The Nervous System

After studying this chapter, you will be able to:

8.1 Name the parts of the nervous system and discuss the function of each part
8.2 Define the combining forms used in building words that relate to the nervous system
8.3 Identify the meaning of related abbreviations
8.4 Name the common diagnoses, laboratory tests, and clinical procedures used in testing and treating disorders of the nervous system
8.5 List and define the major pathological conditions of the nervous system
8.6 Define surgical terms related to the nervous system
8.7 Recognize common pharmacological agents used in treating disorders of the nervous system

Structure and Function

The nervous system directs the function of all the human body systems (Figure 8-1). Every activity, whether voluntary or involuntary, is controlled by some of the more than 100 billion nerve cells throughout the body. The nervous system is divided into two subsystems: the central nervous system (CNS) and the peripheral nervous system (PNS).

A nerve cell or neuron (Figure 8-2) is the basic element of the nervous system. Neurons are highly specialized conducting cells and vary greatly in function, shape, and size. All neurons have three parts:

1. The cell body, which has branches or fibers that reach out to send or receive impulses. The cell body contains all the biological structures that are common to all human cells.
2. Dendrites, which are thin branching extensions of the cell body. They conduct nerve impulses toward the cell body.
3. The axon, which conducts nerve impulses away from the cell body. It is generally a single branch covered by fatty tissue called the myelin sheath. This protective sheath prevents the nerve impulse from transmitting in the wrong direction.

Outside the myelin sheath is a membranous covering called the neurilemma. At the end of the axon, there are terminal end fibers through which pass the impulses leaving the neuron. The nerve impulse then jumps from one neuron to the next over a space called a synapse. The nerve impulse is
stimulated to jump over the synapse by a neurotransmitter, any of various substances produced by and located in tiny sacs at the end of the terminal end fibers. Table 8-1 lists some common neurotransmitters.

All neurons also have two basic properties—excitability, the ability to respond to a stimulus (anything that arouses a response), and conductivity,
the ability to transmit a signal. The three types of neurons are classified by the direction in which they transmit impulses:

1. **Efferent (motor) neurons**, which convey information to the muscles and glands from the central nervous system
2. **Afferent (sensory) neurons**, which carry information from sensory receptors to the central nervous system
3. **Interneurons**, which carry and process sensory information and make possible more complex types of reflexes.

Some nerves contain combinations of at least two types of neurons.

Neurons are microscopic entities that form bundles called **nerves**, the bearers of electrical messages to the organs and muscles of the body. The body’s cells contain stored electrical energy that is released when the cells receive outside stimuli or when internal chemicals (for example, acetylcholine) stimulate the cells. The released energy passes through the nerve cell, causing a **nerve impulse**. Nerve impulses are received or transmitted by tissue or organs called **receptors**. These impulses are then transmitted to other receptors throughout the body.

In addition to nerve cells, other cells in the nervous system support, connect, protect, and remove debris from the system. These cells, **neuroglia** or **neuroglial cells**, do not transmit impulses. Each of the three types of neuroglia serves different purposes.

1. Star-shaped **astroglia** (or **astrocytes**) maintain nutrient and chemical levels in neurons and form a supporting network in the brain and spinal cord.
2. **Oligodendroglia** produce myelin and help in supporting neurons by forming rows between neurons in the brain and spinal cord.
3. **Microglia** are phagocytes—small cells that remove debris.

Certain neuroglia, along with the almost solid walls of the brain’s capillaries, form what is known as the **blood-brain barrier**, the barrier that permits some chemical substances to reach the brain’s neurons, but blocks most others, thereby protecting vital brain tissue. Figure 8-3 shows neuroglia.
Central Nervous System

The central nervous system (CNS) consists of the brain and spinal cord. The word central is the key to understanding the purpose of this subsystem. It is located centrally along the midsagittal plane of the body and is the center of control, receiving and interpreting all stimuli and sending nerve impulses to instruct muscles and glands to take or respond to certain actions. Designated actions throughout the body include both voluntary and involuntary movement, sight, hearing, thinking, secretion of hormones, memory, and responses to outside stimuli. The meninges (described later) are a covering crucial to the protection of the brain and spinal cord.

Brain

The human adult brain weighs about three pounds, is 75 percent water, has the consistency of gelatin, contains over 100 billion neurons, and is responsible for controlling the body’s many functions and interactions with the outside world. The brain has four major divisions:

1. the brainstem
2. the cerebrum
3. the cerebellum
4. the diencephalon

The brainstem

The brainstem is made up of the midbrain (involved with visual reflexes), the pons (controls certain respiratory functions), and the medulla oblongata (contains centers that regulate heart and lung functions, swallowing, vomiting, coughing, and sneezing). The brainstem connects the brain to the spinal cord and even small areas of damage can be devastating, even fatal. The midbrain connects the pons beneath it with the cerebellum and cerebrum above. The pons lies between the midbrain and the medulla oblongata, which connects the pons to the spinal cord (see Figure 8-4).

The cerebellum

The cerebellum is the area that coordinates musculoskeletal movement to maintain posture, balance, and muscle tone.

The cerebrum

Above the cerebellum lies the cerebrum, the third major brain structure. The cerebrum is the largest area of the brain, taking up about 85 percent of its mass. The cerebrum has two hemispheres, with an outer portion called the cerebral cortex. The inner portion is divided into two hemispheres—one on the left and one on the right.

The cerebral cortex (area of conscious decision making) has many fissures (also called sulci) and convolutions (also called gyri) and is composed

FIGURE 8-3 The three types of neuroglia shown here perform different functions in the nervous system.

Astrocyte    Oligodendroglia    Microglia
of gray matter, the substance in the brain composed mainly of nerve cells and dendrites.

Below the cerebral cortex are white matter, substance in the brain composed mainly of nerve fibers, and masses of gray matter called the basal ganglia (involved with musculoskeletal movement). The left and right hemispheres of the cerebrum are each divided into four parts or lobes.

1. The frontal lobe controls voluntary motor movements, emotional expression, and moral behavior.
2. The parietal lobe controls and interprets the senses and taste.
3. The temporal lobe controls memory, equilibrium, emotion, and hearing.
4. The occipital lobe controls vision and various forms of expression.

The two hemispheres of the cerebrum are connected by the corpus callosum, a bridge of nerve fibers that relays information between the two hemispheres.

The diencephalon The diencephalon is the deep portion of the brain containing the thalamus, hypothalamus, epithalamus, and the ventral thalamus. These parts of the diencephalon serve as relay centers for sensations. They also integrate with the autonomic nervous system in the control of heart rate, blood pressure, temperature regulation, water and electrolyte balance, digestive functions, behavioral responses, and glandular activities.

The brain sits inside the cranium, a strong bony structure that protects it. The area between the brain and the cranium is filled with cerebrospinal fluid (CSF), a watery fluid that contains various compounds and flows throughout the brain and around the spinal cord delivering essential nutrients. This watery fluid cradles and cushions the brain. The fluid acts as a shock absorber in the event of head trauma. Ventricles or cavities in the brain also contain this fluid. The cranial meninges have the same structure as the spinal meninges (described next) and also protect the brain. Figure 8-4 illustrates the brain.
Spinal Cord

The spinal cord extends from the medulla oblongata of the brain to the area around the second lumbar vertebra in the lower back. The spinal cord is contained within the vertebral column. The space that contains the spinal column is called the vertebral canal. The spinal cord is protected by the bony structure of the vertebral column, by the cerebrospinal fluid that surrounds it, and by the spinal meninges. Figure 8-5 illustrates a section of the spinal cord. Extending out from the spinal cord are the nerves of the peripheral nervous system.

Meninges

The meninges (Figure 8-6) are three layers of connective tissue membranes that cover the brain and spinal cord. The outer layer, the dura mater (from Latin, “hard mother”), is a tough, fibrous membrane that covers the entire length of the spinal cord and contains channels for blood to enter brain tissue. The middle layer, the arachnoid, is a weblike structure that runs across the space (called the subdural space) containing cerebrospinal fluid. The pia mater (Latin, “tender mother”), the innermost layer of meninges, is a thin membrane containing many blood vessels that nourish the spinal cord. The space between the pia mater and the bones of the spinal cord is called the epidural space. It contains blood vessels and some fat. It is the space into which anesthetics may be injected to dull pain (as during childbirth and some pelvic operations) or contrast material for certain diagnostic procedures.

Peripheral Nervous System

The peripheral nervous system includes the 12 pairs of cranial nerves that carry impulses to and from the brain and the 31 pairs of spinal nerves that carry messages to and from the spinal cord and the torso and extremities of the body. Table 8-2 lists the cranial nerves and their functions.

Severe spinal cord injuries usually result in some type of paralysis. Research is under way to grow replacement cells for injured nerves. It is expected that some types of paralysis will be cured by 2010.

For an easy way to remember and even test your cranial nerves, go to http://faculty.washington.edu/chudler/cranial.html.
The 31 pairs of spinal nerves are grouped according to the segments of the spinal cord out of which they extend. Table 8-3 lists those groups and the regions served by the nerves of each group. The peripheral nerves are further divided into two subsystems—the somatic and autonomic nervous systems—according to their function.

### Somatic Nervous System

Nerves of the somatic nervous system receive and process sensory input from the skin, muscles, tendons, joints, eyes, tongue, nose, and ears. They also excite the voluntary contraction of skeletal muscles.
**Autonomic Nervous System**

Nerves of the autonomic nervous system carry impulses from the central nervous system to glands, various smooth (involuntary) muscles, cardiac muscle, and various membranes. The autonomic nervous system stimulates organs, glands, and senses by stimulating secretions of various substances.

The autonomic nerves are further divided into the sympathetic nervous system and the parasympathetic nervous system. In general, the two systems play opposite roles. The sympathetic system operates when the body is awakening, increasing activity, or under stress. It helps to activate responses necessary to react to sudden changes in activity level or to dangerous or abnormal situations. These nerves control the “fight or flight” reaction to stress—that means it tells the body when to fight back or to flee in dangerous situations. The parasympathetic system, on the other hand, operates to keep the body in homeostasis or balance under normal conditions, as in the “rest and digest” activity of the body.

**VOCABULARY REVIEW**

In the previous section, you learned terms relating to the nervous system. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>acetylcholine</td>
<td>Chemical that stimulates cells.</td>
</tr>
<tr>
<td>afferent</td>
<td>Neuron that carries information from the sensory receptors to the central nervous system.</td>
</tr>
<tr>
<td>arachnoid</td>
<td>Middle layer of meninges.</td>
</tr>
<tr>
<td>astrocyte, astroglia</td>
<td>A type of neuroglia that maintains nutrient and chemical levels in neurons.</td>
</tr>
<tr>
<td>autonomic nervous system</td>
<td>Part of the peripheral nervous system that carries impulses from the central nervous system to glands, smooth muscles, cardiac muscle, and various membranes.</td>
</tr>
<tr>
<td>axon</td>
<td>Part of a nerve cell that conducts nerve impulses away from the cell body.</td>
</tr>
<tr>
<td>basal ganglia</td>
<td>Large masses of gray matter within the cerebrum.</td>
</tr>
<tr>
<td>brain</td>
<td>Body organ responsible for controlling the body’s functions and interactions with outside stimuli.</td>
</tr>
<tr>
<td>cell body</td>
<td>Part of a nerve cell that has branches or fibers that reach out to send or receive impulses.</td>
</tr>
</tbody>
</table>

256 Chapter 8 The Nervous System
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>central nervous system</td>
<td>The brain and spinal cord.</td>
</tr>
<tr>
<td>cerebellum [sér-ē-BĔL-ūm] Latin, little brain</td>
<td>One of the four major divisions of the brain; division that coordinates musculoskeletal movement.</td>
</tr>
<tr>
<td>cerebral cortex [SĔR-ē-brāl KŎR-tēks]</td>
<td>Outer portion of the cerebrum.</td>
</tr>
<tr>
<td>cerebrospinal [SĔR-ē-brō-spī-nāl] fluid (CSF) cerebro-, cerebrum + spinal</td>
<td>Watery fluid that flows throughout the brain and around the spinal cord.</td>
</tr>
<tr>
<td>cerebrum [SĔR-ē-brūm, sē-RĒ-brūm] Latin, brain</td>
<td>One of the four major divisions of the brain; division involved with emotions, memory, conscious thought, moral behavior, sensory interpretations, and certain bodily movement.</td>
</tr>
<tr>
<td>convolutions [kŏn-vŏ-LŬ-shŭnz]</td>
<td>Folds in the cerebral cortex; gyri.</td>
</tr>
<tr>
<td>corpus callosum [KŎR-pūs kă-LŎ-sūm] Latin, body with a thick skin</td>
<td>Bridge of nerve fibers that connects the two hemispheres of the cerebrum.</td>
</tr>
<tr>
<td>cranial [KRÀ-nē-ăL] nerves</td>
<td>Any of 12 pairs of nerves that carry impulses to and from the brain.</td>
</tr>
<tr>
<td>cranium [KRÀ-nē-ŭm]</td>
<td>Bony structure that the brain sits in.</td>
</tr>
<tr>
<td>dendrite [DĔN-drĭt]</td>
<td>A thin branching extension of a nerve cell that conducts nerve impulses toward the cell body.</td>
</tr>
<tr>
<td>diencephalon [di-ĕn-SĔF-ă-lŏn] di-, separated + Greek enkephalos, brain</td>
<td>One of the four major structures of the brain; it is the deep portion of the brain and contains the thalamus.</td>
</tr>
<tr>
<td>efferent [ĒF-ĕr-ĕnt] (motor) neuron</td>
<td>Neuron that carries information to the muscles and glands from the central nervous system.</td>
</tr>
<tr>
<td>epidural [ĕp-ĭ-DŬ-răl] space epid-, upon + dur(a mater)</td>
<td>Area between the pia mater and the bones of the spinal cord.</td>
</tr>
<tr>
<td>epithalamus [ĔP-ĭ-THĂL-ă-mŭs] epit- + thalamus</td>
<td>One of the parts of the diencephalon; serves as a sensory relay station.</td>
</tr>
<tr>
<td>fissure [FIȘH-ŭr]</td>
<td>One of many indentations of the cerebrum; sulcus.</td>
</tr>
<tr>
<td>frontal lobe</td>
<td>One of the four parts of each hemisphere of the cerebrum.</td>
</tr>
<tr>
<td>gyrus (pl., gyri) [Ĭ-rŭs (Ĭ-rĭ)]</td>
<td>See convolution.</td>
</tr>
<tr>
<td>hypothalamus [Ĭ-pŏ-THĂL-ă-mŭs] hypo-, below + thalamus</td>
<td>One of the parts of the diencephalon; serves as a sensory relay station.</td>
</tr>
<tr>
<td>interneuron [ĬN-tĕr-NŬ-rŏn] inter-, between + neuron</td>
<td>Neuron that carries and processes sensory information.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>medulla oblongata [mē-DUH-luh-OB-long-GAH-tuh] Latin, long marrow</td>
<td>Part of the brain stem that regulates heart and lung functions, swallowing, vomiting, coughing, and sneezing.</td>
</tr>
<tr>
<td>meninges (sing., meninx) [mē-NIN-jës (MÉ-nëngks)] Greek, plural of meninx, membrane</td>
<td>Three layers of membranes that cover and protect the brain and spinal cord.</td>
</tr>
<tr>
<td>microglia [mē-KRÖG-lë-ä] micro-, small + Greek glia, glue</td>
<td>A type of neuroglia that removes debris.</td>
</tr>
<tr>
<td>midbrain mid-, middle + brain</td>
<td>Part of the brainstem involved with visual reflexes.</td>
</tr>
<tr>
<td>myelin sheath [MEE-ën sheth]</td>
<td>Fatty tissue that covers axons.</td>
</tr>
<tr>
<td>nerve [nërv]</td>
<td>Bundle of neurons that bear electrical messages to the organs and muscles of the body.</td>
</tr>
<tr>
<td>nerve cell</td>
<td>Basic cell of the nervous system having three parts: cell body, dendrite, and axon; also called a neuron.</td>
</tr>
<tr>
<td>nerve impulse</td>
<td>Released energy that is received or transmitted by tissue or organs and that usually provokes a response.</td>
</tr>
<tr>
<td>neurilemma [nūr-I-LEM-ä] neuri-, nerve + Greek lemma, husk</td>
<td>Membranous covering that protects the myelin sheath.</td>
</tr>
<tr>
<td>neuroglia [nū-RÖG-lë-ä], neuroglial [nū-RÖG-lë-ä] cell neuro-, nerve + Greek glia, glue</td>
<td>Cell of the nervous system that does not transmit impulses.</td>
</tr>
<tr>
<td>neuron [NŪR-ôn] Greek, nerve</td>
<td>Basic cell of the nervous system having three parts; also called a nerve cell.</td>
</tr>
<tr>
<td>neurotransmitters [NŪR-o-trahns-MĪT-ërz] neuro- + transmitter</td>
<td>Various substances located in tiny sacs at the end of the axon.</td>
</tr>
<tr>
<td>occipital lobe [ok-SIP-ī-tahl lob]</td>
<td>One of the four parts of each hemisphere of the cerebrum.</td>
</tr>
<tr>
<td>oligodendroglia [ŌL-i-gō-dëN-DROG-lë-ä] oligo-, few + Greek dendron, tree + glia, glue</td>
<td>A type of neuroglia that produces myelin and helps to support neurons.</td>
</tr>
<tr>
<td>parasympathetic [pär-ä-sim-pä-THÉT-ëk] nervous system para-, beside + sympathetic</td>
<td>Part of the autonomic nervous system that operates when the body is in a normal state.</td>
</tr>
<tr>
<td>parietal lobe [pā-RI-ē-tahl lob]</td>
<td>One of the four parts of each hemisphere of the cerebrum.</td>
</tr>
<tr>
<td>pons [pōnz] Latin, bridge</td>
<td>Part of the brainstem that controls certain respiratory functions.</td>
</tr>
<tr>
<td>receptor [rē-SĒP-tēr]</td>
<td>Tissue or organ that receives nerve impulses.</td>
</tr>
</tbody>
</table>
Chapter 8  The Nervous System

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>somatic nervous system</td>
<td>Part of the peripheral nervous system that receives and processes sensory input from various parts of the body.</td>
</tr>
<tr>
<td>spinal cord</td>
<td>Ropelike tissue that sits inside the vertebral column and from which spinal nerves extend.</td>
</tr>
<tr>
<td>spinal nerves</td>
<td>Any of 31 pairs of nerves that carry messages to and from the spinal cord and the torso and extremities.</td>
</tr>
<tr>
<td>stimulus (pl., stimuli)</td>
<td>Anything that arouses a response.</td>
</tr>
<tr>
<td>subdural space</td>
<td>Area between the dura mater and the pia mater across which the arachnoid runs.</td>
</tr>
<tr>
<td>subcortical</td>
<td>See fissure.</td>
</tr>
<tr>
<td>sympathetic nervous system</td>
<td>Part of the autonomic nervous system that operates when the body is under stress.</td>
</tr>
<tr>
<td>synapse</td>
<td>Space over which nerve impulses jump from one neuron to another.</td>
</tr>
<tr>
<td>temporal lobe</td>
<td>One of the four parts of each hemisphere of the cerebrum.</td>
</tr>
<tr>
<td>terminal end fibers</td>
<td>Group of fibers at the end of an axon that passes the impulses leaving the neuron to the next neuron.</td>
</tr>
<tr>
<td>thalamus</td>
<td>One of the four parts of the diencephalon; serves as a sensory relay station.</td>
</tr>
<tr>
<td>ventral thalamus</td>
<td>One of the four parts of the diencephalon; serves as a sensory relay station.</td>
</tr>
<tr>
<td>ventricle</td>
<td>Cavity in the brain for cerebrospinal fluid.</td>
</tr>
</tbody>
</table>

CASE STUDY

Neurological Problem

Jose Gutierrez is a patient of Dr. Marla Chin, an internist. He is scheduled for his six-month checkup and medication review. Mr. Gutierrez has a history of heart disease and skin carcinoma. In the past few months he has been having trouble buttoning his shirts and remembering things. He has also developed a limp. Dr. Chin orders some tests.

Critical Thinking

1. Mr. Gutierrez has some new problems. According to his symptoms, what areas of the brain might have been affected by some disorder?

2. Dr. Chin does a thorough checkup and asks both Mr. Gutierrez and his wife many questions about such things as respiratory function, sleep habits, and so on. How will the answers to the questions help Dr. Chin determine the next steps to take?
Know the Position

3. The brain and spinal cord are protected by three layers of meninges. Name the three layers in order from inside the skull to the brain and describe the structure of each.
   a. ______________________________________________________________________________________
   b. ______________________________________________________________________________________
   c. ______________________________________________________________________________________

Find a Match

Match the definition in the right-hand column to the word in the left-hand column.

4. _____ neuroglia
   a. gray matter

5. _____ meninges
   b. weblike meningeal layer

6. _____ neuron
   c. internal chemical

7. _____ acetylcholine
   d. cell that does not transmit impulses

8. _____ excitability
   e. fissures

9. _____ ventricle
   f. area between pia mater and spinal bones

10. _____ basal ganglia
    g. responsiveness to stimuli

11. _____ sulci
    h. protective membranes

12. _____ arachnoid
    i. cell that transmits impulses

13. _____ epidural space
    j. cavity for fluid

Complete the Thought

Fill in the blanks.

14. Organs that receive [or transmit] nerve impulses are called ____________.

15. Each axon is covered by a ____________ ____________.

16. Neuron structures that conduct nerve impulses toward the cell body are called ____________.

17. Neuron structures that conduct nerve impulses away from the cell body are called ____________.

18. The spinal cord connects to the brain at the ____________ ____________.

19. The part of the brain with two hemispheres is called the ____________.

20. The part of the brainstem that controls certain respiratory functions is called the ____________.

21. The bony structure protecting the brain is the ____________.

22. Ventricles hold ____________ ____________.

23. The deep portion of the brain is called the ____________.

Spell It Correctly

Write the correct spelling in the blank to the right of each word. If the word is already correctly spelled, write C.

24. meninxes ____________

25. thalomus ____________

26. ganoglia ____________

27. gyri ____________
The lists below include combining forms and abbreviations that relate specifically to the nervous system. Pronunciations are provided for the examples.

<table>
<thead>
<tr>
<th>Combining Form</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>cerebell(o)</td>
<td>cerebellum</td>
<td>cerebellitis [sĕr-ĕ-bĕl-Ĭ-tĭs], inflammation of the cerebellum</td>
</tr>
<tr>
<td>cerebr(o), cerebri</td>
<td>cerebrum</td>
<td>cerebralgia [sĕr-ĕ-BRĀL-jē-ă], pain in the head</td>
</tr>
<tr>
<td>crani(o)</td>
<td>cranium</td>
<td>craniofacial [KRĀ-nē-ō-FĀ-shāl], relating to the face and the cranium</td>
</tr>
<tr>
<td>encephal(o)</td>
<td>brain</td>
<td>encephalitis [ĕn-sĕf-ă-LĬ-tĭs], inflammation of the brain</td>
</tr>
<tr>
<td>gangli(o)</td>
<td>ganglion</td>
<td>gangliform [GĂNG-glē-fŏrm], having the shape of a ganglion</td>
</tr>
<tr>
<td>gli(o)</td>
<td>neuroglia</td>
<td>gliomatosis [gli-ŏ-mā-TŎ-sĭs], abnormal growth of neuroglia in the brain or spinal cord</td>
</tr>
<tr>
<td>mening(o), meningi(o)</td>
<td>meninges</td>
<td>meningocele [mĕ-NĬNG-gō-sĕl], protrusion of the spinal meninges above the surface of the skin; meningitis [mĕn-ĭn-JĬ-tĭs], inflammation of the meninges</td>
</tr>
<tr>
<td>myel(o)</td>
<td>bone marrow, spinal cord</td>
<td>myelomalacia [MĬ-ĕ-lō-mă-LĂ-shē-ă], softening of the spinal cord</td>
</tr>
<tr>
<td>neur(o), neuri</td>
<td>nerve</td>
<td>neuritis [nū-RĬ-tĭs], inflammation of a nerve</td>
</tr>
<tr>
<td>spin(o)</td>
<td>spine</td>
<td>spinoneural [spĭ-nō-nŬ-răl], relating to the spine and the nerves that extend from it</td>
</tr>
<tr>
<td>thalam(o)</td>
<td>thalamus</td>
<td>thalamotomy [thăl-ă-MŎT-ŏ-mē], incision into the thalamus to destroy a portion causing or transmitting sensations of pain</td>
</tr>
<tr>
<td>vag(o)</td>
<td>vagus nerve</td>
<td>vagectomy [vă-JĔK-tŏ-mē], surgical removal of a portion of the vagus nerve; vagotomy [vă-GŎT-ŏ-mē], surgical severing of the vagus nerve</td>
</tr>
<tr>
<td>ventricul(o)</td>
<td>ventricle</td>
<td>ventriculitis [vĕn-trĭk-yū-LĬ-tĭs], inflammation of the ventricles of the brain</td>
</tr>
</tbody>
</table>
### Abbreviation and Meaning

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ach</td>
<td>acetylcholine</td>
<td>CSF</td>
<td>cerebrospinal fluid</td>
</tr>
<tr>
<td>ALS</td>
<td>amyotrophic lateral sclerosis</td>
<td>CT or CAT scan</td>
<td>computerized (axial) tomography</td>
</tr>
<tr>
<td>BBB</td>
<td>blood-brain barrier</td>
<td>CVA</td>
<td>cerebrovascular accident</td>
</tr>
<tr>
<td>CNS</td>
<td>central nervous system</td>
<td>CVD</td>
<td>cerebrovascular disease</td>
</tr>
<tr>
<td>CP</td>
<td>cerebral palsy</td>
<td>PNS</td>
<td>peripheral nervous system</td>
</tr>
</tbody>
</table>

### Case Study

**Referral to a Neurologist**

Dr. Chin takes some blood tests and decides to send Mr. Gutierrez to a neurologist, Dr. Martin Stanley, for an evaluation. Dr. Stanley reviews Dr. Chin’s notes and finds that Mr. Gutierrez has no history of CVA, but is experiencing numbness in his fingers and has some difficulty walking. Dr. Stanley will test for CVA, but since Mr. Gutierrez has a history of normal blood pressure, he suspects another disorder.

**Critical Thinking**

34. Why is Mr. Gutierrez referred to a neurologist?
35. What nerves might affect Mr. Gutierrez’s walking?

### Combining Forms and Abbreviations Exercises

#### Root Out the Meaning

Find at least two nervous system combining forms in each word. Write the combining forms and their definitions in the space provided.

36. encephalomyelitis: ____________________________
37. craniomeningocele: __________________________
38. gliomegaly: ____________________________
39. cerebromeningitis: __________________________
40. spinoneural: __________________________

#### Trace the Root

Add the combining form that completes the word.

42. Acting upon the vagus nerve: __________tropic.
43. Tumor consisting of ganglionic neurons: ganglio __________oma.
44. Myxoma containing glial cells: __________myxoma.
45. Relating to nerves and meninges: neuro __________ial.

In each word, find the combining form that relates to the nervous system and give its definition.

46. parencephalia ____________
47. angioneurectomy ____________
48. cephalomegaly ____________
49. myelitis ____________
50. meningocyte ____________
51. neurocyte ____________
52. craniomalacia ____________
53. vagotropism ____________
54. glioblast ____________
55. cerebrosclerosis ____________
### Reviewing Combining Forms

Match the following word parts with the correct meanings. Some answers may be used more than once or not at all.

<table>
<thead>
<tr>
<th>Number</th>
<th>Combining Form</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>56.</td>
<td>encephal(o)</td>
<td>a. sensation, sensitivity, feeling</td>
</tr>
<tr>
<td>57.</td>
<td>gli(o)</td>
<td>b. cerebrum</td>
</tr>
<tr>
<td>58.</td>
<td>myel(o)</td>
<td>c. one, single</td>
</tr>
<tr>
<td>59.</td>
<td>spin(o)</td>
<td>d. paralysis</td>
</tr>
<tr>
<td>60.</td>
<td>cerebell(o)</td>
<td>e. ganglion</td>
</tr>
<tr>
<td>61.</td>
<td>mening(o), meningi(o)</td>
<td>f. neuroglia</td>
</tr>
<tr>
<td>62.</td>
<td>neur(o), neuri</td>
<td>g. meninges</td>
</tr>
<tr>
<td>63.</td>
<td>gangli(o)</td>
<td>h. bone marrow, spinal cord</td>
</tr>
<tr>
<td>64.</td>
<td>crani(o)</td>
<td>i. nerve</td>
</tr>
<tr>
<td>65.</td>
<td>cerebr(o), cerebri</td>
<td>j. spine</td>
</tr>
<tr>
<td>66.</td>
<td>myel(o)</td>
<td>k. four</td>
</tr>
<tr>
<td>67.</td>
<td>ventricul(o)</td>
<td>l. vagus nerve</td>
</tr>
<tr>
<td>68.</td>
<td>radic(o), radicul(o), rhiz(o)</td>
<td>m. half, on one side</td>
</tr>
<tr>
<td>69.</td>
<td>thalam(o)</td>
<td>n. hard, dura mater</td>
</tr>
<tr>
<td>70.</td>
<td>dur(o)</td>
<td>o. mind</td>
</tr>
<tr>
<td>71.</td>
<td>esthesi(o)</td>
<td>p. cerebellum</td>
</tr>
<tr>
<td>72.</td>
<td>mon(o)</td>
<td>q. cranium</td>
</tr>
<tr>
<td>73.</td>
<td>hemi-</td>
<td>r. ventricle</td>
</tr>
<tr>
<td>74.</td>
<td>ment(o), psych(o)</td>
<td>s. nerve root</td>
</tr>
<tr>
<td>75.</td>
<td>quadra, quadri</td>
<td>t. thalamus</td>
</tr>
<tr>
<td>76.</td>
<td>-plegia</td>
<td>u. brain</td>
</tr>
</tbody>
</table>

### Knowing Nervous System Abbreviations

Match the following abbreviations with their correct meaning.

<table>
<thead>
<tr>
<th>Number</th>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>77.</td>
<td>CVA</td>
<td>a. electroencephalography</td>
</tr>
<tr>
<td>78.</td>
<td>ALS</td>
<td>b. central nervous system</td>
</tr>
<tr>
<td>79.</td>
<td>CSF</td>
<td>c. attention deficit hyperactivity disorder</td>
</tr>
<tr>
<td>80.</td>
<td>BBB</td>
<td>d. Alzheimer disease</td>
</tr>
<tr>
<td>81.</td>
<td>CVD</td>
<td>e. amyotrophic lateral sclerosis, Lou Gehrig’s disease</td>
</tr>
<tr>
<td>82.</td>
<td>CNS</td>
<td>f. polysomnography</td>
</tr>
<tr>
<td>83.</td>
<td>PNS</td>
<td>g. acetylocholine</td>
</tr>
<tr>
<td>84.</td>
<td>CP</td>
<td>h. evoked potential (studies)</td>
</tr>
<tr>
<td>85.</td>
<td>CT scan, CAT scan</td>
<td>i. computerized (axial) tomography</td>
</tr>
<tr>
<td>86.</td>
<td>Ach</td>
<td>j. obsessive-compulsive disorder</td>
</tr>
<tr>
<td>87.</td>
<td>AD</td>
<td>k. positron emission tomography</td>
</tr>
<tr>
<td>88.</td>
<td>MS</td>
<td>l. multiple sclerosis</td>
</tr>
<tr>
<td>89.</td>
<td>EP</td>
<td>m. Parkinson’s disease</td>
</tr>
</tbody>
</table>
90. _____ MRI
91. _____ PET
92. _____ EEG
93. _____ LP
94. _____ EMG
95. _____ PSG
96. _____ ADHD
97. _____ OCD
98. _____ PD
99. _____ PTSD
100. _____ TIA

**Remembering Suffixes**

Match the following suffixes commonly used with nervous system terms with their correct meaning.

101. _____ -iatry
102. _____ -iatrist
103. _____ -paresis
104. _____ -logy
105. _____ -algia
106. _____ -cele
107. _____ -itis
108. _____ -osis
109. _____ -phasia
110. _____ -plegia

a. physician, specialist
b. inflammation
c. pain
d. paralysis
e. slight paralysis
f. abnormal condition
g. speech
h. treatment
i. study of
j. hernia

**Diagnostic, Procedural, and Laboratory Terms**

Neurologic assessment is a step-by-step process of evaluating function, reviewing specific problems, and eliminating some causes while building a case for others. Many of the diagnostic tests used to examine the nervous system include electrodagnostic procedures. An **electroencephalogram (EEG)** is a record of the electrical impulses of the brain (Figure 8-7). This record can detect abnormalities that signal certain neurological conditions. **Evoked potentials** are electrical waves observed in an electroencephalogram. Abnormal wave patterns can help in the diagnosis of auditory, visual, and sensory disorders. Peripheral nervous system diseases can sometimes be detected by shocking the peripheral nerves and timing the conductivity of the shock. This procedure is called **nerve conduction velocity** or **electromyogram**. **Polysomnography (PSG)** is a recording of electrical and movement patterns during sleep to diagnose sleep disorders, such as **sleep apnea**, a dangerous breathing disorder.
Various types of imaging are used to visualize the structures of the brain and spinal cord. *Magnetic resonance imaging (MRI)* is the use of magnetic fields and radio waves to visualize structures. *Magnetic resonance angiography (MRA)* is the imaging of blood vessels to detect various abnormalities. *Intracranial MRA* is the visualizing of the head to check for aneurysms and other abnormalities. *Extracranial MRA* is the imaging of the neck to check the carotid artery for abnormalities. *SPECT (single photon emission computed tomography) brain scan* is a procedure that produces brain images in various colors using radioactive isotopes. *PET (positron emission tomography)* is a procedure that produces brain images using radioactive isotopes and tomography. It gives highly accurate images in various colors of the brain structures and physiology and can provide diagnoses of various brain disorders. *Computerized (axial) tomography (CT or CAT) scans* use tomography to show cross-sectional radiographic images.

X-rays are used to diagnose specific malformations or structural disorders. A *myelogram* is an x-ray of the spinal cord after a contrast medium is injected. A *cerebral angiogram* is an x-ray of the brain’s blood vessels after a contrast medium is injected. *Encephalography* is the radiographic study of the ventricles of the brain. The record made by this study is called an *encephalogram*. Sound waves are used to create brain images in a *transcranial sonogram* for diagnosing and managing head and stroke trauma. Ultrasound is also used in *echoencephalography*, encephalography using ultrasound waves.

*Reflexes* are involuntary muscular contractions in response to a stimulus. Reflex testing can aid in the diagnosis of certain nervous system disorders. *Babinski’s reflex* is a reflex on the plantar surface of the foot used to evaluate weakness on one side of the body. In most physical examinations, the reflex of each knee is tested for responsiveness (Figure 8-8).

Cerebrospinal fluid that has been withdrawn from between two lumbar vertebrae during a *lumbar (spinal) puncture* can be studied for the presence of various substances, which may indicate certain diseases. Blood tests are also used to diagnose nervous system disorders.

---

**VOCABULARY REVIEW**

In the previous section, you learned terms relating to diagnosis, clinical procedures, and laboratory tests. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Babinski’s reflex</td>
<td>Reflex on the plantar surface of the foot.</td>
</tr>
<tr>
<td>After Joseph F. Babinski, French neurologist (1857–1932)</td>
<td></td>
</tr>
<tr>
<td>cerebral angiogram</td>
<td>X-ray of the brain’s blood vessels after a dye is injected.</td>
</tr>
<tr>
<td>computerized (axial) tomography</td>
<td>Radiographic imaging that produces cross-sectional images.</td>
</tr>
<tr>
<td>[(ĂKS-ē-ăl) tō-MÔG-ră-fe] (CT or CAT) scan</td>
<td></td>
</tr>
</tbody>
</table>

FIGURE 8-8  Tapping just below the knee usually causes a reflex reaction similar to the one shown here.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>electroencephalogram</strong> [ˈɛləˌɛnˌsɛfəˌlərəɡrɑm] (EEG)</td>
<td>Record of the electrical impulses of the brain.</td>
</tr>
<tr>
<td>electro-, electrical + encephalo-, brain + -gram, a recording</td>
<td></td>
</tr>
<tr>
<td><strong>encephalogram</strong> [ɛnˌsɛfəˌlərəɡrɑm]</td>
<td>Record of the radiographic study of the ventricles of the brain.</td>
</tr>
<tr>
<td>encephalo- + -gram</td>
<td></td>
</tr>
<tr>
<td><strong>evoked potentials</strong> [ɪˈvɑktəd ˈpɛtələnts]</td>
<td>Record of the electrical wave patterns observed in an EEG.</td>
</tr>
<tr>
<td><strong>lumbar</strong> [ˈlʊm bær] (spinal) puncture</td>
<td>Withdrawal of cerebrospinal fluid from between two lumbar vertebrae.</td>
</tr>
<tr>
<td><strong>myelogram</strong> [ˈmaɪəˌlərəɡrɑm]</td>
<td>X-ray of the spinal cord after a contrast medium has been injected.</td>
</tr>
<tr>
<td>myelo-, spinal cord + -gram</td>
<td></td>
</tr>
<tr>
<td><strong>nerve conduction velocity</strong></td>
<td>Timing of the conductivity of an electrical shock administered to peripheral nerves.</td>
</tr>
<tr>
<td><strong>PET (positron emission tomography)</strong> [pɒt ˌpɒsətrən ˈɛmɪʃən ˈtɒməɡrɑfɪ]</td>
<td>Imaging of the brain using radioactive isotopes and tomography.</td>
</tr>
<tr>
<td><strong>polysomnography</strong> [pɔlɪsəʊmˈnəʊɡrɑfɪ] (PSG)</td>
<td>Recording of electrical and movement patterns during sleep.</td>
</tr>
<tr>
<td>poly-, many + somno-, sleep + -graphy, recording</td>
<td></td>
</tr>
<tr>
<td><strong>reflex</strong> [ˈreflɛks]</td>
<td>Involuntary muscular contraction in response to a stimulus.</td>
</tr>
<tr>
<td><strong>SPECT (single photon emission computed tomography) brain scan</strong></td>
<td>Brain image produced by the use of radioactive isotopes.</td>
</tr>
<tr>
<td><strong>transcranial sonogram</strong> [trænˈsɛntrəl ˈsoʊnəˌɡrɑm]</td>
<td>Brain images produced by the use of sound waves.</td>
</tr>
<tr>
<td>trans-, across + cranial</td>
<td></td>
</tr>
</tbody>
</table>

**CASE STUDY**

**Ordering Treatment**

Dr. Stanley orders an electroencephalogram of Mr. Gutierrez’s brain. He also orders some additional blood tests. Dr. Stanley performs a number of reflex tests. The abnormalities present confirm Dr. Stanley’s initial suspicion of Parkinson’s disease. He prescribes several medications and schedules a visit for Mr. Gutierrez in three weeks to discuss his progress. He asks Mr. Gutierrez to keep a daily log of his walking ability, any vision changes, his speech, and tremors for the three weeks until his appointment.

**Critical Thinking**

111. Why does Dr. Stanley want Mr. Gutierrez to keep a log?
112. What might Mr. Gutierrez’s abnormal reflex tests indicate?
**Check Your Knowledge**

Circle T for true and F for false.

113. Extracranial MRA is imaging of the spinal cord. **T** **F**
114. Reflexes are voluntary muscular contractions. **T** **F**
115. An encephalogram is a record of a study of the ventricles of the brain. **T** **F**
116. A lumbar puncture removes blood. **T** **F**
117. PET is an extremely accurate imaging system. **T** **F**
118. Evoked potentials are electrical waves. **T** **F**
119. A myelogram and an angiogram are both taken after injection of a contrast medium. **T** **F**
120. PSG is taken during waking hours. **T** **F**
121. Encephalography uses sound waves to produce brain images. **T** **F**

**Understanding Terms**

Match the following diagnostic, procedural, and laboratory terms with their correct definitions.

122. _____ reflex
123. _____ lumbar puncture
124. _____ Babinski's reflex
125. _____ SPECT
126. _____ cerebral angiogram
127. _____ myelogram
128. _____ encephalogram
129. _____ evoked potentials
130. _____ PET
131. _____ nerve conduction velocity
132. _____ CT scan, CAT scan
133. _____ polysomnography
134. _____ transcranial sonogram
135. _____ electroencephalogram
136. _____ extracranial MRA

- a. brain images produced by using sound waves
- b. record of the electrical wave patterns observed in an EEG
- c. timing of the conductivity of an electrical shock to the peripheral nerves
- d. record of the electrical impulses of the brain
- e. imaging of the brain using radioactive isotopes and tomography
- f. involuntary muscular contraction in response to a stimulus
- g. x-ray of the brain’s blood vessels using contrast dye
- h. recording of electrical and movement patterns during sleep
- i. record of the radiographic study of the brain’s ventricles
- j. reflex to stimulus on the plantar surface of the foot
- k. collection of cerebrospinal fluid from between two lumbar vertebrae
- l. imaging of the neck to check the carotid artery for abnormalities
- m. radiographic imaging that produces cross-sectional images
- n. brain image produced by the use of radioactive isotopes
- o. x-ray of the spinal cord using contrast dye
Neurological disorders can be caused by trauma, congenital abnormalities, infectious disorders, degenerative diseases, or vascular conditions. Bones, cerebrospinal fluid, and the meninges protect the nervous system from most types of external trauma, but not all, and the blood-brain barrier protects the brain from most infectious diseases.

**Trauma Disorders**

A concussion is an injury to the brain from an impact with an object. Cerebral concussions usually clear within 24 hours. Concussions may be followed by nausea, disorientation, dizziness, double vision (diplopia), sensitivity to light (photophobia), and/or vomiting. A severe concussion can lead to coma, abnormally deep sleep with little or no response to stimuli. Coma can also result from other causes, such as stroke. A more serious trauma than concussion is a brain contusion, a bruising of the surface of the brain without penetration into the brain. Brain contusions can result in extreme disorientation, listlessness, and even death. Traumatic injury, as during a car accident, may also cause the brain to hit the skull and then to rebound to the other side of the skull. This is called a closed head trauma, because there is no penetration of the skull. Shaken baby syndrome is a severe form of closed head trauma in which a young child experiences head trauma (as a result of falling, being shaken, or other trauma), causing the brain to hit the sides of the skull and causing potentially fatal damage.

A subdural hematoma (between the dura mater and the arachnoid or at the base of the dura mater) is a tumorlike collection of blood often caused by trauma. Other types of cranial hematomas are epidural hematomas (located on the dura mater) and intracerebral hematomas (within the cerebrum).

Injuries that result in penetration of the brain through the skull are usually extremely serious and often fatal. Depending on the degree of penetration and the place penetrated, brain damage may result. Bleeding in the brain from an injury can also cause brain damage resulting in inability to function normally.

**Congenital Disorders**

Congenital diseases of the brain or spinal cord can be devastating and have an impact on the activities of daily living. Spina bifida is a defect in the spinal column. Spina bifida occulta is a covered lesion of the vertebra that is generally visible only by x-ray. This is the least severe form of spina bifida. Spina bifida cystica is a more severe form of the condition, usually with a meningocele (protrusion of the spinal meninges above the surface of the skin) or a meningomyelocele (protrusion of the meninges and spinal cord).

Tay-Sachs disease is a hereditary disease found primarily in the descendants of Eastern European Jews. It is a genetic disease characterized by an enzyme deficiency that causes deterioration in the central nervous system’s cells. Hydrocephalus is an overproduction of fluid in the brain. It usually occurs at birth (although it can occur in adults with infections or tumors) and is treated with a shunt placed from the ventricle of the brain to the peritoneal space to relieve pressure by draining fluid. Figure 8-9 illustrates an infant with a shunt for relief of the pressure of hydrocephalus.
section on nondegenerative disorders, which discusses cerebral palsy, a disease caused by damage during gestation.

**Degenerative Diseases**

Degenerative diseases of the central nervous system can affect almost any part of the body. Deterioration in mental capacity is found in dementia and Alzheimer’s disease, a progressive degeneration of neurons in the brain, eventually leading to death. Some symptoms that worsen as Alzheimer’s disease progresses are amnesia (loss of memory), apraxia (inability to properly use familiar objects), and agnosia (inability to receive and understand outside stimuli).

Amyotrophic lateral sclerosis (ALS) is a degenerative disease of the motor neurons leading to loss of muscular control and death. It is also known as Lou Gehrig’s disease. Several other degenerative diseases are not necessarily fatal. Huntington’s chorea is a hereditary disease with uncontrollable, jerking movements and progressive loss of neural control. Multiple sclerosis (MS) is the destruction of the myelin sheath, called demyelination, leading to muscle weakness, unsteady gait (walking), paresthesias (odd sensations, of tingling, stinging, etc.), extreme fatigue, and some paralysis. In certain cases, it can lead to death. Myasthenia gravis, a disease with muscle weakness, can be treated to avoid the overproduction of antibodies that block neurotransmitters from sending proper nerve impulses to skeletal muscles. Parkinson’s disease, a degeneration of nerves in the brain, causes tremors, weakness of muscles, and difficulty in walking. It is treated with drugs that increase the levels of dopamine in the brain. Treatment helps relieve symptoms but does not cure the disease. Parkinson’s can become severe and lead to death.

**Nondegenerative Disorders**

Severe neurological disorders cause paralysis, convulsions, and other symptoms, but are not necessarily degenerative or congenital. Palsy is partial or complete paralysis. Cerebral palsy includes lack of motor coordination from cerebral damage during gestation or birth (Figure 8-10). Bell’s palsy is paralysis of one side of the face. It usually disappears after treatment. Ataxia is lack of voluntary muscle coordination resulting from disorders of the cerebellum, pons, or spinal cord.
Epilepsy is chronic, recurrent seizure activity. Epilepsy has been known since ancient times, when victims were thought to be under the influence of outside forces. Now it is understood that this disease occurs because of abnormal conditions in the brain that cause sudden excessive electrical activity. The seizures caused by this activity can be preceded by an aura, a collection of symptoms felt just before the actual seizure. Seizures may be mild or intense. Absence seizures (petit mal seizures) are mild and usually include only a momentary disorientation with the environment. Tonic-clonic seizures (grand mal seizures) are much more severe and include loss of consciousness, convulsions, and twitching of limbs. The most serious form of seizure is called status epilepticus and occurs when one seizure follows another with no recovery period or ability to regain consciousness between attacks. This is considered a medical emergency that requires immediate advanced medical care. In any form of seizure, it is not uncommon for the individual to experience amnesia (loss of memory) of the attack.

Tourette syndrome is a neurological disorder that causes uncontrollable sounds and twitching (tics). Some drugs are helpful in controlling symptoms and allowing sufferers to lead normal lives.

Infectious Diseases
Infectious diseases of the nervous system include shingles and meningitis. Shingles is a viral disease caused by the herpes zoster virus. Its symptoms include pain in the peripheral nerves and blisters on the skin.

Several types of meningitis, inflammation of the meninges, can be infectious. Pyogenic meningitis (also called bacterial meningitis) is caused by bacteria and includes such symptoms as fever, headache, and stiff neck. It is usually treated with antibiotics. In some severe cases, it can be fatal. Viral meningitis is caused by viruses and, although it has the same symptoms as pyogenic meningitis, it is usually allowed to run its course. Medication can be given for some of the more uncomfortable symptoms (fever, headache). Inflammation can also occur in the nerves (neuritis), the spinal cord (myelitis), the brain (encephalitis), the cerebellum (cerebellitis), the dura mater (dureitis), the ganglion (gangliitis), or the spinal nerve roots (radiculitis). Some specific nerve inflammations, such as sciatica, cause pain in the area served by the nerve. This is a common cause of lower back and leg pain.

Abnormal Growths
Abnormal growths in the nervous system usually occur in the brain or the meninges. About one-third of all brain tumors are growths that spread from cancers in other parts of the body (lungs, breasts, skin, and so on). The remaining growths can be benign or malignant. In either case, the pressure and distortion of the brain caused by a tumor may result in many other neurological symptoms. Gliomas (tumors that arise from neuroglia) and meningiomas (tumors that arise from the meninges) can be either benign or malignant. Both may be removed surgically. Astrocytoma, oligodendroglioma, and glioblastoma multiforme are all types of gliomas, with the latter being the most malignant. Tumors can be treated surgically if they have
not infiltrated or affected certain essential areas of the brain. Radiation and medication may be used to try to reduce tumor growth. Some nontumorous growths can cause pain from pressure on nerves. A ganglion is any group of nerve cells bunched together to form a growth or a cyst, usually arising from a wrist tendon.

**Vascular Disorders**

Vascular problems, such as arteriosclerosis, may cause a cerebrovascular accident or CVA, a disruption in the normal blood supply to the brain. Various types of strokes (cerebral infarctions) result from this disruption. A thrombus (stationary blood clot) may cause occlusion (blocking of a blood vessel), which in turn may cause a thrombotic stroke. As the blockage grows, the person may experience milder symptoms before a major stroke. These short incidents are known as transient ischemic attacks (TIAs). TIAs may be symptomless or may cause brief disorientation and speech and motor difficulty. An embolic stroke is caused by an embolus, a clot that travels from somewhere in the body to the cerebral arteries and blocks a small vessel, causing a sudden stroke. A hemorrhagic stroke is caused by blood escaping from a damaged cerebral artery. It may be caused by sudden trauma or an aneurysm, an abnormal bulge in the wall of a blood vessel resulting from weakening of the blood vessel wall.

Strokes can be mild and result in complete recovery, or they can range from mild to severe, with symptoms that remain permanently. Common symptoms are thought disorders, dysphasia (speech difficulty), aphasia, (loss of speech), loss of muscular control, some paralysis, and disorientation. Note that dysphasia is different from dysphagia, difficulty in swallowing, discussed in Chapter 14.

Some states of consciousness are changed by lack of oxygen or brain abnormalities that affect the flow of blood and oxygen to the brain. Fainting or syncope is caused by lack of oxygen to the brain. Somnolence (extreme sleepiness), somnambulism (sleepwalking), and narcolepsy (uncontrollable, sudden lapses into deep sleep) are all altered states of consciousness.

**MORE ABOUT . . .**

**Tourette Syndrome**

Medications for Tourette syndrome do not always work. People who have Tourette syndrome may not be able to function in social and work environments because of their inability to control sounds, often inappropriate in nature, and twitching, often extreme and repetitive. The National Tourette Syndrome Association publicizes information about the syndrome, holds conventions for people with the syndrome, and provides information and support to its members. This large support group holds social events where members feel comfortable with their fellow sufferers. More information is available from the Association’s Web site (www.tsa-usa.org) or from conducting a search for the word tourette.
VOCABULARY REVIEW

In the previous section, you learned terms relating to pathology. Before going on to the exercises, review the terms below and refer to the previous section if you have questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>absence seizure [SÉ-zhūr]</td>
<td>Mild epileptic seizure consisting of brief disorientation with the environment.</td>
</tr>
<tr>
<td>agnosia [āg-NŌ-zhē-ā] Greek, ignorance</td>
<td>Inability to receive and understand outside stimuli.</td>
</tr>
<tr>
<td>Alzheimer’s [ĀLTS-hi-mērz] disease</td>
<td>A type of degenerative brain disease causing thought disorders, gradual loss of muscle control, and, eventually, death.</td>
</tr>
<tr>
<td>aneurysm [ĀN-yū-rīzm] Greek aneurysma, dilation</td>
<td>Abnormal widening of an artery wall that bursts and releases blood.</td>
</tr>
<tr>
<td>apraxia [ā-PRĀK-sē-ā] a- + Greek pratto, to do</td>
<td>Inability to properly use familiar objects.</td>
</tr>
<tr>
<td>astrocytoma [ĀS-trō-sī-TŌ-mā] Greek astron, star + cyt-, cell + -oma, tumor</td>
<td>Type of glioma formed from astrocytes.</td>
</tr>
<tr>
<td>ataxia [ā-TĀK-sē-ā] a- + Greek taxis, order</td>
<td>Condition with uncoordinated voluntary muscular movement, usually resulting from disorders of the cerebellum or spinal cord.</td>
</tr>
<tr>
<td>aura [ĀW-rā] Latin, breeze</td>
<td>Group of symptoms that precede a seizure.</td>
</tr>
<tr>
<td>Bell’s palsy [PĀWL-zē] After Sir Charles Bell, Scottish surgeon (1774–1842)</td>
<td>Paralysis of one side of the face; usually temporary.</td>
</tr>
<tr>
<td>cerebellitis [sēr-ē-bēl-Ī-tīs] cerebell-, cerebellum + -itis, inflammation</td>
<td>Inflammation of the cerebellum.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>cerebral palsy [PĀWL-ze]</td>
<td>Congenital disease caused by damage to the cerebrum during gestation or birth and resulting in lack of motor coordination.</td>
</tr>
<tr>
<td>cerebrovascular [SĒR-ē-brō-VĀS-kyū-lār] accident (CVA) cerebro-, brain + vascular</td>
<td>Neurological incident caused by disruption in the normal blood supply to the brain; stroke.</td>
</tr>
<tr>
<td>coma [KÔ-mä]</td>
<td>Abnormally deep sleep with little or no response to stimuli.</td>
</tr>
<tr>
<td>concussion [kôn-KŪSH-ūn]</td>
<td>Brain injury due to trauma.</td>
</tr>
<tr>
<td>dementia [dē-MĒN-shē-ā]</td>
<td>Deterioration in mental capacity, usually in the elderly.</td>
</tr>
<tr>
<td>demyelination [dē-MĪ-ē-I-NĀ-shūn]</td>
<td>Destruction of myelin sheath, particularly in MS.</td>
</tr>
<tr>
<td>dopamine [DÕ-pā-mēn]</td>
<td>Substance in the brain or manufactured substance that helps relieve symptoms of Parkinson’s disease.</td>
</tr>
<tr>
<td>duritis [dū-RĪ-tīs]</td>
<td>Inflammation of the dura mater.</td>
</tr>
<tr>
<td>dysphasia [dīs-FĀ-zhe-ā]</td>
<td>Speech difficulty.</td>
</tr>
<tr>
<td>embolic [ém-BÕL-īk] stroke</td>
<td>Sudden stroke caused by an embolus.</td>
</tr>
<tr>
<td>embolus [ēM-bō-lūs]</td>
<td>Clot from somewhere in the body that blocks a small blood vessel in the brain.</td>
</tr>
<tr>
<td>fainting</td>
<td>See syncope.</td>
</tr>
<tr>
<td>gait [gāt]</td>
<td>Manner of walking.</td>
</tr>
<tr>
<td>gangliitis [gāng-glē-Ī-tīs] gangli(on) + -itis</td>
<td>Inflammation of a ganglion.</td>
</tr>
<tr>
<td>ganglion (pl., ganglia, ganglions) [GĀNG-glē-ōn (-a, -ons)]</td>
<td>Any group of nerve cell bodies forming a mass or a cyst in the peripheral nervous system; usually forms in the wrist.</td>
</tr>
<tr>
<td>glioma [gli-Ō-mā]</td>
<td>Tumor that arises from neuroglia.</td>
</tr>
<tr>
<td>grand mal [māhl] seizure</td>
<td>See tonic-clonic seizure.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>After George Huntington (1850–1916), U.S. physician</td>
<td></td>
</tr>
<tr>
<td>hydro-, water + Greek kephale, head</td>
<td></td>
</tr>
<tr>
<td>Lou Gehrig's [GÉR-iz] disease</td>
<td>See amyotrophic lateral sclerosis.</td>
</tr>
<tr>
<td>meningioma [mē-NIN-jē-Ö-mā]</td>
<td>Tumor that arises from the meninges.</td>
</tr>
<tr>
<td>mening-, meninges + -oma, tumor</td>
<td></td>
</tr>
<tr>
<td>meningitis [mē-nin-JI-tīs]</td>
<td>Inflammation of the meninges.</td>
</tr>
<tr>
<td>mening-, meninges + -itis</td>
<td></td>
</tr>
<tr>
<td>meningocele [mē-NING-gō-sēl]</td>
<td>In spina bifida cystica, protrusion of the spinal meninges above the surface of the skin.</td>
</tr>
<tr>
<td>meningo-, meninges + -cele, hernia</td>
<td></td>
</tr>
<tr>
<td>meningomyelocele [mē-nīng-gō-MĪ-ē-lō-sēl]</td>
<td>In spina bifida cystica, protrusion of the meninges and spinal cord above the surface of the skin.</td>
</tr>
<tr>
<td>meningo- + myelo-, spinal cord + -cele</td>
<td></td>
</tr>
<tr>
<td>multiple sclerosis [MŪL-tī-pul sklē-RŌ-sīs] (MS)</td>
<td>Degenerative disease with loss of myelin, resulting in muscle weakness, extreme fatigue, and some paralysis.</td>
</tr>
<tr>
<td>myelitis [mī-ē-LĪ-tīs]</td>
<td>Inflammation of the spinal cord.</td>
</tr>
<tr>
<td>myel-, spinal cord + -itis</td>
<td></td>
</tr>
<tr>
<td>narcolepsy [NĀR-kō-lēp-sē]</td>
<td>Nervous system disorder that causes uncontrollable, sudden lapses into deep sleep.</td>
</tr>
<tr>
<td>narco, sleep + -lepsy, condition with seizures</td>
<td></td>
</tr>
<tr>
<td>neuritis [nū-RĪ-tīs]</td>
<td>Inflammation of the nerves.</td>
</tr>
<tr>
<td>neur-, nerve + -itis</td>
<td></td>
</tr>
<tr>
<td>oligodendroglia [ŌLĪ-gō-DĒN-drō-gli-Ö-mā]</td>
<td>Type of glioma formed from oligodendroglia.</td>
</tr>
<tr>
<td>oligodendrogli(a) + -oma</td>
<td></td>
</tr>
<tr>
<td>palsy [PĀWL-zē]</td>
<td>Partial or complete paralysis.</td>
</tr>
<tr>
<td>paresthesia [pār-ēs-THĒ-zhe-ā]</td>
<td>Abnormal sensation, such as tingling.</td>
</tr>
<tr>
<td>para-, beside + Greek aisthesia, sensation</td>
<td></td>
</tr>
<tr>
<td>Parkinson's disease</td>
<td>Degeneration of nerves in the brain caused by lack of sufficient dopamine.</td>
</tr>
<tr>
<td>After James Parkinson (1755–1824), British physician</td>
<td></td>
</tr>
<tr>
<td>petit mal [PĒ-te māhl] seizure</td>
<td>See absence seizure.</td>
</tr>
<tr>
<td>pyrogenic [pī-ro-JĒN-īk] meningitis</td>
<td>Meningitis caused by bacteria; can be fatal; bacterial meningitis.</td>
</tr>
<tr>
<td>pyro-, fever + -genic, producing</td>
<td></td>
</tr>
<tr>
<td>radiculitis [rä-dik-yū-LĪ-tīs]</td>
<td>Inflammation of the spinal nerve roots.</td>
</tr>
<tr>
<td>radicul-, root + -itis</td>
<td></td>
</tr>
</tbody>
</table>
Term | Definition
--- | ---
sciatica [sī-AT-i-kā] | Inflammation of the sciatic nerve.
shingles [SHİNG-glz] | Viral disease affecting the peripheral nerves.
somnolence [SŌM-nō-lēns] Latin, sleepiness | Extreme sleepiness caused by a neurological disorder.
spina bifida [SPĪ-nə BĪF-i-dā] Latin, cleft spine | Congenital defect of the spinal column.
stroke [strōk] | See cerebrovascular accident (CVA).
syncope [SĪN-kō-pē] | Loss of consciousness due to a sudden lack of oxygen in the brain.
Tay-Sachs [TĀ-sāks] disease | Hereditary disease that causes deterioration in the central nervous system and, eventually, death.
thrombotic [thrōm-BÔT-īk] stroke | Stroke caused by a thrombus.
tics [tiks] | Twitching movements that accompany some neurological disorders.
tonic-clonic [TÔN-īk KLŌN-nīk] seizure | Severe epileptic seizure accompanied by convulsions, twitching, and loss of consciousness.
transient ischemic [is-KĒ-mīk] attack (TIA) | Short neurological incident usually not resulting in permanent injury, but usually signaling that a larger stroke may occur.
viral meningitis | Meningitis caused by a virus and not as severe as pyrogenic meningitis.

### Pathological Terms Exercises

### Check Your Knowledge

Fill in the blanks.

137. Palsy is partial or complete ________.
138. Dopamine sometimes helps the symptoms of ________ disease.
139. Inflammation of the spinal nerve roots is called ________.
140. A stationary blood clot is called a(n) ________.
141. A blood clot that moves is called a(n) ________.
142. Abnormally deep sleep with lack of responsiveness is a(n) _________.
143. A mild stroke that may be a signal that a larger stroke will occur is called a(n) _________.
144. ________ seizures are milder than ________ seizures.
145. Multiple sclerosis is usually associated with loss of ________, a covering for nerves.
146. ALS is a disease of the ________ neurons.

Make a Match
Match the definition in the right-hand column with the correct word in the left-hand column.

147. _____ coma 
   a. speech difficulty
148. _____ shaken baby syndrome 
   b. fainting
149. _____ glioma 
   c. disruption in brain’s blood supply
150. _____ duritis 
   d. loss of speech
151. _____ aphasia 
   e. short, mild stroke
152. _____ CVA 
   f. congenital spinal cord disorder
153. _____ spina bifida 
   g. abnormally deep sleep
154. _____ TIA 
   h. brain damage caused by rough handling
155. _____ syncope 
   i. neurological tumor
156. _____ dysphasia 
   j. meningeal inflammation

CASE STUDY

Adjusting the Dosage
When Mr. Gutierrez returns to Dr. Stanley’s office after three weeks, he reports that he can button his shirt again and that his walking has improved. He complains, however, that some of his cognitive symptoms have not improved. Dr. Stanley is encouraged that some of the physical symptoms have begun to improve. He will increase the dosage of the anti-Parkinson’s medication he has prescribed. He is confident that Mr. Gutierrez will stabilize and possibly even gain strength.

Critical Thinking
157. Many medications cure the symptoms, but not the disease. How might exercise help Mr. Gutierrez regain mobility?
158. What compound does Mr. Gutierrez’s medication contain?

Surgical Terms

Neurosurgeons are the specialists who perform surgery on the nervous system, especially on the brain and spinal cord. Neurosurgery is considered high risk because the potential for permanent injury is great. When some brain diseases, such as epilepsy, do not respond well to drugs, they may, in extreme cases, require surgery. A lobectomy is removal of a portion of the brain to treat epilepsy and other disorders, such as brain cancer. A lobotomy, severing of nerves in the frontal lobe of the brain, was once considered a primary method for treating mental illness. Now it is rarely used. Laser surgery
to destroy damaged parts of the brain is also used to treat some neurological disorders. Often, treatment is a combined approach, using surgery, radiation therapy, chemotherapy, and other medications.

When it is necessary to operate directly on the brain (as in the case of a tumor), a cranietomy, removal of part of the skull, or a craniotomy, incision into the skull, may be performed. Trephination (or trepanation) is a circular opening into the skull to operate on the brain or to relieve pressure when there is fluid buildup. Stereotaxy or stereotactic surgery is the destruction of deep-seated brain structures using three-dimensional coordinates to locate the structures.

Neuroplasty is the surgical repair of a nerve. Neurectomy is the surgical removal of a nerve. A neurotomy is the dissection of a nerve. A neurorrhaphy is the suturing of a severed nerve. A vagotomy is the severing of the vagus nerve to relieve pain. Cordotomy is an operation to resect (remove part of) the spinal cord.

**Vocabulary Review**

In the previous section, you learned terms relating to surgery. Before going on to the exercises, review the terms below and refer to the previous section if you have questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>cordotomy</td>
<td>Greek chord, cord + -otomy, a cutting</td>
</tr>
<tr>
<td>craniectomy</td>
<td>cranio-, cranium + -ectomy, removal</td>
</tr>
<tr>
<td>craniotomy</td>
<td>cranio-, cranium + -otomy, incision into the skull</td>
</tr>
<tr>
<td>lobectomy</td>
<td>lob-, lobe + -ectomy, removal of a portion of the brain to treat certain disorders</td>
</tr>
<tr>
<td>lobotomy</td>
<td>lobo-, lobe + -otomy, incision into the frontal lobe of the brain</td>
</tr>
<tr>
<td>neurectomy</td>
<td>neur-, nerve + -ectomy, surgical removal of a nerve</td>
</tr>
<tr>
<td>neuroplasty</td>
<td>neuro-, nerve + -plasty, repair</td>
</tr>
<tr>
<td>neurorrhaphy</td>
<td>neuro- + -rraphy, a suturing</td>
</tr>
<tr>
<td>neurosurgeon</td>
<td>neuro- + surgeon, medical specialist who performs surgery on the brain and spinal cord</td>
</tr>
<tr>
<td>neurotomy</td>
<td>neuro- + -otomy, dissection of a nerve</td>
</tr>
<tr>
<td>stereotaxy, stereotactic surgery</td>
<td>Greek stereos, solid + taxis, orderly arrangement</td>
</tr>
<tr>
<td>stereotactic surgery</td>
<td>Destruction of deep-seated brain structures using three-dimensional coordinates to locate the structures.</td>
</tr>
</tbody>
</table>

Brain surgery is often performed using computers and minimal incisions. For up-to-date information, go to www.brain-surgery.com.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>trephination, trepanation</td>
<td>Circular incision into the skull.</td>
</tr>
<tr>
<td>vagotomy</td>
<td>Surgical severing of the vagus nerve.</td>
</tr>
</tbody>
</table>

**CASE STUDY**

**Repairing a Neurological Injury**

Later in the year, Mr. Gutierrez was seriously injured in a car accident. He experienced some nerve damage in his leg. A neurosurgeon was called in to see if she could repair enough of the leg nerves to allow Mr. Gutierrez to walk. She operated, and the results were mixed. The trauma of the accident seemed to worsen some of the symptoms of Parkinson’s disease, but Mr. Gutierrez experienced improvement with his walking after undergoing physical therapy. The neurologist decided not to increase Mr. Gutierrez’s medication and to give him time to overcome the trauma.

**Critical Thinking**

159. The damaged leg nerves could actually be a result of an injury elsewhere in the body. What particular nerves or areas might the neurosurgeon examine before determining exactly where to operate?

160. Traumas can temporarily change body chemistry. The body produces dopamine naturally. Why did the doctor not increase the dosage?

**SURGICAL TERMS EXERCISES**

**Check Your Knowledge**

Fill in the blanks.

161. An incision into the skull is a(n) ___________.
162. Removal of a portion of the skull is a(n) ___________.
163. A circular skull incision is ___________.
164. The incision into the frontal lobe is called a(n) ___________.
165. The removal of a portion of the brain is called a(n) ___________.
166. Suturing of a severed nerve is ___________.
167. Removal of a nerve is ___________.
168. Repair of a nerve is ___________.
169. Vagotomy is severing the ___________ nerve.
170. Removing a part of the spinal cord is a ___________.

**Pharmacological Terms**

The nervous system can be the site of severe pain. **Analgesics** relieve pain. Other problems of the nervous system may be associated with diseases such as epilepsy. **Anticonvulsants** are often used to treat epilepsy and other disorders to lessen or prevent convulsions. **Narcotics** relieve pain by inducing a stuporous or euphoric state. **Sedatives** and **hypnotics** relax the nerves and sometimes induce sleep. **Anesthetics** block feelings or sensation and are used in surgery. Anesthetics can be given **locally** (to numb sensation to one section of the body) or **generally** (to numb sensation to the entire body).
Chapter 8  The Nervous System

Table 8-4 lists some of the common pharmacological agents prescribed for the nervous system.

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Purpose</th>
<th>Generic</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>analgesic</td>
<td>relieves or eliminates pain</td>
<td>salicylates (aspirin) acetaminophen acetaminophen and codeine ibuprofen</td>
<td>various Tylenol, various Tylenol #3 Advil, Motrin, Nuprin</td>
</tr>
<tr>
<td>local anesthetic</td>
<td>causes loss of sensation in a localized area of the body</td>
<td>lidocaine procaine</td>
<td>Lidoderm Novocain</td>
</tr>
<tr>
<td>general anesthetic</td>
<td>causes loss of sensation over the whole body</td>
<td>enfurane propofol ketamine midazolam</td>
<td>Ethrane Diprivan Ketalar Versed</td>
</tr>
<tr>
<td>anticonvulsant</td>
<td>lessens or prevents convulsions</td>
<td>phenobarbital carbamazeprine clonazepam phenytoin</td>
<td>Luminal, Solfoton Tegretol Klonopin Dilantin</td>
</tr>
<tr>
<td>sedative/hypnotic</td>
<td>relieves feeling of agitation; induces sleepiness</td>
<td>diazepam zolpidem methaqualone meprobamate</td>
<td>Valium Ambien Quaalude Miltown</td>
</tr>
</tbody>
</table>

**VOCABULARY REVIEW**

In the previous section, you learned terms relating to pharmacology. Before going on to the exercises, review the terms below and refer to the previous section if you have questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>analgesic [än-äl-JÉ-žik]</td>
<td>Agent that relieves or eliminates pain.</td>
</tr>
<tr>
<td>Greek analgesia, insensibility</td>
<td></td>
</tr>
<tr>
<td>anesthetic [än-ës-THÉT-ık]</td>
<td>Agent that causes loss of feeling or sensation.</td>
</tr>
<tr>
<td>Greek anæsthesia, without sensation</td>
<td></td>
</tr>
<tr>
<td>anticonvulsant [ÂN-tē-kōn-VÜL-sánt]</td>
<td>Agent that lessens or prevents convulsions.</td>
</tr>
<tr>
<td>anti-, against + convulsant</td>
<td></td>
</tr>
<tr>
<td>hypnotic [hip-NÖT-ık]</td>
<td>Agent that induces sleep.</td>
</tr>
<tr>
<td>Greek hypnótikos, inducing sleep</td>
<td></td>
</tr>
<tr>
<td>narcotic [när-KÖT-ık]</td>
<td>Agent that relieves pain by inducing a stuporous or euphoric state.</td>
</tr>
<tr>
<td>Greek narkotikos, numbing</td>
<td></td>
</tr>
<tr>
<td>sedative [SÉD-a-tív]</td>
<td>Agent that relieves feelings of agitation.</td>
</tr>
<tr>
<td>Latin sedativus</td>
<td></td>
</tr>
</tbody>
</table>
Mr. Gutierrez’s internist, Dr. Chin, visited him in the hospital daily. She reconsidered all his medications in light of his trauma. She checked all the medications for any side effects that might be harmful and for any possible interactions among the medications. She ordered a sedative and a mild painkiller, to be taken as needed. Dr. Chin also made notes for the nutritionist, now that Mr. Gutierrez will have to stay in the hospital for at least three more weeks.

Critical Thinking
171. Pain management is a delicate art. Physicians have to consider the addictive nature and strong side effects of many painkillers while at the same time making the patient comfortable enough to recover. Many physicians and medical ethicists have endorsed the unlimited use of pain medication for those with terminal diseases. What might explain the reluctance of some practitioners to allow unlimited painkillers?

172. What might Dr. Chin ask the nutritionist to consider for Mr. Gutierrez in the next three weeks?

Check Your Knowledge
Fill in the blanks.
173. An agent that induces sleep is called a(n) ___________.
174. An agent that causes loss of feeling is called a(n) ___________.
175. An agent that relieves nervousness is called a(n) ___________.
176. A drug prescribed for epilepsy is probably a(n) ___________.
177. Pain is relieved with a(n) ___________.
178. A pain reliever that induces a euphoric state is a(n) ___________.

Challenge Section
Dr. Stanley has a 72-year-old patient whose diagnosis of a sleep disorder does not fit with some of the symptoms she is now experiencing. Dr. Stanley gives the patient, Mary Carpenter, a full physical exam and records notes on her chart.

The patient has had sleep difficulties since her CABG (coronary artery bypass graft) in 2004. She falls asleep easily but awakens 1 to 2 hours later and then sleeps little through the night. In the last two years she has noted increased difficulty in remembering names, numbers, and how to do things. She lost her way while driving, and her family wishes her to surrender her license. She has had intermittent numbness in her fingers and legs and seems more unsteady on her feet.

Objective:
General: very slow and wobbly gait.
Critical Thinking

Dr. Stanley tested physical and cognitive functions. He noted that Mary’s family wanted her license surrendered and seemed to be legitimately worried about her ability to concentrate. What disease might Dr. Stanley be considering as a diagnosis? Does a sleep disorder affect cognitive functioning?

Terminology in Action

The following chart is for a 30-year-old. Write a brief paragraph discussing his current health and what steps he should be taking in light of his genetic profile.

Using the Internet

Go to the Alzheimer’s Association Web site (http://www.alz.org) and write a paragraph on recent developments in Alzheimer’s research. Also, list the stages of Alzheimer’s disease.
CHAPTER REVIEW

The material that follows is to help you review all the material in this chapter.

Understanding Nervous Systems Terms

For the following definitions, write the correct term in the space provided.

179. star-shaped neuroglia; maintain nutrient and chemical levels in the neurons ______________________
180. conveys information to the muscles and glands from CNS_ _____________________
181. thin branching extensions of the cell body ______________________
182. portion of the brain that controls voluntary movements, emotional expression, and moral behavior ______________________
183. consists of the brain and spinal cord ______________________
184. made up of the midbrain, pons, and medulla oblongata ______________________
185. the largest portion of the brain, with two hemispheres ______________________
186. strong bony structure that protects the brain ______________________
187. the three layers of connective tissue membranes that cover the brain and spinal cord ______________________
188. carries impulses to and from the brain and includes 12 pairs of cranial nerves and 31 pairs of spinal nerves ______________________
189. receives and process sensory input from the skin, muscles, tendons, joints, eyes, tongue, nose, and ears ______________________
190. chemical that stimulates cells ______________________
191. considered the “basic element” of the nervous system ______________________
192. conducts nerve impulses away from the cell body_ ______________________
193. neurons that carry information from sensory receptors to the central nervous system ______________________
194. produce myelin and help support neurons ______________________
195. permits some chemical substances to reach the brain’s neurons but blocks others_ ______________________
196. portion of the brain that controls and interprets the senses and taste ______________________
197. area of the brain that coordinates musculoskeletal movement to maintain posture, balance, and muscle tone ______________________
198. congenital disease causing a defect in the spinal column ______________________
199. overproduction of fluid in the brain ______________________
200. hereditary disease with uncontrollable, jerking movements and progressive loss of neural control ______________________
201. a degeneration of nerves in the brain, causing tremors, weakness of muscles, and difficulty in walking ______________________
202. viral disease caused by the herpes zoster virus ________________
203. mild epileptic seizure consisting of brief disorientation ________________
204. abnormally deep sleep with little or no response to stimuli ________________
205. deterioration in mental capacity, usually in the elderly ________________
206. brain injury due to trauma ________________
207. sleepwalking ________________
208. twitching movements that accompany some neurological conditions ________________

True or False
Circle T for true or F for false.
209. Spina bifida may cause paralysis. T F
210. A transient ischemic attack (TIA) causes death of affected brain cells. T F
211. CT stands for carinothoracic. T F
212. Epilepsy is a brain disorder characterized by recurrent seizures. T F
213. Sciatica causes nerve pain in the legs. T F
214. A CVA causes death of the affected brain cells. T F
215. A form of facial paralysis affecting one or both sides of the face and usually temporary is called Bell's palsy. T F
216. Medications prescribed to relieve pain are called analgesics. T F
217. A surgical procedure to sever nerves in the frontal lobe of the brain is called a lobectomy. T F

Remembering Prefixes
Match the following prefixes commonly used with nervous system terms with their correct meaning.
218. _____ hemi- a. positioned beneath
219. _____ poly- b. half
220. _____ dys- c. four
221. _____ eu- d. equal
222. _____ iso- e. without
223. _____ bi- f. difficult, abnormal
224. _____ infra- g. beside, involving two parts
225. _____ para- h. normal
226. _____ a-, an- i. many
227. _____ quadri-, quadra- j. two

Word Building
Using word parts you have learned in this chapter, build the correct medical terms for the following definitions.
228. any disease of the mind ________________
229. condition of difficulty speaking ________________
230. pertaining to below the dura mater ________________
231. paralysis of four limbs ________________
232. record of the electrical impulses of the brain ______________________
233. excision of a nerve ______________________
234. tumor of the meninges ______________________
235. nerve weakness ______________________
236. softening of the brain ______________________
237. protrusion of the meninges ______________________
238. disease of nerves and joints ______________________
239. recording of impulses of the brain ______________________
240. inflammation of a nerve ______________________
241. pertaining to within the cerebrum ______________________
242. physician who treats and studies diseases of the nervous system ______________________
243. paralysis of one limb ______________________
244. inflammation of many nerves ______________________
245. disease of the nerves ______________________
246. incision into a nerve root ______________________
247. slight paralysis of one limb ______________________
248. originating in the mind ______________________
249. specialist of the mind ______________________
250. pain in a nerve ______________________
251. process of recording the electrical impulses of the brain ______________________
252. pertaining to the mind and the body ______________________
253. protrusion of the meninges and spinal cord ______________________
254. the study of nerves ______________________
255. paralysis of half of the body ______________________
256. loss of feeling or sensation ______________________
257. pertaining to the cerebrum ______________________

**Definitions**

Define the following terms and combining forms. Review the chapter before starting. Make sure you know how to pronounce each term as you define it. The blue words in curly brackets are references to the Spanish glossary available online at www.mhhe.com/medterm3e.

**Word**

267. aneurysm [AN-yū-rīm] (aneurisma)
268. anticonvulsant [ĀN-tē-kōn-VŪL-sān]
269. aphasia [ā-FĀ-zhe-ā] (afasia)
270. apraxia [ā-PRĀK-sē-ā] (apraxia)
271. arachnoid [ā-RĀK-nōyd] (aracnoideo)
272. astrocyte [ĀS-trō-sēt], astroglia [ās-TRŌG-lē-ā] (astrocito, astroglia)
273. astrocytoma [ĀS-trō-sē-TŌ-mā] (astrocitoma)
274. ataxia [ā-TĀK-sē-ā] (ataxia)
275. aura [ĀW-rā] (aura)
276. autonomic [āw-tō-NŌM-īk] nervous system
277. axon [ĀK-sōn] (axon)
278. bacterial meningitis [mēn-īn-JĪ-tīs]
279. Babinski’s [bā-BĪN-skē] reflex
280. basal ganglia [BĀ-sāl GÅNG-glē-ā]
281. Bell’s palsy [PĀWL-zē]
282. brain [brān] (cerebro)
283. brain contusion [kōn-TŪ-zhūn]
284. brainstem (tronco encefálico)
285. cell body
286. central nervous system
287. cerebell(o)
288. cerebellitis [sēr-ē-bēl-Ī-tīs] (cerebelitis)
289. cerebellum [sēr-ē-BĒL-ūm]
290. cerebr(o), cerebri
291. cerebral [SĒR-ē-brāl] angiogram
292. cerebral cortex [KŌR-tēks]
293. cerebral infarction [īn-FĀRK-shūn]
294. cerebral palsy [PĀWL-zē]
295. cerebrospinal [SĒR-ē-brō-spi-nāl] fluid (CSF)
296. cerebrovascular [SĒR-ē-brō-VĀS-kīy-lār] accident (CVA)
297. cerebrum [SĒR-ē-brūm, sē-RĒ-brūm] (cerebrum)
298. coma [KŌ-mā] (coma)
299. computerized (axial) tomography [(ĀKS-ē-āl) tō-MÖG-rā-fē] (CT or CAT) scan
300. concussion [kōn-KŪSH-ūn] (concusión)
301. conductivity [kōn-dūk-TĪV-ī-tē] (conductividad)
302. convolution [kōn-vō-LŪ-shūn] (circunvolución)
303. cordotomy [kōr-DŌT-ō-mē] (cordotomía)
304. corpus callosum [KŌR-pūs kā-LŌ-sūm]
305. crani(o)
306. cranial [KRĀ-nē-āl] nerves
307. cranietomy [krā-nē-ĒK-tō-mē] (cranietomía)
308. craniotomy [krā-nē-ŌT-ō-mē] (craneotomía)
309. cranium [KRĀ-nē-ūm] (cráneo)
310. dementia [dē-MĒN-shē-ā] (demencia)
311. demyelination [dē-MĒ-ē-Ī-NĀ-shūn] (demielinación)
312. dendrite [ĐĒN-dēt] (dendrita)
313. diencephalon [dī-e-NĒF-ā-lōn] (diencefalo)
314. dopamine [DŌ-pā-mēn] (dopamina)
315. dura mater [DŪ-rā MĀ-tēr]
316. duritis [dū-RI-tīs]
317. dysphasia [dīs-FĀ-zhe-ā] (disfasia)
318. efferent [ĒF-ēr-ēnt] (motor) neuron
319. electroencephalogram [ē-LĒK-tō-ēn-SĒF-ā-lō-grām] (EEG) (electroencefalografía)
320. embolic [ēm-BÔL-īk] (embolo) stroke
321. embolus [ĒM-bō-lūs]
322. encephal(o)
323. encephalitis [ēn-sēf-ā-LĪ-tīs] (encefalitis)
324. electroencephalogram [ēn-SĒF-ā-lō-grām] (encefalograma)
325. epidural [ēp-ī-DŪ-rāl] space
326. epilepsy [ĒP-ī-LĒP-sē] (epilepsia)
327. epithalamus [ēp-ī-THĀL-ā-mūs] (epitáalamo)
328. evoked potentials [ē-VŌKT pō-TĒN-shālz]
329. excitability [ēk-SĪ-ťā-BĪL-ī-tē] (excitabilidad)
330. fainting
331. fissure [FĪSH-ūr] (fisura)
332. frontal lobe
333. gait [gāt] (marcha)
334. gangli(o)
335. gangliitis [gāng-glē-Ī-tīs] (gangliitis)
336. ganglion (pl. ganglia, ganglions) [GĀNG-glē-ōn (-a, -ons)] (ganglio)
337. gli(o)
338. glioblastoma multiforme [GLĪ-ō-blās-TŌ-mā MŪL-tī-fōrm]
339. glioma [gli-ō-mā] (glioma)
340. grand mal [māhl] seizure

Chapter 8  The Nervous System 285
341. gyrus (pl., gyri) [JI-rūs (JI-rī)] (circunvolución)
342. hemorrhagic [hēm-ō-RĀ-ık] stroke
343. Huntington’s chorea [kōr-Ē-ā]
344. hydrocephalus [hī-drō-SĒF-ā-lūs] (hídrosfália)
345. hypnotic [hīp-NŌT-ık]
346. hypothalamus [HI-pō-THĀL-ā-mūs] (hipotálamo)
347. interneuron [IN-tēr-NŪ-rōn] (interneurona)
348. lobectomy [lō-BĒK-tō-mē] (lobotomía)
349. lobotomy [lō-BŌT-ō-mē]
350. Lou Gehrig’s [GĒR-īz] disease
351. lumbar [LŪM-bār] (spinal) puncture
352. medulla oblongata [mē-DŲL-ā ɔb-lōŋ-GĀ-tā]
353. mening(o), meningi(o)
354. meninges (sing., meninx) [mē-NĪN-jēz (MĒ-ningks)] (meninges)
355. meningioma [mē-NĪN-jē-Ō-mā] (meningioma)
356. meningitis [mēn-īn-]JĪ-tīs] (meningitis)
357. meningocele [mē-NĪNG-gō-sēl] (meningocele)
358. meningomyelocele [mē-nīng-gō-MĪ-Ī-lō-sēl] (meningomielocele)
359. microglia [mī-KRŌG-lē-ā] (microglia)
360. midbrain (cerebro medio)
361. multiple sclerosis [MŪL-Ī-tī-pūl sklē-ŘŌ-sīs] (MS)
362. myasthenia gravis [mī-ās-THĒ-nē-ā GRĀV-is]
363. myel(o)
364. myelin sheath [MĪ-ē-līn shēth]
365. myelitis [mī-ē-LĪ-tīs]
366. myelogram [MĪ-ē-lō-grām] (mielograma)
367. narcolepsy [NĀR-kō-lēp-se] (narcolepsia)
368. narcotic [när-KŌT-ık]
369. nerve [nērv] (nervio)
370. nerve cell
371. nerve conduction velocity
372. nerve impulse
373. neur(o), neuri
374. neurectomy [nū-RĒK-tō-mē] (neurectomía)
375. neurilemma [nūr-ī-LĒM-ā] (neurilema)
376. neuritis [nūr-Ī-tĭs] (neuritis)
377. neuroglia [nū-RŌG-lē-ā], neuroglial [nū-RŌG-lē-āl] cell
378. neuron [NĪR-ōn] (neurona)
379. neuroplasty [NĪR-ō-PLĀS-tē]
380. neurorhaphy [nūr-ŌR-ā-ĕf]
381. neurosurgeon [nūr-ō-SĒR-jūn] (neurocirujano)
382. neurotomy [nū-RŌT-ō-mē]
383. neurotransmitter [NĪR-ō-trańska-MĪT-ĕr] (neurotransisor)
384. occipital lobe [ōk-SĪP-ī-tāl lōb]
385. occlusion [ō-KLŪ-zhūn] (oclusión)
386. oligodendroglioma [ŌL-ī-gō-dēn-DRŌG-lē-ā] (oligodendroglioma)
387. oligodendroglioma [ŌL-ī-gō-DĒN-dō-gli-Ō-mā] (oligodendroglioma)
388. palsy [PĀWL-ze] (parálisis)
389. parasympathetic [pār-ā-sīp-THĒ-ık] nervous system
390. paresthesia [pār-ēs-THĒ-zhē-ā]
391. parietal lobe [pā-ŘĪ-ě-tāl lōb]
392. Parkinson’s disease
393. PET (positron emission tomography) (TEP)
394. petit mal [PĒ-tē māhl] seizure
395. pia mater [PI-ā, PĒ-ā MĀ-tēr, MĀ-tēr] (piamadre)
396. polysomnography [PŌL-ē-sōm-NŌG-rā-ĕf] (PSG)
397. pons [pōns] (pons)
398. pyogenic [pi-rō-JĒN-ı̇k] meningitis
399. radiculitis [rā-dīk-yū-LI-tīs] (radiculitis)
400. receptor [rē-SĒP-ter] (receptor)
401. reflex [RĒ-flēks] (reflejo)
402. sciatica [sī-AT-ī-kā] (ciática)
403. sedative [SĒD-ā-tīv]
404. shingles [SHĪNG-glē] (culebrilla)
405. somatic [sō-MĀT-ık] nervous system
406. somnambulism [sōm-NĀM-bī-yū-ĭzām] (sonambulismo)
407. somnolence [SŌM-nō-lēns] (somnolencia)
408. SPECT (single photon emission computed tomography) brain scan
WORD

409. spin(o) 419. synapse [SIN-əps] {sinapsis}
410. spina bifida [SPī-nā BĪF-ī-dā] 420. syncope [SĪN-kō-pe] {síncope}
411. spinal cord 421. Tay-Sachs [TĀ-sāks] disease
412. spinal nerves 422. temporal lobe [TĒM-pō-rāl lōb]
413. stereotaxy [stēr-ē-ō-TĀ-kē], 423. terminal end fibers
stereotactic [stēr-ē-ō-TĀ-k-ē] 424. thalam(o)
surgery 425. thalamus [THĀL-ā-mūs] {tálamo}
414. stimulus (pl., stimuli) 426. thrombotic [thrōm-BÔT-ēk]
[STĪM-yū-lūs (STĪM-yū-lī)] stroke 427. thrombus [THRŌM-būs]
{stimulo} 428. tic [tīk] {tic}
415. stroke [strōk] {accidente cerebrovascular} 429. tonic-clonic [TÔN-ēk KLÔN-nīk] seizure
417. sulcus (pl., sulci) [SŪL-kūs] {trombo}
{SUL-sī} {surco} 431. trephination [trēf-ī-NĀ-shūn], 432. Tourette [tu-RĒT] syndrome
trepanation [trēp-ā-NĀ-shūn] 433. transient ischemic {is-KĒ-mīk} attack (TIA)
434. vag(o) 435. vagotomy [vā-GŌT-o-mē]
436. ventral thalamus 437. ventricle [VĒN-trī-kl] {ventrículo}
438. ventricul(o) 439. viral meningitis

Abbreviation
Write out the full meaning of each abbreviation.

ABBREVIATION

| 440. ACH | 444. CP | 448. CVD |
| 441. ALS | 445. CSF | 449. PNS |
| 442. BBB | 446. CT OR CAT SCAN | |
| 443. CNS | 447. CVA | |
Answers to Chapter Exercises

1. brainstem, frontal lobe, temporal lobe
2. symptoms may point to one or two specific disorders
3. a. dura mater, tough fibrous membrane
   b. arachnoid, weblike structure across a space
   c. pia mater, thin membrane containing blood vessels
4. d
5. h
6. i
7. c
8. g
9. j
10. a
11. e
12. b
13. f
14. receptors
15. myelin sheath
16. dendrites
17. axons
18. medulla oblongata
19. cerebrum
20. pons
21. cranium
22. cerebrospinal fluid
23. diencephalon
24. meninges
25. thalamus
26. ganglia
27. C
28. C
29. axon
30. C
31. acetylcholine
32. neuroglia
33. cerebellum
34. Mr. Gutierrez has normal blood pressure and no history of CVA. He does, however, have neurological impairments and may well have a neurological disorder.
35. sacral, sciatic, spinal, leg
36. encephalo-, brain; myelo-, spinal cord
37. cranio-, skull; meningo-, meninges
38. glio-, neuroglia; neuro-, nerve
39. cerebro-, cerebrum; meningo-, meninges
40. spino-, spine; neur-, nerve
41. neuro-, nerve, encephalo-, brain, myelo-, spinal cord
42. vago-
43. neur-
44. glio-
45. meningo-
46. encephalo-, brain
47. neur-, nerve
48. cephalo-, head
49. myelo-, spinal cord
50. meningo-, meninges
51. neuro-, nerve
52. cranio-, cranium
53. vago-, vagus nerve
54. glio-, neuroglia
55. cerebro-, cerebrum
56. u
57. f
58. h
59. j
60. p
61. g
62. i
63. e
64. q
65. b
66. h
67. r
68. s
69. t
70. n
71. a
72. c
73. m
74. o
75. k
76. d
77. t
78. e
79. u
80. n
81. q
82. b
83. o
84. w
85. i
86. g
87. d
88. l
89. h
90. v
91. k
92. a
93. r
94. x
95. f
96. c
97. j
98. m
99. s
100. p
101. h
102. a
103. e
104. i
105. c
106. j
107. b
108. f
109. g
110. d
111. to see how the medicine is helping to reduce symptoms and to adjust the dosage as necessary
112. weakened reflexes, particularly in the legs and hands
113. F
114. F
115. T
116. F
117. T
118. T
119. T
120. F
121. F
122. f
123. k
124. j
125. n
126. g
127. o
128. i
129. b
130. e
131. c
132. m
133. h
134. a
135. d
136. l
137. paralysis
138. Parkinson's
139. radiculitis
140. thrombus
141. embolus
142. coma
143. transient ischemic attack
144. absence, tonic-clonic (or petit mal, grand mal)
145. myelin
146. motor
147. g
148. h
149. i
150. j
151. d
152. c
153. f
154. e
155. b
156. a
157. Once the weakness symptoms are relieved, exercise can strengthen muscles in the legs and arms
158. dopamine
159. spinal, brainstem
160. because Mr. Gutierrez may normalize within a short time and an overdose might cause other problems
161. craniotomy
162. craniectomy
163. trephination (or trepanation)
164. lobotomy
165. lobectomy
166. neurorrhaphy
167. neuractomy
168. neuroplasty
169. vagus
170. cordotomy
171. Some physicians feel that the addictive nature of painkillers and the strong side effects change the patient's ability to relate normally to family
172. a lower-calorie diet because of his lack of exercise
173. hypotonic (or sedative)
174. anesthetic
175. sedative (or hypnotic)
176. anticonvulsant
177. analgesic
178. narcotic
179. astroglia, astrocytes
180. efferent (motor) neurons
181. dendrites
182. frontal lobe
183. central nervous system (CNS)
184. brainstem
185. cerebrum
186. cranium
187. meninges
188. peripheral nervous system (PNS)
189. somatic nervous system
190. acetylcholine (Ach)
191. nerve cell or neuron
192. axon
193. afferent (sensory) neurons
194. oligodendroglia
195. blood-brain barrier
196. parietal lobe
197. cerebellum
198. spina bifida
199. hydrocephalus
200. Huntington's chorea
201. Parkinson's disease
202. shingles
203. absence seizure
204. coma
205. dementia
206. concussion
207. somnambulism
208. tics
209. T
210. F
211. F
212. T
213. T
214. T
215. T
216. T
217. F
218. b
219. i
220. f
221. h
222. d
223. j
224. a
225. g
226. e
227. c
228. psychopathy
229. dysphasia
230. subdural
231. quadriplegia
232. electroencephalograph
233. neurectomy
234. meningioma
235. neurasthenia
236. encephalomalacia
237. meningocele
238. neuroarthritis
239. electroencephalography
240. neuritis
241. intracerebral
242. neurologist
243. monoplegia
244. polyneuritis
245. neuropathy
246. radicotomy
247. monoparesis
248. psychogenic
249. psychologist
250. neuralgia
251. electroencephalography
252. psychosomatic
253. meningomyelocele
254. neurology
255. hemiparesis
256. anesthesia
257. cerebral
258-449. Answers are available in the vocabulary reviews in this chapter.