may want to use visuals that show a closer look on the location of medulla oblongata in relation to the spine. In addition, referencing to the human skeleton may further clarify the spatial relationship of brain and body.

Sheep Brain Dissection

Sheep brain dissection is a fun simple dissection that can keep students "hooked" after learning difficult new information and is a nice transition to brain micro-anatomy. The brain dissection will bring closure and a clearer physical visual understanding to the concepts of the macro-brain or gross anatomy of the cortex and its role in processing, perception, thinking, and memory. Students may work in groups. This discussion is intended to introduce the brain science in a safe and welcoming learning environment. The introduction to new academic vocabulary on brain structure and function may be more of challenging for ELL (English Language Learner) and the disabled. This activity will encourage and allow all students at all levels of competency to participate safely.

Materials: dissection trays, dissection kits, aprons, gloves, goggles, white paper, and sheep brain.

Teacher Task

Teachers may want to do a short lesson on brain macroanatomy to review before the dissection. Chart and explain directional terminology (i.e. anterior, posterior, etc.). Teachers will need to review lab safety and handling instructions and clean up. I also suggest that any clear visuals and posters be posted during this time. The dissection is teacher directed and students should follow step-by-step instructions. At their lab tables, guide students in the orientation of the brain. Have them sketch the brain and identify the longitudinal fissure, two cerebral hemispheres, the cerebellum, and the brain stem. Guide students in a saggital cut. Have them sketch the parts and identify the corpus callosum and other regions.

Be sure to allow enough time for clean up.

Homework: students are to define the parts identified.

Quizzes: Maybe a fill in the blanks, and labeling a brain diagram.

Neurons

This short worksheet activity will help students synthesize the overall pathway of an action potential. Students will know what a cell body, dendrite, axon, pre-synaptic receptor, post-synaptic receptor, and synaptic cleft. The introduction to new academic vocabulary on brain structure and function may be more challenging for ELL (English Language Learner) and the disabled.

Materials: Neuron worksheet and any relevant posters and notes.

Teacher Task

Teacher should prepare a worksheet that shows two neurons with spaces to fill in for cell body, dendrite, axon, pre-synaptic receptor, post-synaptic receptor, and synaptic cleft.

Homework: Have students explain the pathway of an action potential.

Parkinson's Disease

Parkinson's Disease is a slowly progressing degenerative disease that suppresses motor function. Below are few short activities for students. The introduction to new academic vocabulary on brain structure and function may be more challenging for ELL (English Language Learner) and the disabled. The video and research will help students visualize the disease.

Materials: Michael J. Fox video (michaeljfox.org or utube.com)

Teacher Task

Teacher takes a tally on how many students have family members that have PD. Have students also research a celebrity who has PD. Ask them to list the symptoms of PD and what part of the brain is effected. Show the video to show the effects of the disease. Generate additional materials of an image of the midbrain and substantia nigra and have students label the parts.

Alcohol

Alcohol is a growing problem in America among teens. Students don't realize that alcoholism is a psychiatric disease. Below is an activity that will help students understand the effects of being drunk and where in the brain alcohol has its effects. The introduction to new academic vocabulary on brain structure and function may be more challenging for ELL (English Language Learner) and the disabled.

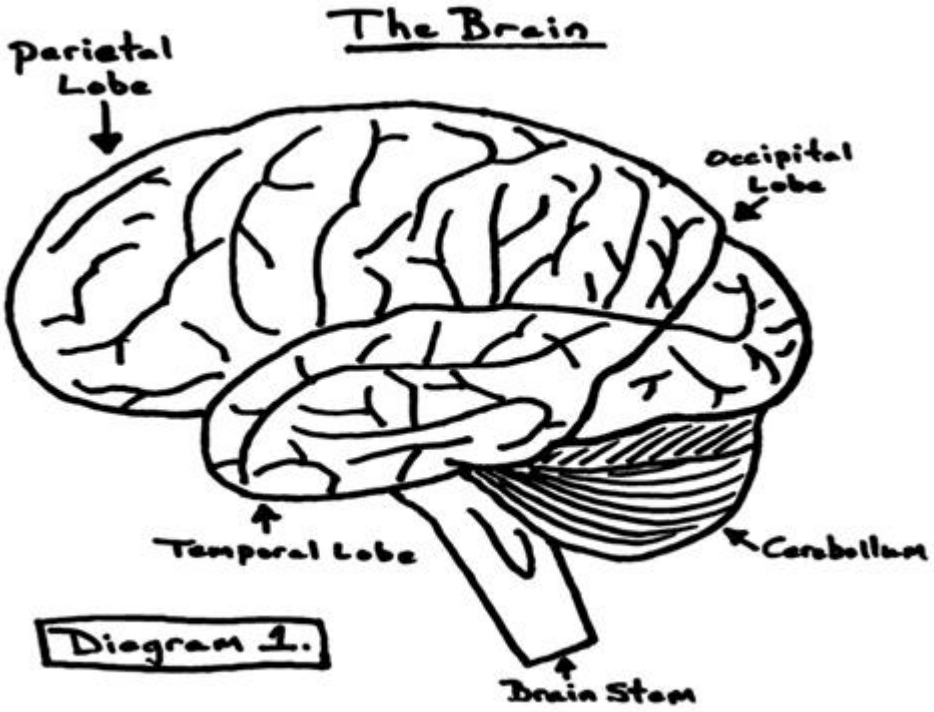
Materials: "Drunk" goggles and images of brain atrophy of alcoholics

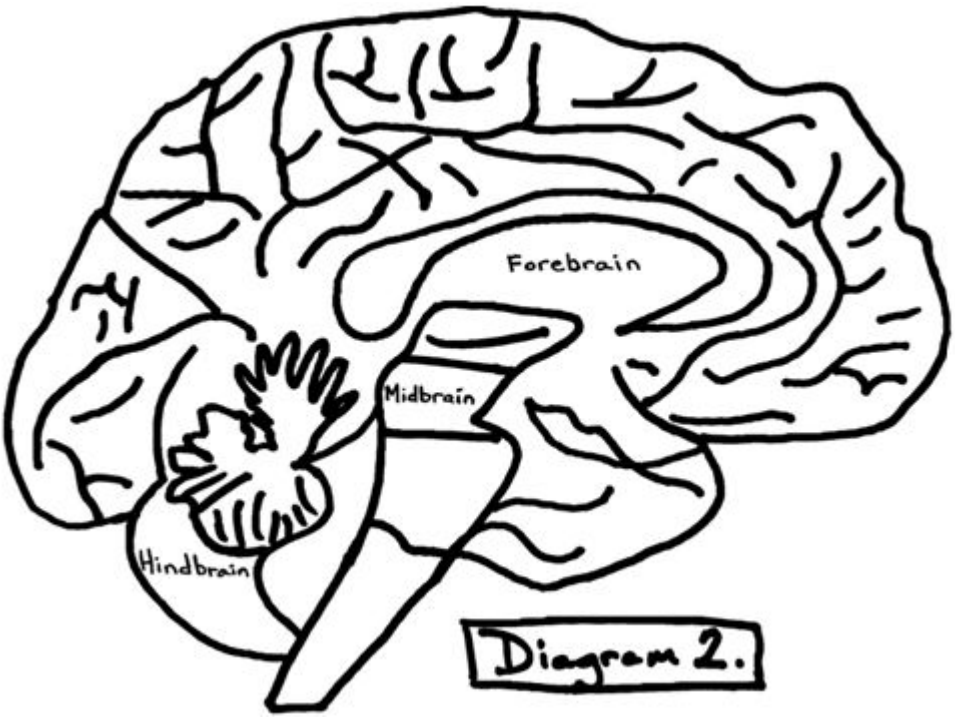
Teacher Task

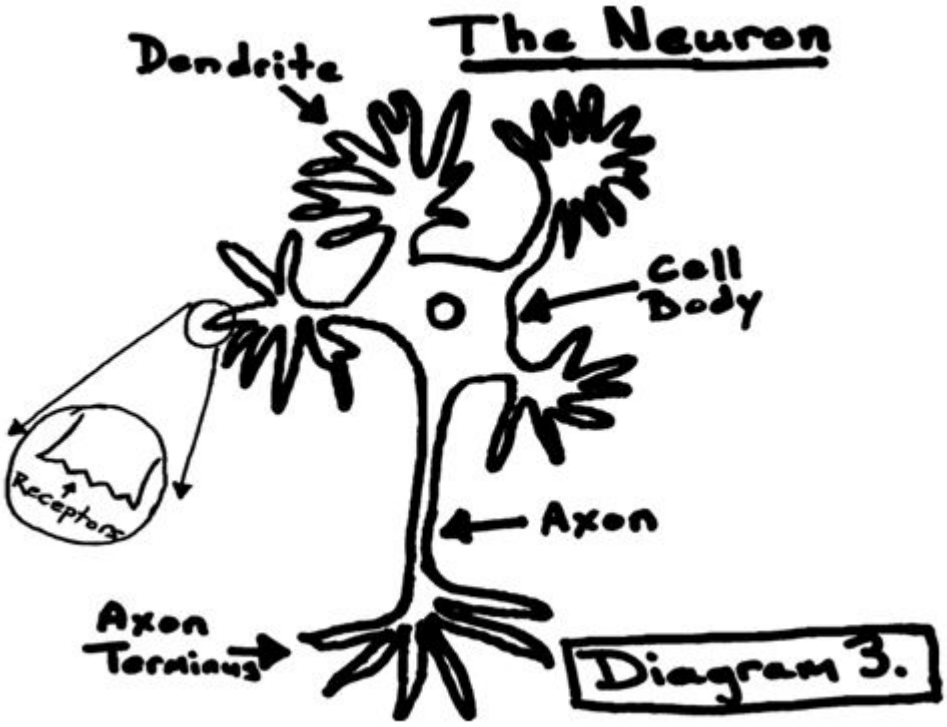
Teacher can start the activity with a short lesson showing images of brain atrophy. Students are grouped by two's. Have one student wear the "drunk goggles" and try to walk. The other team member records his/her observations. Together they list the motor experiences while being drunk and identify the parts of the brain that are responsible for changes in motor function.

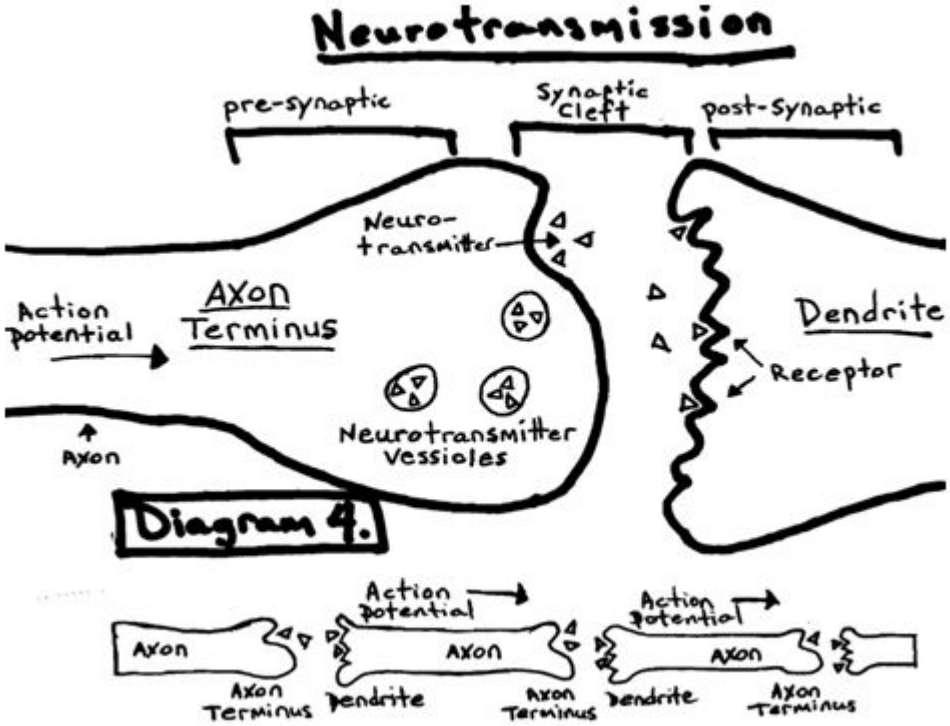
Brain Bingo

Brain bingo is a teacher-guided game with whole class participation that will bring closure to this unit. Teacher draws a question out of the bag until someone gets bingo.


The Brain
Parietal Lobe
Occipital Lobe
Temporal Lobe
Cerebellum
Brain Stem
Diagram 1.


Forebrain
Midbrain
Hindbrain
Diagram 2.


The Neuron
Dendrite
Cell Body
Receptors
Axon
Axon Terminus
Diagram 3.


Neurotransmission
pre-synaptic
Synaptic Cleft
post-Synaptic
Neuro-transmitter
Action potential
AXON Terminus
Dendrite
Receptor
Neurotransmitter Vessioles
Axon
Diagram 4.
Action potential
Action potential
Axon
Axon
Axon
Axon Terminus
Dendrite
Axon Terminus
Dendrite
Axon Terminus

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Standards

Structure and Function in Living Organisms

Standard 7.5 The anatomy and physiology of plants and animals illustrate the complementary nature of structure and function. As a basis for understanding this concept:

Standard 7.5a Students know plants and animals have levels of organization for structure and function, including cells, tissues, organs, organ systems, and the whole organism.

Standard 7.5b Students know organ systems function because of the contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system.

Standard 7.5c Students know how bones and muscles work together to provide a structural framework for movement.

Physical Principles in Living Systems

Standard 7.6 Physical principles underlie biological structures and functions. As a basis for understanding this concept:

Standard 7.6b Students know that for an object to be seen, light emitted by or scattered from it must be detected by the eye.

Health Education Standards

Standard 2.1G Analyze how internal and external influences affect growth and development, relationships, and sexual behavior.

Standard 2.3G Analyze the influence of alcohol and other drugs on sexual behaviors

Standard 2.5G Recognize that there are individual, family, and cultural differences in relationships.

Standard 8.1G Support and encourage safe, respectful, and responsible relationships.

Standard 8.1S Support changes to promote safety in the home, at school, and in the community.

Standard 1.1.A Describe the harmful short and long-term effects of alcohol, tobacco, and other drugs, including steroids, performance-enhancing drugs and inhalants.

Standard 1.2.A Describe the relationship between using alcohol, tobacco, and other drugs and engaging in other risky behaviors.

Standard 1.3.A Explain the dangers of drug dependence and addiction.

Standard 1.6.A Explain the short and long-term consequences of using alcohol and other drugs to cope with problems.

Standard 1.7.A Explain why most youths do not use alcohol, tobacco, or other drugs.

Standard 2.1.A Analyze internal influences that affect the use and abuse of alcohol, tobacco, and other drugs.

Standard 2.2.A Evaluate the influence of marketing and advertising techniques and how they affect alcohol, tobacco, and other drug use and abuse.

Standard 2.3.A Analyze family and peer pressure as influences on the use of alcohol, tobacco, and other drugs.

Standard 6.1.A Develop short and long-term goals to remain drug-free.

Standard 7.1.A Use a variety of effective coping strategies when there is alcohol, tobacco, or other drug use in group situations.

Standard 7.2.A Practice positive alternatives to the use of alcohol, tobacco, and other drugs.

Standard 8.1.A Participate in school and community efforts to promote a drug-free lifestyle.

Standard 1.5.M Recognize diversity among people, including disability, gender, race, sexual orientation, and body size.

Standard 1.11.M Describe common mental health conditions and why seeking professional help for these conditions is important.

Standard 3.1.M Access accurate sources of information and services about mental, emotional, and social health.