

THE NERVOUS SYSTEM

The nervous system is the master coordinating system of the body. Every thought, action, and sensation reflects its activity. The structures of the nervous system are described in terms of two principal divisions—the central nervous system (CNS) and the peripheral nervous system (PNS). The CNS (brain and spinal cord) interprets incoming sensory information and issues instructions based on past experience. The PNS (cranial and spinal nerves and ganglia) provides the communication lines between the CNS and the body's muscles, glands, and sensory receptors. The nervous system is also divided functionally in terms of motor activities into the somatic and autonomic divisions. It is important, however, to recognize that these classifications are made for the sake of convenience and that the nervous system acts in an integrated manner both structurally and functionally.

Student activities provided in this chapter review neuron anatomy and physiology, identify the various structures of the central and peripheral nervous system, consider reflex and sensory physiology, and summarize autonomic nervous system anatomy and physiology. Because every body system is controlled, at least in part, by the nervous system, these understandings are extremely important to understanding how the body functions as a whole.

1. List the three major functions of the nervous system.

1. _____

2. _____

3. _____

ORGANIZATION OF THE NERVOUS SYSTEM

2. Choose the key responses that best correspond to the descriptions provided in the following statements. Insert the appropriate letter or term in the answer blanks.

Key Choices

- | | |
|---------------------------------|------------------------------------|
| A. Autonomic nervous system | C. Peripheral nervous system (PNS) |
| B. Central nervous system (CNS) | D. Somatic nervous system |

- | | |
|-------|---|
| _____ | 1. Nervous system subdivision that is composed of the brain and spinal cord |
| _____ | 2. Subdivision of the PNS that controls voluntary activities such as the activation of skeletal muscles |
| _____ | 3. Nervous system subdivision that is composed of the cranial and spinal nerves and ganglia |
| _____ | 4. Subdivision of the PNS that regulates the activity of the heart and smooth muscle, and of glands; it is also called the involuntary nervous system |
| _____ | 5. A major subdivision of the nervous system that interprets incoming information and issues orders |
| _____ | 6. A major subdivision of the nervous system that serves as communication lines, linking all parts of the body to the CNS |

NERVOUS TISSUE—STRUCTURE AND FUNCTION

3. This exercise emphasizes the difference between neurons and neuroglia. Indicate which cell type is identified by the following descriptions. Insert the appropriate letter or term in the answer blanks.

Key Choices

- | | |
|------------|--------------|
| A. Neurons | B. Neuroglia |
|------------|--------------|

- | | |
|-------|---|
| _____ | 1. Support, insulate, and protect cells |
| _____ | 2. Demonstrate irritability and conductivity, and thus transmit electrical messages from one area of the body to another area |
| _____ | 3. Release neurotransmitters |
| _____ | 4. Are amitotic |
| _____ | 5. Able to divide; therefore are responsible for most brain neoplasms |

4. Relative to neuron anatomy, match the anatomical terms given in Column B with the appropriate descriptions of functions provided in Column A. Place the correct term or letter response in the answer blanks.

	Column A	Column B
_____	1. Releases neurotransmitters	A. Axon
_____	2. Conducts electrical currents toward the cell body	B. Axon terminal
_____	3. Increases the speed of impulse transmission	C. Dendrite
_____	4. Location of the nucleus	D. Myelin sheath
_____	5. Generally conducts impulses away from the cell body	E. Cell body

5. Certain activities or sensations are listed below. Using the key choices, select the specific receptor type that would be activated by the activity or sensation described. Insert the correct term(s) or letter response(s) in the answer blanks. Note that more than one receptor type may be activated in some cases.

Key Choices

- | | | |
|------------------------------|-------------------------|-----------------------|
| A. Bare nerve endings (pain) | C. Meissner's corpuscle | E. Pacinian corpuscle |
| B. Golgi tendon organ | D. Muscle spindle | |

Activity or Sensation

Receptor Type

Walking on hot pavement	1. (Identify two) _____ and _____
Feeling a pinch	2. (Identify two) _____ and _____
Leaning on a shovel	3. _____
Muscle sensations when rowing a boat	4. (Identify two) _____ and _____
Feeling a caress	5. _____

6. Using the key choices, select the terms identified in the following descriptions by inserting the appropriate letter or term in the spaces provided.

Key Choices

- | | | |
|--|----------------------|-------------------|
| A. Afferent neuron | F. Neuroglia | K. Proprioceptors |
| B. Association neuron (or interneuron) | G. Neurotransmitters | L. Schwann cells |
| C. Cutaneous sense organs | H. Nerve | M. Synapse |
| D. Efferent neuron | I. Nodes of Ranvier | N. Stimuli |
| E. Ganglion | J. Nuclei | O. Tract |

- | | |
|-------|---|
| _____ | 1. Sensory receptors found in the skin, which are specialized to detect temperature, pressure changes, and pain |
| _____ | 2. Specialized cells that myelinate the fibers of neurons found in the PNS |
| _____ | 3. Junction or point of close contact between neurons |
| _____ | 4. Bundle of nerve processes inside the CNS |
| _____ | 5. Neuron, serving as part of the conduction pathway between sensory and motor neurons |
| _____ | 6. Gaps in a myelin sheath |
| _____ | 7. Collection of nerve cell bodies found outside the CNS |
| _____ | 8. Neuron that conducts impulses away from the CNS to muscles and glands |
| _____ | 9. Sensory receptors found in muscle and tendons that detect their degree of stretch |
| _____ | 10. Changes, occurring within or outside the body, that affect nervous system functioning |
| _____ | 11. Neuron that conducts impulses toward the CNS from the body periphery |
| _____ | 12. Chemicals released by neurons that stimulate other neurons, muscles, or glands |

7. Figure 7–1 is a diagram of a neuron. First, label the parts indicated on the illustration by leader lines. Then choose different colors for each of the structures listed below and use them to color in the coding circles and corresponding structures in the illustration. Next, circle the term in the list of three terms to the left of the diagram that best describes this neuron's structural class. Finally, draw arrows on the figure to indicate the direction of impulse transmission along the neuron's membrane.

- ☐ Axon
☐ Dendrites
☐ Cell body
☐ Myelin sheath

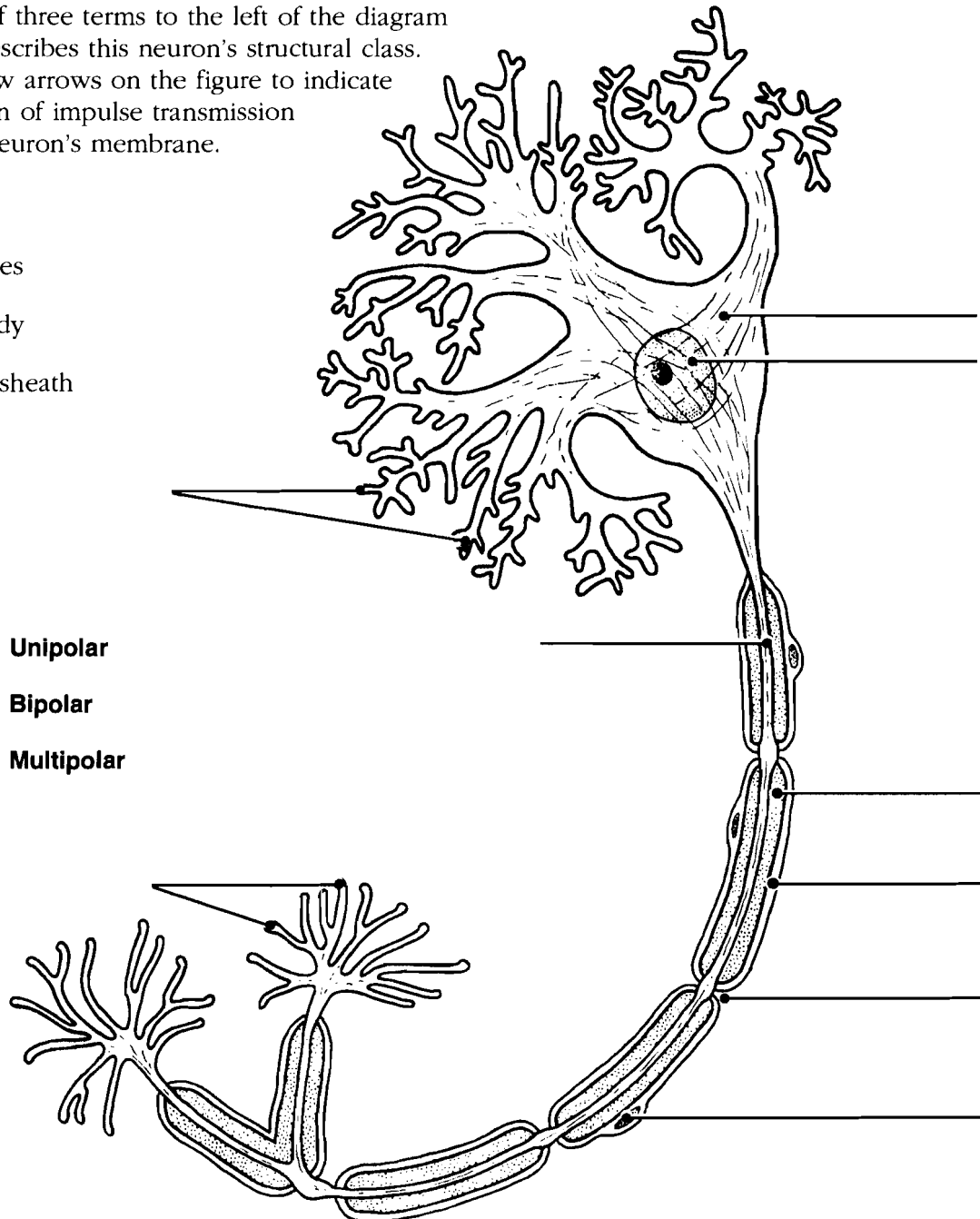


Figure 7–1

8. List in order the *minimum* elements in a reflex arc from the stimulus to the activity of the effector. Place your responses in the answer blanks.

- | | |
|-------------|-------------------|
| 1. Stimulus | 4. _____ |
| 2. _____ | 5. Effector organ |
| 3. _____ | |

- 11.** Refer to Figure 7–2, showing a reflex arc, as you complete this exercise. First, briefly answer the following questions by inserting your responses in the spaces provided.

1. What is the stimulus? _____
2. What tissue is the effector? _____
3. How many synapses occur in this reflex arc? _____

Next, select different colors for each of the following structures and use them to color in the coding circles and corresponding structures in the diagram. Finally, draw arrows on the figure indicating the direction of impulse transmission through this reflex pathway.

- | | |
|---------------------------------------|---------------------------------------|
| <input type="radio"/> Receptor region | <input type="radio"/> Interneuron |
| <input type="radio"/> Afferent neuron | <input type="radio"/> Efferent neuron |
| <input type="radio"/> Effector | |

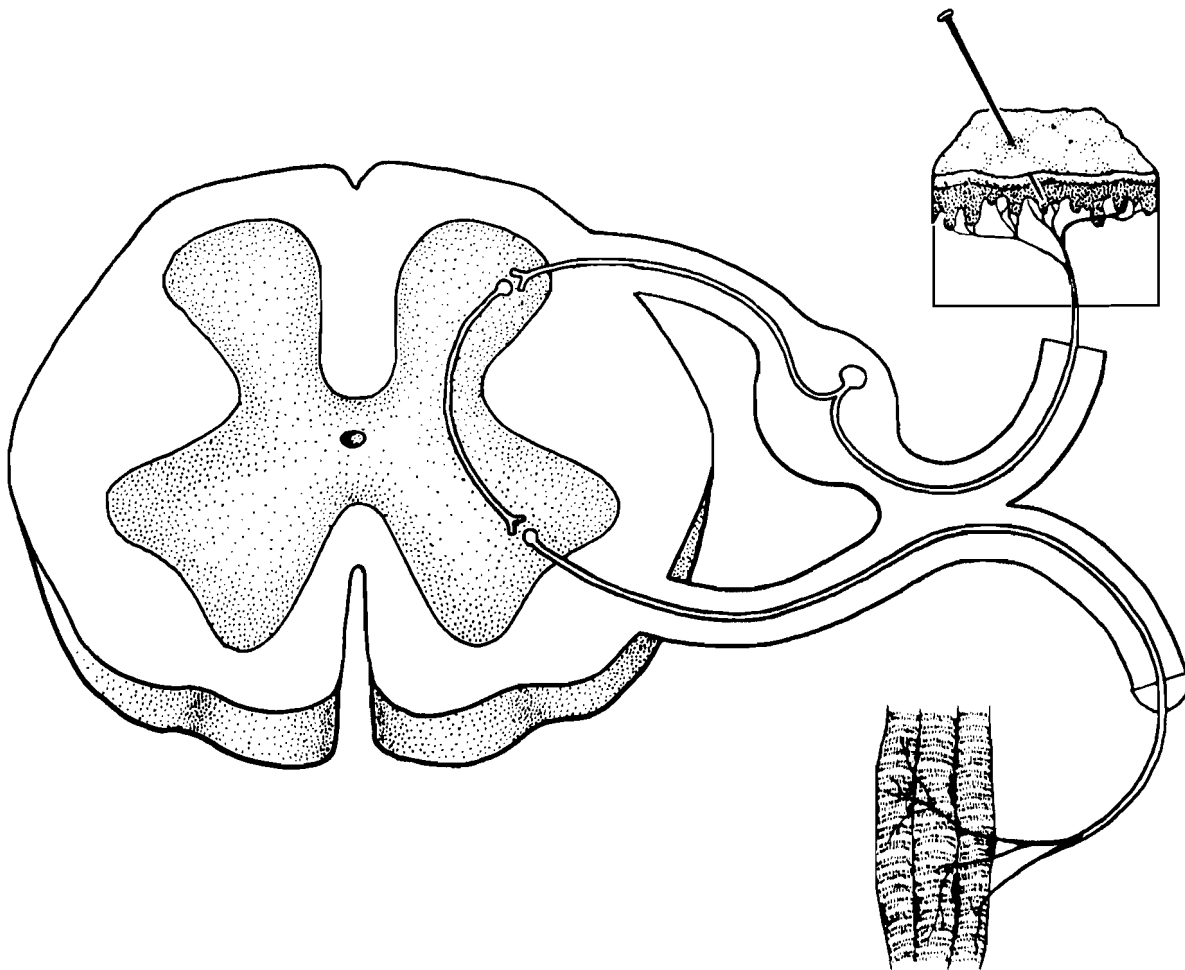


Figure 7–2

- 16.** Figure 7-3 is a diagram of the right lateral view of the human brain. First, match the letters on the diagram with the following list of terms and insert the appropriate letters in the answer blanks. Then, select different colors for each of the areas of the brain provided with a color-coding circle and use them to color in the coding circles and corresponding structures in the diagram. If an identified area is part of a lobe, use the color you selected for the lobe but use *stripes* for that area.

- | | |
|--|--|
| _____ 1. <input type="radio"/> Frontal lobe | _____ 7. <input type="radio"/> Lateral sulcus |
| _____ 2. <input type="radio"/> Parietal lobe | _____ 8. <input type="radio"/> Central sulcus |
| _____ 3. <input type="radio"/> Temporal lobe | _____ 9. <input type="radio"/> Cerebellum |
| _____ 4. <input type="radio"/> Precentral gyrus | _____ 10. <input type="radio"/> Medulla |
| _____ 5. <input type="radio"/> Parieto-occipital fissure | _____ 11. <input type="radio"/> Occipital lobe |
| _____ 6. <input type="radio"/> Postcentral gyrus | _____ 12. <input type="radio"/> Pons |

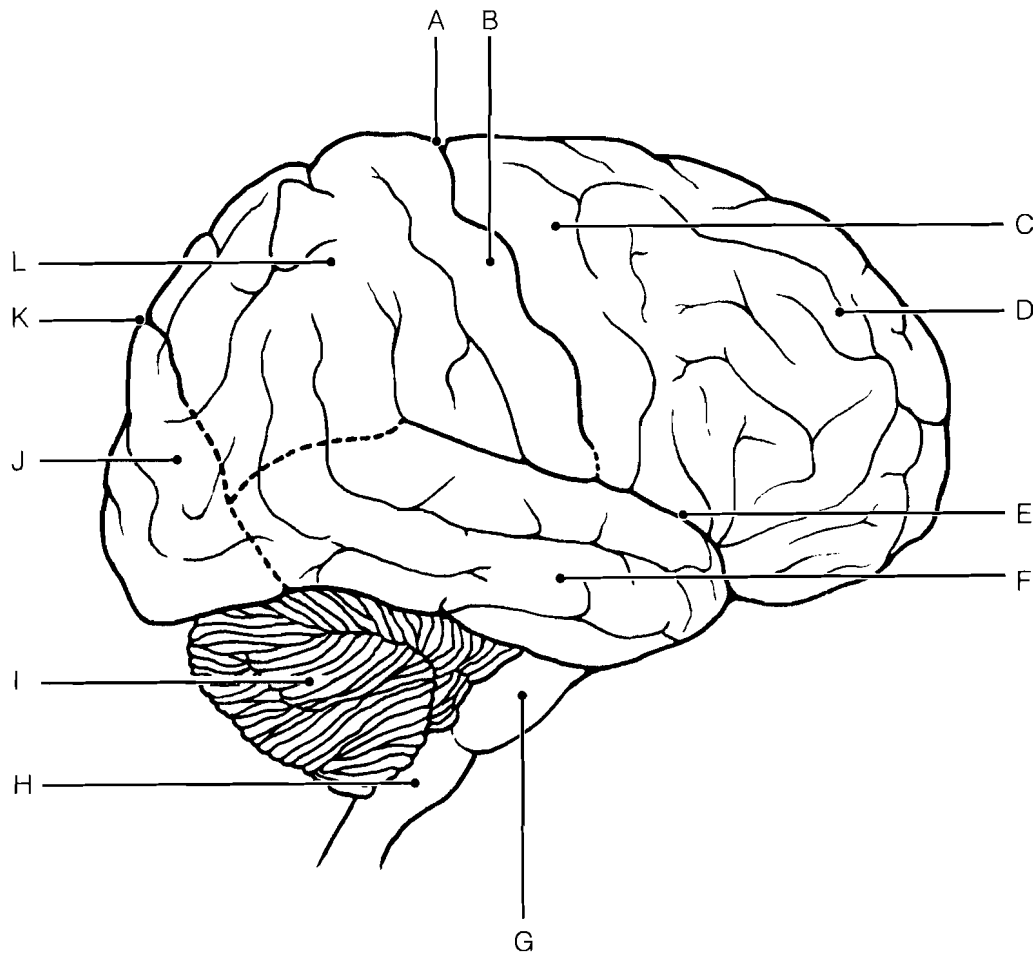


Figure 7-3

- 17.** Figure 7-4 is a diagram of the sagittal view of the human brain. First, match the letters on the diagram with the following list of terms and insert the appropriate letter in each answer blank. Then, color the brain-stem areas blue and the areas where cerebrospinal fluid is found yellow.

- | | |
|-------------------------------|-----------------------------|
| _____ 1. Cerebellum | _____ 9. Mammillary body |
| _____ 2. Cerebral aqueduct | _____ 10. Medulla oblongata |
| _____ 3. Cerebral hemisphere | _____ 11. Optic chiasma |
| _____ 4. Cerebral peduncle | _____ 12. Pineal body |
| _____ 5. Choroid plexus | _____ 13. Pituitary gland |
| _____ 6. Corpora quadrigemina | _____ 14. Pons |
| _____ 7. Corpus callosum | _____ 15. Thalamus |
| _____ 8. Fourth ventricle | |

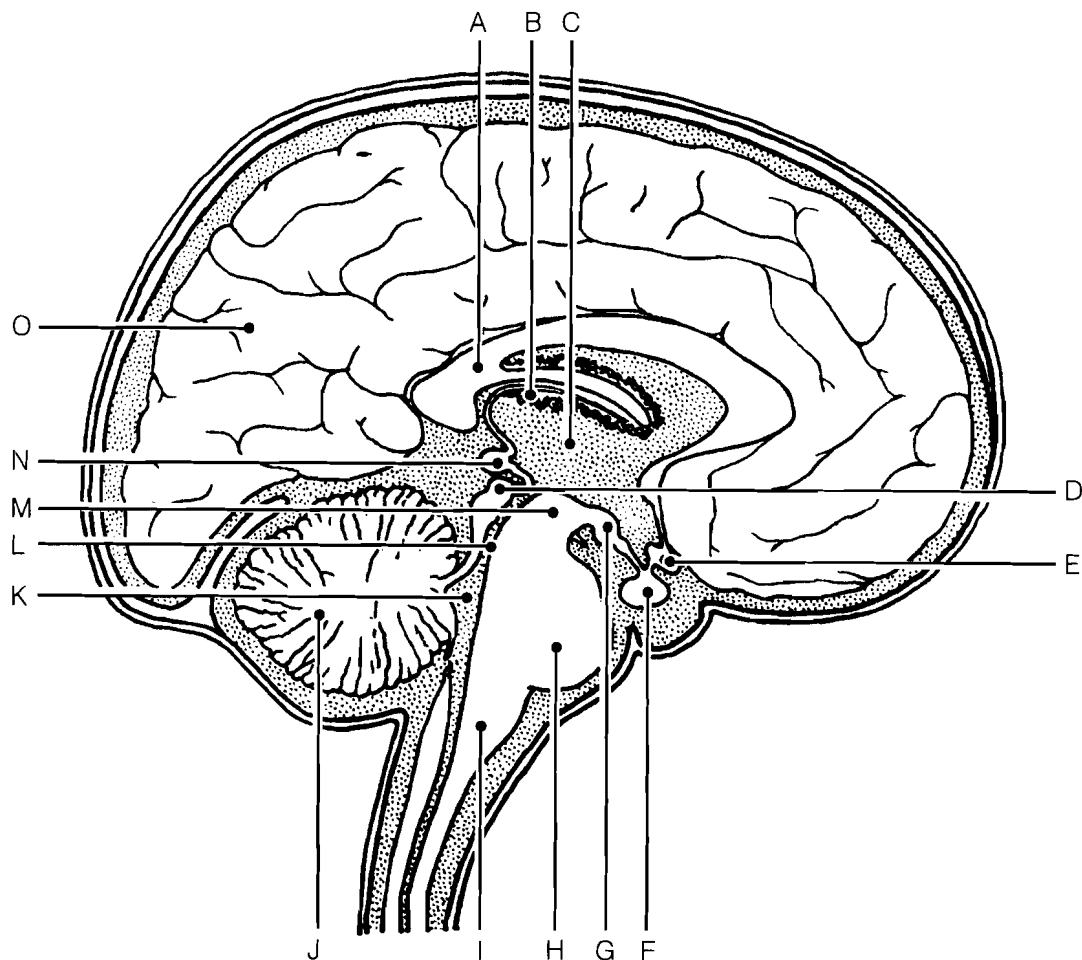


Figure 7-4

- 18.** Referring to the brain areas listed in Exercise 17, match the appropriate brain structures with the following descriptions. Insert the correct terms in the answer blanks.

- | | |
|-------|---|
| _____ | 1. Site of regulation of water balance and body temperature |
| _____ | 2. Contains reflex centers involved in regulating respiratory rhythm in conjunction with lower brain-stem centers |
| _____ | 3. Responsible for the regulation of posture and coordination of skeletal muscle movements |
| _____ | 4. Important relay station for afferent fibers traveling to the sensory cortex for interpretation |
| _____ | 5. Contains autonomic centers, which regulate blood pressure and respiratory rhythm, as well as coughing and sneezing centers |
| _____ | 6. Large fiber tract connecting the cerebral hemispheres |
| _____ | 7. Connects the third and fourth ventricles |
| _____ | 8. Encloses the third ventricle |
| _____ | 9. Forms the cerebrospinal fluid |
| _____ | 10. Midbrain area that is largely fiber tracts; bulges anteriorly |
| _____ | 11. Part of the limbic system; contains centers for many drives (rage, pleasure, hunger, sex, etc.) |

- 19.** Some of the following brain structures consist of gray matter; others are white matter. Write G (for gray) or W (for white) as appropriate.

- | | |
|-------------------------------|------------------------------|
| _____ 1. Cortex of cerebellum | _____ 5. Pyramids |
| _____ 2. Basal nuclei | _____ 6. Thalamic nuclei |
| _____ 3. Anterior commissure | _____ 7. Cerebellar peduncle |
| _____ 4. Corpus callosum | |

Protection of the CNS

22. Identify the meningeal (or associated) structures described here.

- _____ 1. Outermost covering of the brain, composed of tough fibrous connective tissue
- _____ 2. Innermost covering of the brain; delicate and vascular
- _____ 3. Structures that return cerebrospinal fluid to the venous blood in the dural sinuses
- _____ 4. Middle meningeal layer; like a cobweb in structure
- _____ 5. Its outer layer forms the periosteum of the skull

23. Figure 7-6 shows a frontal view of the meninges of the brain at the level of the superior sagittal (dural) sinus. First, label the *arachnoid villi* on the figure. Then, select different colors for each of the following structures and use them to color the coding circles and corresponding structures in the diagram.

- | | |
|---------------------------------------|--|
| <input type="radio"/> Dura mater | <input type="radio"/> Pia mater |
| <input type="radio"/> Arachnoid mater | <input type="radio"/> Subarachnoid space |

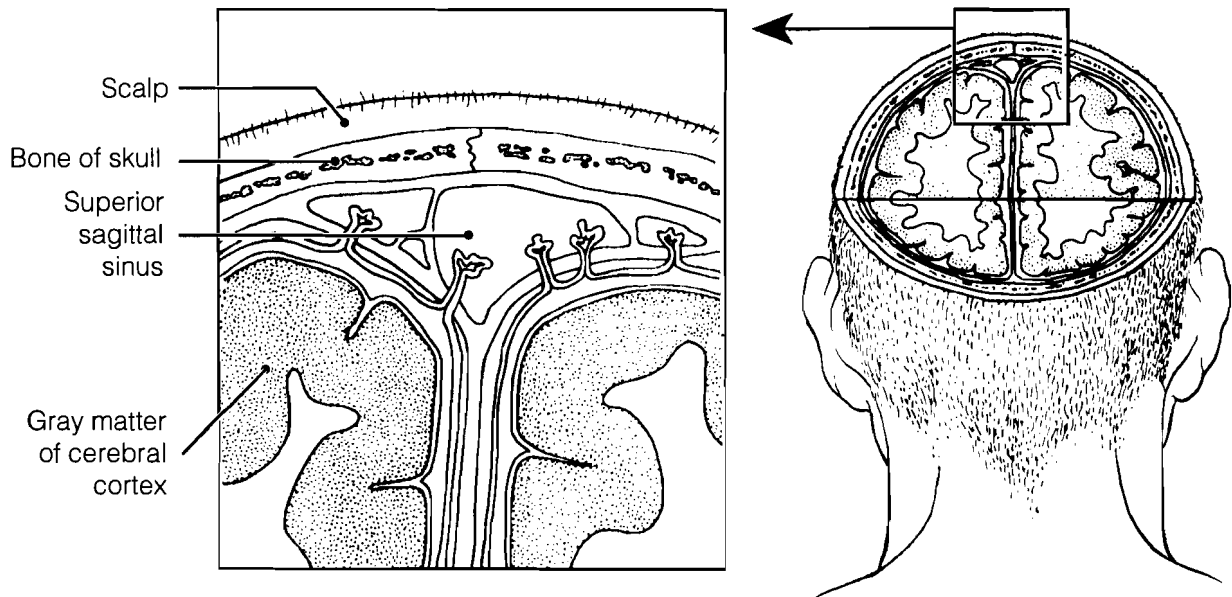


Figure 7-6

- 28.** Figure 7–7 is a cross-sectional view of the spinal cord. First identify the areas listed in the key choices by inserting the correct letters next to the appropriate leader lines on parts A and B of the figure. Then, color the bones of the vertebral column in part B gold.

Key Choices

- | | | |
|----------------------------|-------------------------|-----------------|
| A. Central canal | E. Dorsal root | I. Ventral horn |
| B. Columns of white matter | F. Dorsal root ganglion | J. Ventral root |
| C. Conus medullaris | G. Filum terminale | |
| D. Dorsal horn | H. Spinal nerve | |

On part A, color the butterfly-shaped gray matter gray, and color the spinal nerves and roots yellow. Finally, select different colors to identify the following structures and use them to color the figure.

- | | | |
|---------------------------------|----------------------------------|---------------------------------------|
| <input type="radio"/> Pia mater | <input type="radio"/> Dura mater | <input type="radio"/> Arachnoid mater |
|---------------------------------|----------------------------------|---------------------------------------|

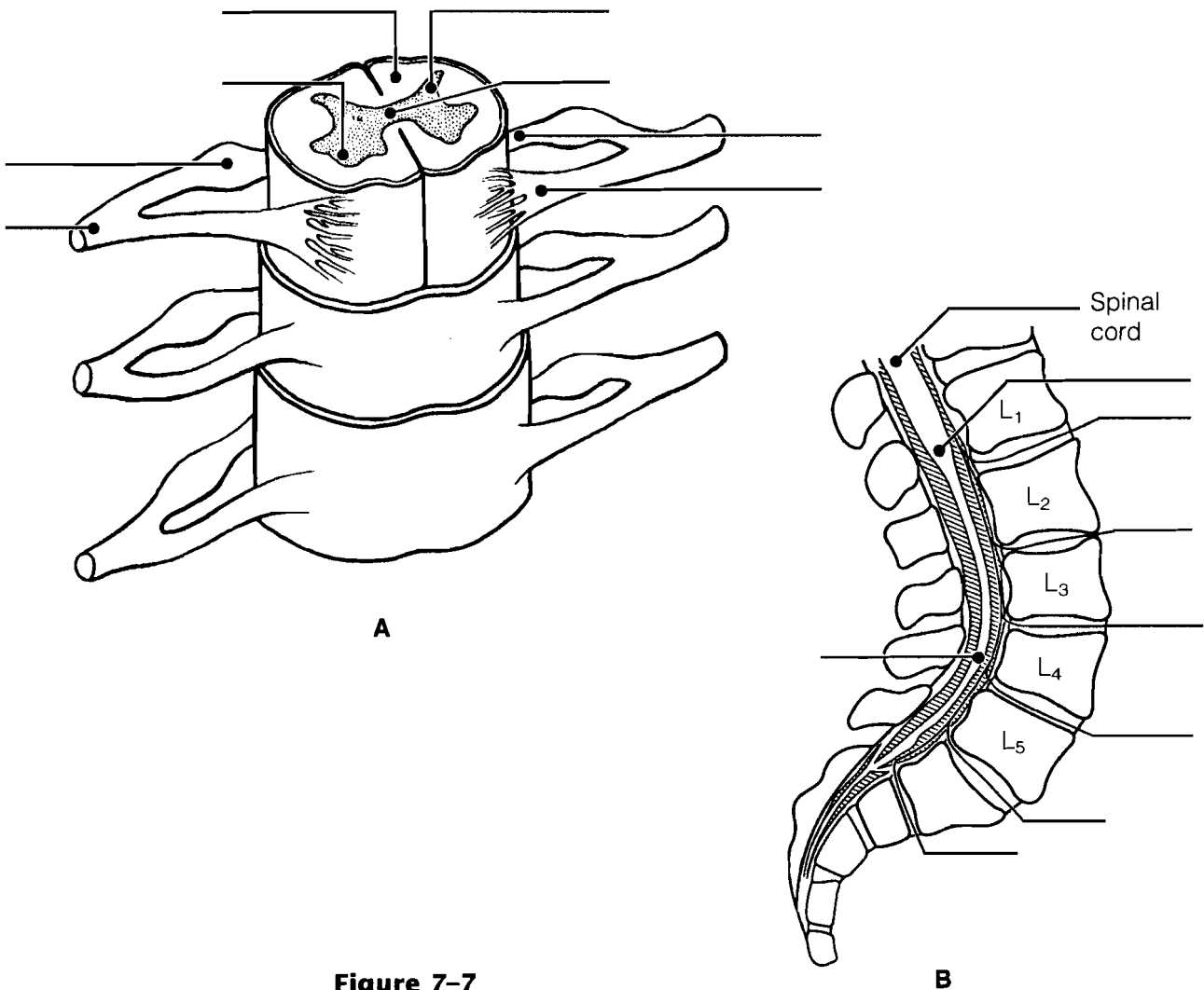


Figure 7–7

44. Application of knowledge: You have been given all of the information needed to identify the brain regions involved in the following situations. See how well your nervous system has integrated this information, and name the brain region (or condition) most likely to be involved in each situation. Place your responses in the answer blanks.

1. Following a train accident, a man with an obvious head injury was observed stumbling about the scene. An inability to walk properly and a loss of balance were quite obvious. What brain region was injured?

2. An elderly woman is admitted to the hospital to have a gallbladder operation. While she is being cared for, the nurse notices that she has trouble initiating movement and has a strange “pill-rolling” tremor of her hands. What cerebral area is most likely involved?

3. A child is brought to the hospital with a high temperature. The doctor states that the child’s meninges are inflamed. What name is given to this condition?

4. A young woman is brought into the emergency room with extremely dilated pupils. Her friends state that she has overdosed on cocaine. What cranial nerve is stimulated by the drug?

5. A young man has just received serious burns, resulting from standing with his back too close to a bonfire. He is muttering that he never felt the pain. Otherwise, he would have smothered the flames by rolling on the ground. What part of his CNS might be malfunctioning?

6. An elderly gentleman has just suffered a stroke. He is able to understand verbal and written language, but when he tries to respond, his words are garbled. What cortical region has been damaged by the stroke?

7. A 12-year-old boy suddenly falls to the ground, having an epileptic seizure. He is rushed to the emergency room of the local hospital for medication. His follow-up care includes a recording of his brain waves to try to determine the area of the lesion. What is this procedure called?
