CHAPTER 10
NERVOUS SYSTEM I: BASIC STRUCTURE AND FUNCTION

OVERVIEW
The body uses two systems to coordinate and integrate the functions of body systems so that the internal environment remains stable. These systems are the nervous system and the endocrine system. Chapter 10 begins with a discussion of the general functions of the nervous system, the types of cells that comprise nervous tissue, and the two major groups of nervous system organs (Learning Outcomes 1-3). The chapter continues with discussion of sensory receptors and how they respond to stimuli (Learning Outcomes 4-5). The chapter continues with a detailed discussion of neurons and their component parts and the classification of nervous system cells in both the central and peripheral nervous systems (Learning Outcomes 6-12). Finally, the processes of impulse conduction conclude this chapter on the structure and function of the nervous system (Learning Outcomes 13-18).

LEARNING OUTCOMES
After you have studied this chapter, you should be able to:

10.1 Introduction (p. 354)
1. Describe the general functions of the nervous system.
2. Identify the two types of cells that comprise nervous tissue.
3. Identify the two major groups of nervous system organs.

10.2 General Functions of the Nervous System (p. 355)
4. List the functions of sensory receptors.
5. Describe how the nervous system responds to stimuli.

10.3 Description of Cells of the Nervous System (p. 356)
6. Describe the parts of a neuron.
7. Describe the relationships among myelin, the neurilemma, and nodes of Ranvier.
8. Distinguish between the sources of white matter and gray matter.

10.4 Classification of Cells of the Nervous System (p. 359)
10. Identify the types of neuroglia in the central nervous system and their functions.
11. Describe the Schwann cells in the peripheral nervous system.

10.5 The Synapse (p. 365)
12. Explain how information passes from a presynaptic neuron to a postsynaptic cell.

10.6 Cell Membrane Potential (p. 365)
13. Explain how a cell membrane becomes polarized.
14. Describe the events leading to the conduction of a nerve impulse.
15. Compare nerve impulse conduction in myelinated and unmyelinated neurons.

10.7 Synaptic Transmission (p. 371)
16. Identify the changes in membrane potential associated with excitatory and inhibitory neurotransmitters.
17. Explain what prevents a postsynaptic cell from being continuously stimulated.

10.8 Impulse Processing (p. 374)
18. Describe the basic ways in which the nervous system processes information.

FOCUS QUESTION
How is the nervous system organized at the cellular level to coordinate and integrate the functions of the other body systems?

MASTERY TEST
Now take the mastery test. Do not guess. Some questions may have more than one correct answer. As soon as you complete the test, correct it. Note your successes and failures so that you can read the chapter to meet your learning needs.

1. The two basic types of cells found in neural tissue are _______ and _______ cells.
2. Nerves are bundles of
   a. axons.
   b. dendrites.
   c. axons and dendrites.

93
3. The functions of neuroglia include
   a. support of neurons.
   b. filling spaces.
   c. sending and receiving messages.
   d. all of the above
4. The small spaces between neurons are called _______________.
5. Electrochemical messages are carried across synapses by _______________.
6. The nervous system is composed of two groups of organs called the _______________ nervous system and the _______________ nervous system.
7. Monitoring such phenomena as light, sound, and temperature is a _______________ function of the nervous system.
8. The peripheral nervous system has two parts: the _______________ nervous system and the _______________ nervous system.
9. The basic unit of structure and function of the nervous system is the _______________.
10. Another name for the cell body of a neuron is the _______________ or _______________.
11. The cells that give rise to new neural tissues are _______________ _______________.
12. Which of the following structures is not common to all nerve cells?
   a. cell body
   b. axon
   c. dendrite
   d. Schwann cells
13. The structure that carries impulses away from the cell body of the neuron is the
   a. dendrite.
   b. neurofibril.
   c. axon.
   d. neurilemma.
14. The neurilemma is composed of
   a. Nissl bodies.
   b. myelin.
   c. the cytoplasm and nuclei of Schwann cells.
   d. neuron cell bodies.
15. The type of neuron that lies totally within the central nervous system is the
   a. sensory neuron.
   b. motor neuron.
   c. interneuron.
   d. unipolar neuron.
16. The supporting framework of the nervous system is composed of
   a. neurons.
   b. dendrites.
   c. neuroglial cells.
   d. myelin.
17. The neuroglial cells that can phagocytize bacterial cells and increase when there is inflammation of the brain or spinal cord are
   a. astrocytes.
   b. oligodendrocytes.
   c. microglia.
   d. ependyma.
18. Which of the following injuries to nervous tissue can be repaired?
   a. damage to a cell body
   b. damage to nerve fibers that have myelin sheaths
   c. damage to nerve fibers that have a neurilemma
   d. Nerve damage cannot be repaired.
19. The neuron that brings an impulse to the synapse is a _______________ neuron.
20. The difference in electrical charge between the inside and the outside of the membrane in the resting nerve cell is called the _______________.
21. The difference in electrical charge between the inner and outer surfaces of the cell membrane is its _______________.
22. The propagation of action potentials along a fiber is called
   a. a threshold potential.
   b. repolarization.
   c. a nerve impulse.
   d. a sensation.
23. The period of total depolarization of the neuron membrane when the neuron cannot respond to a second stimulus is called the _______________ period.
24. The refractory period acts to limit the
   a. intensity of nerve impulses.
   b. rate of conduction of nerve impulses.
   c. permeability of nerve cell membranes.
   d. excitability of nerve fibers.
25. In which type of fiber is conduction faster?
   a. myelinated
   b. unmyelinated

26. A decrease in calcium ions below normal limits will
   a. facilitate the movement of sodium across the cell membrane.
   b. inhibit the movement of sodium across the cell membrane.
   c. facilitate the movement of potassium across the cell membrane.
   d. inhibit the movement of potassium across the cell membrane.

27. The neurotransmitter that stimulates the contraction of skeletal muscles is
   a. dopamine.
   b. acetylcholine.
   c. gamma-aminobutyric acid.
   d. encephalins.

28. The amount of neurotransmitter released at a synapse is controlled by
   a. calcium.
   b. sodium.
   c. potassium.
   d. magnesium.

29. Continuous stimulation of a neuron on the distal side of this junction is prevented by
   a. exhaustion of the nerve fiber.
   b. the chemical instability of neurotransmitters.
   c. enzymes within the neural junction.
   d. rapid depletion of ionized calcium.

30. Neuropeptides that are synthesized by the brain and spinal cord in response to pain are __________.

31. The process that allows coordination of incoming impulses that represent information from a variety of receptors is called __________.

32. Axons originating from different parts of the nervous system leading to the same neuron exhibit __________.

33. The process by which an impulse from a single neuron may be amplified by spreading to other neurons is __________.

STUDY ACTIVITIES

Definition of Word Parts (p. 353)

Define the following word parts used in this chapter.
  astr-
  ax-
  bi-
  dendr-
  ependym-
  -lemm
  moto-
  multi-
  oligo-
  peri-
  saltator-
  sens-
  syn-
  uni-
10.1 Introduction (p. 354)
A. When the nervous system detects changes in the body it can stimulate ___________ and ___________ to respond.
B. 1. Name the two types of cells that make up neural tissue.
2. Structures that bring input to the cell bodies are ___________; information is carried away from the neuron by (a/an) ___________.
3. Nerves are comprised of (axons/dendrites).
4. The space between a neuron and the cell with which it communicates is a ___________.
C. Name the two divisions of the nervous system and list their component parts.

10.2 General Functions of the Nervous System (p. 355)
A. What are the three general functions of the nervous system?
B. 1. Where are sensory receptors located?
2. What is the function of sensory receptors?
3. In what part of the nervous system are sensory receptors integrated and interpreted?
C. Effectors are (inside/outside) the nervous system.
D. 1. Conscious control of activities is overseen by the ___________ nervous system.
2. Involuntary control of body activities is characteristic of the ___________ nervous system.

10.3 Description of Cells of the Nervous System (p. 356)
A. Label the structures that are identified by numbers in the following drawing of motor neurons.
B. Match the parts of a neuron in the first column with the correct description in the second column.

1. neurofibrils  
2. Nissl bodies  
3. dendrites  
4. axon  
5. Schwann cells

a. slender fiber that carries impulses away from the cell body; this fiber may give off collaterals
b. membranous sacs in the cytoplasm associated with the manufacture of protein molecules
c. cells of the myelin sheath
d. network of fine threads that extend into nerve fibers
e. highly branched to provide receptor surfaces to which processes from other neurons can communicate

C. Describe how Schwann cells make up the myelin sheath and the neurilemma on the outsides of nerve fibers.

D. What is the composition of white matter in the brain and spinal cord? Of gray matter?

10.4 Classification of Cells of the Nervous System (p. 359)

A. What are two ways in which neurons are classified?

B. Describe each kind of neuron and its location.
   bipolar
   unipolar
   multipolar

C. The neurons in section B are classified according to ________________.

D. Describe each kind of neuron and its location.
   sensory neuron
   interneuron
   motor neuron
E. Fill in the following chart.

### Neuroglial Cells

<table>
<thead>
<tr>
<th>Cell</th>
<th>Location</th>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astrocytes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oligodendrocytes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microglia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ependyma</td>
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<td></td>
</tr>
</tbody>
</table>

F. When during pregnancy does myelin begin to form?

G. Describe the regeneration of nerve fibers. Include a description of a neuroma.

### 10.5 The Synapse (p. 365)

A. Label the numbered structures in the accompanying drawing of a synapse.

B. How does a neurotransmitter initiate depolarization? (Include the role of both the presynaptic and the postsynaptic neuron membranes.)
10.6 Cell Membrane Potential (p. 365)

A. Describe membrane potential, resting potential, and action potential. Which of these events is a nerve impulse?

B. What happens when a threshold potential is reached?

C. How would hyperpolarization affect the threshold potential?

D. Answer the following concerning impulse conduction.
   1. How do the nodes of Ranvier affect nerve impulse conduction? What kind of conduction is this called?

   2. Define refractory period, absolute refractory period, relative refractory period, and all-or-none response in neurons.

   3. What is the result of increasing the permeability of the cell membrane to sodium? Of decreasing the permeability?

   4. How does calcium affect nerve impulse conduction?

10.7 Synaptic Transmission (p. 371)

A. How do excitatory potentials and inhibitory potentials differ?

B. List the substances that act as neurotransmitters.

C. How is transmission across the synapse halted?

D. What are neuropeptides and what is their function?

10.8 Impulse Processing (p. 374)

A. What is a neuronal pool?

B. Explain the relationship between neuronal pools and facilitation, convergence and divergence.
C. Answer the following questions about addiction and the role of receptors.
   1. Briefly describe the history of addiction.

   2. Define addiction.

   3. Describe the role of neurotransmitters and their receptors in the development of addiction.

**Clinical Focus Question**

Jack, age 24, amputated his finger while cutting the lawn two days ago. The amputated part was brought to the hospital and reattached using microsurgery techniques. Jack is very angry as you meet him this morning. He explains that the surgeon was quite sure that the surgery would be successful but he still has no sensation in the finger. What would you tell Jack?

When you have completed the study activities to your satisfaction, retake the mastery test. If there are still some areas you do not understand, repeat the appropriate study activities.