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Chapter 2: The Brain and Behavior

Learning Goals

1. The Nervous System 2. Neurons 3. Structures of the Brain and Their Functions 4. The Endocrine System 5. Brain Damage, Plasticity, and Repair 6. Genetics and Behavior Chapter Overview

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- **Teaching the Chapter**
- **Critical Thinking Questions**
- **Readings, Videos, and Web Site Suggestions**
- **Activity Handouts**

Chapter Overview

Extraordinary Engine: The Human Brain

This chapter begins with a story about Adam Lepak, a first-year community college student who had a motor bike accident that left him with a brain injury. Adam's accident had damaged the regions of his brain responsible for the warm glow of familiarity that comes from recognizing others. His brain no longer detected the feeling of ―home.‖ The author

goes on to discuss how his progress demonstrates that the brain can potentially repair itself but that such healing requires hard work and active effort. The brain is extraordinarily complex.

1. The Nervous System

The *nervous system* is the body's electrochemical communication system. *Neuroscience* is the field of study of the nervous system. The researchers who conduct research on the nervous system are *neuroscientists*.

A. Characteristics of the Nervous System

- Complexity

The brain is made up of billions of nerve cells, the orchestration of which allows a person to carry out a variety of activities.

- Integration

The brain integrates information from the environment so that people can function in the world.

Each nerve cell in the brain communicates with some 10,000 other nerve cells.

- Adaptability

As the world constantly changes, the brain and nervous system allow a person to adjust to those changes.

The brain has a lot of **plasticity**, meaning it has a vast capacity for modification and change.

- Electrochemical Transmission

Electrical impulses and chemical messenger systems allow the brain and nervous system to work as an information-processing system.

B. Pathways in the Nervous System

As people interact with and adapt to the world around them, the brain and nervous system receive and transmit incoming sensory information. The brain and nervous system integrate this information and direct the body's motor activities. **Afferent nerves** carry information to the brain.

Efferent nerves carry information from the brain out to the body.

Neural networks, made up of nerve cells, integrate sensory input and motor output.

C. Divisions of the Nervous System

The **central nervous system (CNS)** is comprised of the brain and spinal cord.

The **peripheral nervous system (PNS)** consists of the nerves that connect the brain and spinal cord to other parts of the body. The function of the PNS is to direct information to and from the brain and spinal cord. It also carries out the commands of the CNS. The PNS is comprised of the **somatic nervous system** and the **autonomic nervous system**.

The function of the somatic nervous system is to convey information from the skin and muscles to the CNS. It regulates information such as signals about pain and temperature.
The autonomic nervous system's function is to take messages to and from the body's internal organs, thus regulating breathing, heart rate, and digestion.
The autonomic nervous system is comprised of both the **sympathetic nervous system** and the **parasympathetic nervous system**. The sympathetic nervous system prepares a person for a stressful situation; the parasympathetic nervous system calms the body down after the stressful situation.
Stress is the response of individuals to **stressors**, circumstances or events that threaten an individual's well-being.
When a person experiences stress, physiological changes take place, such as sweating and an elevated heart beat.
When a person is exposed to a stressful situation this activates their sympathetic nervous system (the fight or flight response).
Acute stress, the momentary stress response, ends with the ceasing of the stressful event. *Chronic stress* is stress that occurs continuously. In this type of stress the nervous system sends out corticosteroids (stress hormones) that can wear down the immune system.

2. Neurons

Neurons are the nerve cells that control the information-processing function. **Mirror neurons** play a role in imitation. They are activated when we perform an action or observe others in action. These neurons are implicated in empathy and understanding others.
Glial cells provide support and nutrition to the nervous system.

A. Specialized Cell Structures

Not all neurons are alike, but they all have a cell body, dendrites, and an axon. The **cell body** contains the nucleus that manufactures what neurons need for growth and maintenance.
Dendrites receive information and send it on to the cell body.
The **axon** carries information away from the cell body and on to other cells. A **myelin sheath**, which covers the axon, is semipermeable, meaning that certain substances can pass into and out of the axon. The degenerative nerve disorder called multiple sclerosis occurs when there is a breakdown of the myelin sheath.

B. The Neural Impulse

The axon is a tube encased in a membrane. The membrane has hundreds and thousands of tiny gates in it.
The membrane is *semipermeable* because fluids can sometimes flow in and out of these gates.
Floating in those fluids are electrically charged particles called *ions.* The positive ions are sodium and potassium. The negative ions are chlorine and other elements.
In order for a neuron to send information to another neuron, the source neuron first sends an electrical charge.

Inside the membrane of the axon are gated pathways known as *ion channels*. These channels open and close, allowing the positive and negative ions to cross into and out of the axon. When a neuron is at rest and not transmitting information, the ion channels are closed and there is a negative charge on the inside of the axon and a positive charge on the outside of it.
The stable, negative charge of a neuron is called its **resting potential**.
When an electrical impulse flows down the axon it becomes *depolarized.* The channels open and the positive ions move into the axon and the negative ions move outside the axon. Then the potassium channels open and the positive ions move back out and return the axon to its normal charge.
The term **action potential** describes the brief wave of positive electrical charge that sweeps down the axon.
The **all-or-nothing principle** refers to the situation that occurs when an electrical impulse reaches a certain level of intensity called its *threshold*, it fires and moves all the way down the axon, without losing any of its intensity.

C. Synapses and Neurotransmitters

- Synaptic Transmission

Synapses are the junctions between neurons. The space between one neuron and the dendrites of another neuron is called the *synaptic gap*.
At the end of the axon there are fibers that end in what are called *terminal buttons*.
Neurotransmitters are stored in the terminal buttons. These carry the electrical information across the synaptic gap.

- Neurochemical Messengers

There are a variety of neurotransmitters. Each plays a different role and has its own function. Some neurotransmitters excite the neuron and cause it to fire, while other neurotransmitters inhibit the neuron. Some neurotransmitters are both excitatory *and* inhibitory.
After the neurotransmitter crosses over the synaptic gap, it gets picked up by a receiving neuron. Most neurons pick up and secrete only one type of neurotransmitter.
Acetylcholine sets the firing of neurons into motion and is involved in muscle action, learning, and memory.
GABA keeps many neurons from firing. Low levels of GABA are involved in anxiety.
Norepinephrine inhibits the firing of neurons in the CNS, but it excites the heart muscle, intestines, and urogenital tract. Stress stimulates the release of norepinephrine.
Dopamine helps to control voluntary movement and also affects sleep, mood, attention, learning, and the ability to recognize rewards. Low levels of dopamine are associated with Parkinson's disease.
Serotonin is involved in sleep regulation, mood attention, and learning.
Endorphins stimulate neuron firing.
Endorphins alleviate pain and elevate feelings of pleasure.

Oxytocin plays a role in the feelings of love and human bonding.

- Drugs and Neurotransmitters

A drug that mimics a neurotransmitter's effect is known as an **agonist**.
A drug that blocks a neurotransmitter's effect is known as an **antagonist**.

D. Neural Networks

Neural networks can be altered through changes in synaptic connections. How strongly neurons are connected determines how well a person remembers information.

3. Structures of the Brain and Their Functions

Neuron networks are not visible to the human eye; however, technology has helped neuroscientists form pictures of the structures of the neurons and the brain.

A. How Researchers Study the Brain and Nervous System

Much of the brain imaging available today has come from studies on patients with brain damage or injury from disease.

- Brain Lesioning

Brain lesions can be the result of injury or disease.
Neuroscientists sometimes create lesions in the brains of animals to see the effect on the animal's behavior.
Brain lesions can be made by removing brain tissue, destroying tissue with a laser, or eliminating tissue by injection with a drug.

- Electrical Recording

The *electroencephalograph (EEG)* records the electrical activity in the brain. When electrodes are placed on a person's scalp, they detect brain-wave activity, which is recorded on a chart.
The EEG is used to assess brain damage, epilepsy, and other problems. *Single-unit recording* is used when a probe is inserted in or near an individual neuron. The probe transmits the electrical activity to an amplifier so that researchers can see the activity.

- Brain Imaging

A *computerized axial tomography* (*CAT scan* or *CT scan*) produces a three- dimensional image obtained through X-rays of the head.
A *positron-emission tomography* or *PET scan* measures the amount of glucose in various areas of the brain, and then sends this information to a computer, where it is analyzed.
A *magnetic resonance image (MRI)* creates a magnetic field around a person's body and uses radio waves to construct images of the person's tissue and biochemical activities. A newer method of the MRI is the *functional magnetic resonance image (fMRI)*, which allows researchers to see what is happening in the brain while it is working.

An additional method for studying brain functioning, and one that does allow for causal inferences, is *transcranial magnetic stimulation (TMS).* In the TMS procedure, magnetic coils are placed over the person's head and directed at a particular brain area. TMS uses a rapidly changing magnetic field to induce brief electric current pulses in the brain, and these pulses trigger action potentials in neurons. Immediately following this burst of action potentials, activity in the targeted brain area is inhibited, causing what is known as a *virtual lesion*.

B. How the Brain Is Organized

The nervous system starts out as a long, hollow tube. Then, three weeks after conception, cells making up the tube start to differentiate into neurons. These neurons begin to develop into the three major parts of the brain: the hindbrain, the midbrain, and the forebrain.

- The Hindbrain

The **hindbrain** is the lowest portion of the brain.
The *medulla* helps in controlling breathing and heart rate. It also regulates our reflexes.
The *cerebellum* plays an important role in motor coordination. For example, it controls leg and arm movements. The *pons* is involved in sleep and arousal.
The *brain stem* (the oldest part of the brain) includes much of the hindbrain except the cerebellum and the midbrain. The brain stem determines alertness and regulates such basic survival functions as breathing, heart rate, and blood pressure.

- The Midbrain

The **midbrain** is located between the hindbrain and the forebrain.
The midbrain communicates information between the brain and the eyes and ears.
The **reticular formation** is involved in walking, sleeping, or turning to attend to a noise. It uses the neurotransmitters serotonin, dopamine, and norepinephrine.
The *brain stem* encases the reticular formation. It regulates survival-type functions like breathing, heartbeat, and blood pressure.

- The Forebrain

The **forebrain** is the brain's largest division and its most forward part.

Limbic System

The **limbic system** is important in both memory and emotion.
The **amygdala** is somewhat like an awareness center. It fires selectively at the sight of appropriate food, mates, and social rivals. The amygdala is also involved in emotional awareness and expression.
The **hippocampus** is involved in the formation and storage of memories. People who have hippocampus damage cannot retain new memories after the damage.

Thalamus

An important function of the **thalamus** is to sort through information and send it to the appropriate place in the forebrain for further integration and interpretation.

Basal Ganglia

The **basal ganglia** works with the cerebellum and the cerebral cortex in coordinating voluntary movements.

Hypothalamus

The **hypothalamus** monitors eating, drinking, and sexual behavior, along with emotion, stress, and reward.

C. The Cerebral Cortex

The **cerebral cortex**, the outer layer of the brain, controls some of the highest mental functions, such as thinking and planning.

The **neocortex**, the outermost part of the brain, makes up 80 percent of the cerebral cortex.

- Lobes

The lobes are divided into two *hemispheres*, and each hemisphere is divided into four lobes: the occipital lobe, the temporal lobe, the frontal lobe, and the parietal lobe.

The **occipital lobes**, in the back of the head, responds to visual stimuli.

The **temporal lobes**, in the cerebral cortex just above the ears, are involved in hearing, language processing, and memory.

The **frontal lobes**, behind the forehead, is involved in the control of voluntary muscles, intelligence, and personality. A fascinating case study illustrates how damage to the frontal lobes can significantly alter personality. Phineas Gage, a 19th-century railroad worker. During an accident, an iron rod went through his face and up into his brain, and damaged his frontal lobe. After the accident, Phineas's personality changed dramatically. He became obstinate, moody, irresponsible, selfish, and incapable of taking part in planned activities.

The **prefrontal cortex,** an important part of the frontal lobes, is at the front of the motor cortex. It is involved in higher cognitive functions such as planning, reasoning, and self-control.

The **parietal lobes,** at the top and toward the rear of the head, involves registering spatial location, attention, and motor control.

- Somatosensory Cortex and Motor Cortex

The **somatosensory cortex** processes information about body sensations.

The **motor cortex** processes information about voluntary movements.

The somatosensory and motor areas are associated with different parts of the body. When Wilder Penfield conducted research on the somatosensory and motor areas, he found that when he stimulated certain somatosensory and motor areas of the brain, a certain part of the body would move.

- Association Cortex

The **association cortex** processes information about sensory input and motor output. The association cortex is involved in thinking and problem solving.

D. The Cerebral Hemispheres and Split-Brain Research

Aphasia is a language disorder associated with brain damage.
Damage to *Broca's area* causes a person to have difficulty in speaking a language.
Damage to *Wernicke's area* causes problems in comprehending language.

- The Role Of The Corpus Callosum

The **corpus callosum** is a bundle of axons that connects the left and right hemispheres of the brain. If the corpus callosum is severed, the two hemispheres cannot communicate with each other. If a memory is stored in the left hemisphere it cannot be communicated with the right hemisphere; therefore, the memory appears to be gone.

- Hemispheric Differences In Functioning

In people with intact brains, specialization of function, or what is sometimes called *lateralization*, occurs in some areas.
Left hemisphere: The most extensive research on the brain's two hemispheres has focused on language. Speech and grammar are localized to the left hemisphere.
Right hemisphere: The right hemisphere dominates in processing nonverbal information such as spatial perception, visual recognition, and emotion.
The right hemisphere also may be more involved than the left hemisphere in processing information about emotions, both when we express emotions ourselves and when we recognize others' emotions. It is also adept at interpreting story meanings and voice intonations.

E. Integration of Function in the Brain

There is considerable integration of function between different areas in the brain. When information, or stimuli, is noticed, the information gets sent to the correct area of the brain, where it is processed, and then sent out of the brain to the correct area in the body. Along the way, from the beginning to the end, the information goes through various areas of the brain and all the areas work together to have the information processed.

4. The Endocrine System

The **endocrine system** consists of glands that regulate certain organs by releasing their chemical products into the bloodstream.
Glands are organs or tissues in the body that create chemicals that control many bodily functions.
Hormones are chemical messengers that are manufactured by the endocrine system.
The **pituitary gland** involves growth and regulates other glands.
The **adrenal glands** are involved in regulating mood, energy level, and the ability to cope with stress. The adrenal glands secrete both epinephrine and norepinephrine. The **pancreas** is involved in the digestive and endocrine functions. It secretes insulin, which controls blood sugar, which itself is implicated in metabolism and weight and obesity.
The **ovaries** in females and the **testes** in males are involved in sexual development, reproduction, and sexual characteristics.

5. Brain Damage, Plasticity, and Repair

Research has been conducted on patients with brain damage to determine how well the brain can repair itself. Recovery from brain damage depends on the age of the individual and the extent of the brain damage.

A. The Brain's Plasticity and Capacity for Repair Although the young child's brain has more plasticity than an older child's, because of its immaturity it also is more vulnerable to insults.

Much of the brain's ability to repair itself depends on whether the neurons in the damaged area have been completely destroyed. If these neurons were not totally destroyed, brain function may be restored over time.

Collateral sprouting is one way in which the brain can repair itself. In this process, the axons on adjacent neurons grow more branches.

Substitution of function is a second way the brain can repair itself. When this happens, another area in the brain takes over the functions of the damaged area. *Neurogenesis* is the process through which new neurons are generated.

B. Brain Tissue Implants

Brain grafts are implants of healthy tissue into damaged brains.

The most successful cases of brain grafts occur when the tissue for the implants comes from the fetal stage.

The use of *stem cells* has been a topic for hot debate in recent years. Stem cells are unique, because they have the ability to develop into most types of cells.

6. Genetics and Behavior

A. Chromosomes, Genes, and DNA

The nucleus of each cell contains 46 *chromosomes,* which are essentially 23 pairs of chromosomes with one of each pair coming from each parent.

Chromosomes contain *deoxyribonucleic acid,* or *DNA*. DNA is the molecule that carries a person's genetic information.

Genes are the segments of chromosomes that are composed of DNA. Genes carry the heredity information of the individual.

An international research program called the Human Genome Project is dedicated to documenting the human genome.

B. The Study of Genetics

Gregor Mendel first started the research on genetics in the mid-nineteenth century when he studied heredity in pea plants.

The **dominant recessive genes principle** refers to the principle that if one gene of a pair is dominant and one is recessive, the dominant gene overrides the recessive gene. A recessive gene exerts its influence only if both genes of a pair are recessive.

- Molecular Genetics

Molecular genetics involves the manipulation of genes.

- Selective Breeding

Selective breeding occurs when organisms are chosen for reproduction based on how much of a particular trait they display.

- Behavior Genetics

Behavior genetics is the study of the degree and nature of heredity's influence on behavior.
In twin studies, behavior genetics studies the extent to which individuals are shaped by their heredity and the influence of the environment on them. The behavioral similarity of identical twins is compared to the behavioral similarity of fraternal twins.

C. Genes and the Environment A
genotype is a person's genetic heritage.
A **phenotype** is a person's observable characteristics. The phenotype is influenced by the genotype but also by environmental factors.

Box Features in This Chapter
Intersection: Neuroscience and Personality: Are Some Brains Nicer Than Others?
Challenge Your Thinking: Do Mirror Neurons Hold the Key to Social Understanding?
Psychology in Our World: Protecting the Athlete's Brain
Do It!
The Happiness Gene (p. 78)

Connections: Tools for Success—A Safety Net for Students and Instructors

Take advantage of all the other teaching tools available for this chapter.

Student Ancillaries:

Student Study Guide and *Online Learning Center* quizzes can be found at www.mhhe.com/kingep2e
Psych 2.0: This is a password-protected site. Students can purchase the access code directly or it may be included (for a fee) with a new textbook. See your Sales Representative for details.

There are four interactivities appropriate for use with this chapter:

- **The Structure of Neurons.** The neuron is introduced as the basic element of the nervous system. The student watches an animation of a neuron signal's path through the body when a stimulus is detected.
- **Areas and Functions of the Brain.** Shows the location, function, and pronunciation of the names for each part of the brain.

- **Brain Lateralization.** Describes which areas of the brain are responsible for language, emotions, thoughts, behaviors, and so on. A video clip of a subject named Nancy shows which parts of the brain are used during everyday activities. Following the clip is an interactivity exercise in which students first tap the space bar as many times as they can in 20 seconds using their right hand, then the left hand, then repeat this activity while reading some text, to demonstrate the differences between the functions of the left and right sides of the brain.
- **Localization of Function: Second-Language Learning and Brain Plasticity.** This activity demonstrates how experience influences the way the brain processes language. As students will see, through a series of short videos and self-reflective quizzes, the age at which a person learns a language influences where in the brain the vocabulary and grammatical rules for that language are represented.
- **College Stress Test.** Students take the college stress test and are given a score, which is then explained.

Instructor Supplements:
Text:

Opportunities for Thinking
These opportunities can be found in the text on pp. 43, 44, 46, 47, 50, 53, 55, 57, 59, 62, 63, 65, 66, 68, 70, 76, 78, and 80.

Other in-text features can also function as discussion or assignment topics:
Intersection: ―Neuroscience and Personality: Are Some Brains Nicer Than Others?‖ on p. 58.
Psychology in Our World: ―Protecting the Athlete's Brain‖ on p. 74.
Challenge Your Thinking: ―Do Mirror Neurons Hold the Key to Social Understanding? on p.
48.

Test Bank: The test bank for Chapter Two comes with answers and references to where in the textbook the information for the questions can be found.
PowerPoint Presentation: The PowerPoint slides for Chapter Two include 34 slides covering the information pertaining to biological psychology, 7 figure slides, and 3 chapter summary slides. There are activities and demonstrations in the Notes sections of slides 20, 27, 31, and 35.
Concept-Based Dynamic PowerPoint Presentations: Concepts for Chapter Two include the Nervous System, Brain, Endocrine System, Genetics, and Limbic System. Also available in PowerPoint are the ―Touring the Brain‖ and ―Nervous System‖ overlays from the text.

There are four videos that go with Chapter Two:

- *Neurons and How They Work* provides a virtual tour inside the brain, from the cortex to the communication of the neurons, describing how neurons work together to create brain activity.
- *Functions of Neurotransmitters* gives a virtual tour of neurotransmitters and discusses their function.
- *Brain Structures and Imaging Methods* shows an example of an *f*MRI. *Brain Plasticity* shows a girl who had the right hemisphere of her brain removed because of epileptic seizures but after the surgery was able to function normally, because of the brain's plasticity.

Teaching the Chapter

Learning Goal One: The Nervous System

1. The Nervous System (p. 43) **A. Characteristics of the Nervous System** Complexity
- Integration
- Adaptability
- Electrochemical transmission
- **B. Pathways in the Nervous System**

Afferent nerves
Efferent nerves Neural networks
C. Divisions of the Nervous System
Central nervous system (CNS)
Peripheral nervous system (PNS)
Somatic nervous system
Autonomic nervous system
Sympathetic nervous system
Parasympathetic nervous system
Stress

Lecture/Discussion Suggestions

Central and Peripheral Nervous Systems. The major divisions of the human nervous system, the central and peripheral are to be indicated with the pictorial depiction. It also describes the bodily functions that each part controls. The students could be asked to identify each part of both the nervous systems.
Self-Talk. Ask the students to think about a time in their lives that was stressful for them. Ask them to write down how they overcame that stress and dealt with the situation. Discuss with the class how the technique of self-talk can help in stressful situations.

Sometimes a person does not feel comfortable talking to someone else, or maybe there is no one else around in a stressful situation. When this happens, self-talk can help.

Goal Reinforcement Activities— Goal One: The Nervous System.

Electrochemical Transmission. Have the students search on the Internet for a Web site that talks about epileptic seizures. After the students find and read the Web page, have them write a one- to two-page paper on how electrical charges are disrupted during a seizure and how this affects information being passed from one area of the brain to the other. **The Nervous System.** Break the class into groups and tell them to imagine themselves walking down a dark street late at night. All of a sudden they think they hear someone following them. Ask them to discuss and write down what would be happening to them physiologically as the information they are hearing is going through the nervous system. After they are finished, write the six nervous systems on the board and have one member of each group come to the front of the room and explain the physiological characteristics their group decided on.
Changing the Brain: In a share-pair or small group, instruct students to discuss the following: ―If the brain is changed, is it the same person?‖ Use textbook information to justify their answer. If in a large group (60+) randomly call on share-pairs to offer their findings to the rest of the class. If the class is smaller in size, have one person from each small group share the group's results.
Goals: Have each student list their lifetime goals. Instruct them to determine how their thinking might have to change in order to achieve their goals. Finally, ask each student to submit a short essay outlining how they will change their thinking to achieve their goals.

Apply it! (p. 47) Have students complete the Apply it! Next, have them justify their answer. This can be homework (as they read the chapter), a quiz in class, class discussion, or an essay.

Learning Goal Two: Neurons

2. Neurons (p.
47) Neurons
Mirror neurons
Glial cells
A. Specialized Cell Structure
Cell body
Dendrites
Axon
Myelin sheath
B. The Neural Impulse
Ions
Ion channels
Resting potential

Action potential
All-or-nothing principle

C. Synapses and Neurotransmitters

- Synaptic transmission

Synaptic gap
Terminal buttons
Neurotransmitters

- Neurochemical messengers

Acetylcholine
GABA
Norepinephrine
Dopamine
Serotonin
Endorphin
Oxytocin

- Drugs and neurotransmitters

D. Neural Networks

Change in synaptic connections Strong neurons

Lecture/Discussion Suggestions

The Neuron and the Synapse. Students should be able to identify the various parts of the neuron and the synapse, and be able to explain how information is communicated between neurons.

The Resting Potential and the Action Potential. Students should be able to describe how ions maintain a resting potential and how a change in the charge of the ion can cause action potential.

Goal Reinforcement Activities—Goal Two: Neurons

Neural Transmission. Write the steps for neural transmission on the board. Ask for 12 volunteers. Assign a role to each of the students: electrical stimulus, dendrite, cell body, axon, myelin sheath (use four students for this one), positive ion, negative ion, terminal button, and neighboring neuron. Line up the students up so that they are in the correct order. Go through the steps on the board with the students and have them act out their parts as you are going through the steps. Do this a couple of times until you think they have understood it. Next, allow the students to run through the steps by themselves. The students should gain a hands-on idea of how electrical information is passed along an axon for neural transmission to occur.

Neurotransmitters. Use ―Activity Handout 2.1: Neurotransmitters‖ as a way for students to understand the needs and functions of the various neurotransmitters. The students will have to find, on their own, the purpose for each of the neurotransmitters and determine what could possibly occur if there was a decrease or excess of neurotransmitters.

Drugs and Neurotransmitters. Use ―Activity Handout 2.2: What's in Your Medicine Cabinet?‖ This activity will have students examine their own medications to find out if any of them are agonists or antagonists.
Neural Networks: Have each student construct a real life connection to each of the concepts mentioned in the chapter. (A good example would be to relate each part of the nervous system to a relative). If there is time, have students share their networks/connections to further reinforce their learning and to promote ideas for others.

Apply it! (p. 56) Have students complete the Apply it! Next, have them justify their answer. This can be homework (as they read the chapter), a quiz in class, class discussion, or an essay.

Learning Goal Three: Structures of the Brain and their Functions

3. Structures of the Brain and Their Functions (p. 56) **A. How Researchers Study the Brain and Nervous System**

- Brain lesioning
- Electrical Recording
- Brain Imaging

CT scan
PET scan
MRI scans
fMRI scans
Transcranial Magnetic Stimulation (TMS)

B. How the Brain Is Organized

- Hindbrain

Medulla
Cerebellum
Pons
Brain stem

- Midbrain

Reticular formation

- Forebrain

Limbic system
Amygdala
Hippocampus
Thalamus
Basal ganglia
Hypothalamus

C. The Cerebral Cortex

- Lobes

Occipital lobe
Temporal lobe

Frontal lobe

Parietal lobe

- The Somatosensory Cortex and Motor Cortex
- The Association Cortex

D. The Cerebral Hemispheres and Split-Brain Research

The role of the corpus callosum

Aphasia

Broca's area

Wernicke's area

The corpus callosum

- Hemispheric differences in functioning Lateralization

Left-hemisphere

Right-hemisphere

E. Integration of Function in the Brain

Lecture/Discussion Suggestions

Structure and Function of the Brain. The students should be able to identify the structures of the brain and describe their functions.

Cerebral Cortex Lobes and Association Areas. The students should be able to locate and describe the four lobes of the cerebral cortex.

The Split Brain. The students should be able to describe hemispheric lateralization and how information is communicated between the two hemispheres of the brain.

Goal Reinforcement Activities— Goal Three: Structures of the Brain and their Functions

Brain Imaging. Have the students write down and explain the various techniques for imaging the brain. Discuss with the students how brain images can show damage to various areas of the brain.

Brain Organization. Bring drawings of the brain to class and pass them out to the students. Write the various parts of the organization of the brain on the board. Break the students into groups and have them work together on labeling and defining the parts of the brain, using the parts of the brain listed on the board.

Left and Right Brain Hemispheres. Use ―Activity Handout 2.3: Which Hemisphere Is It?‖ Have students identify the hemisphere responsible for different activities. The students will gain an idea of how different the hemispheres are.

Split Brains. Have the students go onto the Internet and find a web site that discusses split-brain surgery. Next, have them write a one- to two-page paper summarizing what they read and their feelings on the ethics of conducting split-brain surgery.

Apply it! (p. 71) Have students complete the Apply it! Next, have them justify their answer. This can be homework (as they read the chapter), a quiz in class, class discussion, or an essay.

Learning Goal Four: The Endocrine System

4. The Endocrine System (p. 71) **A. Endocrine System Structures and Functions**
Hormones
Pituitary gland
Adrenal glands
The pancreas
Ovaries and testes

Lecture/Discussion Suggestions

Goal Reinforcement Activities— Goal Four: The Endocrine System

Hormones. Have the students do a search on the Internet and find a Web site that discusses hormonal changes in animals. Ask the students to discuss, in a one- to two-page paper, how animal hormonal changes differ from human hormonal changes.

Apply it! (p. 73) Have students complete the Apply it! Next, have them justify their answer. This can be homework (as they read the chapter), a quiz in class, class discussion, or an essay.

Learning Goal Five: Brain Damage, Plasticity, and Repair

5. Brain Damage, Plasticity, and Repair (p. 73) **A. The Brain's Plasticity and Capacity for Repair** Collateral sprouting
Substitution of function Neurogenesis
B. Brain Tissue Implants Brain
grafts
Stem cells

Lecture/Discussion Suggestions

Goal Reinforcement Activities— Goal Five: Brain Damage, Plasticity, and Repair

Brain Damage Repair. Have the students go onto the Internet and find cases where neurogenesis has been successful. Have them discuss how the research was conducted and what concerns there are for conducting this type of research in humans.
Brain Grafts and Stem Cell Research. Break the class into two groups and have them make a pro and con list for the use of stem cells in research and the possible use of stem cells in

helping humans. The students will probably get an active debate going, and they should see how much of a controversial issue this really is.
Stem Cells: Ask students to write an essay regarding the following topic: ―Do you oppose the use of stem cells in research. Why?‖ To further the idea of research, require two valid research articles to support the student's opinion.
Stem Cell Videos: There are three video clips in the video section of this chapter. As the students watch the clips, have them record three observations. If there is time in class, for a small class, have each student share at least one observation. If the class is large (60+) have students share their observations in a share-pair and then call on a pair randomly to share their observations.

Apply it! (p. 76) Have students complete the Apply it! Next, have them justify their answer. This can be homework (as they read the chapter), a quiz in class, class discussion, or an essay.

Learning Goal Six: Genetics and Behavior

6. Genetics and Behavior (p. 76) **A. Chromosomes, Genes, and DNA** Chromosomes
DNA
Genes
Human Genome Project
B. The Study of Genetics □ Molecular genetics □ Selective breeding □
Behavior genetics
C. Genes and the Environment Genotypes
Phenotypes

Lecture/Discussion Suggestions

Goal Reinforcement Activities—Goal Six: Genetics and Behavior

Behavior Genetics. Find an article discussing the Minnesota Twin Study. Bring copies of this article to class and pass it out to the students. Tell the students to take about 15 minutes or so to read over the article. After they finish reading the article, break them into groups to discuss what this article tells them about behavior genetics.
Springer Twins: After reading the material in the textbook, in small groups or share-pairs, discuss how similar Jim Springer would be to any man his same age and same name. Is it possible that some of his similarities to Jim Lewis were not so surprising?
Happiness Gene: This can be assigned as homework or an in-class project in share-pairs or small groups. Have students search the web for information about the happiness gene. Answer the questions on the Activity Handout 2.4. If in a large class, randomly ask share-pairs to report their results. If the class is in groups, ask one student from each group to report on the findings.

Genes and the Environment. Use ―Activity Handout 2.5: The Human Genome Project.‖ Have the students go to the following Web site: http://www.ornl.gov/sci/techresources/Human_Genome/project/about.shtml and have them read about the human genome project. Next ask them to go to the following Web site: http://www.ornl.gov/sci/techresources/Human_Genome/medicine/medicine.shtml. Here they will read about genes and testing for various diseases. The students will gain knowledge about the human genome project and how knowing about genes will help researchers in conducting research on various diseases and disorders.

Apply it! (p. 81) Have students complete the Apply it! Next, have them justify their answer. This can be homework (as they read the chapter), a quiz in class, class discussion, or an essay.

Critical Thinking Questions

- Why do you believe there has been an increasing interest in hemispheric specialization (the difference in right-brained and left-brained functions) in the public?
- Imagine your favorite food. Now imagine taking a bite of that food. What parts of the brain became activated as you ate your favorite food?
- What role—pro or con—do you take when it comes to stem cell research? Explain both sides.
- What is the importance of considering genetics and the brain when analyzing behavior and mental processes?
- What behaviors have been passed on in your family and how far back can they be traced? What behaviors do you want to pass on to your children and why?

Readings, Videos, and Web Site Suggestions

Readings

Beatty, J. *Principles of Behavioral Neuroscience*. New York: McGraw-Hill, 1995.
Bouchard, T. J., Jr.; Lykken, D. T.; McGue, M.; Segal, N. L., and Tellegen, A. ―Sources of human psychological differences: The Minnesota study of twins reared apart.‖ *Science,* no.
250 (1990), pp. 223–28.
Rowe, D. C. *The Limits of Family Influence: Genes, Experience, and Behavior*. New York: Guilford, 1994.
Sperry, R. W. ―Hemisphere disconnection and unity in conscious awareness.‖ *American Psychologist*, no. 23 (1968), pp. 723–33.

Videos

Discovering Psychology: The Behaving Brain. Annenberg/CPB Collection, 1990. (30 minutes)
This video provides an overview of the structure and function of the brain through a description of the biochemical reactions involved in thoughts, feelings, and actions.

Discovering Psychology: The Responsive Brain. Annenberg/CPB Collection, 1990. (30 minutes)
This video describes the relationship between the structures and functions of the brain and the environment.
Discovering Psychology: The Mind Hidden and Divided. Annenberg/CPB Collection, 1990. (30 minutes)
This piece examines how the unconscious mind influences thought and behavior.
The Brain. Insight Media. (50 minutes)
This video demonstrates with animation and models of the brain the structures and functions of the brain.
The Mind. 2nd ed., teaching module #5, ―Endorphins: The brain's natural morphine,‖ Video File, 1999. Video posted to http://www.learner.org/resources/series150.html This video explores neural networks, synapses, and neurotransmitters.
The Mind. 2nd ed., teaching module #7, ―The frontal lobes: Cognition and awareness,‖ Video File, 1999. Video posted to http://www.learner.org/resources/series150.html

The brain's frontal lobes and function are the topics of nd discussion.
The Mind. 2 , ed., teaching module #26, ―The bilingual brain.‖ Video File, 1999. Video posted to http://www.learner.org/resources/series150.html The use of fMRI studies is used to demonstrate brain function.
Vannato, Frank, J.; Bennett, Thomas, L.; and Butler, Michelle. *The Brain*. Teaching module #1, ―Organization and evaluation of brain function.‖ Video File, 1997. Video posted to http://www.learner.org/resources/series142.html
Brain structures and functions.
Vannato, Frank, J., et al. *The Brain*. Teaching module #2, ―The effects of hormones and the environment on brain development.‖ Video File, 1997. Video posted to http://www.learner.org/resources/series142.html
Research on the differences between the male and female brain.
Vannato, Frank, J., et al. *The Brain*. Teaching module #5, ―The divided brain.‖ Video File, 1997. Video posted to http://www.learner.org/resources/series142.html Hemispheric functions and the split brain.
Vannato, Frank, J., et al. *The Brain*. Teaching module #7, ―Brain anomaly and plasticity: hydrocephalus.‖ Video File, 1997. Video posted to http://www.learner.org/resources/series142.html Brain plasticity.
Vannato, Frank, J., et al. Teaching module #30, ―Understanding the brain through epilepsy.‖ Video File, 1997. Video posted to http://www.learner.org/resources/series142.html The effects of neurotransmitters and epilepsy.
Vannato, Frank, J., et al. *The Brain*. Teaching module #31, ―Brain transplants in Parkinson's patients.‖ Video File, 1997. Video posted to http://www.learner.org/resources/series142.html
Brain transplants as a treatment for Parkinson's disease.
Vannato, Frank, J., et al. *The Brain*. Teaching module #32, ―Neurorehabilitation.‖ Video File, 1997. Video posted to http://www.learner.org/resources/series142.html
Case studies of brain injuries and their treatments.

The Nervous System: Neurons, Networks, and the Human Brain, (2007) Insight Media, 32 Minutes
The film introduces the Central Nervous System, Peripheral Nervous System, brain structures and functions and the spinal cord.
The Most Amazing Machine: Neuroscience and Behavior. (2006) Insight Media, 30 minutes. This film focuses on the connection between biology and behavior
Cracking the Code of Life. NOVA Video File (2001). Video posted to: http://www.pbs.org/wgbh/nova/teachers/programs/2809_genome.html Sixteen video clips (105 minutes) that focus on the human genome Epigenetics. NOVA Science Now Video File (2007). Video posted to: http://www.pbs.org/wgbh/nova/sciencenow/3411/02.html This film is approximately 13 minutes and focuses on epigenetics.
Personal DNA Testing. NOVA Video File (2008). Video posted to: http://www.pbs.org/wgbh/nova/sciencenow/0302/01.html
This video file is approximately 13 minutes and concentrates on personal DNA testing Brain Trauma. NOVA Science Now Video File (2008). Video posted to: http://www.pbs.org/wgbh/nova/sciencenow/0306/02.html An 11 minute video that discusses brain trauma.
Mirror Neurons. NOVA Science Now Video File (2005). Video posted to: http://www.pbs.org/wgbh/nova/sciencenow/3204/01.html A 14 minute video that addresses mirror neurons.
Stem Cells. NOVA Science Now Video File (2005). Video posted to: http://www.pbs.org/wgbh/nova/sciencenow/3209/04.html
An 8 minute video that discusses a new technique for creating stem cells. Stems Cells Breakthrough. NOVA Science Now Video File (2008). Video posted to: http://www.pbs.org/wgbh/nova/sciencenow/0305/03.html
A 13 minute video that shows creating stem cells without harming human embryos. Stem Cells Update. NOVA Science Now Video File (2006). Video Posted to: http://www.pbs.org/wgbh/nova/sciencenow/3302/06.html An 8 minute video addressing the ethical concerns of stem cell research.

Web Sites

http://www.med.harvard.edu/AANLIB/home.html An atlas of the whole brain.

http://www.univ-st-etienne.fr/lbti/Mednucl/AtlasEnd/aindex.htm An atlas of the endocrine system.

http://www.ornl.gov/sci/techresources/Human_Genome/project/about.shtml The Human Genome Project.

http://www.sfn.org/
The Society of Neuroscience's official Web site. The purpose of the organization is to understand and promote education concerning the nervous system.

http://faculty.washington.edu/chudler/experi.html Nervous system animations and games.
http://learn.genetics.utah.edu
This site teaches basic genetics and stem cells through the use of easy-to-understand animations.

http://www.dnaftb.org/dnaftb/1/concept
A comprehensive resource for information regarding genetics.

http://thebrain.mcgill.ca/flash/index_i.html
This site is a comprehensive site for studying the brain from top to bottom. It includes information concerning the brain and memory, consciousness, drugs, and sleep/dream/wake cycles.

Activity Handouts

Activity Handout 2.1

Neurotransmitters

Find the purpose of each of the neurotransmitters listed below. Also, describe what might happen to a person if they had an excess amount or a lesser amount of each of these neurotransmitters.
Acetylcholine
GABA
Norepinephrine
Dopamine
Serotonin
Endorphin
Oxytocin

Activity Handout 2.2

What's in Your Medicine Cabinet?

Go home and take a look in your medicine cabinet. Take out all the prescription medications. Go on the Internet and search for each of these medications. Find out what warnings there are for the medications and determine if they are agonists or antagonists.

Activity Handout 2.3

Which Hemisphere Is It?

Read each of the activities below and then circle which hemisphere—the left or the right—controls that behavior.

1. Writing lecture notes while in class. LEFT or RIGHT. Why?
2. Watching your favorite TV show. LEFT or RIGHT. Why?
3. Catching a ball in left field. LEFT or RIGHT. Why?
4. Doing math problems for a homework assignment. LEFT or RIGHT. Why?
5. Doing a crossword puzzle in the newspaper. LEFT or RIGHT. Why?
6. Running a marathon. LEFT or RIGHT. Why?
7. Listening to a love song with your significant other. LEFT or RIGHT. Why?
8. Putting together a desk kit that you just bought at the local office superstore. LEFT or RIGHT. Why?
9. Taking a spelling test. LEFT or RIGHT. Why?
10. Doing your yearly taxes. LEFT or RIGHT. Why?

Activity Handout 2.4

Happiness Gene

Search the internet for information about a happiness gene. Answer the following questions.

1. How would you evaluate research on such a gene, given what you have read so far in the textbook?
2. What (if anything) would the existence of such a gene mean for your ability to find happiness in your life?

Activity Handout 2.5

The Human Genome Project

Go to the following Web site:
http://www.ornl.gov/sci/techresources/Human_Genome/project/about.shtml and read about the Human Genome Project.
Next, go to this Web site:
http://www.ornl.gov/sci/techresources/Human_Genome/medicine/medicine.shtml Choose a topic under the heading ―Disease Intervention,‖ then write a one- to two-page paper summarizing what you have read. Also write about your thoughts on the Human Genome Project.