

# Chapter 3—The Brain and Behavior

## Learning Goals

1. Discuss the nature and basic functions of the nervous system.
2. Explain what neurons are and how they process information.
3. Identify the brain's levels and structures, and summarize the functions of its structures.
4. State what the endocrine system is and how it affects behavior.
5. Explain how genetics and evolutionary psychology increase our understanding of behavior.

*After studying Chapter 3, you will be able to:*

- Describe what the nervous system is and discuss what the field of neuroscience is about.
- Explain how the nervous system is organized.
- Describe what neurons are and how they process information.
- Understand the role of glial cells in the nervous system.
- Describe the process through which neurons communicate with one another, including the role of neurotransmitters.
- Outline the structures and functions of the hindbrain, midbrain, and forebrain.
- Explain how the cerebral cortex is organized and discuss its functions.
- Understand the role of the endocrine system in psychology.
- State some basic ideas about heredity, the evolutionary perspective, and how genetics and the environment interact to influence behavior.

## CHAPTER 3: OUTLINE

- The brain is a complex, versatile, and flexible network that controls our behaviors and mental processes.
- The evolutionary psychology approach, which emphasizes the importance of adaptation, reproduction, and natural selection in explaining psychology, considers how the human nervous system has evolved to its complex present state.
- Most scientists believe that behavior is determined by the interaction of the environment and the organism's biological inheritance.
- The nervous system is made up of interconnected nerve cells that transmit information throughout the body. There are four defining characteristics of the nervous system: (1) it communicates via electrochemical transmission; (2) it is characterized by its complexity, since the brain alone is composed of billions of nerve cells; (3) it can integrate information from many sources and create a coherent psychological experience; and (4) it has a great capacity to adapt to changes in the environment and the body.
- The capacity of the brain to adapt is termed *plasticity*.
- Cells that carry input to the brain are called *sensory neurons*; those that carry output from the brain are called *motor neurons*. Most of the communication in the nervous system takes place through neural networks, which are nerve cells that integrate sensory input and motor output.
- The nervous system is divided into the central nervous system and the peripheral nervous system. The central nervous system consists of the brain and the spinal cord.

- The peripheral nervous system connects the brain and the spinal cord to the other parts of the body. The peripheral nervous system is divided into the somatic nervous system, which contains sensory and motor nerves, and the autonomic nervous system, which monitors the body's internal organs.
- There are two types of nerve cells: neurons and glial cells. The neurons are in charge of communication, and the glial cells support and nourish the neurons. A neuron is made of (1) a cell body, which regulates the cell's growth and maintenance; (2) dendrites, which collect information for the neuron; and (3) an axon, which carries information away from the cell body to other cells. Most axons are covered with a layer of fat cells called the *myelin sheath*, which insulates the axon and speeds up the impulse.
- Neurons send information down the axon in the form of waves of electricity called the *action potential*. The neuron has a cell membrane that allows certain substances to enter the cell and other substances to exit the cell. The action potential operates according to the all-or-none principle.
- Each axon branches out into numerous fibers that store substances called *neurotransmitters*. When the electrochemical wave arrives at the end of an axon, the neurotransmitter is released onto the synapse, the tiny gap between neurons. The neurotransmitters carry the message across the synapse to the receiving dendrite or cell body of the next neuron.
- Dendrites and some soma have receptor sites, which are neurotransmitter specific. The most common analogy is that of a lock and key. The neurotransmitter is the key and the receptor site is the lock.
- When the neurotransmitter latches onto a receptor site, it initiates an electrochemical wave in the receiving neuron. This is how neurons communicate! However, some neurotransmitters are inhibitory, which means that when they latch onto a receptor site, they keep the next neuron from starting an action potential. The neurotransmitters that stimulate other neurons to start the action potential are referred to as *excitatory*.
- Chapter 2 includes a discussion of six neurotransmitters that are very important in the human nervous system: acetylcholine, GABA, norepinephrine, dopamine, serotonin, and endorphins.
- Glial cells provide support and nutritive functions for neurons.
- The neural communication is the foundation of our psychology. Whenever we have an experience, say stepping on a sharp stone, a number of neurons are stimulated and neural communication takes place throughout the nervous system. Some of those neurons will control your movements as you retrieve your foot and regain your balance; they will communicate again in the future when you recall the event and when a similar experience occurs.
- The brain consists of the hindbrain, the midbrain, and the forebrain.
- The hindbrain is the lowest portion of the brain and consists of the medulla, the cerebellum, and the pons.
- The midbrain is an area where many nerve-fibers ascend and descend and relay information between the brain and the eyes and ears. An important structure of the midbrain is the reticular formation.
- The highest region of the brain is the forebrain. Its major structures include the limbic system, thalamus, basal ganglia, hypothalamus, and cerebral cortex. Each performs certain specialized functions involving emotion, memory, senses, movement, stress, and pleasure.
- The cerebral cortex constitutes the largest part of the brain and comprises two hemispheres (left and right) and four lobes (occipital, temporal, parietal, and frontal). The cerebral cortex consists of the sensory cortex, the motor cortex, and the association cortex. The two hemispheres are connected by the corpus callosum. No complex function can be assigned to one single hemisphere or the other. There is interplay between the two hemispheres.

- A number of important body reactions produced by the autonomic nervous system result from its action on the endocrine glands. The endocrine system is a set of glands (pituitary, thyroid, parathyroid, adrenal, pancreas, and the ovaries in women and the testes in men) that regulate the activities of certain organs by releasing hormones into the bloodstream. The anterior part of the pituitary is called the *master gland*; it is controlled by the hypothalamus. The adrenal glands play an important role in mood, energy, and stress.
- Our psychology has genetic and evolutionary foundations. The last part of Chapter 2 explores the basic concepts of genetics and heredity. The nucleus of each human cell contains 46 chromosomes (23 pairs) that contain DNA.
- Genes, the units of hereditary information, are short segments of chromosomes.
- Genes combine with other genes to determine our characteristics. There are dominant and recessive genes.
- Polygenic inheritance is the effect that multiple genes have on behaviors and mental processes.
- The study of genetics has progressed from the basic experiments of Mendel to molecular genetics and the development of genomes. The Human Genome Project strives to describe the complete set of instructions for making a human being. There are great expectations for this project to contribute to the understanding of physical disease and mental disorders. Genetic methods include selective breeding and behavior genetics.
- Psychologists now face the challenge of finding theoretical frameworks that successfully integrate the biological foundations of psychology and research in genetics and neuroscience with the wealth of psychological theories that explore the influences of the environment and experiences on human psychology.

## Building Blocks of Chapter 3

### Clarifying some of the tricky points in Chapter 3 and In Your Own Words

*To respond to the questions and exercises presented in the “In Your Own Words” section, please write your thoughts, perspectives, and reactions on a separate piece of paper.*

#### ***The Nervous System***

The body’s electrochemical communication circuitry is known as the *nervous system*; the field that studies this system is called *neuroscience*. The four characteristics of the nervous system are *complexity*, *integration*, *adaptability*, and *electrochemical transmission*. The capacity of the nervous system to adapt is reflected in *plasticity*, which is the capacity of the brain to modify and change. This means with experience our brain literally changes!

When neurons communicate with one another they use chemicals, called *neurotransmitters*. Our nervous system is divided into two parts: the *central nervous*

*system (CNS)* and the *peripheral nervous system (PNS)*. The CNS consists of the *brain and spinal cord*; the PNS *connects the brain and spinal cord to other parts of the body*.

The peripheral nervous system consists of two major divisions: one, which contains both sensory nerves and motor nerves, is called the *somatic nervous system*. The other, which monitors breathing, heart rate, and digestion, is the *autonomic nervous system*. The autonomic nervous system is divided into

the *sympathetic nervous system*, which helps arouse the body, and the *parasympathetic nervous system*, which helps calm the body.

### In Your Own Words

*Please write your thoughts, perspectives, and reactions on a separate piece of paper.*

- ✓ *What are some circumstances in which the sympathetic nervous system is activated? In these circumstances, what advantage does one gain from the sympathetic nervous system being activated?*

### Neurons

There are two types of cells in the nervous system: *neurons* and *glial cells*.

### Helpful Hints for Understanding Neuropsychology

#### Helpful Hint #1:

*Neurons are the cells that process information; the glial cells provide support and nutrition in the nervous system. Think of the glial cells as the caretakers of the neurons. There are many more glial cells in the human brain than there are neurons, so we know neurons need nutrition and support to function well.*

Neurons have three parts: *dendrites*, *cell body*, and *axon*. The part of the neuron that *receives information* is the *dendrite*; the part that *carries the information away* from the cell body is the *axon*.

Neurons send messages by creating a brief wave of electrical charge; this charge is called an *action potential*. The action potential abides by the *all-or-none principle*. Each axon branches out into numerous fibers that store those chemicals called *neurotransmitters*. These are chemicals that are released onto the *synapse*, the tiny gap between neurons.

*Acetylcholine* is a neurotransmitter involved in the actions of muscles, learning, and memory. *GABA* is a neurotransmitter that *inhibits* the firing of neurons. Too little of the neurotransmitter *norepinephrine* is associated with *depression*, and too much is linked to agitated, *manic* states. Low levels of the neurotransmitter *dopamine* are associated with *Parkinson's disease*. A neurotransmitter that is involved in the regulation of *sleep and attention* is *serotonin*. Finally, neurotransmitters that seem to function as *natural opiates* are called *endorphins*.

#### Helpful Hint #2:

*A release of endorphins is what runners experience when they say they have a "runners high." You may have experienced that same feeling after a workout at the gym or other physical exercise.*

### Structures of the Brain and Their Functions

There are three major divisions of the brain: *hindbrain*, *midbrain*, and *forebrain*. The hindbrain contains the *medulla*, which helps control *breathing*. The *cerebellum* is believed to help control *movement*. The *pons* is a *bridge* in the hindbrain involved in *sleep and arousal*.

The *midbrain* is involved in the *relay of information between the brain and the hindbrain and forebrain*. A midbrain structure called the *reticular formation* is involved in *stereotyped patterns of behavior*.

The *highest region* of the brain is called the *forebrain*. A forebrain structure that plays important roles in both memory and emotion is the *limbic system*. One main part of the limbic system is the *amygdala*, which is *important in the organism's survival and emotion*. Another part of the limbic system, the *hippocampus*, plays a role in the storage of *memory*. (Hint: if you saw a *hippo* walking across your *campus*, you would *remember* it!) A forebrain structure that serves mainly as a *relay station* is called the *thalamus*. The forebrain structure that *regulates eating, drinking, and sex* is called the *hypothalamus*. Olds and Milner's rat research in the 1950s pointed to the existence of a *pleasure center* in the hypothalamus. Their research

has important implications for drug addiction.

The largest part of the brain in volume is the *cerebral cortex*, which is divided into two halves, called *hemispheres*. Each is half divided into four *lobes*. The *temporal* lobe processes visual information; hearing is associated with the *occipital* lobe; control of the voluntary muscles, personality and intelligence is associated with the *frontal* lobe. The parietal lobe is involved in body sensation.

The *corpus callosum* is a large bundle of axons connecting the two cerebral hemispheres. Speech and grammar are localized to the *left hemisphere*, which mainly controls this ability in most people. Understanding aspects of language such as humor and metaphors is localized in the *right hemisphere*, which is involved in the processing of nonverbal information. Researchers believe that complex thinking involves both sides of the brain.

### In Your Own Words

*Please write your thoughts, perspectives, and reactions on a separate piece of paper.*

- ✓ *Imagine that an evil scientist kidnaps you to study your brain. In his diabolical investigation, he must destroy one part of your brain. He asks you, "What part of the brain are you willing to give up for my diabolical investigation?" So, what part of the brain would you give up and why?*

### The Endocrine System

The endocrine system is a set of *glands* that regulates the activities of organisms by releasing *hormones* into the *bloodstream*. Among the important endocrine glands are (1) the gland that sits at the base of the skull, called the *pituitary gland*, and (2) the *adrenal glands*, which secrete *epinephrine* and *norepinephrine* and which play an important role in our *moods, our energy level, and our ability to cope with stress*.

### Genetic and Evolutionary Blueprints of Behavior

The nucleus of each human cell has 46 *chromosomes*. Chromosomes contain *DNA*, a complex molecule that contains genetic information. Short segments of chromosomes that carry hereditary information are termed *genes*. Each person has *two genes for each hereditary characteristic*.

According to the dominant-recessive genes principle, the *dominant* gene exerts its influence. A recessive gene exerts its influence only when the two genes of a pair are both *recessive*. The term *polygenic inheritance* refers to the influence of multiple genes on behavior.

Three of the fields dedicated to the study of genetics are *molecular genetics, selective breeding, and behavioral genetics*. The Human Genome Project is an effort to identify all the genes in human DNA and map them. *Selective breeding* is a genetic method in which organisms are selected for reproduction based on how much of a particular trait they have. *Behavior genetics* is the study of the degree to which heredity influences behavior. One form of behavior genetics is the study of twins. *Identical twins* develop from a single fertilized egg, whereas *fraternal twins* develop from separate eggs fertilized by separate sperm.

A contemporary view that emphasizes the importance of adaptation, reproduction, and the survival of the fittest in explaining behavior is called the *evolutionary psychology approach*. Scientists warn that while evolution has shaped our body structures and biological potential, it did not give us behavioral dictates.

### In Your Own Words

*Please write your thoughts, perspectives, and reactions on a separate piece of paper.*

- ✓ *Think of five possible applications for the Human Genome Project.*

### Correcting the Incorrect

Carefully read each statement. Determine if the statement is correct or incorrect. If the statement is incorrect, make the necessary changes to correct it. Then check the answer key at the end of the chapter for the correct statement and page reference in the textbook.

1. The human nervous system is made up of approximately one million cells.
2. In general, the brains of individuals with epilepsy do not work effectively between seizures.
3. Motor nerves are the ones that carry sensory information to the brain.
4. Neural networks integrate sensory information and motor instructions from the brain.
5. The two main parts of the nervous system are the central nervous system and the autonomic nervous system.
6. The parasympathetic nervous system consists of the brain and the spinal cord.
7. The somatic nervous system consists of sensory nerves.
8. The sympathetic nervous system is involved when we are in a relaxed state.
9. Nerves are the basic unit of the nervous system.
10. Glial cells transmit messages throughout the nervous system.
11. The neurons consist of a cell body, dendrites, and axon.
12. The wave of electricity within the axon is called the resting potential.
13. The gap between neurons is called the axon.
14. Neurotransmitters move across the synapse.
15. GABA, dopamine, and serotonin are examples of endorphins.
16. Neural networks, once created, are static and cannot be changed.
17. A structure in the hindbrain is the reticular formation.
18. The medulla plays important roles in motor behavior.
19. The thalamus plays an important role in memory and emotion.
20. A person suffering damage to the hippocampus would be unable to see.
21. The Olds studies have important implications for research on Alzheimer's disease.
22. The occipital lobe is involved in hearing.
23. The parietal lobe is involved in bodily sensation.
24. The large bundle of axons that connects the brain's two hemisphere is called the pons.
25. The left hemisphere is associated with humor.
26. Endocrine glands release their chemicals directly into the brain.
27. The pituitary gland regulates mood, energy levels, and the ability to cope with stress.
28. Chromosomes are made up of genes.
29. A recessive gene can exert influence even if only one gene is recessive.
30. Behavioral genetics involves the manipulation of genes using technology to determine their effects on behavior.
31. Evolutionary psychologists believe that the specialized brain functions evolved because they helped humans adapt to the challenges of the environment.

### Practice Test 1

1. The nervous system is made up of \_\_\_\_\_ of interconnected cells.
  - a. approximately ten thousand
  - b. billions
  - c. approximately one million
  - d. less than one million
2. Which of the following is NOT one of the characteristics of the nervous system?

- a. integration
  - b. adaptability
  - c. simplicity
  - d. electrochemical transmission
3. \_\_\_\_\_ is the brain's capacity to modify and change.
- a. Plasticity
  - b. Integration
  - c. Electrochemical transmission
  - d. Evolution
4. Which of the following types of nerves carry input to the brain?
- a. sensory nerves
  - b. motor nerves
  - c. interneurons
  - d. foreneurons
5. The majority of the brain consists of which type of nerves?
- a. sensory nerves
  - b. motor nerves
  - c. neural networks
  - d. axons
6. The brain and the spinal cord constitute the
- a. central nervous system.
  - b. peripheral nervous system.
  - c. autonomic nervous system.
  - d. sympathetic nervous system.

7. When you accidentally touch a hot burner on a stove, which part of your nervous system carries the pain message from your skin to your brain?
- the autonomic nervous system
  - the sympathetic nervous system
  - the parasympathetic nervous system
  - the somatic nervous system
8. The physiological arousal that you feel as you enter a classroom to take an exam is produced by the \_\_\_\_\_ nervous system.
- parasympathetic
  - sympathetic
  - somatic
  - central
9. Messages from other neurons are collected by the \_\_\_\_\_ of the receiving neuron.
- axon
  - synapse
  - neurotransmitter
  - dendrite
10. The part of the neuron that carries messages away from the cell body is called the
- nucleus.
  - axon.
  - dendrite.
  - neurotransmitter.
11. The \_\_\_\_\_ is the brief wave of electrical change that races down the axon.
- action potential
  - achievement potential
  - all-or-none principle
  - ion
12. A neurotransmitter associated with schizophrenia is
- GABA.
  - acetylcholine.
  - dopamine.
  - norepinephrine.
13. If a person has a low level of dopamine, this would most likely cause which problem?
- The person would have difficulty with walking.
  - The person would suffer from anxiety.
  - The person would suffer from depression.
  - The person would have sleep problems.
14. The hindbrain structure that helps to control our breathing is called the
- pons.
  - reticular formation.
  - medulla.
  - cerebellum.

15. The \_\_\_\_\_ is the forebrain structure that monitors eating, drinking, and sexual behavior.
- thalamus
  - hypothalamus
  - neocortex
  - cerebellum
16. A forebrain structure that plays an important role in the storage of memories is the
- hippocampus.
  - amygdala.
  - thalamus.
  - limbic system.
17. Which of the following is not one of the lobes of the neocortex?
- occipital
  - frontal
  - temporal
  - posterior
18. Research about various brain areas indicates that higher mental processes such as thinking and problem solving are located within the
- association area.
  - parietal sulcus.
  - limbic system.
  - thalamic nuclei.
19. The two hemispheres are connected by which structure?
- corpus callosum
  - thalamus
  - hypothalamus
  - reticular formation
20. Dr. Beenken is working on one of the largest scientific projects ever done. Her responsibility is to map out the 19th chromosome pair. She is working on
- the evolutionary perspective.
  - the Mankato Nun study.
  - split brain research.
  - the Human Genome Project.
21. Genes are short segments of \_\_\_\_\_ that are composed of \_\_\_\_\_.
- neurons; glial cells
  - chromosomes; dopamine
  - chromosomes; DNA
  - DNA; chromosomes
22. The dominant-recessive genes principle applies to all the following except which one?
- A recessive gene exerts its influence only if both genes of a pair are recessive.
  - Dominant genes override the effect of a recessive gene.
  - If one gene of a pair is dominant and one is recessive, the dominant gene exerts its effect.
  - If both genes of a pair are dominant, the effect converts into a recessive trait.

23. According to evolutionary psychology, fears and phobias are related to
- the inheritance of recessive genes.
  - the inheritance of dominant genes.
  - successful survival and reproduction.
  - low rate of survival and reproduction.

### Practice Test 2

- The part of the nervous system that includes the brain and the spinal cord is the
  - central nervous system.
  - peripheral nervous system.
  - autonomous nervous system.
  - somatic nervous system.
- Glial cells
  - are fewer in number than neurons.
  - have dendrites just like neurons.
  - provide supportive and nutritive functions in the brain.
  - are specialized to send and receive information.
- Which division of the nervous system is the one involved in relaxation and the calming of the body?
  - somatic
  - central
  - sympathetic
  - parasympathetic
- Most neurons have \_\_\_\_\_ dendrites.
  - many
  - one
  - no
  - myelinated
- The tiny holes on the cell membrane of neurons are termed
  - dendrites.
  - channels.
  - axons.
  - cell bodies.
- The layer of fat cells that insulate most axons is the
  - myelin sheath.
  - cell body.
  - plasticity.
  - ion.
- Which neurotransmitter is the one that is involved in the action of muscles, learning, and memory?
  - dopamine
  - acetylcholine
  - GABA
  - norepinephrine

8. Which of the parts of the hindbrain is the one that is involved in motor coordination?
- medulla
  - cerebellum
  - pons
  - reticular formation
9. This system in the midbrain is involved in the control of walking, sleeping, and turning to attend sudden noise.
- pons
  - brain stem
  - reticular formation
  - hypothalamus
10. The “pleasure center” discovered by Olds and Milner is found in the
- thalamus.
  - midbrain.
  - hippocampus.
  - hypothalamus.
11. The lobe that is associated with the control of voluntary muscles, intelligence, and personality is the \_\_\_\_\_ lobe.
- frontal
  - occipital
  - temporal
  - parietal
12. The association cortex constitutes \_\_\_\_\_% of the entire cerebral cortex.
- 10
  - 50
  - 75
  - 99.9
13. Which of the following functions has NOT been associated with the left hemisphere of the cerebral cortex?
- speech
  - grammar
  - humor
  - mathematics
14. The \_\_\_\_\_ controls growth and regulates other glands, and part of it is controlled by the hypothalamus.
- adrenal gland
  - spinal cord
  - pituitary gland
  - thalamus

### Practice Test 3

1. The hypothalamus can be described best as a(n)
- screen.
  - subordinate.

- c. regulator.
- d. advisor.

2. Which of the following descriptions of the brain correspond to the characteristic of integration?
  - a. The brain is composed of billions of brain cells.
  - b. The brain has plasticity.
  - c. Behaving in a coordinated way requires a lot of connections in your brain.
  - d. The brain is powered by electrical impulses.
  
3. When people are unexpectedly tapped on the shoulder from behind, they usually turn around pretty quickly. This is not a reflex, but it requires some pretty fast neural transmissions. When the person senses the tapping on the shoulder, which nerves are the ones transmitting information to the brain?
  - a. sensory nerves
  - b. motor nerves
  - c. movement nerves
  - d. glial cells
  
4. Jack stayed up until 3:00 a.m. studying for a test the next day, but by that time he could barely keep a posture and was too sleepy to continue. Which division of the nervous system was the one that initiated the set of psychological experiences of Jack at 3:00 a.m.?
  - a. the somatic nervous system
  - b. the parasympathetic nervous system
  - c. the sympathetic nervous system
  - d. the spinal cord
  
5. The input is to the \_\_\_\_\_ as the output is to the \_\_\_\_\_.
  - a. axon; dendrite
  - b. cell body; dendrite
  - c. dendrite; cell body
  - d. dendrite; axon
  
6. Fernanda was bitten by a black widow spider while on a trek. Which of the following neural activities did she experience?
  - a. The level of norepinephrine was reduced.
  - b. The level of dopamine was increased.
  - c. Acetylcholine overflowed the nervous system.
  - d. GABA was increased.
  
7. Which of the following neurotransmitters is not involved in the regulation of sleeping patterns?
  - a. endorphins
  - b. serotonin
  - c. norepinephrine
  - d. acetylcholine
  
8. The drug morphine reduces pain because it mimics the effects of \_\_\_\_\_.
  - a. GABA
  - b. acetylcholine
  - c. endorphins
  - d. serotonin

9. The reason why a person feels relaxed and uninhibited after a couple of alcoholic drinks is because alcohol blocks the activity of
  - a. endorphins.
  - b. acetylcholine.
  - c. GABA.
  - d. serotonin.
  
10. The most common myth about hemispheric specialization is that
  - a. speech and grammar are localized in the left hemisphere.
  - b. the right hemisphere is more dominant in processing nonverbal information.
  - c. humor is localized in the right hemisphere.
  - d. the left hemisphere is logical and the right hemisphere is creative.
  
11. Which of the following statements is NOT true about chromosomes?
  - a. The nucleus of each human cell contains 46 chromosomes, or 23 pairs.
  - b. Each pair of chromosomes comes from one of the parents.
  - c. Chromosomes contain DNA.
  - d. Genes are short segments of chromosomes.
  
12. \_\_\_\_\_ is the genetic research method in which organisms are chosen for reproduction based on how much of a particular trait they display.
  - a. Molecular genetics
  - b. Behavioral genetics
  - c. Selective breeding
  - d. Evolution

## Connections

*Take advantage of all the other study tools available for this chapter!*

## Media Integration

NAME OF CLIP	DESCRIPTION	KEY CONCEPTS AND IDEAS
		<b>The Nervous System</b>
Neurons: How They Work	This video clip addresses the role of evolution in the development of the brain and discusses the lower parts of the human brain that are shared with other species. The functions of the cerebral cortex are discussed. The development of neural networks is shown, including animations and a video of live neurons under a microscope. Animation is used to illustrate the activity in the synaptic gap.	Brain Evolution Cerebral cortex Neural networks Neurons Synapsis
		<b>Neurons</b>
Neural Functioning	Participants are asked to identify the parts of the neuron in an interactive matching exercise. An animation of the neural	Parts of the neuron Axon Axon terminal

	transmission is presented, including detailed illustrations of the action potential and comparisons of the resting potential and action potential. An animation of transduction in the retina is used to illustrate the reason why we can experience different degrees of a stimulus even though the action potential is an all-or-none phenomenon.	Dendrite Myelin sheath Node of Ranvier Nucleus Synapse Resting potential Action potential Terminal buttons Synaptic vesicles Presynaptic neuron Postsynaptic membrane Nerve impulse Oscilloscope Transduction
Functions of Neurotransmitters	This video clips illustrates the role of neurotransmitters in a variety of psychological phenomena, including aggression, detection of threats, pain, and mood disorders.	Neurotransmitter Serotonin Noradrenaline Substance P. Endorphins
Brain Development	This video clip presents an introduction to the brain. The relationship among genes, the environment, and brain development is discussed. The process of development of neural maps and networks is presented, as well as a discussion of the differences in brain elasticity of young and older brains. The relationship between experience and the strength of neural circuits is illustrated.	Brain Nature vs. nurture Neural maps Neural networks Brain elasticity
		<b>Structures of the Brain and Their Functions</b>
Brain Structure and Imaging Methods	This video clip presents the scanning of an active brain as it processes visual information. Applications for brain mapping are discussed.	MRI FMRI Brain mapping
Parts of the Brain	This video clip provides an interactive three-dimensional tour of the brain, including descriptions of names, locations, and functions.	Brain Temporal lobe Parietal lobe Occipital lobe Frontal lobe Brain stem Lateral view Sagittal view Cerebellum

		<ul style="list-style-type: none"> <li>Cerebral cortex</li> <li>Corpus callosum</li> <li>Hypothalamus</li> <li>Medulla oblongata</li> <li>Midbrain</li> <li>Olfactory tract</li> <li>Pineal gland</li> <li>Pituitary gland</li> <li>Pons</li> <li>Thalamus</li> <li>Ventricle(s)</li> </ul>
<p>Sensorimotor Neural Circuits</p>	<p>This interactivity demonstrates with animation the neural coordination, including motor and sensory coordination, needed to perform the simple act of opening a jar of pickles and how it is far more complicated than it seems, involving various areas of the brain. A second interactive exercise allows participants to test their own visual reaction time and relate their results to methods of measuring decision-making effort.</p>	<ul style="list-style-type: none"> <li>Motor cortex</li> <li>Sensory cortex</li> <li>Information processing</li> <li>Frontal lobe</li> <li>Parietal lobe</li> <li>Spinal cord</li> <li>Somatosensory area</li> </ul>
<p>Brain Lateralization</p>	<p>This interactivity introduces students to the concept of brain hemispheres in a two-part simulation. The first part is a replication of the experiment by Dr. Jerry Levy that explores how emotions are perception and processing of emotions and their corresponding facial expressions. The second simulation involves a split-brain task. The interactivity introduces students to the differences between the functions of the brain hemispheres and the role of the corpus callosum in sharing information between the hemispheres.</p>	<ul style="list-style-type: none"> <li>Brain hemispheres</li> <li>Experiment</li> <li>Emotions</li> <li>Facial expressions</li> <li>Split-brain</li> <li>Corpus callosum</li> </ul>
<p>Sensory Processes and Brain Integration</p>	<p>This video introduces students to the complexities of sensory integration. The question of whether or not there is a specific part of the brain that integrates sensory information is addressed. Students are also introduced to the process of creation of mental maps.</p>	<ul style="list-style-type: none"> <li>Sensory integration</li> <li>Perception</li> <li>Brain</li> <li>Memory</li> <li>Neural networks</li> <li>Mental maps</li> </ul>

		<b>The Endocrine System</b>
		<b>Brain Damage, Plasticity, and Repair</b>
Brain Plasticity	This video presents the case of Jodi Miller, a young girl who experienced epileptic seizures only on her right hemisphere. A hemispherectomy was performed; the video presents the extraordinary evidence of brain plasticity, demonstrating how half of the brain may be removed and still the person can function normally.	Epileptic seizures Brain hemispheres Hemispherectomy Brain plasticity Cerebral cortex
		<b>Genetic and Evolutionary Blueprints of Behavior</b>
Nature and Nurture: The Study of Twins	This video clip presents the case of identical twins who manifest a variety of physical differences owing to unequal nourishment in the womb; however, twins are very similar in a variety of characteristics, including psychological characteristics such as intelligence and personality.	Identical twins Environmental influences Genetic potential

### Online Learning Center ([www.mhhe.com/Santrockp7u](http://www.mhhe.com/Santrockp7u))

- Interact and make learning fun!
  - **Interactive Exercises**
    - Neural Functioning
    - Sensorimotor Neural Circuits
    - Parts of the Brain
  - **Interactive Reviews**
    - Level of Analysis: Immune Functioning
    - Neuron Labeling
    - Brain Labeling
    - Brain Labeling II
    - Brain Labeling III
    - Metabolic Structures Labeling
    - Sensorimotor Neural Pathways
    - Neural Transmission
- Brush up on the Key Terms for this chapter by first reviewing the electronic **Glossary** (in English or Spanish) and then testing your retention using the **Flashcard** feature.
- **“Notes”**—this feature allows you to use the website as you would your text, inserting your own study notes and highlighting areas of particular importance.

### In Your Text

- Found throughout each chapter, the **Review and Sharpen Your Thinking** feature breaks the text into logical chunks, allowing you to process, review, and reflect thoughtfully on the information that you’ve just read. When going back to *study* the chapter, try reading the feature *before* the section of text to which it relates. In doing so, you will be able to focus your attention

on important concepts *as* you encounter them. In this chapter, this feature can be found on the following pages: pp. 47, 53, 64, 65, and 71.

### Practice Quizzes

- Test your knowledge of the connection between biology and behavior by taking the different practice quizzes found on your text's **Online Learning Center** and on the **In-Psych Plus CD-ROM** packaged with your text.

## ANSWER KEY

### In Your Own Words

- ✓ Imagine that an evil scientist kidnaps you to study your brain. In his diabolical investigation, he must destroy one part of your brain. He asks you, "What part of the brain are you willing to give up for my diabolical investigation?" So, what part of the brain would you give up and why?

*This question requires critical thinking about the specialized functions of parts of the brain and the hierarchy of values and priorities of the student. Some students may be willing to sacrifice motor control while others may think it less important to be able to do math.*

- ✓ Think of an activity that you have done in the last 24 hours. Describe the brain areas that were especially active as you performed the activity.

*To answer this question the student must be familiar with the specialization of the brain and be able to associate his or her everyday activities with electrochemical transmissions in the brain.*

- ✓ Think of five possible applications for the Human Genome Project.

*The Human Genome Project seeks to map the complete human genome. Some of the possible applications are (1) results can help determine the degree of genetic similarity between humans and other species predicted to be part of our evolutionary history; (2) link DNA with specific diseases and reactions to drugs; (3) prevention based on genetic information; and creation of genetic profiles; and many others.*

### Correcting the Incorrect

1. The human nervous system is made up of *billions* of cells. (p. 78)
2. In general, the brains of individuals with epilepsy *do work effectively* between seizures. (p. 80)
3. *Sensory* nerves are the ones that carry sensory information to the brain. (p. 80)
4. Neural networks integrate sensory information and motor instructions from the brain. (p. 80)
5. The two main parts of the nervous system are the central nervous system and the *peripheral* nervous system. (p. 80)
6. The *central* nervous system consists of the brain and the spinal cord. (p. 80)
7. The somatic nervous system consists of sensory nerves. (p. 80)
8. The *parasympathetic* nervous system is involved when we are in a relaxed state. (p. 81)
9. *Neurons* are the basic unit of the nervous system. (p. 82)
10. *Neurons* transmit messages throughout the nervous system. (p. 82)
11. The neurons consist of a cell body, dendrites, and axon. (p. 82)
12. The wave of electricity within the axon is called the *action* potential. (p. 84)
13. The gap between neurons is called the *synapse*. (p. 85)
14. Neurotransmitters move across the synapse. (p. 86)
15. GABA, dopamine, and serotonin are examples of *neurotransmitters*. (p. 87)

16. Neural networks are *not* static and *can* be changed. (p. 88)
17. A structure in the *midbrain* is the reticular formation. (p. 92)
18. The medulla plays important roles in *breathing and reflexes*. (p. 92)
19. *The limbic system* plays an important role in memory and emotion. (p. 93)
20. A person suffering damage to the hippocampus *would be unable to remember new memories*. (p. 93)
21. The Olds studies have important implications for research on *drug addiction*. (p. 94)
22. The *temporal* lobe is involved in hearing. (p. 95)
23. The parietal lobe is involved in bodily sensation. (p. 96)
24. The large bundle of axons that connects the brain's two hemisphere is called the *corpus callosum*. (p. 98)
25. The *right* hemisphere is associated with humor. (p. 100)
26. Endocrine glands release their chemicals directly into the *bloodstream*. (p. 102)
27. The *adrenal* gland regulates mood, energy levels, and the ability to cope with stress. (p. 103)
28. Chromosomes are made up of *DNA*. (p. 106)
29. A recessive gene can exert influence *only if both genes are recessive*. (p. 106)
30. *Molecular* genetics involves the manipulation of genes using technology to determine their effects on behavior. (p. 107)
31. Evolutionary psychologists believe that the specialized brain functions evolved because they helped humans adapt to the challenges of the environment. (p. 110)

### Practice Test 1

1.
  - a. no; a single cubic centimeter of the human brain has well over 50 million nerve cells
  - b. YES; the total number varies from person to person, but it is in the billions
  - c. no; this would not account for even one cubic centimeter of the human brain
  - d. no; this would not account for even one cubic centimeter of the human brain

p. 79
2.
  - a. no; this is an important characteristic of the nervous system
  - b. no; this is an important characteristic of the nervous system
  - c. CORRECT; the nervous system is characterized by its complexity, not simplicity
  - d. no; electrochemical transmission is part of the foundation of the nervous system

p. 79
3.
  - a. YES; this is the correct term used to refer to the capacity of the brain to change
  - b. no; this is the brain's capacity to organize complex information into integrated experiences
  - c. no; this is the method of communication in the nervous system
  - d. no; evolution may have caused changes in the brain across millions of years, but it is not the process of change and modification of the brain within a person's lifespan

p. 79
4.
  - a. YES; sensory nerves carry sensory information to the brain
  - b. no; sensory nerves carry motor messages from the brain
  - c. no; interneurons mediate sensory input and motor output
  - d. no

p. 80
5.
  - a. no; sensory nerves carry information to the brain
  - b. no; motor nerves carry the brain's output

- c. YES; most of the brain comprises neural networks  
d. no; an axon is a part of a neuron, not a nerve  
p. 80
6. a. THAT'S RIGHT; the central nervous system is made up of the brain and the spinal cord  
b. no; the peripheral nervous system is made up of the somatic nervous system and the autonomic nervous system  
c. no; this is part of the peripheral nervous system  
d. no; the sympathetic nervous system is part of the autonomic nervous system  
p. 80
7. a. no; the autonomic nervous system regulates internal organs  
b. no; while the sympathetic nervous system will likely be involved in your reaction to the pain, it is not involved in the sending of the sensory pain information to the brain  
c. no; the parasympathetic nervous system calms the body  
d. YES; the somatic nervous system contains sensory neurons  
p. 81
8. a. no; the parasympathetic nervous system calms the body  
b. THAT'S RIGHT; during stressful situations, the sympathetic nervous system increases the body's arousal  
c. no; the somatic nervous system provides sensory information to the central nervous system  
d. no; the central nervous system is made up of the brain and spinal cord  
p. 81
9. a. no; the axon carries information away from the cell body to other cells  
b. no; the synapse is the space between neurons  
c. no; neurotransmitters are involved in the transmission but are not the recipients of the message  
d. YES; the dendrites collect information  
p. 82
10. a. no; the nucleus is part of the cell body  
b. CORRECT  
c. no; the dendrite receives information  
d. no; neurotransmitters are not a part of the neuron  
p. 82
11. a. YES; the action potential is caused by the exchange of ions across the neuron's membrane  
b. no  
c. no; the all-or-none principle describes the action potential  
d. no  
p. 84
12. a. no; GABA is related to anxiety  
b. no; acetylcholine is associated with learning and memory  
c. YES; high levels of dopamine are linked to schizophrenia  
d. no; norepinephrine is implicated in depression and manic states  
p. 87
13. a. YES; dopamine is involved in voluntary movement  
b. no; the neurotransmitter GABA is involved with anxiety

- c. no; depression and serotonin and norepinephrine are related
  - d. no; sleep problems are associated with serotonin
- p. 87
14. a. no; the pons is a structure in the hindbrain that is involved in sleep and arousal
- b. no; the reticular formation is involved in stereotyped behaviors
  - c. YES; the medulla controls breathing and other reflexes
  - d. no; the cerebellum plays a role in motor behavior
- p. 92
15. a. no; the thalamus is not involved in these behaviors
- b. CORRECT; the hypothalamus monitors eating, drinking, and sexual behavior
  - c. no; the cerebral cortex is another portion of the forebrain
  - d. no; the cerebellum is involved in motor behavior and is in the hindbrain
- p. 94
16. a. RIGHT; this structure plays a role in the storage of memories
- b. no; the amygdala plays a role in emotions
  - c. no; the thalamus serves as a relay station-like function for sensory information
  - d. no; the limbic system is a network of structures
- p. 94
17. a. no
- b. no
  - c. no
  - d. CORRECT; there is no posterior lobe in the neocortex
- p. 95
18. a. YES; association areas are involved in the highest intellectual functions
- b. no
  - c. no
  - d. no
- p. 98
19. a. CORRECT; the corpus callosum, a large bundle of fibers, connects the hemispheres
- b. no; the thalamus serves to relay sensory information
  - c. no; the hypothalamus is involved in eating, drinking, and sex
  - d. no; the reticular formation plays a role in stereotyped behaviors
- p. 98
20. a. this is not related to mapping out human genes
- b. this study has nothing to do with mapping out human genes
  - c. split brain research would not map out human genes
  - d. RIGHT; the Human Genome Project hopes to map out every human gene
- p. 107
21. a. no
- b. no; dopamine is a neurotransmitter
  - c. CORRECT
  - d. no; it is the other way around
- p. 106

22. a. no; this statement is correct  
b. no; this statement is correct  
c. no; this statement is correct  
d. YES; this statement is incorrect

p. 106

23. a. no  
b. no  
c. RIGHT; the evolutionary perspective focuses on natural selection, survival, and reproduction  
d. no; fears and phobias are seen as being adaptive, leading to successful survival and reproduction

p. 110

### Practice Test 2

1. a. YES; the central nervous system includes the brain and spinal cord  
b. no; the peripheral nervous system connects the brain and the spinal cord with the rest of the body and external stimuli  
c. no; this is a division of the peripheral nervous system  
d. no; this is a division of the peripheral nervous system

p. 80

2. a. no; there are more glial cells than neurons  
b. no; glial cells do not have dendrites or axons  
c. YES; these are the functions of glial cells  
d. no; glial cells do not send and receive information

p. 82

3. a. no  
b. no  
c. no; this division of the autonomous nervous system is involved in arousal  
d. YES; this is the division of the autonomous nervous system that calms the body

p. 81

4. a. YES; most neurons have numerous dendrites  
b. no; most neurons have numerous dendrites  
c. no; all neurons have at least one dendrite  
d. no; axons are the part of the neuron covered by the myelin sheath

p. 82

5. a. no; these are parts of the neuron  
b. YES; the channels allow certain substances to pass into and out of the neurons  
c. no; the axons are parts of the neuron  
d. no; the cell bodies are parts of the neuron

p. 82

6. a. YES; the myelin sheath speeds up transmissions  
b. no; the cell body is a part of the neuron  
c. no; plasticity is the capacity of the brain to modify and change  
d. no; an ion is an electrically charged particle

p. 82

7. a. no; while dopamine is associated with learning, it also affects sleep, mood, and attention  
 b. YES; these are some of the psychological factors associated with acetylcholine  
 c. no; GABA has been linked to anxiety  
 d. no; while this neurotransmitter works with acetylcholine, it is associated with depression and mania  
 p. 86
8. a. no; the medulla is involved in breathing and reflexes  
 b. YES; leg and arm movement is coordinated at the cerebellum  
 c. no; the pons is involved in sleep and arousal  
 d. no; this is a part of the midbrain  
 p. 92
9. a. no; this is a part of the hindbrain  
 b. no; while this is a part of the midbrain, it is involved in alertness, breathing, heartbeat, and blood pressure  
 c. YES; it is a diffuse collection of neurons associated with those functions  
 d. no; the hypothalamus is part of the forebrain  
 p. 92
10. a. no; the thalamus relays sensory information to the appropriate areas of the brain  
 b. no; this “pleasure center” is in a part of the forebrain  
 c. no; the hippocampus is linked to memory  
 d. YES; the hypothalamus is involved in pleasurable feelings  
 p. 94
11. a. YES; damage to the frontal lobe can affect personality, as in the case of Phineas T. Gage  
 b. no; this lobe is associated with the processing of visual information  
 c. no; this lobe is associated with the processing of auditory information  
 d. no; this lobe is associated with the processing of special location, attention, and motor control  
 p. 95
12. a. no  
 b. no  
 c. YES; most of the cerebral cortex is dedicated to the processing of sensory information and integrating it with the motor output generated by the brain; this is where thinking and problem solving take place  
 d. no  
 p. 98
13. a. no; speech is localized in the left hemisphere  
 b. no; grammar is localized in the left hemisphere  
 c. YES; our sense of humor resides in the right hemisphere  
 d. no; the left hemisphere participates more in the kind of logic used to prove geometric theorems  
 p. 99
14. a. no; the adrenal gland regulates moods, energy level, and the ability to cope with stress  
 b. no; this is a part of the central nervous system, not a gland  
 c. YES; the anterior part of the pituitary gland is also referred to as the master gland  
 d. no; the thalamus is not a gland  
 p. 102

### Practice Test 3

1. a. no  
b. no  
c. YES; the hypothalamus regulates several behaviors by its interaction with the pituitary gland  
d. no  
p. 94
2. a. no; this corresponds to the characteristic of complexity  
b. no; this corresponds to the characteristic of adaptability  
c. YES; this item makes reference to the issue of coordination and connections in the brain, required for an integrated psychological experience  
d. no; this corresponds to the characteristic of electrochemical transmission  
p. 101
3. a. YES; the afferent or sensory nerves carry the information from the sensory organs (in this case the sense of touch is involved) to the brain  
b. no; these nerves carry information from the brain to the different parts of the body  
c. no  
d. no; these are not nerves and do not engage in electrochemical transmission  
p. 80
4. a. no, this division does not initiate these relaxation psychological experiences  
b. YES; the parasympathetic nervous system calms the body and prepares it for sleep, relaxation, and restoration  
c. no, the sympathetic nervous system does the opposite, it works when we are in high alert  
d. no, this is not a division of the nervous system but rather a part of the central nervous system  
p. 81
5. a. no; the opposite is true  
b. no; while the cell body may initiate messages, the dendrites would not be the source of output  
c. no; while dendrites do receive the message and can be considered “input,” the cell body is an intermediary and not the sender of the message  
d. YES; this analogy is the correct one  
p. 82
6. a. no  
b. no  
c. YES; and as a result, the person may experience violent spasms  
d. no  
p. 86
7. a. YES; endorphins are associated with increasing pleasure and reducing pain  
b. no; serotonin works with norepinephrine and acetylcholine to regulate the states of sleeping and wakefulness  
c. no; norepinephrine works with serotonin and acetylcholine to regulate the states of sleeping and wakefulness  
d. no; acetylcholine works with norepinephrine and serotonin to regulate the states of sleeping and wakefulness  
p. 87
8. a. no

- b. no
- c. YES
- d. no

p. 87

9. a. no
- b. no
  - c. no
  - d. YES; alcohol blocks the inhibitory effects of serotonin

p. 87

10. a. no; this is true
- b. no; this is true
  - c. no; this is true
  - d. YES; this is a myth—logic and creativity are really broad capabilities, and we can be logical and creative about many things; therefore, logic and creativity are involved in the activity of both hemispheres

p. 99

11. a. no; this is true
- b. CORRECT ANSWER; in each pair of chromosomes, one member of each pair comes from each parent: one chromosome comes from the biological mother and the other chromosome comes from the biological father
  - c. no; this is true
  - d. no; this is true

p. 106

12. a. no; this method involves the manipulation of genes using technology to determine their effect on behavior
- b. no; this method is the study of the degree to which nature influences behavior
  - c. YES; selective breeding is what Mendel used in his study of pea plants
  - d. no; this is not a research method

p. 108