CHAPTER 8 READING QUESTIONS

These reading questions are designed to help you focus your reading on the most important points in the chapter. They are arranged using chapter section headers so that the file can be easily edited to reflect the material covered in class.

8.1 ORGANIZATION OF THE NERVOUS SYSTEM

1. Briefly describe the following components of the nervous system:

central nervous system

peripheral nervous system

sensory neurons (afferent)

efferent neurons

somatic motor division

autonomic nervous division

sympathetic branch

parasympathetic branch

enteric nervous system

8.2 CELLS OF THE NERVOUS SYSTEM

2. Name the two primary cell types found in the nervous system.

Neurons Carry Electrical Signals

3. Describe and illustrate a model neuron. (Fig. 8.2f)

4. The functional classification separates neurons into three groups: sensory (afferent)

neurons, interneurons, and efferent neurons. Compare and contrast these functional groups.

The Cell Body Is the Control Center

5. Describe a neuron cell body (soma). What would the extensive cytoskeleton suggest about functions of neurons?

Dendrites Receive Incoming Signals

6. Describe the structure and function of dendrites. (Figs. 8.2f, 8.24)

7. How is dendritic function different in the CNS than in the PNS?

Axons Carry Outgoing Signals

8. Briefly describe the primary function of a neuron.

9. Distinguish between slow axonal transport and fast axonal transport. Identify purposes and mechanisms for each. (Fig. 8.3)

Establishing Synapses Depends on Chemical Signals

10. Identify the components of a synapse. (Fig. 8.2f)

11. How do embryonic nerve cells establish synapses with the correct targets, and what must happen in order for new synapses to survive? (Fig. 8.4)

Glial Cells Provide Support for Neurons

12. Are there more neurons or glial cells in the nervous system?

13. What are the two main types of glial cells in the PNS? What are the four types of glial cells in the CNS? (Fig. 8.5)

Myelin-Forming Glia

14. What is myelin? Why is it important? (Fig. 8.5b)

15. Which glial cells form myelin in the CNS? Which ones form myelin in the PNS? (Fig. 8.5b–d)

Schwann Cells

16. What are nodes of Ranvier? (Fig. 8.5c)

Satellite Cells

17. What do satellite cells do? (Fig. 8.5a)

Astrocytes

18. Describe astrocytes and identify their roles in the CNS. (Fig. 8.5a, b)

Microglia

19. Describe microglia and identify their roles in the CNS. (Fig. 8.5a, b)

Ependymal Cells

20. Describe ependymal cells and identify their roles in the CNS. (Fig. 8.5a, b)

Can Stem Cells Repair Damaged Neurons?

21. Describe the cellular events that follow damage to a neuron. (Fig. 8.6)
22. Contrast injury and repair in CNS neurons and PNS neurons.
23. What are neural stem cells? Why could they be important in treating neural injuries and degenerative diseases?

8.3 Electrical Signals in Neurons

The Nernst Equation Predicts Membrane Potential for a Single Ion

24. What two factors influence membrane potential?
25. Why is the Nernst equation ineffective for determining the resting membrane potential of neurons?

The GHK Equation Predicts Membrane Potential Using Multiple Ions

26. Which three ions are most influential in creating the membrane potential in resting cells? Write out the GHK equation for these three ions. (Tbl. 8.2)

Ion Movement Creates Electrical Signals

27. For a neuron, a sudden increase in Na^+ permeability would favor Na^+ movement _____ (into or out of?) the cell. When Na^+ moves in this case, it is moving _____ (down or against?) its concentration gradient and _____ (down or against?) its electrical gradient.
28. Depolarization implies that a cell's membrane potential has become more _____ (negative or positive?) as a result of ion movement.
29. Describe two examples of how ion movement can hyperpolarize a cell.

Gated Channels Control the Ion Permeability of the Neuron

30. How does a cell change its ion permeability?
31. How are ion channels classified? Name four types of selective ion channels in the neuron.
32. For each of the following types of gated channels, identify the stimuli that cause them to open or close:

    mechanically gated ion channels

    chemically gated ion channels

    voltage-gated ion channels
33. Describe variations in ion channel behavior.

Current Flow Obeys Ohm's Law

34. The direction of ion movement depends on the _____ gradient of the ion.

35. Mathematically, Ohm's Law states: I = V/R. Briefly describe its meaning in words and identify all variables. What biological factors contribute to electrical resistance in neurons?

36. Distinguish between graded potentials and action potentials. (Tbl. 8.3)

Graded Potentials Reflect Stimulus Strength

37. Why are graded potentials called "graded"? How are graded potentials initiated?

38. What is local current flow?

39. Why do graded potentials lose strength as they move through the cytoplasm?

40. Describe what happens when:

    a. a subthreshold graded potential reaches the trigger zone

    b. a suprathreshold graded potential reaches the trigger zone

Action Potentials Travel Long Distances

41. Do action potentials lose strength as they are conducted through the axon? Why or why not? (Fig. 8.8)

42. Why are action potentials called all-or-none phenomena?

Na^+ and K^+ Move across the Membrane during Action Potentials

43. Identify the ion channel types required for conduction of an action potential.

44. Identify the three phases of an action potential. (Fig. 8.9)

Rising Phase of the Action Potential

45. Diagram the events of the rising phase of an action potential. Include relevant ions, ion channels, changes to membrane potential, electrochemical gradients, and direction of ion movement. (Fig. 8.9)

Falling Phase of the Action Potential

46. Diagram the events of the falling phase of an action potential. Include relevant ions, ion channels, changes to membrane potential, electrochemical gradients, and direction of ion movement. (Fig. 8.9)
47. What causes the after-hyperpolarization phase of the action potential?

One Action Potential Does Not Alter Ion Concentration Gradients

48. What membrane transporter maintains sodium and potassium concentrations across a nerve cell membrane?

Axonal Na^+ Channels Have Two Gates

49. Diagram the changes in Na^+ channel activation and inactivation gates as a depolarizing stimulus is conducted along an axon. (Fig. 8.10)
50. How does axonal depolarization represent a positive feedback loop? What act of outside intervention breaks this positive feedback loop? (Fig. 8.11)

Action Potentials Will Not Fire during the Absolute Refractory Period

51. Distinguish between the absolute refractory period and the relative refractory period. Indicate the roles of the various ion channels in each. (Fig. 8.12)

Action Potentials Are Conducted

52. Explain how local current flow is related to the conduction of an AP in an axon. Why does AP strength *not* diminish along the length of the axon? Why is an AP conducted in only one direction, even though backward flow of current is possible? (Figs. 8.13, 8.14)

Conduction Is Faster in Myelinated Axons

53. What physical properties are affected by myelin so that the result is increased speed of conduction in an axon? (Also see the Biotechnology box *The Body's Wiring*.)

54. Diagram saltatory conduction in axons. (Fig. 8.16)

Chemical Factors Alter Electrical Activity

55. Describe changes in neuron excitability that result from hypokalemia and hyperkalemia. (Fig. 8.17)

8.4 Cell-to-Cell Communication in the Nervous System

Neurons Communicate at Synapses

56. Distinguish between electrical synapses and chemical synapses.

Neurons Secrete Chemical Signals

57. Differentiate between the following terms: neurotransmitter, neuromodulator, and neurohormone.

Neurocrine Receptors

58. Contrast ionotropic receptors with GPCRs.

Neurotransmitters Are Highly Varied

59. The CNS can release a variety of neurocrines, but the PNS secretes only three major ones: _____ and _____ (neurotransmitters) and _____ (a neurohormone). (Tbl. 8.4)

60. Fill in the details in the following table to distinguish the major neurocrine molecules you will encounter in this textbook. Note: This is not an exhaustive list but rather a list of representative examples. This table will be similar to Table 8.4 but not identical.

Neurocrine class	**Neurocrine molecules**	**Receptor**	**Subtypes**	**Receptor category**
Acetylcholine	Acetylcholine			
Amines	Norepinephrine (NE)			
	Dopamine (DA)		N/A	
	Serotonin (5-HT)	Serotonergic (5-HT)	N/A	
	Histamine	Histamine (H)	N/A	GPCR
Amino acids	Glutamate			
			N/A	
	GABA		N/A	
	Glycine		N/A	

Neurocrine class	**Neurocrine molecules**	**Receptor**	**Subtypes**	**Receptor category**
Peptides	Substance P, enkephalins, endorphins	**not covered at this time**		
Purines	Adenosine		N/A	
Gases	Nitric oxide (NO)	N/A	N/A	N/A
Lipids	Eicosanoids	Cannabinoid		GPCR

Neurotransmitter Synthesis

61. Contrast the synthesis of polypeptide neurotransmitters with the synthesis of smaller neurotransmitters such as ACh, amines, and purines. Where in the neuron does synthesis take place? Are there organelles involved? How do neurotransmitters get to the presynaptic axon terminal?

Neurotransmitter Release

62. Diagram the Ca^{2+}-dependent exocytosis that releases neurotransmitter at the synapse. (Fig. 8.19a)

63. How does the kiss-and-run pathway of neurotransmitter release compare to the classic exocytosis model?

Termination of Neurotransmitter Activity

64. List and describe the ways neurotransmitter activity can be terminated. (Figs. 8.19b, 8.20)

8.5 Integration of Neural Information Transfer

65. Distinguish between divergence and convergence. (Fig. 8.22 *Essentials: Divergence and Convergence*)

66. What is synaptic plasticity? List some ways neurons can influence activity at the synapse.

Postsynaptic Responses May Be Slow or Fast

67. Contrast the mechanisms behind slow synaptic potentials and fast synaptic potentials.

68. Regardless of "fast" or "slow" mechanisms:

    If the synaptic potential is depolarizing, it is called a(n) _____.

    If the synaptic potential is hyperpolarizing, it is called a(n) _____.

Pathways Integrate Information from Multiple Neurons

69. Distinguish between spatial summation and temporal summation. Describe how multiple signals must be integrated into the postsynaptic cell's response.

Synaptic Activity Can Be Modified

70. Contrast the effects of presynaptic modulation with the effects of postsynaptic modulation. Remember, modulation can be excitatory or inhibitory. (Figs. 8.23, 8.24)

Long-Term Potentiation Alters Synapses

71. Diagram the glutamate-based mechanism involved in long-term potentiation (LTP). (Fig. 8.25)

72. Based on current information, describe the processes that seem to bring about long-term depression (LTD).