

# BIOLOGICAL ASPECTS OF BEHAVIOR

## CHAPTER OUTLINE

### I. THE NERVOUS SYSTEM

**Biological psychology studies how the physical structure and function of the body influences behavior and mental processes. The NERVOUS SYSTEM is a huge network of interconnected cells. Its cells interact to perform three basic functions.**

1. **Receiving input from the senses.**
2. **Processing information by relating it to previous experiences.**
3. **Producing and monitoring bodily actions, or output.**

#### A. CELLS OF THE NERVOUS SYSTEM

1. All body cells have some features in common.
  - a. An outer membrane selectively allows only some substances to pass in and out.
  - b. The cell body contains the nucleus.
  - c. Mitochondria turn oxygen and glucose into energy.
  - d. Special mechanisms change the internal environment of the cell in response to stimuli in the nearby external environment.

Example: Chemicals released by one cell can affect another cell's internal processes.

2. There are two main cell types in the nervous system.
  - a. Neurons are specialized to respond rapidly to signals and send signals of their own.
  - b. Glial cells support neurons in many ways.
    - (1) They physically hold neurons within the nervous system.
    - (2) They help guide the growth of neurons.
    - (3) They secrete and absorb chemicals to maintain a stable chemical environment for neurons.
    - (4) They can send a limited number of signals between neurons.
3. Neurons have special features that permit effective signal communication.
  - a. Neuron cell structure includes fibers that either "send" or "receive" information.
    - (1) An axon is a cell fiber that carries signals away from the cell body. Most neurons have just one axon.
    - (2) A dendrite is a cell fiber that receives signals from other neurons and carries information toward the neuron's cell body. Most neurons have many dendrites.
  - b. Neuronal cell membranes are "excitable." Signals can rapidly spread from one region to another.
  - c. Neurons communicate with each other at synapses, specialized junctions where two neurons are separated by only a tiny gap.

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#### **B. ACTION POTENTIALS**

1. Ions are atoms that carry a positive or negative electrical charge.
2. Cell membranes are selectively permeable: only some substances pass through them.
3. By maintaining an uneven balance of positive and negative ions inside and outside a neuron, the cell membrane keeps the neuron polarized: The inside is slightly negative compared to the outside.
4. This polarity creates an electrochemical potential: a force that would drive positively charged substances into the neuron.
5. Sodium, symbolized  $\text{Na}^+$ , and calcium, symbolized  $\text{Ca}^{++}$ , are both concentrated outside neurons.
6. The negative charge inside the neurons attracts the sodium and calcium, but they can pass into the neuron only through special channels, or holes, in the cell membrane. Channels act as gates that can open or close at strategic times.
7. When sodium and calcium channels open, electrical potential drives sodium and calcium into the neuron. The positive charge entering the neuron reduces polarity, or depolarizes the neuron.
8. If the neuron is depolarized enough—a point called threshold—many sodium gates swing open on the axon, creating an electrical signal called the action potential.
9. Action potentials are self-propagating: an action potential on one region of an axon depolarizes the next region past threshold, so that the signal contagiously regenerates all the way down to the end of the axon.
10. Usually, action potentials occur on axons, but if there are enough sodium and calcium channels on dendrites, action potentials can occur there too. Although many variations occur, the most common pattern is for action potentials and other electrical signals to go from a neuron's dendrites to its axon.
11. Action potentials are all-or-none: a neuron either fires an action potential at full strength, or does not fire at all.
12. The speed of an action potential on a given axon is constant, but different neurons show different speeds relative to each other.
  - a. Action potentials travel faster on axons with large diameter or axons wrapped with myelin, a white, fatty substance. Such axons are often found in the pathways that carry the most “urgent” information.
    - (1) Multiple sclerosis is a disease in which the myelin is destroyed by a person's own immune system. Symptoms result because the correct timing of neuron signalling is thrown off.
13. After an action potential, there is a brief refractory period, during which a neuron cannot fire another action potential. At this time, positively charged potassium ions ( $\text{K}^+$ ) move out of the neuron to repolarize the cell.
14. Neurons code information by varying the pattern in which action potentials occur.

#### **C. SYNAPSES AND COMMUNICATION BETWEEN NEURONS**

1. Two neurons communicate at a synapse, a connection with only a narrow gap separating the two neurons' membranes.

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- a. The first neuron (sending information) is called presynaptic, and the second neuron (receiving information) is called postsynaptic.
  - b. Many patterns occur, but usually the axon of the presynaptic neuron sends signals to the dendrites of the postsynaptic neuron.
2. Messages cross the synapse in the form of chemicals called neurotransmitters, released from sac-like vesicles within the presynaptic axon tip.
  3. A presynaptic action potential causes vesicles to move in the axon tip and release their stored neurotransmitters into the space between the two neurons.
  4. Released neurotransmitters “float” across the synapse to briefly “bind” with receptors in the postsynaptic cell membrane, usually on a dendrite.
  5. The interaction between neurotransmitters and receptors is very specific, like a lock and key: only a specific receptor (a “lock”) can be stimulated by a specific neurotransmitter (a “key”).
  6. When a receptor binds with a neurotransmitter, the receptor alters specific ion channels on the postsynaptic neuron.
  7. As specific ions flow in and out of the neuron, electrical polarity changes, an event called a postsynaptic potential (PSP).
- a. An excitatory PSP (EPSP) makes action potentials more likely.  
  
Example: When sodium flows into the neuron, the reduced membrane polarity (depolarization) brings the neuron closer to threshold.
  - b. An inhibitory PSP (IPSP) makes action potentials less likely.  
  
Example: When potassium flows out of the neuron, the increased membrane polarity (hyperpolarization) takes the neuron farther from threshold.
  - c. The PSPs create tiny electrical charges that spread along the cell membrane. Unlike action potentials, the PSP signals fade as they spread.
  - d. The PSPs sum together at the junction of the cell body and the axon. It takes many EPSPs adding together at this location to create an action potential.

#### **D. ORGANIZATION AND FUNCTIONS OF THE NERVOUS SYSTEM**

1. Many substances probably act as neurotransmitters somewhere in the nervous system. Some brain structures tend to use a certain neurotransmitter, forming a neurotransmitter system.
2. Neurons are organized into functional groups called networks. The nervous system operates by having groups of neurons within networks firing together in varying combinations. Thus, depending on their pattern of activity, the same neurons can help create different kinds of behavioral and psychological functions.
3. Sensory systems are neuron networks receiving input from sensory organs.
4. Motor systems are neuron networks that send output to muscles and other effector organs.
5. The nervous system can be subdivided into two broad systems.
  - a. The central nervous system (CNS), encased in bone, consists of the brain and spinal cord. The CNS is the nervous system’s central executive.
  - b. The peripheral nervous system (PNS), the neurons outside the CNS, carry the incoming sensory signals and outgoing motor signals.

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### II. THE PERIPHERAL NERVOUS SYSTEM

#### A. THE SOMATIC NERVOUS SYSTEM

The somatic nervous system carries signals between the senses and CNS and between the CNS and skeletal muscles.

#### B. THE AUTONOMIC NERVOUS SYSTEM

The autonomic nervous system (ANS) carries messages between the CNS and the viscera (e.g., heart, lungs, other organs, and glands). The ANS has two divisions.

1. The sympathetic system directs the body to spend energy (e.g., increased heart rate, faster breathing, sweating), sometimes called the “fight-or-flight” response.
2. The parasympathetic system directs the body’s functions to conserve energy (e.g., slower heart rate, increased digestive activity). Parasympathetic activity helps “calm” a person after increased sympathetic arousal.
3. Both systems may act on the same body areas, with their relative “balance” regulating the state of the targeted organs.

### III. THE CENTRAL NERVOUS SYSTEM

The workings of the CNS are modeled and researched in fields like computational neuroscience, which studies the neuronal networks needed to perform specific computations. Research suggests that the CNS performs many simultaneous computations on the same information, rather than performing different computations sequentially (one at a time).. This view is called parallel distributed processing. Different computations are performed by different networks of neurons. A “neighborhood” of such clustered-together neurons may be called a nucleus, and the bundles of axon “highways” that interconnect such neighborhoods are called fiber tracts or pathways.

#### A. THE SPINAL CORD

1. Reflexes are simple, involuntary behaviors controlled by spinal cord neurons, without requiring instructions from the brain. A reflex pathway includes a sensory neuron (afferent neuron); a minimal number of connecting neurons (interneurons); and a motor neuron (efferent neuron).
2. Reflexes are controlled by feedback systems, regulatory “circuits” where an action’s consequences alter the original source of the action.

#### B. THE BRAIN

1. The hindbrain is found just above the spinal cord.
  - a. The medulla performs vital coordination of the basic life functions (e.g., blood pressure, heart rate, breathing).
  - b. The reticular formation is a web of neurons that helps alert and arouse other brain areas.
  - c. Neurons of the locus coeruleus connect to many brain areas. These neurons help control sleep and wakefulness, learning, mood, and vigilance.

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- d. The cerebellum maintains balance, coordinates fine motor movements, helps create the precise sequencing and timing of movements, and may also store a memory code for well-rehearsed behaviors.
2. The tiny midbrain relays information from the eyes, ears, and skin and controls certain types of automatic behaviors.
  - a. The midbrain's substantia nigra and its connections to the forebrain's striatum permit the smooth initiation of movement. Note: These connections, which are damaged in Parkinson's disease, use dopamine as a neurotransmitter.
3. The forebrain is the largest part of the brain. Its constituent structures regulate many complex aspects of behavior and mental phenomena.
  - a. Areas of the diencephalon affect emotion, motivational "drives," and sensory processing.
    - (1) The thalamus processes inputs from sense organs and then relays sensory information to appropriate "higher" forebrain areas. It is the primary sensory relay into the rest of the brain.
    - (2) The small hypothalamus has some of the brain's most important control systems. It regulates many physiological feedback systems, coordinating hunger, thirst, temperature regulation, and sexual behavior. It directly influences both the autonomic and endocrine systems. It contains the suprachiasmatic nucleus, an endogenous "clock" that sets biological rhythms for the body.
  - b. The cerebrum is the largest part of the forebrain.
    - (1) The limbic system, a network of interconnected brain areas, helps regulate both emotion and memory. It includes the amygdala, hippocampus, hypothalamus, and septum.

**Note:** Damage to the limbic system may underlie many of the symptoms of Alzheimer's disease.

(a) The amygdala is especially important for creating associations between two sensory modalities or between sensory and emotional information.

Example: The amygdala helps to store the exquisitely detailed memory you have of an experience that "will be with you always."

(b) The hippocampus is critical to the ability to form new memories.

#### **C. FOCUS ON RESEARCH METHODS: MANIPULATION GENES**

1. In Alzheimer's disease, brain cells show two main kinds of damage.
  - a. Plaques are deposits of proteins and dead cells; their major protein component is called beta-amyloid.
  - b. Tangles are twisted fibers within neurons; their major protein component is called tau.
2. Scientists want to identify the gene that codes for these proteins to help detect and treat Alzheimer's disease more effectively.

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3. Rather than intentionally exposing humans to a gene causing Alzheimer's-type brain damage, scientists use animal models in which genetic manipulations are the independent variable. The capacity to experimentally modify an animal's genes has become a vital research tool.
  - a. Scientists can insert some new or modified genes into animal brain cells, or they can incapacitate a specific gene.
  - b. Such manipulations are giving scientists an enormous range of independent variables with which genetic contributions to disease and other phenomena can be explored.

#### E. THE CEREBRAL CORTEX

1. The cerebrum's outer surface, the cerebral cortex, is a thin sheet of neurons. In humans, the sheet folds in on itself, giving the brain its characteristic wrinkled appearance.
2. The left and right cerebral hemispheres are physically separate halves of the cerebrum.
3. The folds of cortex produce gyri (ridges), and sulci or fissures (valleys or wrinkles), on the brain's outer surface. Several deep sulci make convenient markers for dividing the cortex of each hemisphere into four anatomical regions, or lobes: frontal, parietal, occipital, and temporal.
4. Sensory cortex and motor cortex are two of the functional areas of the cortex.
  - a. Each region of the sensory cortex receives and processes input from a single sensory organ.
    - (1) Inputs from the eyes are sent to the visual cortex in the occipital lobe.
    - (2) Inputs from the ears are sent to the auditory cortex in the temporal lobe.
    - (3) Inputs from the skin sensory organs connect to the somatosensory cortex in the parietal lobe.
      - (a) Neighboring body areas send somatosensory inputs to neighboring parts of the somatosensory cortex. This kind of brain organization is called a homunculus.
      - b. Neurons in the motor cortex, in the frontal lobe, initiate voluntary movements of specific body parts.
        - (1) These neurons are organized so that the combined activity of neighboring groups of neurons controls movements of neighboring body regions.
5. Most of the cortex in each lobe is association cortex, with no direct sensory inputs or direct motor outputs.
  - a. Since each region of association cortex is involved in many functions, damage to association cortex creates a variety of different psychological symptoms.
  - b. Some regions of the association cortex are specifically involved in language processing.
    - (1) Brain damage in these areas may cause aphasia, problems understanding or producing speech.
      - (a) **Broca's** area is a region of association cortex, usually in the left frontal lobe. Damage to this region impairs verbal fluency-the ease and richness with which words are produced.
      - (b) **Wernicke's** area is a region of the association cortex, usually in the left temporal lobe. Damage to this region leaves fluency intact, but makes it difficult to understand the meaning of words.

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#### **F. THE DIVIDED BRAIN IN A UNIFIED SELF**

1. The physically separate left and right hemispheres perform functions in slightly different ways.
2. Most sensory and motor pathways cross as they enter or leave the brain. Thus, each hemisphere receives inputs from the opposite side of the world and controls movements of the opposite side of the body.
3. Split-brain patients highlight the different functions of the two hemispheres.
  - a. The cortices of the left and right hemispheres communicate through the corpus callosum, a bundle of several hundred million axons. In some epilepsy patients, a “split-brain” operation cuts the corpus callosum to limit seizures. In such patients, the two hemispheres operate somewhat independently of each other.
  - b. Special techniques were used to present information to only the left or right hemisphere of split brains. Patients could verbally name only those objects shown to the left hemisphere; they could use their hands to recognize objects shown to either hemisphere. This suggested that the left hemisphere, more than the right, is specialized for language.
4. Normally, an intact corpus callosum unites the different activities of each hemisphere.
  - a. Lateralized abilities are those that depend differently on each hemisphere.
  - b. Lateralization varies depending on the behavioral or mental function and on the individual.
    - (1) Language functions of most people depend more on left hemispheric functioning, while visuospatial abilities depend more on right hemispheric functioning.
    - (2) Right-handed people seem to have language more “left-lateralized” about 95 percent of the time, while left-handed people have language more “left-lateralized” about 65 percent of the time.
    - (3) Men may show a greater degree of lateralization of function than do women.

#### **G. PLASTICITY IN THE BRAIN**

1. Brains show synaptic plasticity, adding or changing synapses due to one’s experiences. This may be a physical basis for memory storage.
2. Brain damage is hard to repair since adult neurons do not divide to produce more cells. Also, long distance neuron-to-neuron connections are difficult to reestablish once severed.
  - a. Surviving neurons may begin to perform added functions, sprouting a few new axons and dendrites to help form new short-distance neuron-to-neuron connections.
  - b. Surgical techniques may help repair some types of brain damage.
    - (1) Grafts of fetal brain tissue can partially repair brain damage in Parkinson’s disease.
    - (2) Grafts from one’s own adrenal gland may help repair some of the brain damage in Parkinson’s disease.
    - (3) Brain grafts can be made more effective by adding naturally occurring proteins that act as neurotrophic factors, promoting the growth and survival of neurons.

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(4) Some kinds of brain damage can be reversed or even prevented by the infusion of growth factors into a patient's brain. Some neurons have divided or sprouted axons under the influence of such substances, raising the possibility that one day the right conditions may be created medically to allow an adult brain to repair its own damage.

#### **IV. LINKAGES: HUMAN DEVELOPMENT AND THE CHANGING BRAIN**

1. PET scans, which measure neuronal activity, have shown that brain functioning changes with age.
  - a. Newborns' brain activity is high in the thalamus and low in the striatum, paralleled by uncontrolled gross limb movements. This pattern of brain activity and motor function resembles that seen pathologically after the brain damage in Huntington's disease.
  - b. In the second and third months, brain activity increases in cortical regions, paralleled by a loss of subcortical reflexes.
  - c. In the eighth and ninth months, brain activity increases in the frontal cortex, paralleled with the apparent blossoming of cognitive activity.
  
2. Synaptic plasticity associated with development is largely a selective death or "pruning" of certain extra neurons, rather than the creation of new neurons. Thus, a person's early experiences drive which connections survive between neurons.

#### **V. THE CHEMISTRY OF PSYCHOLOGY**

1. Over 100 substances probably act as neurotransmitters somewhere in the nervous system.
  - a. Neuromodulators are similar to neurotransmitters, but when they stimulate receptors they primarily alter, or "modulate," the way receptors can then later respond to other neurotransmitters.
  - b. Some substances can act as both a neurotransmitter and a neuromodulator.
  - c. Nitric oxide, a major component of air pollution and a toxic gas, has challenged traditional views of neurotransmission. This substance is released normally from some neurons, and it then diffuses into other neurons, directly affecting internal chemical reactions.
  
2. Some brain networks may tend to use certain neurotransmitters. Thus, each neurotransmitter system (the set of neurons that tends to use the same neurotransmitter) may affect specific behaviors.
  - a. Psychoactive drugs affect specific types of neurotransmitters, and thereby affect specific neurotransmitter systems and the specific behaviors which they underlie.
  - b. Neurotransmitter systems are often named by adding an -ergic suffix.

#### **A. SEVEN MAJOR NEUROTRANSMITTERS**

1. **Acetylcholine** is found in the peripheral and central nervous systems.
  - a. In the peripheral nervous system, nerves release acetylcholine onto muscles to cause their contraction.
  - b. Acetylcholine is also released by parasympathetic nerves onto target tissues.
  - c. In the brain, acetylcholine in the striatum is important in gross control of movement.
  - d. Acetylcholine is used by many of the neurons of the hippocampus and other limbic system areas that help form new memories.
  - e. Alzheimer's disease may involve damage to brain cholinergic neurons.

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2. **Norepinephrine**, also called noradrenaline, is found in the peripheral and central nervous system. Norepinephrine-releasing neurons are called adrenergic.
  - a. In the peripheral nervous system, norepinephrine is released by sympathetic nerves onto target tissues.
  - b. The brain's locus coeruleus releases norepinephrine liberally throughout the brain, affecting sleep and wakefulness, learning, mood, and vigilance.
3. **Serotonin** is found mainly in the brain.
  - a. Most serotonergic neurons are in the brain's raphe nuclei, along the midline of the hindbrain.
  - b. Serotonergic neurons synapse widely throughout the brain, affecting arousal, sleep and wakefulness, and mood.
  - c. Brain neurons take up the protein component tryptophan from the blood and use it to make serotonin. Eating foods high in tryptophan-containing proteins (such as chicken and turkey) can increase serotonergic activity in the brain. This is especially so after eating carbohydrates, which increase tryptophan uptake by the brain.
4. **Dopamine** is found in the brain in several major systems.
  - a. Dopamine is used by neurons in the substantia nigra in their communication with the striatum. This pathway is important in controlling movement, and its damage in Parkinson's disease leads to tremors and difficulty initiating movement.
  - b. Dopamine is released by neurons of the midbrain onto neurons of the forebrain in pathways that are important in experiencing reward and pleasure. Stimulation of these pathways is thought to be involved in virtually all psychoactive drugs of abuse.
  - c. Over activity of other dopaminergic neurons appears to underlie symptoms of schizophrenia.
5. **GABA** (gamma-amino butyric acid) is the main inhibitory neurotransmitter in the brain-it causes IPSPs, which make the postsynaptic neuron less likely to fire an action potential.
  - a. Severe anxiety and Huntington's disease involve over activity of dopamine neurons, normally inhibited by GABA neurons.
  - b. A deficiency of GABA may underlie epilepsy, in which neurons become overactive and produce seizures and convulsions.
6. **Glutamate** is the main excitatory neurotransmitter in the brain. Its release is associated with the ability of a synapse to "strengthen" its connection between two neurons, perhaps as part of the physical basis of memory formation.
7. **Endorphin** neurotransmitters are used in brain systems involved in pain perception. Opiate drugs (e.g., morphine) relieve pain by binding to endorphin receptors.

## **VI. THE ENDOCRINE SYSTEM: COORDINATING THE INTERNAL WORLD**

- A. Like the nervous system, the endocrine system is specialized for cell-to-cell communication. Cells of endocrine glands release chemicals called hormones into the bloodstream. Then, cells of target organs use specific receptors to detect specific hormones, causing specific cell responses.
- B. Hormones are often regulated by interactions of many structures.
  1. Neurons in the hypothalamus direct the pituitary gland to secrete specific hormones.
  2. Each pituitary hormone directs a specific endocrine organ to release, or stop releasing, its particular hormone product.
  3. An endocrine organ's hormone product affects cells of a specific target organ of the body.

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4. Hormones can also affect the brain and/ or the hypothalamus, pituitary, or endocrine glands, giving feedback to these structures in their subsequent hormonal regulation.
  - a. In stress of the hormonal system, the hypothalamus directs the pituitary to release the hormone ACTH into the bloodstream.
  - b. ACTH causes the adrenal gland to release the hormone cortisol.
    - (1) Cortisol and sympathetic arousal together cause the fight-or-flight syndrome (e.g., faster heart rate, increased energy use) to help the body respond to a danger.
  - c. Cortisol also affects the pituitary gland and the adrenal gland itself. The result tends to suppress further activity in this system, constituting a negative feedback system.

#### **VII. THE IMMUNE SYSTEM: LINKING THE BRAIN AND THE BODY'S DEFENSE SYSTEM**

- A. The immune system senses and destroys “foreignness” in the body. In AIDS, the immune system is under responsive. In autoimmune disorders, an overactive immune system attacks the normal “host” tissue.
- B. The nervous system and immune system are linked in important ways. Four lines of evidence suggest such links.
  1. Stress can alter the outcome of disease.
  2. Immune responses can be ‘learned.’
  3. Brain stimulation or damage can enhance or impair immune functioning, depending on the nature and location of the neural change.
  4. Immune system activation can alter behavior as well as the brain’s electrical activity or hormonal secretion.

#### **VIII. FUTURE DIRECTIONS**

- A. Technical breakthroughs have allowed large amounts of information to be gathered in a short time. New techniques will allow more rapid and more detailed monitoring of brain activity.
- B. Research is likely to focus on biological factors in diseases such as Alzheimer’s disease, schizophrenia, and alcoholism.
- C. Research will continue to study biological aspects of cognitive functions, including the ways that complex neural networks allow the brain to solve complicated problems. Computer models of mental activity will be especially useful.

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#### **CHAPTER OBJECTIVES**

1. State the definition of biological psychology.
2. Define the nervous system. Describe the three main components of information processing that the nervous system performs.
3. Compare and contrast neurons and glial cells with other body cells
4. Name and describe the functions of the neuronal parts that allow them to communicate with one another.
5. Describe the electrical and chemical changes that lead to an action potential. Define myelin and discuss its effects.
6. Explain how polarization and refractory periods affect signal transduction in the nervous system.
7. Define neurotransmitter and describe its role in nervous-system activity.
8. Describe the role of receptors in the communication process between neurons.
9. Define excitatory and inhibitory postsynaptic potentials. Describe their role in the creation of an action potential in the postsynaptic cell.
10. Compare and contrast action potentials and postsynaptic potentials.
11. Define sensory system and motor system. Describe their roles in two components of information processing: input and output.
12. Name the two major divisions of the nervous system.
13. Name the two components of the peripheral nervous system and describe their functions.
14. Name the two components of the autonomic nervous system and describe their functions.
15. Define nuclei and fiber tracts.
16. Name the type of neurons found in the spinal cord and describe their function. Define reflex.
17. Name and define the three major subdivisions of the brain and describe their functions.
18. Name and define the structures in the hindbrain. Describe their functions.
19. Name and define the structures in the midbrain. Describe their functions.
20. Name and define the structures in the forebrain. Describe their functions.
21. Describe the experimental methods used by scientists in their study of Alzheimer's disease.
22. Describe the effects of nootropic drugs and the conclusions that are most reasonable about their use as "smart drugs."
23. Define cerebral cortex. Name the four lobes that make up the cortex and state their locations.
24. Name the three functional divisions of the cortex and describe their functions.
25. Name and describe the role of the areas in the association cortex involved in understanding and producing language.
26. Describe split brain studies and explain the function of the corpus callosum.
27. Describe the lateralization of the cerebral hemispheres.
28. Define synaptic plasticity. Explain why it is impossible for the brain to heal damaged neurons. Describe the methods used to help people recover from brain damage today.
29. Describe the changes that occur in the nervous system throughout development.
30. Define neurotransmitter systems. Name and describe the location of the seven major neurotransmitters. Discuss the behaviors and mental processes associated with each of them.
31. Define endocrine system, glands, and hormones. Compare and contrast the differences between the communication processes of the nervous and endocrine systems.
32. Define the fight-or-flight syndrome.
33. Define negative feedback systems.
34. Compare and contrast the functionality of the immune system to the nervous and endocrine systems. Define autoimmune disorder.
35. Describe the interaction of the immune, nervous, and endocrine systems.