Chapter 2

The Biological Bases of Psychological Functioning

Outline

I. Neurons: The Building Blocks of the Nervous System
   A. A **neuron** is a nerve cell that transmits information from one part of the body to another via neural impulses.
   B. There are approximately 100 billion neurons in the human brain.

II. The Structure of Neurons
   A. No two neurons are exactly alike, but they have structures in common.
   B. The **cell body** contains the cell's nucleus.
   C. **Dendrites,** tentacle-like structures, receive neural impulses from neurons.
   D. An **axon** is a long tail-like extension of a neuron that carries impulses away from the cell body to other cells.
      1. About half of all axons contain **myelin**, which is a white substance made up of fat and protein, that insulates and protects them and speeds impulses along.
      2. Myelin tends to be found on axons that carry impulses relatively long distances.
      3. A loss of myelin is the cause of **multiple sclerosis**.
      4. **Axon terminals** are where axons end in a branching series of bare end points and communicate with adjacent neurons.
   E. In most cases, dead neurons are not replaced with new ones.
      1. Functions of lost neurons can be taken over by surviving neurons.
      2. New research suggests that the growth of new neurons occurs in the adult human brain—although at nowhere near the rate of growth observed before and right after birth.

III. The Function of Neurons
   A. The function of a neuron is to transmit neural impulses from one place in the nervous system to another.
   B. A **neural impulse** is a rapid and reversible change in the electrical charges inside and outside a neuron.
   C. **Chemical ions** are particles that carry a small, measurable electrical charge that is either positive or negative.
      1. When it is "at rest," there are more negative ions than positive ions inside the axon.
      2. Electrical tension results from the attraction between the negative ions and positive ions.
         a. This tension is called the **resting potential.**
         b. The resting potential of a neuron is about -70mV.
         c. At rest the neuron is said to be in a polarized state.
         d. The resting potential is released when a neuron is stimulated to fire.

3. When it is stimulated, the polarity of the nerve cell changes and the process is called depolarization.
    a. The **action potential** is the short-lived electrical burst caused by the sudden reversal of electric charges inside and outside a neuron in which the inside becomes positive (about +40 mV).
    b. The neuron becomes hyperpolarized during the refractory period and cannot fire.
    c. Eventually, the membrane returns to normal restoring the normal distribution of ions across the cell membrane.

D. A neuron either fires or it does not—an observation called the **all-or-none principle.**
E. The **neural threshold** is the minimum amount of stimulation needed to fire a neuron.

IV. From One Neuron to Another: The Synapse
A. The **synapse** is where one neuron communicates with other cells.
B. The **synaptic cleft** is the space between a neuron and the next cell at a synapse.

V. Synaptic Transmission
A. **Vesicles** are small containers concentrated in a neuron's axon terminals that hold neurotransmitter molecules.
B. **Neurotransmitters** are chemical molecules released at the synapse that, in general, will either excite or inhibit a reaction in the cell on the other side of the synapse.
C. **Receptor sites** are places on a neuron where neurotransmitters can be received.
    1. It is the interaction of neurotransmitter and receptor site that causes inhibition or excitation.
    2. Once released form their receptor sites, neurotransmitter are either destroyed by enzymes, or taken back up into the neuron from which they came, a process called **reuptake**.

VI. Neurotransmitters
A. Today, we know of nearly 100 neurotransmitters, and there are many yet to be discovered.
B. There are probably more than 1,000 kinds of neurotransmitter receptors.
    1. There are subtypes of receptor sites for brain chemicals.
    2. The search for and identification of these receptor sites has become one of the hottest areas of brain research.
C. There are many neurotransmitters, including:
    1. *Acetylcholine (ACh)* is found throughout the nervous system, where it acts as either an excitatory or inhibitory neurotransmitter, both within the brain and between neurons and muscle cells.
    2. *Norepinephrine* is involved in activation, vigilance, and mood regulation.
    3. Dopamine has been associated with the thought and mood disturbances of some psychological disorders, and impairment of movement.
    4. *Serotonin* is related to various behaviors such as the sleep/wake cycle, and plays a role in depression and aggression.
    5. *Endorphins* are natural pain suppressors.
D. Any neuron can have hundreds or thousands of axon terminals and synapses, and has the potential for exciting or inhibiting many other neurons.

VII. The Human Nervous Systems: The Big Picture
A. The **central nervous system (CNS)** includes all neurons and supporting cells in the spinal cord and brain.
B. The **peripheral nervous system (PNS)** consists of all neurons *not* found in the brain and spinal cord but in the periphery of the body.

C. The PNS is divided into two parts.
    1. The **somatic nervous system (SNS)** includes sensory and motor neurons outside the CNS that serve the sense receptors and the skeletal muscles.
    2. The **autonomic nervous system (ANS)** involves neurons in the peripheral nervous system that activate smooth muscles, such as the stomach, intestines, and glands.
        a. The ANS consists of the sympathetic and the parasympathetic divisions.
        b. The sympathetic division is active when we are in states of emotional excitement or under stress.
        c. The parasympathetic division is active when we are relaxed.

VIII. The **endocrine system** is a network of glands that affects behaviors through the secretion of chemicals called hormones.
A. Its function is to transmit information from one part of the body to another.
B. Hormones can exert a direct influence over behavior.
C. There are several endocrine glands throughout our bodies.
    1. The **pituitary gland**, nestled under the brain, is the master gland, and secretes many different hormones.
        a. This gland controls such processes as body growth rate, water retention, and the release of milk from the mammary glands.
        b. It also regulates the output of the thyroid and adrenal glands, as well as the sex glands.
    2. The **thyroid gland** releases thyroxine, the hormone that regulates the pace of the body's functioning.
    3. The **adrenal glands**, located on the kidneys, release adrenaline, or epinephrine, into the bloodstream to activate the body in times of stress or danger.

IX. Genetics and Psychological Traits
A. The passing of genetic information takes place at conception when the father's sperm unites with the mother's ovum.
    1. We inherit chromosomes, genes, and DNA.
    2. These, in turn produce certain chemicals, largely proteins and enzymes.
    3. We do not inherit talents or psychological characteristics.
B. **Behavior genetics** is the name of the discipline that studies the effects of genetics on psychological functioning.
    1. Over several generations, **inbreeding studies** can indicate which traits tend to "run in families."
    2. **Family history studies** were begun in earnest by Francis Galton in the 1800s.
    3. **The Human Genome Project** has cataloged the location of all human genes and seeks to "read" the information contained on all strands of DNA
        a. Genes have been found that are related to several outcomes, including Alzheimer's dementia, schizophrenia, alcoholism, and muscular dystrophy.
        b. It still remains the case that genes carry potentials and the expression of those genes requires an interaction with the environment.

X. The Structure of the Spinal Cord
A. **The spinal cord** is a mass of interconnected neurons within the spinal column that transmits impulses to and from the brain and is involved in spinal reflex behaviors; it reaches from the lower back to high in the neck, just below the brain.
B. **Sensory neurons** carry impulses from the sense receptors to the central nervous system.
C. **Motor neurons** carry impulses away from the central nervous system to muscles and glands.
D. **Interneurons** are neurons within the CNS.

XI. The Functions of the Spinal Cord

A. The communication function of the spinal cord involves the transmission of information to and from the brain.
B. The second function of the spinal cord involves the control of spinal reflexes.
    1. **Spinal reflexes** are simple, involuntary responses to a stimulus that involve sensory neurons, the spinal cord, and motor neurons.
    2. With a simple spinal reflex, impulses travel in on sensory neurons, within on interneurons, and out on motor neurons.
    3. Some spinal reflexes require only sensory neurons, motor neurons, and synapses connecting, and do not require interneurons within the spinal cord itself.

XII. The "Lower Brain Centers"

A. The lower brain centers are physically located beneath the cerebral cortex.
B. The lower brain centers develop first, both in an evolutionary sense and within the developing brain.
C. The **brainstem** is the lowest part of the brain, just about the spinal cord, and consists of the medulla and the pons.
    1. The **medulla** is the structure in the brain stem that contains centers that monitor reflex functions such as heart rate and respiration.
        a. **Cross laterality** is the arrangement of nerve fibers crossing from the left side of the body to the right side of the brain, and from the right side of the body to the left side of the brain.
        b. Cross laterality begins in the medulla and also occurs in the pons.
    2. The **pons** is a brain stem structure that forms a bridge that organizes fibers from the spinal cord to the brain and vice versa.
D. The **cerebellum** is a spherical structure at the rear, base of the brain that coordinates fine and rapid muscular movements.
    1. Damage to the outer region of the cerebellum results in intention **tremors**, which are involuntary trembling movements.
    2. Damage to inner areas of the cerebellum results in tremors at rest.
E. The **reticular formation** is a network of nerve fibers extending from the base of the brain to the cerebrum; it controls one's level of activation of arousal.
F. The **basal ganglia** are collections of structures in the center of the brain that are involved in the control of large, slow movements; a source of much of the brain's dopamine.
    1. Dopamine, created and usually found in great quantity in the basal ganglia, is insufficient in those persons with Parkinson's disease.
    2. L-dopa is a drug that increases dopamine availability in the basal ganglia.
    3. Transplanting stem cells from aborted human fetuses (and other sources) into the brains of persons with Parkinson's may reverse the course of the disease.
G. The **limbic system** is a collection of structures near the middle of the brain involved in emotionality and long-term memory storage.
    1. The *amygdala* produces reactions of rage or aggression when stimulated.
    2. The *septum* reduces the intensity of emotional responses.
    3. The *hippocampus* is involved with the formation of memories for experiences.
    4. The **hypothalamus** is a structure made up of several nuclei involved in feeding, drinking, temperature regulation, sex, and aggression.
H. The **thalamus** is located just below the cerebral cortex; it projects sensory impulses to the appropriate areas of the cerebral cortex.
    1. While it also acts like a relay station, its major function involves the processing of information from the senses.
    2. Like the pons, nuclei in the thalamus may have a role in establishing normal patterns of sleep and wakefulness.

XIII. The Cerebral Cortex

A. The **cerebral cortex** is the large, convoluted outer covering of the brain that is the seat of voluntary action and cognitive functioning.

B. Neuroscientists have learned about the structures and functions of the cerebral cortex by using several different methods.

1. One can work backward, examining damaged areas of the brain and discovering what function or functions have been lost as a result.
2. Surgical lesions (cuts) or ablations (removals) can be made to see what happens to behaviors and mental processes without the brain tissue affected,
3. Small electrodes can be inserted into the brain tissue of conscious persons to stimulate small areas of the brain to see the result.
4. The electroencephalogram (EEG) can measure the electrical activity of brain functioning,
    a. The procedure is not invasive.
    b. It provides only general information.
5. Areas of the intact, functioning brain can be studied by several imaging techniques.
    a. The CAT Scan (or CT scan) or computerized axial tomography image is a series of thousands of X-ray images of "slices" of the brain.
    b. The PET scan (positron emission tomography) shows the functioning brain by looking at minute radioactive "traces" that are brightest in areas of brain activity.
    c. Magnetic resonance imaging (MRI) or functional magnetic resonance imaging (fMRI) measures the movement of molecules of blood, providing clear images of brain activity, even in very small areas.

XIV. Lobes and Localization

A. A crevice runs down the middle of the cortex dividing it into the left and right cerebral hemispheres.

C. There are four major divisions of each hemisphere, called lobes.

1. The *frontal lobes* (left and right) are largest, and are defined by two crevices called the central fissure and the lateral fissure.
2. The *temporal lobes* are located at the temples, below the lateral fissure, with one on each side of the brain.
3. The *occipital* lobes are at the back of the brain.
4. The *parietal lobes* are wedged in behind the frontal lobes and above the occipital and temporal lobes.

C. In terms of *function*, there are three major areas of the cerebral cortex.

1. **Sensory areas** receive and process impulses from sense receptors.
2. **Motor areas** are where most voluntary muscular movements originate.
3. **Association areas** are in the frontal, temporal, and parietal lobes where incoming sensory input is integrated with motor responses, and where higher mental processes are thought to occur.
    a. Broca's area controls the production of speech.
    b. Wernicke's area is involved in speech comprehension and organizing ideas.
    c. Planning ahead and forethought in general seem to be localized in the very front of the frontal lobes.

XV. The Two Cerebral Hemispheres: Splitting the Brain

A. The two hemispheres are connected by the **corpus callosum**, a network of fibers.

B. The **split-brain procedure** involves surgical lesioning (or removal) of the corpus callosum, the structure that separates the functions of the left and right hemispheres of the cerebral cortex and is a treatment of last resort for epilepsy.

C. Virtually no behavior or mental process is the product of one hemisphere alone, but one hemisphere may be dominant with respect to a given task or processing certain types of information, the left hemisphere usually associated with linguistic and serial processing while the right hemisphere is associated with visual/spatial processing and seems more involved in emotionality.

XVI. SPOTLIGHT: Learning Disabilities and the Brain

A. **Learning disabilities** involve problems/disorders in development of language, speech, reading, and associated communication skills.
B. They affect 8-15 percent of children in the public school system and of three main types:
    1. **Dyslexia**—an impairment of reading skills.
    2. **Discalculia**—an impairment in arithmetic skills
    3. **Dysgraphia**—difficulties with writing skills.
C. Most neuroimaging studies of the brain have focused on problems in the left-rear portions of the cerebral cortex, toward the back of the temporal lobe.
    1. Brain problems tend to be in or near areas of the brain associated with language skills (Broca's and Wernicke's Areas).
    2. It also seems that brains of children with learning disabilities have developed more slowly than those of their age-mates, beginning at puberty,

XVII. SPOLIGHT: The Two Sexes: Male and Female Brains

A. Except for differences that are directly related to reproductive function, there are very few differences that are of real consequence between male and female brains.
B. There is a difference in the lateralization of the brains of left-handed persons compared to right-handed persons, but no differences in cognitive abilities.
    1. Similar findings for male/female differences have proven difficult to replicate.
    2. Women are more likely than men to show signs of recovery from a stroke because the unaffected side of the brain is better able to compensate for losses in the affected side.

Practice Test Questions

Multiple Choice

1. Which of the following lists the major structures of the neuron in the correct order?
   ___a. cell body, dendrite, axon
   ___b. axon, dendrite, cell body
   ___c. dendrite, cell body, axon
   ___d. Any of these may be correct, depending upon the particular neuron involved.

2. Of the following structures, which is likely to occur in neurons in the greatest number?
   ___a. dendrites
   ___b. nuclei
   ___c. axons
   ___d. cell bodies

3. Myelin sheaths serve several different functions. Which of these is NOT something that myelin normally does?
   ___a. insulates axons from other nearby axons
   ___b. helps to speed up impulse transmission
   ___c. produces and stores the neuron's neurotransmitters
   ___d. protects the delicate axon against physical damage

4. When a neuron is "at rest,"
   ___a. it has no electrical charge.
   ___b. the inside of the neuron has a negative charge compared to the outside.
   ___c. it is in the process of "firing," or transmitting an impulse.
   ___d. chemical ions are racing in and out of the neuron.

5. When an impulse moves down or along a neuron, what physically moves from one end of the neuron to the other?
   ___a. the chemical ions involved
   ___b. the neural membrane itself
   ___c. the fluids within the neuron
   ___d. nothing

6. The "all-or-none principle" states that
   ___a. a neuron will either fire or it won't.
   ___b. neural impulses always travel in one direction.
   ___c. some neurons always fire; some neurons never fire.
   ___d. neurons either have a threshold or they don't.

7. Although there are many specific neurotransmitters, we can classify them in terms of their actions as being either
   ___a. central or peripheral.
   ___b. sensory or motor.
   ___c. excitatory or inhibitory.
   ___d. axonic or dendritic.

8. The action of neurotransmitters at the synapse is basically a(n) _____ process.
   ___a. electrical
   ___b. mechanical
   ___c. chemical
   ___d. psychological

9. Of these, which neurotransmitter is said to act like a natural pain suppressant, influencing our experience of pain?
   ___a. serotonin
   ___b. endorphin
   ___c. acetylcholine
   ___d. dopamine

10. The first major division of the human nervous system is into the _____ nervous system and the _____ nervous system.
    ___a. motor; sensory
    ___b. affective; cognitive
    ___c. central; peripheral
    ___d. somatic; automatic

11. Of the following, which "nervous system" is most intimately involved in our experience of emotion?
    ___a. peripheral nervous system
    ___b. parasympathetic nervous system
    ___c. automatic nervous system
    ___d. sympathetic nervous system

12. The endocrine system operates mostly on the basis of
    ___a. neurons in the spinal cord.
    ___b. hormones in the bloodstream.
    ___c. neurotransmitters in the brain.
    ___d. ions in the neuron.

13. The endocrine gland most intimately involved in metabolism (the body's rate of oxygen use, and growth) is the _____ gland.
    ___a. pituitary
    ___b. execrine
    ___c. thyroid
    ___d. adrenal

14. The Human Genome Project is reinforcing the notion that
    ___a. every behavior can be accounted for by the action of a few genes working together.
    ___b. scientists are unlikely to ever understand the relationship between individual genes and human behaviors.
    ___c. the in heritance of proteins and enzymes at conception accounts for the individual's assortment of genes and chromosomes.
    ___d. any traits involving behavior are likely to have a complex genetic basis.

15. Conscious, voluntary actions originate in the
    ___a. cerebral cortex.
    ___b. spinal cord.
    ___c. brain stem.
    ___d. muscles and glands.

16. When we look at a cross-section of the spinal cord, we clearly see areas that are made up of white matter. In this white matter we have
    ___a. the area where reflex action takes place.
    ___b. fibers going to and from the brain.
    ___c. nerve fibers entering and leaving the spinal cord itself.
    ___d. the part of the CNS that controls emotions.

17. In a spinal reflex, neural impulses enter the spinal cord on
    ___a. motor neurons.
    ___c. ascending tracts or fibers.
    ___c. sensory neurons.
    ___d. descending tracts or fibers.

18. As one travels up through the brain from the spinal cord, the first brain structure to be encountered would be the
    ___a. corpus callosum.
    ___b. basal ganglia.
    ___c. medulla.
    ___d. thalamus.

19. Which of the following is best associated with the medulla?
    ___a. thinking or problem solving
    ___b. breathing reflexes
    ___c. sensory projections to the cerebral cortex
    ___d. muscle coordination

20. Cross laterality occurs (mostly) in the
    ___a. spinal cord.
    ___b. brain stem.
    ___c. limbic system.
    ___d. basal ganglia.

21. If I were to electrically stimulate the reticular formation of a sleeping cat, the result would be that the cat would
    ___a. no longer demonstrate normal emotional responses.
    ___b. die.
    ___c. begin to make small twitching motions, indicative of dreaming.
    ___d. wake up.

22. Which lower brain center is most clearly involved in the experience of being thirsty?
    ___a. the hypothalamus
    ___c. the amygdala
    ___c. the hippocampus
    ___d. the septum

23. The brain structure that sends, or "projects," sensory impulses to the appropriate area of the cerebral cortex is the
    ___a. thalamus.
    ___c. basal ganglia.
    ___b. projectorator.
    ___d. body sense area of the parietal lobe.

24. The small structure in the limbic system that seems to be involved in the formation of long-term memories is the
    ___a. amygdala.
    ___c. ganglion.
    ___b. hippocampus.
    ___d. septum.

25. Of these, the neuroimaging technique that involved the injection of a radioactive "tracer" element is the
    ___a. EEG.
    ___c. CT, or CAT scan.
    ___b. PET scan
    ___d. MRI or fMRI.

26. Our body senses (touch, pressure, and the like) are largely processed at the front of the _____ lobe of the cerebral cortex.
    ___a. occipital
    ___c. temporal
    ___b. parietal
    ___d. frontal

27. The two hemispheres of the cerebral cortex are richly interconnected by the
    ___a. white matter of the spinal cord.
    ___c. corpus callosum.
    ___c. frontal lobe.
    ___d. left and right ventricles.

28. A person who has had a split-brain operation is blindfolded. A paper clip is placed in her LEFT hand and we ask her to tell us what we have placed there. She is most likely to
    ___a. tell us that the object is a paper clip and be able to point to it when it is placed on a table with other objects.
    ___b. have no idea of what is in her hand.
    ___c be unable to tell us what we put in her hand, but be able to point to the paper clip when it is on a table with other objects.
    ___d. respond just as if we had placed the paper clip in her RIGHT hand.

29. The difference between male and female brains for which there is the greatest amount of evidence is that
    ___a. the brains of females are significantly larger than those of males.
    ___b. female brains have no hypothalamus.
    ___c. the brains of females are more likely to recover from traumas, such as a stroke.
    ___d. men tend to use their frontal lobes for the storage of long-term memories, whereas women use their parietal lobes.

True/False

1. ____True ____False Myelinated neurons carry impulses faster than do unmyelinated neurons.

2. ____True ____False The number of neurons in your body gradually increases from birth until they begin to die off in old age.

3. ____True ____False Every neuron has its own threshold—the minimal amount of stimulation required to get it to "fire."

4. ____True ____False Neurotransmitters move across a synapse to either excite a new impulse in the next neuron or to inhibit that neuron from firing.

5. ____True ____False Because it uses the bloodstream instead of the neurons, information travels faster in the endocrine system than it does in the nervous system.

6. ____True ____False The correct sequence of impulses involved in a spinal reflex may be summarized as: in on sensory neurons, within on interneurons, and out on motor neurons.

7. ____True ____False The basal ganglia are involved in the movement of large skeletal muscles, such as those that are involved in walking.

8. ____True ____False Visual information is processed in the occipital lobe of the cerebral cortex.

9. ____True ____False Someone whose corpus callosum has been severed in a split-brain operation will probably need to be hospitalized or closely supervised for the rest of his or her life.

10. ____True ____False There are simply no structural differences—in general—between the brains of men and the brains of women.

Key Terms and Concepts

neuroscientists_____

_____

neuron_____

_____

cell body_____

_____

dendrites_____

_____

axon_____

_____

myelin_____

_____

axon terminals_____

_____

neurogenesis_____

_____

neural impulse_____

_____

chemical ions_____

_____

resting potential_____

_____

action potential_____

_____

refractory period_____

_____

all-or-none principle_____

_____

neural threshold_____

_____

synapse_____

_____

synaptic cleft_____

_____

vesicles_____

_____

neurotransmitters_____

_____

receptor sites_____

_____

excitatory_____

_____

inhibitory_____

_____

reuptake_____

_____

central nervous system (CNS)_____

_____

peripheral nervous system (PNS)_____

_____

somatic nervous system_____

_____

autonomic nervous system_____

_____

sympathetic division_____

_____

parasympathetic division_____

_____

endocrine system_____

_____

pituitary gland_____

_____

thyroid gland_____

_____

adrenal glands_____

_____

spinal cord_____

_____

sensory neurons_____

_____

motor neurons_____

_____

interneurons_____

_____

spinal reflexes_____

_____

brainstem_____

_____

medulla_____

_____

cross laterality_____

_____

pons_____

_____

cerebellum_____

_____

tremors

reticular formation

basal ganglia

Parkinson's disease

limbic system

hypothalamus

thalamus

cerebral cortex

electroencephalogram (EEG)

sensory areas

motor areas

association areas

corpus callosum

split-brain procedure

Answers to Practice Test Questions

Multiple Choice

1. **c** Within a neuron, impulses travel (typically) from dendrite to cell body to axon. Here's a good example of an item for which "all of the above" is not the correct choice.
2. **a** A neuron will have only one cell body and one nucleus. As it happens, some may have two axons, but the structure most likely to occur in great numbers is the dendrite.
3. **c** Myelin serves each of the functions named in alternatives **a**, **b**, and **d**. Be careful to note the "not" in this item. Neurotransmitters are manufactured within the neuron and stored in vesicles.
4. **b** At rest, a neuron is in position to fire, with many more negative ions inside and positive ions outside, which makes the second alternative correct.
5. **d** Nothing physically moves down a neuron when it fires. Physical movement is of ions going in and out of the neuron. What moves "down" a neuron is where this ion movement takes place.
6. **a** This one is straightforward. Alternative **a** is correct by definition.
7. **c** Watch out for this item! An important phrase in this item is "in terms of their actions," which means we're looking for what they do—which is to either excite or inhibit neural impulse transmission.
8. **c** Within a neuron, impulse transmission is electrochemical, but at the synapse, given the action of the neurotransmitters, it is basically a chemical process.
9. **b** Actually, there are several different endorphins, but each is involved in moderating our experience of pain.
10. **c** The major division of the human nervous system is into central and peripheral systems. Each of these, in turn, has its own divisions.
11. **d** It is important to know how the various nervous systems are interrelated, and the major functions of each. While the parasympathetic division is active when we are relaxed and calm, the sympathetic division is involved in emotionality. Note the spelling of alternative **c**; there is no such thing as an "automatic" nervous system.
12. **b** The endocrine system influences behaviors and mental processes, but does so through hormones transmitted through the bloodstream.
13. **c** The thyroid gland secretes thyroxin—the growth hormone—and is, thus, the best choice here. Yes, the pituitary does influence this gland, as it influences them all, but this item is more specific than that.
14. **d.** In mapping all of the human genes and chromosomes, the Human Genome Project has reached a significant goal. It remains the case, however, that the influence of genes o behavior is incredibly complex, almost certainly involves the interaction of several genes and the interaction of those genes with forces in the environment.
15. **a** Conscious, voluntary actions originate in the cerebral cortex, even though other CNS structures may be involved.
16. **b** The white matter looks white because of the myelin that surrounds the axons of the fibers going up and down the spinal cord, to and from the brain.
17. **c** This is a straightforward terminology item. For the spinal reflex we have: in on sensory neurons, within on interneurons, and out to muscles or glands on motor neurons.
18. **c** Although it is difficult to tell exactly where the spinal cord leaves off and the brain begins, the first brain structure to be encountered would be the medulla.
19. **b** The medulla contains centers (nuclei) that control several important reflexes, including respiration, or breathing.
20. **b** Cross laterality occurs in the medulla and in the pons. Because these two structures make up the brain stem, this is the best answer.
21. **d** The reticular activating system, as the name implies, controls levels of arousal. All that would happen in this scenario is that the cat would wake up.
22. **a** The hypothalamus is not only involved in the thirst drive, but it is also implicated in the hunger drive, temperature regulation drive, sex drive, and others.
23. **a** This item describes very succinctly the function of the thalamus.

24. **b** Although the septum and the amygdala are considered to be parts of the limbic system, there is no evidence that they have anything to do with memory directly. The structure that does is the hippocampus.
25. **b** The CT and MRI techniques do not really require an injection of any sort, and the EEG measures electrical activity and is not really an imaging technique in the first place.
11. **b** This gets a bit technical. But you should know the major features of cerebral localization (vision, hearing, movement, etc.), and you should know that the body senses are processed in the front of the parietal lobe.
12. **c** It is the corpus callosum that normally interconnects the two hemispheres of the cerebral cortex so that as soon as one side "knows" what is going on, the other side "knows" as well.
13. **c** Don't panic just because this item is wordy. Remember the basics of the split-brain procedure, and remember that speech is a left-hemisphere activity, and that information from the left hand would be processed in the right hemisphere. These details make alternative **c** the correct one.
14. **c** As a rule of thumb, there are very few differences between the brains of females and males—either structurally or functionally. For reasons not yet fully understood, however, the brains of females do recover more quickly from cerebral accidents or traumas, such as strokes.

True/False

1. **T** Indeed, one of the important functions of myelin is to speed impulses along.
2. **F** This may sound logical, but it is not true. We are born with more neurons than we'll ever have again.
3. **T** The threshold of one neuron may be different from that of other neurons, but every neuron does have its own threshold value of stimulation required to get it to fire.
4. **T** This is a simple, but accurate, statement of what neurotransmitters do.
5. **F** Actually, because it uses the bloodstream rather than neurons, the action of the endocrine system is significantly slower than the action of the central nervous system.
6. **T** This is basically a repeat of item #16 in true-false form. This sequence is correct.
7. **T** This statement is true, reinforcing the notion that the basal ganglia are implicated in Parkinson's disease.
8. **T** Again, you should know the localization of the major functions of the cerebral cortex, including the fact that vision is processed in the occipital lobe.
9. **F** No, as it happens, it is often very difficult to tell if someone has had this procedure, except when certain brain functions are tested in the laboratory. Split-brain patients can, and do, lead relatively normal lives.
10. **F** Granted, as I said above, there are very few differences between the brains of females and males, but to claim that there are NO structural differences is silly.

A Few Flash Card Possibilities for Chapter 2

(Remember: The best flash cards are those you make yourself.)

PARTS of a NEURON	**cell body (& cell's nucleus), dendrites, and axon with bare endings**
MYELIN	**white, fatty covering on some axons; insulates, protects, speeds impulses**
CHEMICAL ION	**electrically charged (+ or -) chemical particle**
NEURAL THRESHOLD	**minimum amount of stimulation required to get a neuron to fire**
COMPONENTS of the ANS	**autonomic nervous system = sympathetic + parasympathetic divisions**
ENDOCRINE SYSTEM	**glands that release hormones into the bloodstream (slower than nervous system)**
SYNAPTIC SPACE	**tiny space between the axon of one neuron and dendrite of the next—where neurotransmitters go**
2 FUNCTIONS of SPINAL CORD	**1. spinal reflex behaviors 2. speed impulses to and from brain**
2 PARTS of BRAIN STEM	**the medulla and the pons**
PARTS OF LIMBIC SYSTEM	**1. amydala (emotion) 2. septum (emotion) 3. hippocampus (memory)**
CORPUS CALLOSUM	**fibers that connect left and right hemispheres of cerebral cortex—severed in split brain operation**
CEREBRAL CORTEX LOBES	**frontal, temporal, occipital, & parietal**

EXPERIENCING PSYCHOLOGY

How Fast Do Neural Impulses Travel?

As neural impulses speed from one part of your body to another, they travel at incredibly high rates of speed. You step on a tack, and the experience of pain is nearly immediate. Can you measure the speed of impulse transmission without the use of sophisticated equipment? Yes, you can, with the help of a few friends, if you don't mind being a little imprecise.

Ask ten people to stand next to each other with their eyes closed and holding hands. At your signal, the first person is to squeeze the hand of the next person who will, in turn, squeeze the hand of the next person, and so on, until the last person's hand is squeezed and signals so by raising his or her free hand. As you give the signal to begin, you start a stopwatch and stop it when that last person signals that he or she has received a squeeze. Repeat the procedure until the time becomes reasonably stable. Divide that time by 10.

Now have the people in the same group put their left hands on the right shoulders of the person standing next to them. At your signal, the first person squeezes the shoulder of whomever is standing to the left. The second person then squeezes the should of the person to his or her left and so on, until the last person signals being squeezed. Again, repeat the procedure until the time interval stabilizes, and again divide by 10.

Although it is a crude measure, the difference between the two time intervals, once each has been divided by 10, represents the time it takes for the neural impulses to travel between the hands and the shoulders of your volunteers. If you get an average of the length of their arms, you could convert your measurements into inches per second.

[This project is adapted from: Rozin, P. & Jonides, J. (1977). Mass reaction time: Measurement of the speed of the nerve impulse and the duration of mental processes in class. ***Teaching of Psychology***, **4**, 91-94.]

Using the Internet to Expand Your Appreciation of Psychology

1. NEURONS: THE BUILDING BLOCK OF THE NERVOUS SYSTEM (pp. 41-46)

When one considers the complexity of the simple nerve cell, it is no wonder that a full understanding of how the human brain functions remains beyond the grasp of contemporary science. After all, there may be 100 billion neurons in the human brain. And as we learn in this first Topic of Chapter Two, although the neuron is but a single cell, it is in no way to be considered simple. As you might imagine, many of the Internet websites that can help us appreciate the neuron are from disciplines other than psychology. Many such websites are simply beyond the level of a beginning psychology class. I have tried to choose a few that are instructive, not overwhelming. Indeed, I've included a few specifically designed for "kids" and one designed for "beginning neuroscientists." All of them involve colorful illustrations, simple explanations, and even an occasional animation.

http://faculty.washington.edu/chudler/cells.html

(a website called *Neuroscience for Kids*, maintained by Eric H. Chudler, PhD, of the University of Washington in Seattle.)

2. FROM ONE NEURON TO ANOTHER: THE SYNAPSE (pp. 47-51)

The sites listed above focus largely on the structures of neurons and, in general terms, how they function. The activity of just one neuron is exciting enough, but nothing much really happens in the nervous system unless neurons can communicate with each other. That communication takes place at the synapse, and the process is most dynamic indeed. The following websites deal with synaptic activity and the neurotransmitters that make it all happen.

http://faculty.washington.edu/chudler/synapse.html

(More of *Neuroscience for Kids* with links to others, including a summary from the Society of Neuroscience, "How do nerve cells communicate?")

http://synapses.bu.edu

(This site can be nearly overwhelming—and quite technical. Click on "Synapse Web," a site from the Medical College of Georgia expressly for beginning neuroscientists—and who knows, that could be you! In the second box at Synapse Web, click on "synapses." Here you will find a great schematic diagram of a synapse, like ours on page 47. BUT clicking on each structure in the diagram will give you an image of that structure taken by an electron microscope.)

http://faculty.washington.edu/chudler/chnt1.html

(*Neuroscience for Kids* covers neurotransmitters)

http://web.indstate.edu/thcme/mwking/nerves.html

(a site that is quite complete without being overly "technical," but it is more wordy than it is visual)

http://www.williams.edu/imput/introduction_main.html

(Now *this* is what an educational website should look like! It is awesome, downright fun, and difficult to leave. (Imagine anyone saying that about anything having to do with neurotransmitters!)

3. THE ENDOCRINE SYSTEM (pp. 53-54)

The endocrine system mirrors the nervous system in many ways. Here are two websites that expand that discussion.

http://www.nlm.nih.gov/medlineplus/endocrinesystemhormones.html

(If you have a question about the endocrine system or hormones, you can find it answered here—a service of the U.S. National Library of Medicine and the U.S. National Institutes of Health.)

http://www.endo-society.org

(website of "the most active professional organization of endocrinologists in the world")

4. THE SPINAL CORD (pp. 57-60)

Almost all of the websites in any way related to the spinal cord have a focus on spinal cord *injuries* and their treatment. We can do no better here than to recommend the same two sites we mentioned in the text.

http://www.christopherreeve.org

(You will find out a lot about the late actor Christopher Reeve, and discover a lot about research and treatment programs for people with spinal cord injuries.)

http://www.spinalcord.org

(Under the button "News and Information" a click takes you to a very long list of "Resources" on the spinal cord, and up-to-date "Fact Sheets.")

5. THE "LOWER" BRAIN CENTERS (pp. 60-66) AND THE CEREBRAL CORTEX (pp. 66-77)

I suspect that you have a pretty good idea of the extent of the coverage of "the brain" on the Internet. In less than 0.20 seconds, *Google* located 20,700,000+ entries! There probably are very good sites buried in the list. For introductory psychology students I would caution that we not get carried away. Chapter Two provides a comprehensive summary of what you need to know for now. Nonetheless, there are a few sites that are worth a visit.

http://www.waiting.com/brainanatomy.html

(One of many with a focus on brain injury, this site provides some very nice and colorful visuals)

http://www.pbs.org/wnet/brain

(A website derived form the PBS series on the brain. You'll find excellent visuals, of the brains of babies, children, teenagers, adults, and the elderly.)

http://www.msu.edu/~brains/humanatlas

(The human brain is a rather homely organ. This site (from Michigan State University) provides photographs of actual MRI sections of the brain. It is not very pretty, and not very instructive, but if you'd like to see what a brain really looks like, here is a place to go.

http://www.brainexplorer.org

(this website gives an opportunity to explore what the brain looks like. Click on "Brain Atlas" and you will find great images that are easy to navigate.)

http://web.sfn.org

(site of the Society for Neuroscience, 34,000 thousand scientists worldwide devoted to the study of the brain. I recommend clicking on "Publications." The first three on the list are technical, scientific journals and pretty heavy reading. "Brain Briefings" will reward you with a list of scores of 2-page summaries on "how neuroscience discoveries lead to clinical applications." Perhaps the most useful part of this section of the site is "Brain Facts" a 52-page primer in pdf format.)