

2

Neuroscience and Behavior

CHAPTER OVERVIEW

Chapter 2 is concerned with the functions of the brain and its component neural systems, which provide the basis for all human behavior. Under the direction of the brain, the nervous and endocrine systems coordinate a variety of voluntary and involuntary behaviors and serve as the body's mechanisms for communication with the external environment.

The brain consists of the brainstem, the thalamus, the cerebellum, the limbic system, and the cerebral cortex. Knowledge of the workings of the brain has increased with advances in neuroscientific methods. Studies of split-brain patients have also given researchers a great deal of information about the specialized functions of the brain's right and left hemispheres.

Many students find the technical material in this chapter difficult to master. Not only are there many terms for you to remember, but you must also know the organization and function of the various divisions of the nervous system. Learning this material will require a great deal of rehearsal. Working the chapter review several times, drawing and labeling brain diagrams, and mentally reciting terms are all useful techniques for rehearsing this type of material.

NOTE: Answer guidelines for all Chapter 2 questions begin on page 59.

CHAPTER REVIEW

First, skim each section, noting headings and boldface items. After you have read the section, review each

objective by answering the fill-in and essay-type questions that follow it. As you proceed, evaluate your performance by consulting the answers beginning on page 59. Do not continue with the next section until you understand each answer. If you need to, review or reread the section in the textbook before continuing.

Introduction (pp. 53–54)

David Myers at times uses idioms that are unfamiliar to some readers. If you do not know the meaning of any of the following words, phrases, or expressions in the context in which they appear in the text, refer to page 68 for an explanation: *to shoot a basketball*; *an ill-fated theory*; *a wrong-headed theory*.

Objective 1: Explain why psychologists are concerned with human biology, and describe the ill-fated phrenology theory.

1. In the most basic sense, every idea, mood, memory, and behavior that an individual has ever experienced is a _____ phenomenon.
2. The theory that linked our mental abilities to bumps on the skull was _____.
3. Researchers who study the links between biology and behavior are called _____.

Neural Communication (pp. 54–61)

If you do not know the meaning of any of the following words, phrases, or expressions in the context in which they appear in the text, refer to pages 68–69 for an explanation: *happy fact of nature*; *building blocks*; *a sluggish 2 miles per hour to . . . a breakneck 200 or more miles*; *rather like manhole covers flipping open*; *boggles*; *somewhat like pushing a neuron's accelerator . . . more like pushing its brake*; *How do we distinguish a gentle touch from a big hug*; *"protoplasmic kisses"*; *"runner's high"*; *They trigger unpleasant, lingering aftereffects*; *Agonists excite . . . Antagonists inhibit*; *some chemicals can slither through this (blood-brain) barrier.*

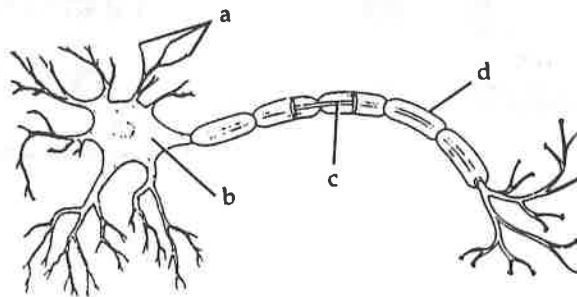
Objective 2: Explain how viewing each person as a biopsychosocial system helps us understand human behavior, and discuss why researchers study other animals in search of clues to human neural processes.

1. We are each a _____ system, composed of _____ that are parts of larger _____, which are parts of an even larger _____.
2. Viewing each person in this way allows psychologists to study behavior and mental processes from multiple levels, noting how _____, _____, and _____ systems work and interact.

Objective 3: Describe the parts of a neuron, and explain how its impulses are generated.

3. Our body's neural system is built from billions of nerve cells, or _____.
4. The extensions of a neuron that receive messages from other neurons are the _____.
5. The extension of a neuron that transmits information to other neurons is the _____; some of these extensions are insulated by a layer of fatty cells called the _____, which helps speed the neuron's impulses.

6. Identify the major parts of the neuron diagrammed below:



- a. _____ c. _____
 b. _____ d. _____

7. The neural impulse, or _____, is a brief electrical charge that travels down a(n) _____.
8. The fluid interior of a resting axon carries mostly _____ (positively/negatively) charged ions, while the fluid outside has mostly _____ (positively/negatively) charged ions. This polarization, called the _____, occurs because the cell membrane is _____.
9. An action potential occurs when the first part of the axon opens its gates and _____ (positively/negatively) charged ions rush in, causing that part of the neuron to become _____.
10. During the resting pause following an action potential, called the _____, the neuron pumps _____ (positively/negatively) charged ions outside the cell.
11. In order to trigger a neural impulse, _____ signals minus _____ signals must exceed a certain intensity, called the _____. Increasing a stimulus above this level _____ (will/will not) increase the neural impulse's intensity. This phenomenon is called an _____ - _____ response.

12. The strength of a stimulus _____ (does/does not) affect the speed of a neural impulse.

Objective 4: Describe how nerve cells communicate.

- 13. The junction between two neurons is called a _____, and the gap is called the _____. This discovery was made by _____.
- 14. The chemical messengers that convey information across the gaps between neurons are called _____. These chemicals unlock tiny channels on receptor sites, allowing electrically charged atoms (_____) to enter the neuron.
- 15. Neurotransmitters influence neurons either by _____ or _____ their readiness to fire. Excess neurotransmitters are reabsorbed by the sending neuron in a process called _____.

Outline the sequence of reactions that occur when a neural impulse is generated and transmitted from one neuron to another.

Objective 5: Explain how neurotransmitters affect behavior, and outline the effects of acetylcholine and the endorphins.

16. Among the neurotransmitters that researchers have pinpointed are _____, which

influences movement, learning, attention, and emotion; _____, which affects mood, hunger, sleep, and arousal; _____, which helps control alertness and arousal; _____, which is an inhibitory neurotransmitter whose undersupply is linked to seizures, tremors, and insomnia; and _____, which is involved in memory.

- 17. A neurotransmitter that is important in muscle contraction is _____.
- 18. Naturally occurring opiatelike neurotransmitters that are present in the brain are called _____. When the brain is flooded with drugs such as _____ or _____, it may stop producing these neurotransmitters.

Objective 6: Explain how drugs and other chemicals affect neurotransmission, and describe the contrasting effects of agonists and antagonists.

- 19. Drugs that produce their effects by mimicking neurotransmitters are called _____. Drugs that block the effects of neurotransmitters by occupying their _____ are called _____. While certain _____ drugs create a temporary "high" by mimicking the endorphins, the poison _____ produces paralysis by blocking the activity of the neurotransmitter ACh.
- 20. The molecular shape of some drugs prevents them from passing through the _____ by which the brain fences out unwanted chemicals.
- 21. The tremors of _____ disease are due to the death of neurons that produce the neurotransmitter _____. People with this condition can be helped to regain control over their muscles by taking _____.

The Nervous System (pp. 61–65)

If you do not know the meaning of any of the following words, phrases, or expressions in the context in which they appear in the text, refer to pages 69–70 for an explanation: *Like an automatic pilot, this system may be consciously overridden; yield an ever-changing wiring diagram that dwarfs a powerful computer; information highway; The knee-jerk response . . . a headless warm body could do it; Being human takes a lot of nerve; work groups.*

Objective 7: Describe the nervous system's two major divisions, and identify the three types of neurons that transmit information through the system.

1. Taken altogether, the neurons of the body form the _____.
2. The brain and spinal cord comprise the _____ nervous system. The neurons that link the brain and spinal cord to the body's sense receptors, muscles, and glands form the _____ nervous system.
3. Sensory and motor axons are bundled into electrical cables called _____.
4. Information arriving in the central nervous system from the body travels in _____ neurons. The neurons that enable internal communication within the central nervous system are called _____.
5. The central nervous system sends instructions to the body's tissues by means of _____ neurons.

Objective 8: Identify the subdivisions of the peripheral nervous system, and describe their functions.

6. The division of the peripheral nervous system that enables voluntary control of the skeletal muscles is the _____ nervous system.
7. Involuntary, self-regulating responses—those of the glands and muscles of internal organs—are controlled by the _____ nervous system.
8. The body is made ready for action by the _____

_____ division of the autonomic nervous system.

9. The _____ division of the autonomic nervous system produces relaxation.

Describe and explain the sequence of physical reactions that occur in the body as an emergency is confronted and then passes.

Objective 9: Contrast the simplicity of the reflex pathways with the complexity of neural networks.

10. Automatic responses to stimuli, called _____, illustrate the work of the _____ . Simple pathways such as these are involved in the _____ response and in the _____ reflex.

Beginning with the sensory receptors in the skin, trace the course of a spinal reflex as a person reflexively jerks his or her hand away from an unexpectedly hot burner on a stove.

11. To perform complex computations, neurons in the brain cluster into work groups called _____.

The Endocrine System (pp. 65–67)

If you do not know the meaning of any of the following words, phrases, or expressions in the context in which they appear in the text, refer to page 70 for an explanation: *kindred systems; Conducting and coordinating this whole electrochemical orchestra is that maestro we call the brain.*

Objective 10: Describe the nature and functions of the endocrine system and its interaction with the nervous system.

1. The body's chemical communication network is called the _____.

This system transmits information through chemical messengers called _____ at a much _____ (faster/slower) rate than the nervous system, and its effects last _____ (a longer time/a shorter time).

- In a moment of danger, the _____ glands release _____ and _____.
- The most influential gland is the _____, which, under the control of an adjacent brain area called the _____, helps regulate _____ and the release of hormones by other endocrine glands.

Write a paragraph describing the feedback system that links the nervous and endocrine systems.

Objective 11: Describe several techniques for studying the brain.

- Researchers sometimes study brain function by producing _____ or by selectively destroying brain cells. The oldest technique for studying the brain involves _____ of patients with brain injuries or diseases.
- The _____ is a recording of the electrical activity of the whole brain.
- The technique depicting the level of activity of brain areas by measuring the brain's consumption of glucose is called the _____.

Briefly explain the purpose of the PET scan.

The Brain (pp. 67–92)

If you do not know the meaning of any of the following words, phrases, or expressions in the context in which they appear in the text, refer to pages 70–72 for an explanation: *we live in our heads; neural cartographers; snoop on the messages . . . and eavesdrop on the chatter of billions of neurons; the right side of the body is wired to . . . ; Newer windows into the brain . . . Supermanlike; snapshots of the brain's changing activity provide . . . divides its labor; This peculiar cross-wiring is but one of many surprises the brain has to offer; . . . what London is to England's trains; the doughnut-shaped limbic system; reduced fits of rage; magnificent mistake; wrinkled organ, shaped somewhat like the meat of an oversized walnut; neural nannies; spine-tingling thrills; eyes in the back of our head; most widespread falsehoods; frontal lobes ruptured . . . Gage's moral compass; What you experience as . . . the visible tip of the information-processing iceberg; one patient even managed to quip that he had a "splitting headache"; When the "two minds" are at odds; pretzel-shaped finding . . . breadstick-shaped story; appear alike to the naked eye . . . harmony of the whole; southpaws; dwarfs.*

- A technique that produces clearer images of the brain by using magnetic fields and radio waves is known as _____.
- By taking pictures less than a second apart, the _____ detects blood rushing to the part of the cortex thought to control the bodily activity being studied. Using this technique, researchers found that activity increases in the _____ when people experience conflicting _____.

Objective 12: Describe the components of the brainstem, and summarize the functions of the brainstem, thalamus, and cerebellum.

- The oldest and innermost region of the brain is the _____.

7. At the base of the brainstem, where the spinal cord enters the skull, lies the _____, which controls _____ and _____. Just above this part is the _____, which helps coordinate movements.
8. Nerves from each side of the brain cross over to connect with the body's opposite side in the _____.
9. The _____ is contained inside the brainstem and plays an important role in controlling _____. Electrically stimulating this area will produce an _____ animal. Lesioning this area will cause an animal to lapse into a _____.
10. At the top of the brainstem sits the _____, which serves as the brain's sensory switchboard, receiving information from all the senses except _____ and routing it to the regions dealing with those senses. These egg-shaped structures also receive replies from the higher regions, which they direct to the _____ and the _____.
11. At the rear of the brainstem lies the _____. It influences one type of _____ and memory, but its major function is coordination of voluntary movement and _____ control.
12. The lower brain functions occur without _____ effort, indicating that our brains process most information _____ (inside/outside) of our awareness.
- Objective 13:** Describe the structures and functions of the limbic system, and explain how one of these structures controls the pituitary gland.
13. Between the brainstem and cerebral hemispheres is the _____ system. One component of this system that processes memory is the _____.
14. Aggression or fear will result from stimulation of different regions of the _____.
15. Amygdala lesions, produced by _____ techniques, have been used to treat violent humans. This treatment is controversial and _____ (widely/seldom) used today.
16. Below the thalamus is the _____, which regulates bodily maintenance behaviors such as _____, _____, and _____. This area also regulates behavior by secreting _____ that enable it to control the _____ gland. Olds and Milner discovered that this region also contains _____ centers, which animals will work hard to have stimulated.
17. Some researchers believe that alcoholism, drug abuse, binge eating, and other _____ disorders may stem from a genetic _____ in the natural brain systems for pleasure and well-being.
- Objective 14:** Define *cerebral cortex*, and explain its importance to the human brain.
18. The most complex functions of human behavior are linked to the most developed part of the brain, the _____. This thin layer of interconnected neural cells is the body's ultimate control and _____ center.
- Objective 15:** Identify the four lobes of the cerebral cortex.
19. The non-neural cells that support, protect, and nourish cortical neurons are called _____. New evidence suggests that these cells may also play a role in _____ and _____.

20. Compared to the cortexes of lower mammals, the human cortex has a _____ (smoother/more wrinkled) surface. This _____ (increases/decreases) the overall surface area of our brains.
21. List the four lobes of the brain.
- a. _____ c. _____
b. _____ d. _____

Objective 16: Summarize some of the findings on the functions of the motor cortex and the sensory cortex, and discuss the importance of the association areas.

22. Electrical stimulation of one side of the _____ cortex, an arch-shaped region at the back of the _____ lobe, will produce movement on the opposite side of the body. The more precise the control needed, the _____ (smaller/greater) amount of cortical space occupied. Research findings from studies involving _____, in which recording electrodes are implanted in this area of animals' brains, raise hopes that people who are _____ may one day be able to control machines directly with their _____.
23. At the front of the parietal lobes lies the _____ cortex, which, when stimulated, elicits a sensation of _____.
24. The more sensitive a body region, the greater the area of _____ devoted to it.
25. Visual information is received in the _____ lobes, whereas auditory information is received in the _____ lobes.
26. Areas of the brain that don't receive sensory information or direct movement but, rather, integrate and interpret information received by other regions are known as _____. Approximately _____

_____ of the human cortex is of this type. Such areas in the _____ lobe are involved in judging and planning, and in some aspects of personality. In the _____ lobe, these areas enable mathematical and spatial reasoning, and an area of the _____ lobe enables us to recognize faces.

Objective 17: Describe the five brain areas that would be involved if you read this sentence aloud.

27. Brain injuries may produce an impairment in language use called _____. Studies of people with such impairments have shown that _____ is involved in producing speech, _____ is involved in understanding speech, and the _____ is involved in recoding printed words into auditory form.
28. Although the mind's subsystems are localized in particular brain regions, the brain acts as a _____.

Objective 18: Discuss the brain's plasticity following injury or illness.

29. The quality of the brain that makes it possible for undamaged brain areas to take over the functions of damaged regions is known as _____. This quality is especially apparent in the brains of _____ (young children/adolescents/adults).
30. Although most severed neurons _____ (will/will not) regenerate, neural tissue can _____ in response to damage. New evidence suggests that adult mice and humans _____ (can/cannot) generate new brain cells in two older brain regions; research also reveals the existence of master _____ cells in the developing fetal brain that can develop into any type of brain cell.

Objective 19: Describe split-brain research, and explain how it helps us understand the functions of our left and right hemispheres.

31. Because damage to it will impair language and understanding, the _____ hemisphere came to be known as the _____ hemisphere.
32. In treating several patients with severe epilepsy, Vogel and Bogen separated the two hemispheres of the brain by cutting the _____. When this structure is severed, the result is referred to as a _____.
33. In a split-brain patient, only the _____ hemisphere will be aware of an unseen object held in the left hand. In this case, the person would not be able to _____ the object. When different words are shown in the left and right visual fields, if the patient fixates on a point on the center line between the fields, the patient will be able to say only the word shown on the _____.

Explain why a split-brain patient would be able to read aloud the word *pencil* flashed to his or her right visual field, but would be unable to identify a pencil by touch using only the left hand.

34. When the “two minds” of a split brain are at odds, the _____ hemisphere tries to rationalize what it doesn’t understand. The _____ hemisphere often acts on autopilot. This phenomenon demonstrates that the _____ mind _____ (can/cannot) control our behavior.
35. Researchers studying undivided brains _____ (have/have not) found evidence of hemispheric specialization, which is also called _____. For example, pictures are recognized more rapidly when they are

flashed to the _____ (right/left) hemisphere, whereas words are recognized faster and more accurately when flashed to the _____ (right/left) hemisphere.

36. Deaf people use the _____ hemisphere to process sign language.

Objective 20: Discuss the relationships among brain organization, handedness, and mortality.

37. In all cultures of the world, most of the human population is _____ (right/left)-handed. Genetic factors _____ (play/do not play) a role in handedness. This handedness bias is unique to humans and to our nearest _____ relatives.
38. With age, the percentage of left-handers _____ (increases/decreases). One controversial explanation of this difference is that _____ (right/left)-handers die at a younger age than their counterparts.

Identify several health risks that left-handers are more likely to have experienced.

PROGRESS TEST 1

Multiple-Choice Questions

Circle your answers to the following questions and check them with the answers beginning on page 61. If your answer is incorrect, read the explanation for why it is incorrect and then consult the appropriate pages of the text (in parentheses following the correct answer).

- The axons of certain neurons are covered by a layer of fatty tissue that helps speed neural transmission. This tissue is:
 - the glia.
 - the myelin sheath.
 - acetylcholine.
 - an endorphin.