Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2006 Volume VI: Anatomy and Art: How We See and Understand

Teaching Neuroanatomy through Schematic Diagrams

Curriculum Unit 06.06.06
by Justin M. Boucher

Introduction

It has been said that to truly understand something, one needs to be able to draw a schematic diagram of it. Never was this simple statement more accurate then in the case of the human brain. An impossibly complex organ, with a myriad of functions, the brain demands a thorough understanding if any attempt is going to be made at diagramming it. Conversely, only through some sort of visual representation could most people keep track of the structures, levels, functions and interactions of the brain as a functioning organ. In this dichotomy lies the challenge of teaching the brain to High School students and a strategy for meeting that challenge.

Each level of brain anatomy is responsible for its own function, and contributes to the overall understanding of the brain. These levels must not only be understood completely in and of themselves, but also, they must be understood in relation to one another so as to provide an appreciation of the whole, rather than the appearance of understanding.

Keeping track of this wide array of levels and functions and pieces and parts is next to impossible for even the most gifted student, and so teaching a topic of this depth necessitates the use of diagrams. Even simply viewing diagrams of the brain, or models of it, or even simple diagrams of function and relation can drastically enhance a unit of this kind. This kind of exposure can help students to put their thoughts and their facts in order. The limitation of this process is however that the students are simply memorizing a means of organizing specific information. Such a study may have validity in terms of studying for an exam, but it does not lead to the kind of synthesis, which is required for the students to access this knowledge later in the year.

It is for this reason that I propose not only to allow my students to view these diagrams, but to create them themselves. This unit will necessarily begin with viewing diagrams, and studying the most basic levels of neuroanatomy. We will view graphics and representations of the Neuron (the basic building block of brain and nervous system anatomy) combined with the expectation that the students will create their own simple diagrams of Neuron function. This will allow the students to approach simpler material when their diagramming skills are at their least defined.

As the unit progresses, we will view more and more complex diagrams and representations. As a means of granting my students a fuller more "real" view of the brain, we will look at more accurate and "real"

representations of the brain in the form of x-rays, MRIs and CAT scans. This will have the added benefit of orienting my students to the actual technologies used in studying the brain as well as giving them less figurative views to work with.

It will be my goal to move from viewing these representations to creating diagrams of our own. This creation will be a cumulative process. Beginning with the neuron, we will then jump to larger pieces of the brain. The lobes, hemispheres, and other structures will be presented in the most straightforward terms, and diagramed as we go along to allow for complete understanding of function and interaction.

The diagrams will progress with the study so that ultimately the students will leave the unit with a schematic diagram of the brain of their own creation. This will benefit them on multiple levels.

In order to create their diagrams the students must appreciate each level of the brain and its function. This conceptual understanding will then be accessible later, both physically in terms of the diagram, and mentally, in terms of the understanding gained through the process. Additionally, it will offer students and unorthodox way of approaching the material, which can lead to a fuller understanding as well as an increased interest on their part.

Context

It is my intention to use this unit in my Advanced Placement Psychology class, though it is applicable to anatomy or biology courses at the high school level as well. AP Psychology is a social studies course that is heavily rooted in scientific research and principles. Though psychology is indeed a social science, most social studies teachers have their background in history. This background can pose a challenge when presenting units, which are predominantly based in the sciences. The brain, the nervous system and the biology of the five senses are particularly poignant examples of topics, which the average history teacher might lack the background to sufficiently address. Thus this unit seeks not only to provide that background in the case of the nervous system and the brain, but also to provide an approach to this subject matter, which is accessible to both students and teachers.

The nature of Advanced Placement Psychology presents a number of challenges as well in terms of teaching neuroanatomy. In addition to the daunting nature of neuroanatomy as a subject, an AP psychology class requires that this topic be covered comprehensively and memorably in a very short period of time. It is this time constraint that poses the largest obstacle to full student understanding of the brain, given that the brain could be studied for years without gaining a full understanding. It is therefore extremely difficult to present students with the information they need to understand the brain, and then to be able to access that understanding later in the course.

It is particularly pivotal that a student be able to access this material later in the course, given that so much of the material in an AP Psychology course is linked in some way to the brain. After the history of Psychology and Research methods it is one of the first topics covered in the course. Given that this is a recurring theme throughout the year, the student's understanding of the brain must be comprehensive enough to do the organ justice, memorable enough to be accessible and quick enough to cover the whole brain in about a month or less.

Objectives

To teach the brain in such a short period, a teacher must cover all of the functions and levels of neuroanatomy in an extremely focused and organized way. Any effort to teach this material, which does not benefit from a careful and methodical approach to brain hierarchy is doomed to fail. Therefore it is necessary to prepare a unit that follows each level of that anatomy logically and methodically. This is where a diagrammed approach begins to fit into the equation.

The goal of creating a comprehensive schematic diagram can be accomplished in a way that allows the class to break down the many levels of brain function. Students will need to appreciate the complexities of the system while simplifying the geography and functions of the brain into a form that can be put down on paper. This will ensure that the topic is taken in digestible pieces rather than the overwhelming whole and will aid in remembering what was learned later in the course.

This process is predicated on the understanding that, in the end, the students will learn this material more successfully if they are allowed to learn it in their own way. For this reason the students will never be asked simply to copy down diagrams that are presented to them. They will be given freedom to diagram with as little or as much abstraction as they see fit, so long as their diagrams demonstrate the needed information. In the early stages of the unit there will likely be little variation, but by the end of the unit, there should be a great deal of variety from one student to the next in terms of their work.

For the purposes of this unit, this process will be broken down into the following specific learning objectives. Each objective represents a full lesson, which may last a day or more in the classroom.

As a result of this unit the students will be able to,

1. Identify the parts and function of a neuron
2. Explain and illustrate the levels and functions of the nervous system including
a. Neurons
b. The Central and Peripheral Nervous Systems
c. The Autonomic Nervous System (Sympathetic and Parasympathetic)
d. The Somatic Nervous System (Sensory and Motor)
3. Analyze and Diagram the Endocrine System
4. Analyze and Diagram the Brainstem
5. Analyze and Diagram the Lobes and Structures of the Cortex along with their functions
6. Construct a Comprehensive Diagram of the brain, nervous and endocrine systems, showing their levels, interactions, functions and influences on behavior.

These objectives represent a progression of understanding on two levels. Firstly, there is a progression in terms of the students' understanding of brain and nervous system anatomy and function. Each objective both stands alone, and builds on the previous objective to result in a fairly comprehensive understanding of these concepts. In this way students move from simple to complex so as to ensure that at any given step the students are being prepared for the next objective.

The same is true of the second level of this progression, that of diagramming skill. This unit assumes a limited ability on the part of the student to successfully diagram an anatomical system on both the schematic and anatomical level. Furthermore it assumes that the level of abstraction required for a good schematic is something that needs to be built, rather than something that comes totally naturally. While certainly some students will enter the class and the unit with the skills necessary, it is also certain that far more will need to build those skills throughout the unit. Therefore, each step in the unit will allow the students to build their diagramming and abstraction skills to the point where, in the end, they will be able to diagram the entire system.

Strategies

This section of the unit details strategies to be used with each objective. These explanations correspond with lesson plans in the classroom activities section, and seek to explain those lessons as fully as possible. Each objective also corresponds to the web-sites in the resources section, which provides useful images, in addition to information to guide students in diagramming.

Objective 1: Identify and the parts and functions of a neuron.

As the building block of the nervous system on the cellular level, the neuron is a very good place to start when considering the anatomy of the brain and nervous system. The neuron is simple enough to be understood without prior study, yet complex enough to begin initiating students to the immense variety and complexity of our anatomy. The neuron demonstrates to students the great variation that can stem from a simple structure, and thereby demonstrates the value of understanding a basic structure as a means or understanding the larger whole. A simple diagram of a neuron including a cell body, axon, dendrites, nucleus and myelin sheath can show the structure of a typical neuron, while further study into the nervous system can demonstrate the different types of neurons e.g. motor neuron, sensory neuron, and dorsal root ganglion.

Such a diagram allows the student to encapsulate various neurochemical processes into their simplest form, allowing also for the study of these processes. Since a correct diagram would require inclusion of a synapse and a visible space left between the axon terminals and the dendrites. This space, though small in the diagram, and much smaller in the body is one of the most important empty spaces in the body, and it is the center of much activity in the nervous system.

The students will not only include this space in their diagram, but also they will explain the function of the synapse. This explanation will require students to grasp the concept of neurotransmitters, and allow them to demonstrate that understanding. This step will be pivotal in this section of the unit because the students need to understand this process to understand the function of the entire nervous system. Furthermore, with this explanation in mind, students will be able to explain how messages are relayed from the brain to the rest of

the body.

Explaining and diagramming a neuron serves another useful purpose as well. Not only will students be able to discuss and explain the most basic level of the nervous system, but also they will begin the process of diagramming anatomy in a way that is both simple and useful. In addition to building the student's understanding of neuroanatomy and neurochemical processes, this unit builds the student's ability to conceptualize complex ideas and put them down in the form of a diagram.

It is therefore necessary for the students to work their way up to more complex material. Assuming that the students have only limited experience in drawing schematic diagrams, it is necessary to build from the ground up in terms of their diagramming prowess. The neuron is a good place to start in diagramming, in that the diagram can accurately depict the anatomy of the cell, while also depicting its function in the synapse. The synapse diagram will serve the dual purpose of beginning the process of representing functions, which are difficult to depict.

Commonly these diagrams include triangles or squares to represent the neurotransmitters, and receptors. If the students continue this process it will be the beginning of their representation of anatomical processes in a figurative way. This will, of course, become critical when the unit moves on to diagramming much more complex structures and systems.

Objective 2 : Explain and Diagram the levels and functions of the Nervous System.

With the basics of diagramming and nervous system anatomy behind us, the unit will progress to a wider understanding of the nervous system, which will include all of its levels and divisions. This objective also marks the first foray in this unit into schematic diagramming. The diagram of the neuron, while functionally schematic, does not break down the representation into a substantially simpler form. At its heart the neuron diagram is anatomical rather than schematic in nature. As the unit progresses it will become necessary to represent functions in a strictly schematic way, given that the process, or structure itself would be unwieldy as a strictly anatomical diagram. So it will become necessary to break these processes down into a visual representation, and this is the first step in understanding schematic diagramming.

The transition from anatomical representation to schematic diagramming will take place in clearly defined steps. First the students will diagram the anatomy of the nervous system. Their diagrams will include the central and peripheral nervous system and as with neurons, will allow the teacher to remind them of the necessity of simplification, and exaggeration in diagramming anatomy. This anatomical diagramming will be similar to their earlier work in that it will represent a specific piece of the human anatomy.

The students will then be asked to diagram the less anatomically specific divisions in the nervous system. The divisions between the autonomic nervous system and the somatic nervous system, while essentially anatomical in nature would be very difficult to diagram in a strictly anatomical way. Any fully anatomical diagram of these different parts of the whole would have to include a complete diagram of the entire human body. While this would be a useful endeavor for most students to accomplish, it would also be a gargantuan undertaking. Therefore, these divisions need to be simplified to facilitate understanding and diagramming.

The students will begin with the autonomic nervous system, showing examples of organs and body parts affected by it. The diagram will also include the distinction between the sympathetic and parasympathetic functions. For example a student might include the heart as an example of an organ affected by the autonomic nervous system and then include notation of whether it was sympathetic, parasympathetic, or

both.

Similarly, the students will be asked to diagram the somatic nervous system including affective (sensory) and effective (motor) elements. They may consider many different ways of doing this. These diagrams may include a broad picture of the human body, or they may simply be line drawings, with text boxes. In any event the diagrams will require specific information, without requiring a specific type of representation.

It will be necessary for this section to allow the student freedom of representation. While there are basic elements that must be present, each student will be encouraged to represent the systems in their own way, and examples will be offered of various ways of diagramming the system for the students' use. The goal of this individual representation is to shift gears from copying down someone else's picture, to creating their own.

At this point it will also be necessary to define and explain the difference between an anatomical and a schematic diagram. The distinction may be small when dealing with the nervous system, but it will grow larger when dealing with the brain and its structures and functions.

Finally, this section will require a combination of anatomical and schematic diagrams. To fully represent the nervous system, both kinds of representation are required. Given that the ultimate goal of the unit is a diagram of the whole brain and nervous system, the students need to be prepared to combine the two.

Objective 3 : Analyze and diagram the endocrine system.

In many cases the endocrine system, as a system which falls under the biological bases of behavior in the AP Psychology curriculum, is usually tacked on to the end of a unit on the brain and nervous system as almost an afterthought. Frequently the endocrine system is regarded as an inconvenient addition to the unit on biological bases of behavior. In this case, I think that generalization is unfair, and the endocrine system has a useful role to play in the grand scheme of this unit. This is especially true if one considers the hierarchy of these systems. As we progress through the unit we will move from the systems that act as messengers, to the systems actually responsible for control, the endocrine is just such a system.

As a system dealing with hormones as neurochemicals, the endocrine system could rightfully be taught immediately following the whole nervous system. Due to the similarity between hormones and neurotransmitters, it is necessary to discuss fully the distinction between a hormone and a neurotransmitter (that a neurotransmitter is released from a cell to a cell and a hormone travels the body through the bloodstream). Otherwise the endocrine system can be treated remarkably similarly to the whole nervous system in terms of its teaching.

The students will begin with a simple analysis of the system, including explaining the distinction between the endocrine system's hormones and the neurotransmitters used in the nervous system. This analysis will also include a brief run down of all of the glands and organs associated with the endocrine system. In this way the students will become familiar with the parts of the system, and begin to understand their function.

The students will then begin to discuss the functions of the endocrine system. At this stage the students will begin the process of diagramming the endocrine system, including its glands and hormones, in a diagram of the body to accentuate the notion of localized function. They will take part in an activity in which they are given the names of the glands and their functions, and they will need to deduce where the glands might exist based on their function. This will lead to a discussion of the actual locations and a comparison of the endocrine

system and the nervous system as a means of control of the body.

The placement of the endocrine system in this unit, in relation to other systems, serves a third and final function. Through the control the hypothalamus exerts over the pituitary gland (responsible for growth and regulation of water and sale metabolism) the students will be initiated to the brain as the locus of control for these systems. Naturally enough the students will be given the opportunity to briefly approach the brain as an important part of system, without yet approaching the whole complexity of the brain. In this case the students will only see the parts of the brain that control directly other parts of the body through the endocrine system. In this way the students will come to appreciate the control the brain exerts as an introduction to the brain as an organ in and of itself.

Objective 4 : Analyze and Diagram the Brainstem.

With the endocrine system completed, and the admittedly simple notion that the brain is in control cemented, it will be time to turn to the brain itself. As we move to the brain, our combination of schematic and anatomical diagrams will become more important, and less pronounced. This unit is predicated on the notion that students will learn more effectively when given the freedom to diagram as they see fit, rather than following a prescribed plan. That being the case, the balance between strictly anatomical diagramming and schematic diagramming will need to be struck by the student, rather than by the teacher.

For the purposes of this objective the students will be limited to the brainstem (cerebellum, medulla, pons and the midbrain). In this way the students will begin to understand the divisions within the brain, and the different responsibilities and functions of each section of the brain. Furthermore the students will begin to appreciate the complexity of the brain, while approaching it in manageable parts.

The students will then create a schematic of the brainstem including the routes certain signals take from the brain to the body and back. This will be a process, which draws exclusively on textual resources, thereby allowing students to practice this skill in the absence of models to follow. When they have completed their diagram they will compare it to a diagram provided (see resources) and evaluate their own work.

The students will begin with discussion of parts of the brainstem. Explanation may be limited at this point given that these are unique structures within the brainstem, and given that there will be further study, only generalizations are needed. For example, it would suffice to say that the midbrain is responsible for the relaying of sensory material from the brainstem to the cortex. The key to this kind of discussion is that the students understand the fact that the brainstem relays material up to the brain and down to the body, as well as controlling some basic body functions.

The reasoning behind this kind of division is simple. While studying the endocrine system or the nervous system the list of potential functions of any given piece of those systems was relatively short. While both systems are quite complex, the brain is far more so. Therefore, unlike the other parts of this unit, the brain will be approached a bit more slowly to ensure proper organization of all its functions. These divisions will enable students to classify brain structures based on function, thus aiding in their understanding of the organ as a whole. For example, if given a question on the AP exam that asked about a hypothetical student's losing thought processes without losing body function, the students would be able to use this classification to determine that the problem existed in the cerebral cortex or the midbrain, while eliminating the rest of the brainstem as a culprit.

Objective 5 : Analyze and diagram the lobes and structures of the cortex along with their respective functions.

This objective will most likely take more than one day to master, and therefore multiple examples of brain diagramming and brain anatomy will be offered to aid students in their diagramming the cortex. It will be necessary at this point to deal with all of the remaining brain anatomy, and therefore this may be the most challenging objective to fulfill.

In an effort to approach this topic comprehensively, the lesson begins with a brief discussion of phrenology. The students will look into the history of phrenology using web resources, and discuss the successes and failures of this interesting "science". This will allow the students to assimilate the idea that like functions are located close to one another, while studying an interesting topic. The students will then discuss the "science" critically, taking what is useful (the notion that structures responsible for similar function might have similar location) while debunking the notion that complex function (like criminal behavior) might be so easily ascertained.

When this is complete students will look into and discuss the pieces of the brain to be dealt with, along with their function. This list should be exhaustive, covering the lobes, the various cortexes and other brain structures along with their functions.

When the students have an exhaustive list, a task, which might take quite some time, the students will be presented with the means by which function of the brain is studied through fMRI. The students will again use web resources to study the process of fMRI comparing it to phrenology. This will be a primer on creation of their own diagrams. It may be necessary to offer examples of schematics at this point. It may, however, be unnecessary given that they have already had a chance to diagram schematically in the previous lesson.

Once these parts of the lesson are complete, it will be up to the students to put them together in a meaningful way. The students will then use the information they have at hand, the diagrams and scans, as well as their books and the skills they have learned throughout the unit, to create their diagram of the brain and its functions. There will be not limits on this process other than the time available to complete it, and the students' abilities and imaginations. The grading procedure will be equally simple in that it will be based solely on whether or not the students have completely rendered all of the structures and topics required.

Objective 6 : Construct a Comprehensive Diagram of the brain nervous and endocrine systems, showing their levels, interactions, functions and influences on behavior.

For the purposes of this final objective, which also marks the cumulative project of the unit the students will be asked to put together everything they have learned to create a master diagram. This master diagram will include everything covered throughout the unit and may take one of two forms. Either the students will craft this diagram from scratch, combining new versions of their older diagrams into a combination anatomical and schematic diagram, or they will create a collage.

In the case of a wholly new diagram, the students will be expected to create a completely new work, which may have portions of other works, but must be new. This option will allow the teacher to fully assess the understanding of each individual student, while requiring each student to synthesize the material in a new way. The students will have, not only to rehash what they have already completed, but also include the connections between the systems already identified and diagrammed. These connections would make this new diagram substantially different from the old ones.

The chief drawback to this method is time. The students will undoubtedly require a great deal of time to complete such a diagram. Given that each individual part of the diagram would have taken at least a full

lesson in class to complete. Students would therefore need a substantial quantity of time to finish a task this large.

If indeed the time such an activity would take is prohibitive, there is another option. A similar, if not as comprehensive assessment could come from allowing students to create a collage diagram, by combining all of their old diagrams into one larger diagram. Such a collage would require the students to include and demonstrate the connections and crossovers between one diagram and the next. This could be extremely useful, even though it would require less work on the student's part.

In this case, drawing the connections alone would allow students to explore the interactions between these systems, as well as discovering their interactions. The chief downfall of this method is that it would limit students in terms of creativity. In the case of a larger new diagram, the students would be granted the opportunity to rework sections of the unit, or diagrams they did not like. They would also be able to limit or eliminate redundancy. This would not be possible in the case of the collage, without major editing.

In any event the diagram should include a number of specific structures, centers, and systems. All of these pieces have been discussed already in the unit, and it may be useful to ask the students to list them all first. However, it is important to be clear with them that there is a set list of structures and systems which need to be included in their diagram. That list includes the neuron (including a cell body, axon, dendrites, nucleus and myelin sheath), the nervous system (including central, peripheral, sensory, motor, sympathetic and parasympathetic systems), the endocrine system (including its glands and hormones), the brainstem (including the cerebellum, medulla, pons and the midbrain) and the cortex (including lobes, hemispheres, and centers of control). The students should include all of these items in their final diagram to ensure a complete and full diagram.

On the whole the choice will be left to the teacher. AP psychology is such a complex and time constrained course, that either option might seem more palatable when the time comes. In the case of the comprehensive diagram, a teacher might decide that everything needed another once over to ensure synthesis. In the case of the collage, the unit might already be running long, or the students might just get it. At which point it might make much more sense to do the collage and bring the unit to a close. In any event the students will be left with an opportunity to synthesize their understanding, and the teacher will be left with an opportunity to assess it.

Classroom Activities

Lesson 1: The Neuron

Goal : To orient the students to the neuron as the basic building block of the brain and the nervous system.

Objectives:

As a result of this lesson the students will be able to

1. Identify the basic parts of a neuron.

2. Describe the function of each of the basic parts of a neuron.

3. Create a diagram, which depicts these parts and their functions.

Materials :

Board, marker, notebooks, pens, Textbooks

Anticipatory Set :

The students should list the parts of a cell in their notebooks.

Procedure:

1. The teacher will begin the lesson by asking the students to list the parts of a cell. As the student's list, the teacher puts that list on the board.

2. The teacher will then draw a basic diagram of a neuron on the board, allowing students to volunteer the names of each of the parts; the students may use their books.

3. When this is complete the students will be asked to recreate the diagram in their notebooks, including in their diagrams a description of the function of each part. They should be taking this information from their books.

4. The teacher will use this time to check in with students individually to determine their understanding of the assignment and the process.

5. When the students have completed their diagrams, the teacher will lead the class in going over each of the parts, including function and clarifying any errors.

Closure:

The teacher will wrap up class by briefly discussing with the class the benefits of diagramming cells in this way, as well as the drawbacks.

Assessment:

The students will be assessed based on their contributions and the work that they produce.

Homework:

For homework the students will be asked to do the reading in their textbook on the Nervous System.

Lesson 2: The Nervous System

Goal : To orient the students to the nervous system in terms of both anatomical and schematic diagramming

Objectives:

As a result of this lesson the students will be able to

1. Explain and diagram the distinctions between the central and peripheral nervous systems.

2. Discuss the functions of the Autonomic and Somatic Nervous systems including these distinctions on their diagram.

3. Evaluate spinal reflexes in terms of their understanding of somatic and autonomic nervous system function.

Materials :

Board, marker, notebooks, pens, Textbooks, copy paper, colored pencils

Anticipatory Set :

Referring to the previous night's reading, the students will list the functions of the somatic and autonomic nervous system.

Procedure:

1. The teacher will begin the lesson by passing out the copy paper and asking the students to create a diagram of the central and peripheral nervous systems, leaving plenty of space on either side to add information.

2. Before the students begin their work, the teacher will briefly review the benefits and drawbacks of diagramming physical systems in this way.

3. The teacher will then circulate to check for accuracy, and the students will create their diagrams.

4. When most of the students have finished, they will be asked to write Somatic on one side of their diagram and Autonomic on the other side, and note the functions of each as well as how each function works- they should refer these explanations to the nervous system diagram they have created.

5. The teacher will use this time to check in with students individually to determine their understanding of the assignment and the process.

6. When the this is complete the teacher will lead the class in going over their diagrams, and the information contained in them

7. The teacher will then explain briefly the function of spinal reflexes.

Closure:

The teacher will wrap up class by briefly leading the students in discussing how this specific system (Spinal Reflexes) might relate to the systems discussed today.

Assessment:

The students will be assessed based on their contributions, their homework and the work that they produce in class.

Homework:

For homework the students will be asked to create a diagram which demonstrates how spinal reflexes function.

Lesson 3: The Endocrine System

Goal : To orient the students to the endocrine system and basic neurochemistry

Objectives:

As a result of this lesson the students will be able to

1. Define and compare Neurotransmitter and Hormone.

2. Hypothesize, using the definitions, the location of various glands, based on their function in the human body.

3. Compare Endocrine and Nervous systems in terms of their control over the body.

Materials :

Board, marker, notebooks, pens, Textbooks, copy paper, colored pencils

Anticipatory Set :

Using a book the students will be asked to define Neurotransmitter and Hormone.

Procedure:

1. The teacher will begin the lesson by putting the definitions the students came up with on the board.

2. In pairs the students will then hypothesize the similarities and differences between the function of Neurotransmitters and Hormones based on their definitions

3. The teacher will lead the class in discussing their answers once the students have had some time to discuss.

4. When this is complete the teacher will pass out "Where are my glands" activity (see Resources Section) and discuss the activity with the students

5. Students will then, based on the definition/description of each gland, hypothesize the location of that gland in the body based on its function.

6. The teacher will use this time to check in with students individually to determine their understanding of the assignment and the process.

6. When the this is complete the teacher will lead the class in going over their work, including corrections as necessary

7. The students will wrap up class by creating a Venn diagram comparing the endocrine and nervous systems in terms of their control over the body.

Closure:

The teacher will wrap up class by leading the class in a brief discussion of their diagrams.

Assessment:

The students will be assessed based on their contributions, their homework and the work that they produce in class.

Homework:

For homework the students will be asked to read about the brainstem in their textbooks.

Lesson 4: The Brainstem

Goal : To orient the students to the structure of the brainstem

Objectives:

As a result of this lesson the students will be able to

1. Discuss how information is transferred from the brain to the nervous system.
2. Analyze the structure of the brainstem through print resources creating a preliminary schematic diagram.
3. Evaluate their work based on the diagrams provided.

Materials :

Board, marker, notebooks, pens, Textbooks, copy paper, colored pencils

Anticipatory Set :

Students will list the parts of the brainstem.

Procedure:

1. The teacher will begin the lesson by putting the students' list on the board.

2. The teacher will then lead the students in discussing the different parts of the brainstem- what do they do as far as the students know?

3. When this is complete the teacher will demonstrate on the board, the drawing of a schematic, asking the students to recall their neuron diagram and their diagram of the endocrine system. (The teacher can diagram just about any system- as long as they do not diagram the Brainstem at this point)

4. When this is complete the students will create their own schematic of the brainstem, from print resources

(primarily their book, or articles the teacher provides) the diagrams should include the main parts of the brainstem, and directions/pathways for various types of information to travel.

5. The teacher will circulate at this point to ensure that the students are on the right track.

6. When this is complete, the teacher will pass out the provided schematics (see resources) asking students to compare their work to the diagrams provided.

7. Students will then note similarities and differences between their own diagrams and those provided.

Closure:

The teacher will wrap up class by leading the class in a brief discussion of their diagrams and the flaws, or successes in them.

Assessment:

The students will be assessed based on their contributions, their homework and the work that they produce in class.

Homework:

For homework the students will be asked to read about the cortex in their textbooks.

Lesson 5: The Cortex (2 Days)

Goal : To orient the students to the cortex, as the locus of control for higher order thinking

Objectives:

As a result of this lesson the students will be able to

1. Discuss phrenology in terms of its utility, accuracy and inaccuracy in studying the brain.

2. View and discuss examples of modern radiology, as means of understanding and studying the brain.

3. Create a schematic diagram of the Cortex including major centers of function.

Materials :

Board, marker, notebooks, pens, Textbooks, copy paper, colored pencils, examples of fMRI scans, Computers with Internet Access

Anticipatory Set :

Students will respond to the question "How do we know what we know about the brain?"

Procedure:

1. The teacher will begin the lesson by leading the class in brainstorming answers to the Anticipatory question

2. When this is complete the students will be broken into pairs, and they will be given 15 minutes to explore http://pages.britishlibrary.net/phrenology/

3. When this is complete the teacher will lead the class in discussing their findings, specifically the teacher will ask what the successes and failures of phrenology were.

4. After discussion has been exhausted (or when it has run too long) the teacher will transition back to the means by which we know what we know.

5. Students will then go back to their computers to explore http://www.ee.duke.edu/~jshorey/MRIHomepage/fmri1.html in which they will learn about fMRI as a means of studying brain function. The students will list similarities and differences between historic phrenology, and modern fMRI.

6. When the this is complete the teacher will lead the class in going over their work, including corrections as necessary

7. The teacher will then ask the students to compile a list of centers and structures in the cortex, including the function of each structure and center.

8. When this is complete the teacher will lead the students in a discussion of their findings.

9. When this is complete the students will create a schematic diagram of the cortex. This will likely take some time, and so it will probably require a second day of work.

10. The teacher will circulate, monitoring the process, and offering suggestions/ corrections where necessary.

11. When the diagrams are complete the students will switch diagrams with a partner, and they will peer edit each other's diagrams, looking for inaccuracies and problems.

12. Finally the teacher will wrap up the process by leading the class in a discussion of the challenges of such a project as well as their feelings on it.

Closure:

The teacher will wrap up class by briefly going over the advantages and disadvantages of this kind of diagramming.

Assessment:

The students will be assessed based on their contributions, their homework and the work that they produce in class.

Homework:

For homework the students will be asked to compile the diagrams they have done thus far.

Bibliography

Carter, Rita. *Mapping the Mind* . Berkley, CA, University of California Press, 1999.

Mapping the Mind was an excellent resource in writing this unit in that it gives a great deal of practical information in accessible language. There are also a number of very useful diagrams within its pages.

Haines, Duane E. *Neuroanatomy: An Atlas of Structures, Systems, Sections, and Systems* . 4th Ed. Philadelphia, PA. Williams & Wilkins, 1995.

Haines' atlas is a fascinating look into the brain. Offering both anatomical and schematic looks at brain function, it is an extremely useful resource for this unit. It is designed however for anatomy students, and is therefore a bit dense for high school students. The diagrams however can serve as very sound examples for students seeking to create their own versions.

Kasschau, Richard A. *Understanding Psychology* . New York, NY, Glencoe McGraw-Hill. 2003.

Kasschau's *Understanding Psychology* is an introductory psychology text offering a basic overview of the subject. It lacks the depth of Myers' work, and is necessarily more concise. It gives the reader a quick glimpse of many different topics, but skims over some important topics that might be plumbed more deeply.

Myers, David G. *Psychology* , 7th Ed. New York, NY. Worth Publishers. 2004

Myers has written an extremely useful psychology textbook, which is ideally suited to use in the AP Psychology classroom. It provides a great deal of background in a format that is quite accessible. The text, though long winded at times is quite comprehensive and therefore allows students to explore psychology fully. This book is well organized and well written providing a useful tool in the classroom.

Tortora, Gerard J. & Grabowski, Sandra Reynolds. *Principles of Anatomy and Physiology* , 10th Ed. New York, NY. John Wiley and Sons Inc. 2003.

Tortora and Grabowski have created a book, which is both comprehensive and filled with useful diagrams. The book, which is written for medical students and nurses, is likely above the head of most students. But it does provide some very useful background for teachers, and a depth of content which is explores anatomical concepts far beyond the measure of the layman.

Resources

http://faculty.clintoncc.suny.edu/faculty/Michael.Gregory/files/Bio%20102/Bio%20102%20lectures/Endocrine%20System/endocrin.htm

A site including a schematic diagram of the function of the Endocrine System. It is a very in depth resource, but offers a good look at a schematic view of the Endocrine. This site would be useful in conjunction with Objective 3.

http://www.actualfreedom.com.au/library/topics/brainschemes.htm

This site offers some schematic diagrams of brain function. The diagrams include short explanations, which may be useful to students. This site would be useful in conjunction with Objective 4/5.

http://www.bbc.co.uk/science/humanbody/body/factfiles/nervous_anatomy.shtml

An interactive diagram of the whole nervous system. This site would be useful in conjunction with Objective 2

http://www.becomehealthynow.com/article/bodyendocrine/732

This is an interactive diagram of the Endocrine System, which offers interactive glands with information attached to each. This site would be useful in conjunction with Objective 3

http://www.ee.duke.edu/~jshorey/MRIHomepage/fmri1.html

This is a site that offers a great deal of information on the process of fMRI. It includes a number of separate images and is important for lesson 5.

http://www.math.tu-dresden.de/~belov/brain/brainstruc.html

This is a site with photos of an actual brain as well as an anatomical diagram of the brain and brainstem. This site would be useful in conjunction with Objective 4/5.

http://pages.britishlibrary.net/phrenology/

This is a site provided by the British Library and it includes a history of phrenology. This site is useful as an introduction to brain function and it is used in lesson 5.

http://vv.carleton.ca/~neil/neural/neuron-a.html

A useful site including a diagram of a neuron. This site would be useful in conjunction with Objective 1.

https://teachersinstitute.yale.edu
©2019 by the Yale-New Haven Teachers Institute, Yale University
For terms of use visit https://teachersinstitute.yale.edu/terms