Critical Thinking

1. Investigate and compare the cost of at least three tests used to diagnose disorders of the endocrine system.
2. Investigate the function of at least five common medications used in treatment of the endocrine system.
3. List at least five occupations involved in the health care of endocrine system disorders.
4. Compare the difference between the conditions of being a dwarf or midget.
5. Investigate and describe the function of the following exocrine glands: lacrimal, mammary, salivary, and sudoriferous.
6. Use the Internet to research the incidence of steroid abuse in sports and the methods used to combat this problem. Create a pamphlet that describes this issue.
7. Use the Internet to research and review an article regarding a recent development or treatment method relating to the endocrine system.

Explore the Web

Diabetes Success Stories
CDC

CDC
http://www.cdc.gov/diabetes/

IDF Diabetes Atlas
http://www.diabetesatlas.org/

Steroid Abuse
National Institute on Drug Abuse
http://www.drugabuse.gov/students.html

U.S. Department of Justice

Nervous System

LEARNING OBJECTIVES
- Define at least 10 terms relating to the nervous system.
- Describe the function of the nervous system.
- Identify at least 10 structures of the nervous system.
- Identify at least three methods used to assess the function of the nervous system.
- Describe at least five disorders of the nervous system.

KEY TERMS
- Cerebrospinal fluid (seh-reh-spy-ral FLOOR-uh) Fluid contained in the brain's ventricles, intracranial spaces, and central canal of the spinal cord
- Dementia (de-MEN-shoo-uh) Organic loss of intellectual function
- Epilepsy (EP-ih-lep-see) Transient disturbances of brain function
- Impulse (IM-pulz) Sudden pushing force; activity along nerve fibers
- Intracranial (in-tra-KRAY-nee-uh) Situated within the cranium
- Ischemia (is-KEE-nee-uh) Insufficient blood to a body part caused by a functional constriction or actual obstruction of a blood vessel
- Meninges (mih-NEEN-jeez) Three membranes that surround and protect the brain and spinal cord
- Myelography (my-e-uh-LOG-uh-fee) X-rays of the spinal cord after injection of a contrast medium
- Neurotransmitter (nee-roh-TRANS-mit-er) Chemical messenger, released from the axon of one neuron, that travels to another nearby neuron
- Polyneuritis (poh-nee-NOE-RI-tis) Inflammation of many nerves at once
- Reflex (REEF-leez) An involuntary action in response to a stimulus
- Regenerate (re-JEN-uh-rayt) Natural renewal of a structure, as of lost tissue or part
- Senile (SEE-nil) Pertaining to or characteristic of old age, especially physical or mental deterioration accompanying aging
**Nervous System Terminology**

The surface of this brain shows pus from bacterial meningitis. (Courtesy of Dr. John J. Keene, Kansas City, Kansas, in Danjou PN: Pathology for the health professions, ed 3, St. Louis, 2006, Saunders.)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Prefix</th>
<th>Root</th>
<th>Suffix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anesthesia</td>
<td>Without sensation</td>
<td>an</td>
<td>esthes</td>
<td>ia</td>
</tr>
<tr>
<td>Cerebrospinal</td>
<td>Pertaining to the brain and spine</td>
<td>cerebro</td>
<td>spin</td>
<td>al</td>
</tr>
<tr>
<td>Cranatomy</td>
<td>Incision into the skull</td>
<td>cran</td>
<td>otomy</td>
<td></td>
</tr>
<tr>
<td>Encephalotomy</td>
<td>Incision into the brain</td>
<td>enceph</td>
<td>otomy</td>
<td></td>
</tr>
<tr>
<td>Hypnagogic</td>
<td>Pertaining to sleep</td>
<td>hypno</td>
<td>ic</td>
<td></td>
</tr>
<tr>
<td>Insomnia</td>
<td>Lack of sleep</td>
<td>in</td>
<td>somn</td>
<td>ia</td>
</tr>
<tr>
<td>Meningitis</td>
<td>Inflammation of the meninges</td>
<td>mening</td>
<td>itis</td>
<td></td>
</tr>
<tr>
<td>Microencephaly</td>
<td>Small brain</td>
<td>micro</td>
<td>encephal</td>
<td>y</td>
</tr>
<tr>
<td>Neurology</td>
<td>Study of the nerve</td>
<td>neur</td>
<td>algie</td>
<td></td>
</tr>
<tr>
<td>Neurotology</td>
<td>Study of the nerve</td>
<td>neur</td>
<td>ology</td>
<td></td>
</tr>
</tbody>
</table>

*Abbreviations of the Nervous System*

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT</td>
<td>Computerized axial tomography</td>
</tr>
<tr>
<td>CNS</td>
<td>Central nervous system</td>
</tr>
<tr>
<td>CSF</td>
<td>Cerebrospinal fluid</td>
</tr>
<tr>
<td>CVA</td>
<td>Cardiovascular accident</td>
</tr>
<tr>
<td>H/A</td>
<td>Headache</td>
</tr>
<tr>
<td>MRI</td>
<td>Magnetic resonance imagery</td>
</tr>
<tr>
<td>NICU</td>
<td>Neurointensive care unit</td>
</tr>
<tr>
<td>PERLA</td>
<td>Pupils equally reactive to light</td>
</tr>
<tr>
<td>REM</td>
<td>Rapid eye movement</td>
</tr>
<tr>
<td>TIA</td>
<td>Transient ischemic attack</td>
</tr>
</tbody>
</table>

**Structure and Function of the Nervous System**

The nervous system is one of the most complex and interesting body systems. It also appears to be one of the least understood. New discoveries are made almost daily about the capabilities of the nervous system.

The function of the nervous system is to sense, interpret, and respond to internal and external environmental changes to maintain a steady state in the body (homeostasis). The nervous system is divided into two major structures: the central nervous system (CNS) and the peripheral nervous system (PNS) (Fig. 19-1).

The CNS is made up of the brain and spinal cord (Fig. 19-2). It functions as the coordinator of the body's full nervous system and contains the nerves that control connections between impulses coming to and from the brain and the rest of the body. The CNS plays a crucial role in maintaining a healthy, normally functioning body. Because nervous tissues are delicate and easily damaged, tough membranes called meninges surround the tissues. The nervous tissue and meninges are further protected by bones (vertebrae and cranium).

The PNS consists of 12 pairs of cranial nerves and 31 pairs of spinal nerves (Table 19-1) that reach all parts of the body. The cranial nerves originate in the brain, and the spinal nerves emerge from the spinal cord. The spinal cord nerves can act independently from the brain in some reflex reactions (Fig. 19-3). Other reflex actions of the nervous system may lead to the release of glandular secretions.

The organs of the PNS contain sensory (afferent) and motor (efferent) neurons (Fig. 19-4). Afferent neurons, or nerves, carry messages from the sensory cells of the body to the brain. Efferent, or motor, nerves carry messages from the brain to the body organs or parts. The connecting nerves (interneurons) of the CNS carry messages from afferent nerves to efferent nerves. Efferent nerves are classified as voluntary (somatic) or involuntary (autonomic).

The autonomic (involuntary) nervous system (ANS) is a part of the PNS (Fig. 19-5, 6). It has two parts: the sympathetic system and the parasympathetic system. The sympathetic nerves are stimulated in situations that require action, such as the "fight or flight" reaction. The parasympathetic functions in response.
types of neurons are afferent, efferent, and interneuron. Each carries messages, or impulses, to and from the body's organs.

The neuron has several important parts (Fig. 19-6). The dendrites receive impulses and transmit them to the cell body. The cell body, which contains the nucleus of the neuron, transmits the impulse to the axon. The axon transmits the impulse away from the cell body to the dendrite of the next neuron. These impulse transmissions can travel more than 130 meters per second or 300 miles per hour.

Some neurons outside the CNS have a white, fatty substance covering the axon called myelin. Myelin, also called white matter, is arranged in bundles called Schwann cells. Layers of Schwann cells wrap around the axon forming the myelin sheath. The myelin sheath is covered with a membrane called the neurilemma. It is believed that neurilemma enables the axons to repair and regenerate themselves. Axons in the CNS, called gray matter, do not have neurilemma and therefore cannot repair or regenerate themselves. Another benefit of the myelin sheath is the microscopical spaces between the Schwann cells. These are called the nodes of Ranvier, and they greatly increase the speed of impulse transmission.

**BRAIN BYTE**

Neurons are the largest cells in the body and do not perform mitosis.

**Neuroglia**

Neuroglia, often called glia, are special nervous tissue cells that act as "glue" to support, bind, repair, and protect neurons. An estimated 900 billion neuroglia are in the body. They can be divided into four major types:

- *The astrocytes, star-shaped cells, are believed to help transfer substances from the blood to the brain. They make up what is known as the blood-brain barrier.*
- *The oligodendroglia in the CNS and Schwann cells in the PNS help to develop the myelin sheath.*
- *The microglia destroy and engulf bacteria and fight infection.*
- *The ependymal cells line the cavities of the nervous system, producing and circulating fluid in the system.* Neuroglia may become cancerous when they divide to make new cells.

**TABLE 19-1**

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial Nerves</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Olfactory</td>
</tr>
<tr>
<td>II</td>
<td>Optic</td>
</tr>
<tr>
<td>III</td>
<td>Oculomotor</td>
</tr>
<tr>
<td>IV</td>
<td>Trochlear</td>
</tr>
<tr>
<td>V</td>
<td>Trigeminal</td>
</tr>
<tr>
<td>VI</td>
<td>Abducens</td>
</tr>
<tr>
<td>VII</td>
<td>Facial</td>
</tr>
<tr>
<td>VIII</td>
<td>Acoustic (auditory)</td>
</tr>
<tr>
<td>IX</td>
<td>Glossopharyngeal</td>
</tr>
<tr>
<td>X</td>
<td>Vagus</td>
</tr>
<tr>
<td>XI</td>
<td>Spinal accessory</td>
</tr>
<tr>
<td>XII</td>
<td>Hypoglossal</td>
</tr>
</tbody>
</table>

Spinal Nerves

- C1-8 Cervical (8 pair) Neck and head movement; elevation of shoulders; movement of arms, hands, and diaphragmatic breathing
- T1-12 Thoracic (12 pair) Intercostal muscles of respiration and abdominal contractions
- L1-5 Lumbar (5 pair) Leg movement
- S1-5 Sacral (5 pair) Sphincter muscles of anus and urinary meatus; foot movement

S. Sensory; M, motor; B, both sensory and motor functions.

**FIGURE 19-2** Functional areas of the spinal cord. (From Gould BE, Dyer R: Pathophysiology for the health professions, ed 4, St. Louis, 2011, Saunders.)

**FIGURE 19-3** The spinal reflex arc. The motor response to injury is a reflex action controlled by the spinal nerves.

**FIGURE 19-3** The spinal reflex arc. The motor response to injury is a reflex action controlled by the spinal nerves.
Divisions of the Nervous System

Central nervous system (CNS)
- Brain
- Spinal cord

Peripheral nervous system (PNS)
- Motor nerves
- Interneurons
- Sensory nerves

Voluntary nerves (Somatic)
- Sympathetic nervous system
- Parasympathetic nervous system

Involuntary nerves (Autonomic)

FIGURE 19-5 The nervous system may be divided into parts on the basis of their functions.

Synapse

A synapse is the space between two neurons. Neurons may be as close as one millionth of an inch to each other but still not touch. One neuron may send messages to up to 10,000 other neurons through the synapse. Impulses from one neuron are transmitted across the synapse to another neuron by a chemical called a neurotransmitter. The two most common neurotransmitters are acetylcholine and noradrenaline. One neurotransmitter may have different effects in varied synapses. More than 100 chemical messengers used by the nervous system have been identified.

Ganglia

Ganglia are groups of nerve tissue, principally nerve cell bodies, located outside the CNS. These cell bodies have some increased ability to transmit impulses compared with nerve cells because they are clustered together in the ganglion.

 Plexus and Dermatome

Four major networks of interwoven spinal nerves, called plexuses, provide impulses to specific regions of the body. They are called the cervical, brachial, lumbar, and sacral plexuses on the basis of the location of the spinal nerves that are involved in each group. Sensations on the skin surface are controlled by specific spinal nerves. For example, the second cervical spinal nerve senses afferent messages on the top of the cranium. These areas are called dermatomes.

Brain

The brain is the largest structure of the nervous system and one of the largest organs of the body (Fig. 19-7). It weighs about 2 to 3 lb (0.9-1.4 kg). It uses about 20% of the blood flow from the heart. The brain's cells can survive only 4 to 6 minutes without oxygen and glucose from the blood.

The brain is covered by three layers of membranes called meninges: the dura mater, arachnoid, and pia
The brain has four fixed cavities, called ventricles. The inner layers of the brain, spinal cord, and ventricles are filled with a clear fluid called CSF. This fluid acts as a cushion to protect the brain from injury and carries nutrients to, and wastes from, the CNS cells.

The four major areas of the brain are the cerebrum, the diencephalon, the cerebellum, and the brainstem. The cerebrum is the largest area and is divided into two hemispheres. It is concerned with reasoning and the senses. Each of the hemispheres is further divided into lobes and sections on the basis of function (Fig. 19-8). The right hemisphere controls many of the functions of the left side of the body; the left hemisphere controls the right side. One side usually has more influence over the overall body functions.

The diencephalon contains the hypothalamus and the thalamus. The hypothalamus regulates and coordinates the activity of the autonomic nervous system. It also controls hormone secretion and appetite. The thalamus transfers sensory impulses to the sensory areas of the cerebral cortex.

### TABLE 19-2

<table>
<thead>
<tr>
<th>Brain Part</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebrum</td>
<td></td>
</tr>
<tr>
<td>Frontal lobe</td>
<td>Personality, behavior, memory, reasoning, emotion</td>
</tr>
<tr>
<td>Broca's area</td>
<td>Speech</td>
</tr>
<tr>
<td>Sensory cortex</td>
<td>Sensations of heat and pain</td>
</tr>
<tr>
<td>Motor cortex</td>
<td>Controls movement</td>
</tr>
<tr>
<td>Angular gyrus</td>
<td>Written language</td>
</tr>
<tr>
<td>Wernicke's area</td>
<td>Understanding written or spoken language</td>
</tr>
<tr>
<td>Parietal lobe</td>
<td>Understanding speech or choosing words</td>
</tr>
<tr>
<td>Temporal lobe</td>
<td>Hearing and understanding speech and printed words, memory of music and visual scenes</td>
</tr>
<tr>
<td>Occipital lobe</td>
<td>Vision and its interpretation</td>
</tr>
<tr>
<td>Cerebellum</td>
<td>Coordination of voluntary movement, balance</td>
</tr>
<tr>
<td>Brainstem</td>
<td></td>
</tr>
<tr>
<td>Pons</td>
<td>Breathing, relaying impulses between cerebellum and medulla</td>
</tr>
<tr>
<td>Medulla</td>
<td>Control of involuntary movements, heartbeat, blood pressure, respiration, and swallowing</td>
</tr>
<tr>
<td>Midbrain</td>
<td>Visual and auditory reflex</td>
</tr>
</tbody>
</table>

The cerebellum directs coordination, muscle tone, and equilibrium. The brainstem includes the pons, medulla, and midbrain. It maintains the heartbeat, respiration, and blood pressure. Some areas of the brain have been identified with specific functions (Table 19-2).

### BRAIN BYTE

At any time, only 4% of brain cells are active.

The age of 20, humans tend to lose 1 g of brain weight each year.

### Primary Methods of Testing

- **Electroencephalography** is a simple, painless test that measures the electrical activity of the brain and aids in the location and treatment of disorders (Fig. 19-9). Electroencephalography may be used in surgery by applying the electrodes directly to the brain tissue.
- **Lumbar puncture** assesses CSF for blood, foreign cells, infection, and chemical imbalances. Lumbar puncture is performed by a physician using strict aseptic technique to avoid introduction of microorganisms into the spinal column.
- **Myelography** is a type of X-ray of the interior of the spinal cord used to detect growths or displacement of the vertebral column.
- **Nerve conduction velocity** tests the speed of impulses through nerves. This test stimulates nerves on a surface electrode placed on the skin and...
records the time necessary to conduct the information to another electrode. This test may be used to diagnose nerve damage.

- Computed tomography (CT) is a special radiographic technique that uses scanning equipment to reconstruct sectional slices of the body at any angle to detect abnormalities.
- Positron emission tomography is a type of CT using radioactive isotopes introduced into brain cells to detect disorders related to chemical functions.
- Magnetic resonance imagery (MRI) determines the movement of ions in tissue cells by measuring energy changes caused by radio waves (Fig. 19-10). MRI is so sensitive that white matter and fluid in the brain can be seen.
- Network spinal analysis is a technique used by chiropractors. It is based on the Epstein Model of Spine-Brain-Heart-Pulmonary, observation, and thermography studies are used along with traditional medical testing to locate and correct functional or structural disorders (subluxation) of the spinal column.
- Blood flow to the brain may be tested using magnetic resonance angiography, computed tomography angiography, or cerebral angiography. These tests are used to determine the risk of a stroke occurring.

**DISORDERS OF THE Nervous System**

**Alzheimer (AH-LZ-hi-ner) disease** is the most common form of senile dementia, but it also occurs in middle-aged adults. It is reported by the Alzheimer’s Association that as many as 5.3 million Americans have Alzheimer disease, which is more than twice the number in 1980. Although the specific cause is unknown, several forms have been identified, at least one of which is genetically linked. The person with this condition experiences a progressive loss of memory and intellectual impairment (Box 19-1). No single diagnostic test for Alzheimer disease exists. The Mini-Mental State Examination may be used to help with identification of the condition. Lesions caused by deposit of plaque on brain cells can be seen on autopsy. Also, a positron emission tomography scan may be used to identify it. Treatment helps the person control the symptoms, but no cure is known. One area of research for treatment is the use of granulocyte-colony stimulating factor to stimulate growth of blood stem and white blood cells. 

**Cerebrovascular** (se-roc-broy vas-kyoo-lar) or “stroke” or CVAs, are cardiovascular disorders that directly affect the neurological system. According to the American Heart Association statistics for 2006, about 790,000 Americans have a stroke each year. A CVA is caused by loss of oxygen, or ischemia, to an area of the brain when a clot blocks a vessel or when a vessel bursts. The extent of damage depends on the area of the brain that is affected, and the stroke victim may experience mental or physical dysfunction. Prevention of a stroke includes controlling risk factors, such as hypertension, diabetes, and heart disease. Treatment may include anticoagulants, angioplasty, or clot-dissolving drug tissue plasminogen activator. Treatment is also designed to help the person recover from or cope with functional losses caused by tissue death, such as the ability to walk or talk.

**Creutzfeldt-Jakob (kroe-TFEEL-fy yah-kob) disease** (CJD) is a rare degenerative brain disorder. It can be hereditary but may also be caused by an infectious protein, or prion. It is then commonly called “mad cow disease.” Humans may become infected by eating the meat of diseased cows. The incubation period for the disorder can be years. Symptoms may include depression, difficulty walking, and dementia. In 1986 the first case of bovine spongiform encephalopathy, or mad cow disease, was found. The suspected cause of mad cow disease is feeding the cattle meat and bone meal products. As of 2009 a new type of mad cow disease had killed 166 people in the United Kingdom and 44 in other countries. All prion diseases are fatal, and there is no effective treatment available.

**Down syndrome** is one of the most common causes of mental retardation and the most common disorder of human chromosomes. The genetic disorder is caused by the presence of an extra chromosome. The resulting characteristics include short stature, short neck, broad hands and feet with stubby fingers and toes, a large protruding tongue, and mental retardation. The degree of mental retardation varies greatly, but the average mental age that is reached is 8 years. Individuals with Down syndrome are also more likely to have respiratory infections, heart defects, and leukemia. No cure exists.

**Encephalitis** (en-saf-ul-YEE-lee-tis) is inflammation of the brain caused by a virus, bacteria, or chemical agent. Encephalitis is usually an acute condition characterized by fever, headache, extreme irritability of the nervous system, and disorientation. Encephalitis may lead to convulsions and death. Treatment depends on the exact cause and may include antibiotics and precautions to reduce stimulation.

**Guillain-Barré** (gee-YAHN bar-RE) syndrome is also called infectious polyneuritis. The cause is unknown, but it may appear shortly after a viral immunization or infection. The person with this condition experiences muscle weakness that rapidly moves from the legs to the face. Total paralysis of respiratory function may result. Treatment is supportive to maintain vital life functions. About 95% of the Guillain-Barré cases have complete recovery in a few weeks to several months.

**Headache** is a common condition resulting from several different causes. However, headache can be the symptom of another, more serious disorder and should be investigated when occurring frequently. Tension headaches are directly related to stress. The muscles around the occipital area of the brain may constrict the blood flow to the area. Tension headaches are usually dull and steady in nature. They can be relieved with nonprescription analgesics. Treatment includes relaxation techniques, massage of the neck and back muscles, and application of heat such as a hot shower.

**Migraine** headaches are vascular headaches of unknown cause. The pain results from the narrowing of blood vessels in the brain. Migraine headaches are generally throbbing, located in one area on one side of the brain, and involve gastrointestinal disturbances such as vomiting. They may last several days. Treatment includes avoiding triggering factors such as certain foods. Relief from migraine headaches may require prescription medicine.

**Stress** headaches result from the swelling of the membranes that line the sinuses. The pain is usually dull and shifts with head movement. Decongestants and nonprescription analgesics relieve this headache pain.

**Head injury** may occur when the brain impacts the skull as a result of a blow or rapid movement. Depending on the location of the injury, the person who experiences such an injury may experience nausea, confusion, decreased blood pressure, and drowsiness. Treatment includes surgical repair of the brain if necessary. The person is assessed for neurological damage after a head injury for at least 24 hours.

**Huntington disease** is a degenerative neural disorder that affects brain tissue. The condition usually appears between the ages of 35 and 50. The person with Huntington disease first experiences loss of balance and coordination and then progressively involuntary movements and dementia. Death occurs 10 to 20 years after the disease appears. An autosomal dominant gene causes the disease. If one parent has the gene for the disease, each child has a 50% chance of receiving it. The appearance of this gene can now be identified with gene mapping, allowing for counseling of families with a history of the disorder. No treatment is available.
**CASE STUDY 19-1** Your friend tells you that Huntington disease runs in her family, and she may get genetic testing for it. What should you say?

Answers to Case Studies are available on the Evolve website: http://evolve.elsevier.com/Gerdin

Hydrocephalus (hi-dro-SEF-uhs) occurs when the excess fluid increases intracranial pressure and may enlarge the head. It may be caused by developmental defects, infection, trauma, or a tumor in the cranial space. Treatment includes removal of the excess fluid by a tube inserted into the intracranial space.

Intracranial (in-tra-KRAY-nee-uh) tumors may be benign or malignant. Tumors of the nervous system usually involve neuroglia, blood vessels, or membranes rather than neurons. A neuraoma (NOO-ROH-mah) generally refers to a benign or noncancerous growth. A glioma would be more likely to be malignant or cancerous. It is also possible for a growth to be metastatic, originating from cells that have then been transported to the brain by the lymph vessels from another part of the body. Any type of growth can disrupt nervous system function, with symptoms depending on the portion of the brain or nerves that is compressed by the growth. Treatment may include surgical removal, radiation, or chemotherapy and varies with the location and type of growth.

Meningitis (men-ing-ee-TIS) is a serious inflammation of the meninges caused by a bacterium, virus, or fungus. The person can experience a high fever, stiff neck, vomiting, severe headache, and convulsions. Damage to the nervous system may result in blindness, loss of hearing, paralysis, or retardation. Some cases of meningitis are self-limiting and require treatment only to relieve symptoms. In severe cases, treatment varies with the cause and usually includes antibiotics.

**CASE STUDY 19-2** You hear there is a case of meningitis in one of the local schools. What should you do?

Answers to Case Studies are available on the Evolve website: http://evolve.elsevier.com/Gerdin

**MININGOCELL** (me-NIHNG-go-seal) is a birth defect that occurs when the membranes covering the brain or spinal cord protrude through a congenital defect in the skull or spinal column (Fig. 19-11). If treated rapidly with surgery to correct the defect, the damage done to the spinal cord and nerves can be minimized. The cause of meningioma is unknown. However, follicular acid deficiency may play a part in neural tube defects. Environmental factors and a viral cause have also been theorized as a cause.

**Multiple sclerosis** (skle-ROH-sis) results from a defect in electrical transmission of the neurons caused by degeneration of the myelin sheath. Multiple sclerosis usually appears in adults 20 to 40 years of age. The cause is unknown. Most scientists believe that the loss of myelin is caused by a virus or an autoimmune process. The person with multiple sclerosis may first experience double vision or diplopia (di-FLOR-pee-uh), loss of sensation, stiff extremities, or progressive loss of muscle control. Multiple sclerosis is treated with medication such as steroids and other medications to help control the symptoms and disabilities. No cure is available.

**Narcolepsy** (nah-Rahl-kee-lip-seal) is a chronic sleep disorder that causes excessive sleepiness and may result in frequent daytime sleep attacks. Symptoms of narcolepsy may include extreme drowsiness every 3 to 4 hours, dreamlike hallucinations, sleep paralysis, and sudden loss of muscle control leading to an inability to move. The cause of narcolepsy is believed to be related to brain proteins, including orexin and hypocretin. Narcolepsy runs in families, and researchers have identified genes associated with it. There is no known cure for narcolepsy. Treatment is designed to control the symptoms.

Neural (NOO-ROH-tub) tube defect is a defect in the formation of the skull and spinal column caused primarily when the neural tube fails to close during the development of the embryo. Severe mental and physical disorders usually are present as well. Prenatal testing during the fourteenth to sixteenth week can determine whether a neural tube defect is present. Infection of the CSF is the main concern after birth. In some cases, surgery may be performed to correct the deformity.

**Neurofibromatosis** (NOO-roh-fi-ROH-mah-TOE-sis) also called von Recklinghausen (REK-ling-hounz) disease, is caused by a defect in an autosomal dominant gene. It affects more than 100,000 people in the United States. The condition may be caused by genetic mutation in about half of the cases. The condition first causes large tan spots on the skin. Small benign tumors of nervous tissue develop with increased age (Fig. 19-12). The tumors may cause loss of hearing or blindness if located in the ears and eyes. In many cases the symptoms are mild and life expectancy is normal. Although no treatment exists, unsightly tumors can be removed surgically.

Parkinson (PAHR-kin-sun) disease commonly affects people older than 50 years of age (Fig. 19-13). It results from degeneration of certain brain cells and is sometimes called "shaking palsy." A decrease in secretion of the neurotransmitter dopamine, which has no known cause, is responsible for this degeneration. A person with Parkinson disease gradually feels stiffness and tremors, leading to uncontrolled muscular movement and rigidity. Treatment includes medication to decrease the symptoms. Drug therapy is usually successful but has many side effects. Surgery may be performed in some cases.

**Polioimmunity** (pol-ee-oh-im-ni-EET-nee-uh) is caused by a virus that spreads from the nose and throat to neural tissue. The virus destroys neural cell bodies and leads to temporary paralysis. Vaccination prevents the infection and has minimized the incidence of polio. Treatment of the disease includes measures to prevent deformity caused by loss of muscle function.
**BOX 19-2**

**Types of Seizures**

- Generalized
- Absence
- Atonic
- Tonic-clonic
- Myoclonic
- Partial
- Simple
- Complex

Sciatica (sil-AT-i-ha) is characterized by constant pain radiating from the back and buttocks to the leg. Movement may also be limited in the affected leg. The cause is usually an rupture of an intervertebral disk and osteoarthritis (os-teo-to-ar-THAR-tis) producing pressure on the nerve or other nerve injury. Treatment of sciatica requires finding the cause of the pain and controlling it.

A seizure (See-zher) may result from injury, infection, or epilepsy. More than 40 types of seizure are classified into two groups (Box 19-2): (1) partial seizures involving part of the brain and (2) generalized seizures involving the whole brain. Absence seizures, also called petit mal (PET-e mal) seizures, cause a lapse of consciousness for several seconds. Febrile and chemical seizures may be confused with other conditions. Grand mal (grand mal) seizures are a series of distinctive tonic and clonic spasms that last several minutes. In the tonic portion of the seizure, the muscles are contracted rigidly. The clonic phase involves involuntary muscle movements. Seizures may cause injury from uncontrolled movement. Seizures can often be controlled successfully with medication.

**CASE STUDY 19-3** You enter a patient’s room and observe that he is having a seizure. What should you do?

*Answers to Case Studies are available on the Evolve website: http://evolve.elsevier.com/Geradin*

Sleep disorders include more than 100 identified conditions, such as insomnia, apnea, hypersomnia, sleep terrors, restless leg syndrome, and sleep walking. The cause and treatment of the disorders are varied. Some suggestions for improving sleep patterns are to reduce caffeine and exercise before sleep. Other suggestions include developing consistent sleep habits, such as a set bedtime and activities. Medication may be used in some cases.

**CASE STUDY 19-4** You fall asleep every day after eating lunch. Your habit is causing you to be reprimanded and you even worry about driving until you have had a short nap. What should you do?

*Answers to Case Studies are available on the Evolve website: http://evolve.elsevier.com/Geradin*

**FIGURE 19-14** One method used to relieve the pain of trigeminal neuralgia is surgically to remove the ganglion on the end of the nerve. (From Patton KT, Thibodeau GA: Anatomy & physiology, ed 7, St. Louis, 2010, Mosby)

Spinal bifida (SP-i-nil BIF-i-da) is a birth defect involving a malformed spinal column resulting from neural tube defects. Seventy-five percent of spina bifida cases result from myelomeningocele or a neural tube defect. In the United States, 7 of every 10,000 babies are born with this defect each year. Spina bifida is partly hereditary but is also affected by the pregnant woman’s diet and environment. Folic acid supplements before and during pregnancy reduce the risk of spina bifida occurring. At birth the infant’s spinal column is not closed. repair may be needed. The condition may cause problems with bowel and bladder control or paralysis. The opening can be closed surgically to minimize damage.

Spinal cord injuries affect 12,000 people in the United States each year. According to the Spinal Cord Injury Statistical Center, the average age at injury is 40.2 years. About 80.9% of the injuries occur in males. About 42.1% of spinal cord injuries result from automobile accidents, 26.7% from falls, and 15.1% from violence. Most spinal injuries resulting from trauma occur in the cervical and lumbar area of the spinal column, which have the greatest mobility. Injuries to the cervical spine may cause quadriplegia (tetraplegia). In the lumbar region, paraplegia may result. The severity of the injury is diagnosed by using x-ray, CT scan, and/or MRI. Treatment may include steroids to reduce the swelling in the cord and management to prevent complications resulting from lost sensory and motor function.

Transient ischemic attacks (TIAs) are often called “little strokes” and are caused by a decrease in blood to an area of the brain resulting from a small clot that temporarily lodges in a vessel. The person may experience slurred speech, numbness, or vision disturbances that usually disappear within a few days. Because the symptoms disappear, the condition may go unrecognized. TIAs may indicate an impending irreversible CVA, which can be prevented with anti-coagulants or vascular surgery to clear blocked blood vessels.

The storage and recall of information constitutes one of the most specialized functions of the nervous system. Three components of memory include sensory memory, short-term memory, and long-term memory. Sensory memory holds information for 20 to 30 seconds. Short-term memory is information retained for several minutes to several hours. The same information can be converted by repetition to long-term memory that may be retained for years. It is believed that information is stored in different areas of the brain according to whether the method of input is visual, auditory, or touch related (kinesthetic). These areas are interconnected by chemical messengers for more efficient retrieval of information.

Researchers have also determined that memories are retained differently and in separate areas of the brain. For example, discursive or declarative information such as a multiplication table is stored in a different area than procedural information such as how to ride a bike or dance. An aphasic (without speech) injury might allow a person to remember the name of living things but not nonliving things. The temporal lobe is believed to store long-term memory. The hippocampus is the site for facts, events, novelties, and spatial relations. The method that the brain uses to store and recall information is not clearly understood, but ribonucleic acid may play a role. Most research on memory uses a marine slug named Aplysia or people who have sustained neurologic changes resulting from injury or illness as subjects. The slugs are used for memory research because their ganglia are large and their behavior patterns are limited. The slugs do have the capacity to retain short-term memories of environmental changes. Researchers believe that the slug’s memories result from a biochemical change in the synapse receptors. To create a new memory, the synapse reacts differently to the neurotransmitters it receives. In 2005, the Salk Institute for Biological Research announced that it will sequence the genome of this slug.

Neuroscientists believe that the 100 billion neurons of the brain communicate in a complicated network. Any damaged neuron may be replaced by as many as 10,000 other neurons. Computer networks have been designed to try to simulate the action of the brain. Researchers hope to discover how the brain rearranges the connections to store new information and restore operations after damage to some neurons.

**Parkinson Correction**

Parkinson disease is a progressive neurologic disorder characterized by three distinct functional changes. These three changes include slowness of movement (bradykinesia), tremor, and rigidity. According to the National Parkinson Foundation, 60,000 new cases are diagnosed each year. The usual treatment involves a series of drugs that alleviate symptoms and assist the body to make the neurotransmitter dopamine, which is missing in Parkinson patients. The first transplant of adrenal gland cells to the brain in the United States was performed in 1987. Adrenal cells and fetal brain cells may be used to
Review Questions

1. Describe the function of the nervous system.
2. Identify the parts of the neuron.
3. Describe the location and function of each of the following parts of the nervous system: Autonomic nervous system, Sympathetic nervous system, Parasympathetic nervous system.
4. Describe the function of each of the 12 cranial nerves.
5. List the function of the following parts of the brain: frontal lobe, medulla, occipital lobe, parietal lobe, pons, and temporal lobe.
6. Describe three nervous system disorders that are caused by a pathogenic organism.
7. Describe three methods used to assess the function of the nervous system.
8. Use the following terms in one or more sentences that correctly relate their meaning: epilepsy, impulse, myelography, and reflex.

Critical Thinking

1. Investigate and compare the cost of at least three tests used in diagnosing disorders of the nervous system.
2. Compare and contrast Creutzfeldt-Jakob and Parkinson disease. Draw a Venn diagram to show their similarities and differences.
3. Investigate the function of at least five common medications used in treatment of the nervous system.
4. List at least five occupations involved in the health care of nervous system disorders.
5. Use the Internet to research and investigate the methods used to regain use of the brain following injury.
6. Use the Internet to research and review an article regarding a recent development or treatment method relating to the nervous system.
7. Use the Internet to research and create a pamphlet or poster describing methods to improve the lifestyle of an Alzheimer patient.
8. Use the Internet to research and describe the current use of stem cells in treatment of a neurological disorder.
9. Use the Internet to investigate the amount of sleep needed by teenagers. Prepare a poster, pamphlet, or essay about sleep disorders including methods for maintaining good sleep hygiene.

Summary

- The function of the nervous system is to sense, interpret, and respond to internal and external environmental changes to maintain homeostasis.
- Structures of the nervous system include the CNS and PNS and their parts.
- Methods of assessment of the nervous system include electroencephalography, lumbar puncture, myelography, CT, and positron emission tomography.
- Disorders of the nervous system include CVAs, encephalitis, spina bifida, headache, and Huntington disease.