Chapter 2: Communication within the Nervous System

Test Bank

Multiple Choice

1. _____ are one of the cell types composing the nervous system.
a. Soma
b. Neurons
c. Mitochondria
d. Myelin
Ans: B
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: The Cells That Make Us Who We Are
Difficulty Level: Easy

2. William, a philosophy major, asked Ian the psychology major what type of cell contributes the most to Ian's "being" who he is. Without hesitation, Ian replied _____.
a. somatic cells
b. blood cells
c. neurons
d. axons
Ans: C
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Comprehension
Answer Location: The Cells That Make Us Who We Are
Difficulty Level: Medium

3. Cells that convey environmental information, carry out the functions underlying thought, emotion, and movements, and transmit commands out to the body's organs and muscles are called _____.
a. neurons
b. dendrites
c. phagocytes
d. glia
Ans: A
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: The Cells That Make Us Who We Are
Difficulty Level: Easy

4. _____ neurons control movements and actions of organs.
a. Phasic

b. Inter-
c. Sensory
d. Motor
Ans: D
Learning Objective: 2-3: Compare the functions of sensory, motor, and interneurons
Cognitive Domain: Knowledge
Answer Location: Basic Structure: The Motor Neuron
Difficulty Level: Easy

5. The largest part of a neuron is the _____.
a. soma
b. axon
c. terminal
d. dendritic process
Ans: A
Learning Objective: 2-2: Name the structures of neurons
Cognitive Domain: Knowledge
Answer Location: Basic Structure: The Motor Neuron
Difficulty Level: Easy

6. The part of a neuron that contains the nucleus is called the _____.
a. axon
b. soma
c. dendrite
d. mitochondria
Ans: B
Learning Objective: 2-2: Name the structures of neurons
Cognitive Domain: Knowledge
Answer Location: Basic Structure: The Motor Neuron
Difficulty Level: Easy

7. The soma of a neuron contains the _____.
a. glial material
b. neural receptors
c. axons
d. nucleus
Ans: D
Learning Objective: 2-2: Name the structures of neurons
Cognitive Domain: Knowledge
Answer Location: Basic Structure: The Motor Neuron
Difficulty Level: Easy

8. The part of a neuron that transmits information over long distances is the _____.
a. soma
b. axon
c. dendrite

d. synapse
Ans: B
Learning Objective: 2-2: Name the structures of neurons
Cognitive Domain: Knowledge
Answer Location: Basic Structure: The Motor Neuron
Difficulty Level: Easy

9. The dendrites of a neuron _____.
a. transmit information to the cell body
b. provide the life processes of the cell
c. transmit neural impulses to the terminal buttons
d. release neurotransmitters
Ans: A
Learning Objective: 2-2: Name the structures of neurons
Cognitive Domain: Knowledge
Answer Location: Basic Structure: The Motor Neuron
Difficulty Level: Easy

10. Which of the following is true of the axons of neurons?
a. They end in swellings known as terminals.
b. They control the life processes of the cell.
c. They insulate the brain's electrical signals.
d. They contain the cell's nucleus.
Ans: A
Learning Objective: Knowledge
Cognitive Domain: 2-2: Name the structures of neurons
Answer Location: Basic Structure: The Motor Neuron
Difficulty Level: Easy

11. _____ are released from axon terminals and are detected by protein receptors on an adjacent neuron.
a. Hormones
b. Neurotoxins
c. Neurotransmitters
d. Pheromones
Ans: C
Learning Objective: 2-2: Name the structures of neurons
Cognitive Domain: Knowledge
Answer Location: Basic Structure: The Motor Neuron
Difficulty Level: Easy

12. Which of the following is true of axon terminals of neurons?
a. They supply the cell with nutrients and oxygen.
b. They provide insulation.
c. They send electrical impulses.
d. They release neurotransmitters from vesicles.

Ans: D
Learning Objective: 2-2: Name the structures of neurons
Cognitive Domain: Knowledge
Answer Location: Basic Structure: The Motor Neuron
Difficulty Level: Easy

13. _____ can be long enough to provide a direct connection between the spinal cord and the toes of a giraffe.
a. Interneurons
b. Projection neurons
c. Axons
d. Dendrites
Ans: C
Learning Objective: 2-2: Name the structures of neurons
Cognitive Domain: Knowledge
Answer Location: Basic Structure: The Motor Neuron
Difficulty Level: Easy

14. Which of the following is true of sensory neurons?
a. Sensory neurons control muscles and produce movement.
b. Sensory neurons gather information from the environment and convey it into the central nervous system.
c. Sensory neurons have cell bodies covered with myelin.
d. Sensory neurons send messages away from the brain toward the periphery.
Ans: B
Learning Objective: 2-3: Compare the functions of sensory, motor, and interneurons
Other Types of Neurons
Cognitive Domain: Knowledge
Answer Location: Other Types of Neurons
Difficulty Level: Easy

15. Which of the following is a true statement about neuron type?
a. Sensory neurons are typically mutlipolar.
b. Sensory neurons are typically unipolar or bipolar.
c. Motor neurons are typically uniploar.
d. Motor neurons are typically bipolar.
Ans: B
Learning Objective: 2-3: Compare the functions of sensory, motor, and interneurons
Cognitive Domain: Knowledge
Answer Location: Other Types of Neurons
Difficulty Level: Easy

16. A(n) _____ would be found bridging between a sensory neuron and a motor neuron in the spinal cord.
a. glial cell
b. projection neuron

c. interneuron
d. multipolar
Ans: C
Learning Objective: 2-3: Compare the functions of sensory, motor, and interneurons
Cognitive Domain: Knowledge
Answer Location: Other Types of Neurons
Difficulty Level: Easy

17. Many business deals involve a “middle man” who communicates between buyer and seller. The “middle man” between a sensory neuron and a motor neuron is a(n) _____.
a. interneuron
b. synapse
c. projection neuron
d. glial cell
Ans: A
Learning Objective: 2-3: Compare the functions of sensory, motor, and interneurons
Cognitive Domain: Comprehension
Answer Location: Other Types of Neurons
Difficulty Level: Medium

18. The most common type of neuron in the brain is the _____.
a. motor neuron
b. unipolar neuron
c. sensory neuron
d. interneuron
Ans: D
Learning Objective: 2-3: Compare the functions of sensory, motor, and interneurons
Cognitive Domain: Knowledge
Answer Location: Other Types of Neurons
Difficulty Level: Easy

19. The cell membrane of a neuron is a double layer made up of _____.
a. protein and connective tissue
b. protein and lipid (fat)
c. lipid (fat) and connective tissue
d. intracellular material and extracellular material
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Neural Membrane and Its Potentials
Difficulty Level: Easy

20. Which of the statements about cell membranes is correct?
a. Many millennia ago, they were free-living single-celled organisms.
b. They extend between multiple neurons.

c. They contain specialized protein channels.
d. They are primarily made up of calcium.
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Neural Membrane and Its Potentials
Difficulty Level: Easy

21. Which of the following is true about the lipids that compose the cell membrane?
a. The “heads” are in contact with extracellular and intracellular fluid and the “tails” are oriented away from these fluids.
b. The “tails” are in contact with extracellular and intracellular fluid and the “heads” are oriented away from these fluids.
c. Half of all “heads” and “tails” are in contact with extracellular fluid.
d. Both “heads” and “tails” are in contact with intracellular fluid.
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Neural Membrane and Its Potentials
Difficulty Level: Easy

22. The seawater-like solution inside neurons and bathing their outside are known respectively as _____.
a. extracellular and intracellular fluid
b. intracellular and extracellular fluid
c. cellular and extracellular fluid
d. intramembrane and extramembrane fluid
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Neural Membrane and Its Potentials
Difficulty Level: Easy

23. The fact that the cell membrane is highly permeable to some substances and much less so to other substances is one factor that contributes to the cell being _____.
a. potentialized
b. polarized
c. hyperpolarized
d. motor
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge

Answer Location: The Neural Membrane and Its Potentials
Difficulty Level: Easy

24. When it is said that the cell membrane has a difference in electrical charge between its inside and the outside, this means the membrane is _____.
a. potentialized
b. polarized
c. hyperpolarized
d. viable
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Neural Membrane and Its Potentials
Difficulty Level: Easy

25. One function of the specialized protein channels in a cell membrane is to _____.
a. form an impermeable barrier to all substances foreign to the cell
b. package neurotransmitters
c. provide oxygen and nutrients for the cell
d. selectively allow substances to enter or leave the cell
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Neural Membrane and Its Potentials
Difficulty Level: Easy

26. Which of the following is true of a neuron at rest?
a. The inside of the neuron is negatively charged with respect to the outside.
b. The inside of the neuron is positively charged with respect to the outside.
c. The inside of the neuron is not charged.
d. The inside of the neuron converts potential energy into chemical energy.
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

27. The _____ is the difference in electrical potential between the inside and outside of an inactive neuron.
a. action potential
b. resting potential
c. threshold of excitation
d. reaction potential

Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

28. Which of the following is true of the resting membrane potential?
a. It is a function of positively charged ions concentrated inside the cell.
b. It is positive inside with respect to outside.
c. It is the result of a freely permeable membrane.
d. It is the difference in electrical charge inside and outside the inactive neuron.
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

29. _____ are charged atoms that have gained or lost one or more electrons.
a. Ions
b. Polarizations
c. Electrolytes
d. Positrons
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

30. Sodium ions are most concentrated in the _____ fluid.
a. intracellular
b. extracellular
c. intracellular and extracellular
d. polarized
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

31. Potassium ions are most concentrated in the _____ fluid.
a. intracellular
b. extracellular

c. intracellular and extracellular
d. nonpolarized
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

32. Which of the following is true of both chloride ions and anions?
a. They are both concentrated in the extracellular fluid.
b. They are both concentrated in the intracellular fluid.
c. They both carry a positive charge.
d. They both carry a negative charge.
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

33. The condition in which ions of a similar charge repel each other and thus spread evenly through a solution is called _____.
a. repulsion
b. the resting potential
c. electrostatic pressure
d. force of diffusion
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

34. The force by which high concentrations of ions disperse away from each other and thus spread evenly through a solution is called _____.
a. force of diffusion
b. repulsion
c. electrostatic pressure
d. the resting potential
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

35. _____ are concentrated primarily outside of the neuron, in the extracellular fluid, which contributes to the negative resting membrane potential of neurons.
a. Chloride ions
b. Sodium ions
c. Potassium ions
d. Anions
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: The Resting Potential
Difficulty Level: Medium

36. _____ tend to exit a neuron based on weaker electrostatic pressure than their force of diffusion.
a. Protein anions
b. Potassium ions
c. Sodium ions
d. Chloride ions
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

37. _____ would tend to move into the neuron based on both their electrostatic pressure and force of diffusion.
a. Protein anions
b. Potassium ions
c. Sodium ions
d. Chloride ions
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

38. When making dinner, you add salt to a pot of boiling water. At first, the salt remains in one spot, but eventually spreads throughout the water due to the _____.
a. electrostatic pressure
b. different polarizations of the water
c. force of diffusion
d. cell membrane

Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Application
Answer Location: The Resting Potential
Difficulty Level: Hard

39. During a neuron's resting state, channels for potassium and sodium ions are _____.
a. closed
b. open
c. selectively open
d. not gated
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

40. The sodium-potassium pump forces sodium ions _____ and potassium ions into the cell.
a. out of the cell
b. into the cell
c. into the membrane
d. into the nucleus
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

41. In a resting neuron, which force pushes potassium ions into the cell?
a. diffusion
b. saltatory conduction
c. the sodium-potassium pump
d. the action potential
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

42. The sodium-potassium pump accounts for _____ of the neuron's energy expenditure.
a. 75%
b. 60%
c. 40%
d. 25%
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

43. Which of the following can prompt an electrically gated ion channel in the cell membrane to open?
a. activity of the sodium-potassium pump
b. one additional ion entering the cell
c. one ion leaving the cell
d. a change in the electrical potential of the membrane
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Ion Channels and Local Potentials
Difficulty Level: Easy

44. _____ gated ion channels open and close based on the presence of neurotransmitters or hormones.
a. Electrically
b. Chemically
c. Specially
d. Diffusion
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Ion Channels and Local Potentials
Difficulty Level: Easy

45. Which of the following is true of local potential but not action potential?
a. It is decremental.
b. It results from a depolarization of the cell membrane.
c. It results from a hyperpolarization of the cell membrane.
d. It is the result of electrically gated ion channels in the axon.
Ans: A

Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: Ion Channels and Local Potentials
Difficulty Level: Medium

46. The _____ is the neuron's means of transmitting information over long distances.
a. depolarizing potential
b. local potential
c. graded potential
d. action potential
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

47. Which of the following is true of depolarization?
a. It is a change in the resting neuron's polarity away from zero.
b. It is a change in the resting neuron's polarity toward zero.
c. It is the conduction of a graded potential.
d. It changes in conduction capability in myelinated axons.
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

48. The depolarization arriving at an axon from a dendrite is called a graded potential because it can _____.
a. vary in magnitude
b. transmit over long distances
c. vary in speed
d. transmit information
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

49. If the partial depolarization arriving at an axon is sufficiently large, typically _____, it can cause normally closed sodium ion channels to open.
a. 5 mV or more

b. 10 mV or more
c. 30 mV or more
d. 40 mV or more
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

50. When depolarization of the cell membrane reaches threshold, which of the following occurs?
a. Chloride ion channels open.
b. Potassium ion channels open.
c. Sodium ion channels open.
d. The electrical potential of the membrane becomes more negative.
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

51. Which of the following is a brief, rapid reversal of the neuron's potential from –70 mV to +30 or +40 mV and back?
a. sustained membrane reversal
b. a hyperpolarization
c. a refractory period
d. an action potential
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

52. The change in electrical charge from –70 mV to the peak of the action potential is due to _____.
a. inflow of chloride ions
b. inflow of potassium ions
c. inflow of sodium ions
d. outflow of sodium ions
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge

Answer Location: Action Potentials
Difficulty Level: Easy

53. The change in electrical charge from the peak of +30 or +40 mV back to –70 mV is due to _____.
a. outflow of sodium ions
b. outflow of potassium ions
c. inflow of potassium ions
d. inflow of chloride ions
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

54. What ionic movement is responsible for pulling the membrane potential back to a negative voltage during an action potential?
a. Sodium ions move into the cell.
b. Potassium ions move into the cell.
c. Protein anions move out of the cell.
d. Potassium ions move out of the cell.
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

55. An action potential from beginning to end lasts about _____.
a. 1 millisecond
b. 1 second
c. 10 milliseconds
d. 10 seconds
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

56. The action potential spreads through an axon by _____.
a. a decremental of graded potential
b. a nondecremental of graded potential
c. inflow of potassium ions and outflow of sodium ions
d. depolarizing adjacent membrane to threshold, triggering another action potential

Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

57. Which of the following is a true statement about what occurs when an axon transmits an action potential?
a. Electricity flows from one end of the axon to the other.
b. Nothing physically moves down the axon.
c. Neurochemicals flow from one end of the axon to the other.
d. The sodium-potassium pump pushes ions down the axon.
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: Action Potentials
Difficulty Level: Medium

58. Sarah threw rocks of different sizes into a pond. Just as ripple size was a function of size of rock, graded potentials _____ as a function of stimulus intensity.
a. vary in inverse magnitude
b. vary along an exponential continuum
c. vary in magnitude
d. are a graded percentage
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Application
Answer Location: Action Potentials
Difficulty Level: Hard

59. Electricity flowing in power lines drops in voltage over distance, requiring your power company to use transformers to boost the voltage back to the original amplitude. This loss over distance is similar to the behavior of _____ potentials.
a. hyperpolarizing
b. nondecremental
c. action
d. graded
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Application
Answer Location: Action Potentials
Difficulty Level: Hard

60. An action potential occurs at a specific amplitude for that neuron, regardless of the stimulus intensity or how much higher than threshold the stimulus is; this is known as the _____.
a. all-or-none law
b. principle of mass action
c. rate law
d. law of equipotentiality
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

61. Which of the following concepts does the all-or-none law describe?
a. All dendrites must be hyperpolarized before a neuron fires.
b. All neurons in a nerve fire or none of them fires.
c. The size of an action potential does not depend on the amplitude of the stimulus that started it.
d. The frequency at which a neuron fires is independent of the intensity of the stimulus.
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

62. A neuron's cell membrane could become positive through either an inflow of positive ions or an outflow of negative ions. Why is the inflow of positive ions the most logical method for this depolarization?
a. There are already too many protein anions outside of the cell.
b. There are already too many chloride ions outside of the cell.
c. There are too few potassium ions inside of the cell.
d. The potassium ions are kept out of the cell by the sodium-potassium pump.
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: Action Potentials
Difficulty Level: Medium

63. Which of the following is true of action potentials in axons?
a. Only one action potential is generated to produce a depolarization along an entire axon.

b. Only two action potentials are generated to produce depolarization along an entire axon.
c. Many action potentials are generated next to each other along the length of an axon.
d. Action potentials are generated at the beginning, middle, and end of an axon only.
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: Action Potentials
Difficulty Level: Medium

64. Following an action potential, the _____ returns the ions to their resting state concentrations.
a. diffusion gradient
b. sodium-potassium pump
c. action potential
d. resting membrane potential
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

65. Which of the following would be a consequence of the sodium-potassium pump being inactivated?
a. Too many potassium ions would accumulate inside the cell.
b. Too many sodium ions would accumulate outside of the cell.
c. Too many chloride ions would accumulate inside the cell.
d. Action potentials would not be able to be generated.
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Action Potentials
Difficulty Level: Easy

66. Which property of action potentials results in their ability to transmit information over long distances?
a. Action potentials are decremental.
b. Action potentials do not become smaller as they occur down the length of an axon.
c. Action potentials are graded.
d. Action potentials only occur if a threshold level of depolarization is reached.
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication

Cognitive Domain: Comprehension
Answer Location: Action Potentials
Difficulty Level: Medium

67. Intensity of a stimulus, such as the intensity of noise that a person experiences, can be communicated through _____.
a. the size of an action potential
b. the length of the axon an action potential travels along
c. the number of neurons that fire action potentials
d. the speed at which the action potential occurs
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: Action Potentials
Difficulty Level: Medium

68. Most local anesthetics result in numbness because they block sodium channels in cell membranes. What impact does this blocking have on the activity of nerve cells?
a. There is no impact.
b. Action potentials cannot occur because the membrane cannot fully depolarize.
c. Action potentials cannot occur because the membrane remains hyperpolarized.
d. The nerve cell dies.
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Application
Answer Location: Action Potentials
Difficulty Level: Hard

69. Which statement characterizes the absolute refractory period?
a. The neuron cannot fire again because the potassium channels are unable to open.
b. The neuron cannot fire again because the sodium channels are unable to open.
c. The neuron can fire again but only to a stronger-than-threshold stimulus.
d. The neuron can fire again but only at a much slower rate.
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Refractory Periods
Difficulty Level: Easy

70. Which statement characterizes the relative refractory period?
a. The neuron cannot fire again because the potassium channels are unable to open.
b. The neuron cannot fire again because the sodium channels are unable to open.
c. The neuron can fire again but only to a stronger-than-threshold stimulus.

d. The neuron can fire again but only at a much slower rate.
Ans: C.
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Refractory Periods
Difficulty Level: Easy

71. Which of the following is an implication of the absolute refractory period?
a. This limits how often action potentials can occur.
b. This limits the intensity of a stimulus that can be processed by a neuron.
c. This limits the speed at which hyperpolarization can occur during an action potential.
d. This limits the amount of sodium that can leave a neuron.
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Refractory Periods
Difficulty Level: Easy

72. Many people are concerned about eating too much salt, yet table salt (sodium chloride) plays which important role in your nervous system?
a. It holds nerve cells together.
b. It prevents neuron decay.
c. It stimulates the neurons for taste, but not in other areas of the nervous system.
d. It breaks down into ions that are needed for neuron signaling.
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: Action Potentials
Difficulty Level: Medium

73. One property of action potentials is that they move in one direction down the axons of neurons. This occurs due to the _____.
a. electrostatic pressure
b. rate of diffusion
c. relative refractory period
d. absolute refractory period
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: Refractory Periods
Difficulty Level: Medium

74. Which of the following explains a neuron's means of encoding various intensities of stimuli?
a. passive conduction
b. rate law
c. all-or-none law
d. electrostatic pressure
Ans: B
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Refractory Periods
Difficulty Level: Easy

75. After Debbie's car accident, as the doctor asked her if it hurt here or if it hurt when he pressed this hard, Debbie understood why she could tell the differences in amount of pressure the doctor used; her sensory neurons coded the different pressures via _____.
a. different magnitude action potentials
b. differences in thresholds for different neurons
c. different neurotransmitters
d. different rates of firing in neurons
Ans: D
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Application
Answer Location: Refractory Periods
Difficulty Level: Hard

76. When you call your sleeping dog, his eyelids flutter; you call louder and his ears perk up; you call even louder and he wakes up. Why?
a. Different types of stimuli produce responses in different neurons.
b. Greater stimulus intensities activate glial cells as well as neurons.
c. Greater stimulus intensities produce higher rates of action potentials.
d. Different stimulus intensities activate different neurons.
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Application
Answer Location: Refractory Periods
Difficulty Level: Hard

77. What reduces the chances of an action potential being fired during the relative refractory period?
a. The neuron's membrane is slightly more negative than at rest.
b. The neuron's membrane is slightly closer to zero than at rest.
c. The sodium channels remain open.

d. There is not sufficient potassium outside of the neuron.
Ans: A
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Refractory Periods
Difficulty Level: Easy

78. You awake to your phone ringing. What will need to be true of the next stimulus in your environment if it is going to be detectable to you?
a. The next stimulus must be weaker than your phone ringing.
b. The next stimulus must occur through a different sense (such as sight).
c. The next stimulus must be strong enough to overcome a slightly hyperpolarized membrane if it occurs immediately following the ringing phone.
d. The next stimulus must occur at least five minutes after the phone ringing.
Ans: C
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: Refractory Periods
Difficulty Level: Medium

79. Which nervous system cells got their name for one of their previously believed roles, to hold neurons together?
a. anions
b. glia
c. soma
d. mitochondria
Ans: B
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Glial Cells
Difficulty Level: Easy

80. Just as many people want to mistakenly compare the brain's “information processing” capability and speed to that of a computer, the speed of neural impulses is often erroneously compared to the _____.
a. speed of light
b. speed of sound
c. speed of electrical current
d. average reaction time for an average adult human
Ans: C
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Comprehension
Answer Location: Myelination and Conduction Speed
Difficulty Level: Medium

81. The conduction speed of neurons is largely a function of _____.
a. axon length and axon diameter
b. axon diameter and number of ion channels
c. axon length and myelination
d. axon diameter and myelination
Ans: D
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

82. With a bigger fire, a larger-diameter water hose will be needed to put out more water per second. Likewise, _____ axons have evolved to provide less resistance to the conduction of neural potentials.
a. shorter
b. thicker
c. thinner
d. denser
Ans: B
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Comprehension
Answer Location: Myelination and Conduction Speed
Difficulty Level: Medium

83. You have been given the task of designing an animal that needs to have an efficient nervous system, and the animal can be no larger than a human. What feature can you include in the animal's nervous system to ensure that it can respond quickly to its environment?
a. very short axons
b. very long axons
c. very wide axons
d. myelinated axons
Ans: D
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Application
Answer Location: Myelination and Conduction Speed
Difficulty Level: Hard

84. The cells that produce myelin in the brain and spinal cord are called _____.
a. Ranvier cells
b. astrocytes
c. oligodendrocytes
d. Schwann cells
Ans: C
Learning Objective: 2-1: Identify the cells of the nervous system

Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

85. The cells that produce myelin in the parts of the nervous system outside of the brain and spinal cord are called _____.
a. Ranvier cells
b. astrocytes
c. oligodendrocytes
d. Schwann cells
Ans: D
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

86. The gaps in the myelin sheaths on axons are known as _____.
a. synapses of myelin
b. nodes of Schwann
c. oligodendrocytes
d. nodes of Ranvier
Ans: D
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

87. Which of the following statements about neuronal conduction in myelinated neurons is correct?
a. Myelinated axons use saltatory conduction.
b. Myelination is a less efficient way to increase conduction speed than increasing the width of axons.
c. Myelin is only found on neurons in the brain.
d. Thicker myelination on axons results in a slower conduction of action potentials.
Ans: A
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

88. Which of the following is true about the action potential in a myelinated neuron?
a. The action potential jumps from synapse to synapse.
b. The action potential travels faster than in an unmyelinated neuron.
c. The action potential travels more slowly than in an unmyelinated neuron.
d. The action potential is conducted down to the uninsulated parts of the dendrites.
Ans: B

Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

89. Which of the following is true about oligodendrocytes?
a. These are the least common glial cells in the brain.
b. These are the most common glial cells in the brain.
c. These are found exclusively in the nervous system outside of the brain.
d. These perform the function of removing waste from the nervous system.
Ans: B
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

90. The effect of myelination on an axon's conduction speed is the equivalent of increasing an axon's diameter by _____ times.
a. 25
b. 50
c. 100
d. 1000
Ans: C
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

91. Saltatory conduction occurs only in _____.
a. myelinated axons
b. myelinated dendrites
c. unmyelinated axons
d. unmyelinated dendrites
Ans: A
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

92. Where can sodium ions enter a myelinated axon?
a. at the soma
b. through the myelin sheath
c. at the point at which the axon divides and branches
d. at the nodes of Ranvier
Ans: D
Learning Objective: 2-1: Identify the cells of the nervous system

Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

93. The fact that action potentials occur only at the nodes of Ranvier is the basis for _____.
a. increased energy consumption in myelinated neurons
b. saltatory conduction
c. slower conduction speed in myelinated neurons
d. faster conduction speeds in unmyelinated neurons
Ans: B
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

94. Which part of the neuron works less due to myelination reducing the places where sodium can enter a neuron?
a. the cell membrane
b. the axon
c. the sodium-potassium pump
d. the dendrites
Ans: C
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

95. As Francine slowly lost motor function and suffered increasing sensory deficits, she could almost picture her _____ being destroyed by the multiple sclerosis.
a. glial cells
b. axons
c. dendrites
d. myelin
Ans: D
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

96. The disorder multiple sclerosis results in destruction of myelin. Why do people with this disorder experience motor and sensory disturbances?
a. Their nerve cells die off.
b. Their axons are too thin.
c. Their neurons lose the ability to send signals.
d. Their nodes of Ranvier become enlarged.

Ans: C
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Comprehension
Answer Location: Myelination and Conduction Speed
Difficulty Level: Medium

97. Myelinated axons consume less energy than unmyelinated axons because _____.
a. action potentials occur faster
b. the sodium-potassium pumps have less work to do
c. graded potentials do not consume energy
d. the sodium-potassium pumps are more efficient on these neurons
Ans: B
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Comprehension
Answer Location: Other Glial Functions
Difficulty Level: Medium

98. A disease that destroys myelin is _____.
a. Alzheimer's disease
b. Parkinson's disease
c. multiple sclerosis
d. neuropathy
Ans: C
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

99. Which of the following is true of glial cells?
a. They guide new neurons in fetal development.
b. They can function like motor neurons.
c. There are fewer glia than neurons in the brain.
d. They only exist outside of the brain.
Ans: A
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Other Glial Functions
Difficulty Level: Easy

100. Which of the following is a type of glia that helps new neurons reach their final destination in the brain?
a. Schwann cells
b. astrocytes
c. microglia
d. radial glia
Ans: D

Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Other Glial Functions
Difficulty Level: Easy

101. The gap between two adjacent neurons was first observed by _____.
a. Golgi
b. Ranvier
c. Cajal
d. Loewi
Ans: C
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: How Neurons Communicate With Each Other
Difficulty Level: Easy

102. The connection point between two neurons is called the _____.
a. terminal
b. axon
c. soma
d. synapse
Ans: D
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: How Neurons Communicate With Each Other
Difficulty Level: Easy

103. If you could surgically remove a single neuron from the brain and place it on a slide, what structure(s) would you have to destroy?
a. soma
b. axon
c. synapses
d. dendrites
Ans: C
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Comprehension
Answer Location: How Neurons Communicate With Each Other
Difficulty Level: Medium

104. Signals are sent from _____ neurons.
a. postsynaptic
b. presynaptic
c. motor

d. unmyelinated
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: How Neurons Communicate With Each Other
Difficulty Level: Easy

105. Who first observed that neurons communicate at the synapse via chemicals?
a. Golgi
b. Loewi
c. Cajal
d. Broca
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

106. If you have ever awoken from sleep to scribble down a brilliant idea, you can probably relate to Loewi, whose own sleep was interrupted with notes with an insight about _____.
a. synaptic structures
b. action potential speed
c. chemical transmission at the synapse
d. function of the sodium-potassium pump
Ans: C
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

107. What experiment did Loewi perform to show that most synapses are chemical?
a. He dissected the brains of patients who had suffered strokes.
b. He altered the heart rate in frogs by bathing one heart in the chemical solution he collected from another heart.
c. He applied electricity to frogs' legs to animate them.
d. He measured the speed at which neurons sent electrical signals and compared that to the speed of electrical current in a wire.
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse

Difficulty Level: Easy

108. Where are vesicles stored?
a. the axon terminals
b. the soma
c. the synapse
d. the synaptic cleft
Ans: A
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

109. Which of the following is the order of events that prompts release of neurotransmitters into the synapse?
a. An action potential reaches the axon terminals, vesicles fuse with cell membrane, calcium ions enter the terminals, vesicles fuse with cell membrane, neurotransmitter is released.
b. Calcium ions enter the terminals, an action potential reaches the axon terminals, vesicles fuse with cell membrane, neurotransmitter is released.
c. Vesicles fuse with cell membrane, an action potential reaches the axon terminals, calcium ions enter the terminals, neurotransmitter is released.
d. An action potential reaches the axon terminals, calcium ions enter the terminals, vesicles fuse with cell membrane, neurotransmitter is released.
Ans: D
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Comprehension
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Medium

110. After a few too many cups of coffee and having to find a restroom, Sal ironically remembered the meaning of the term vesicle, as in _____.
a. “need to urinate”
b. “full bladder”
c. “little bladder”
d. “need to release”
Ans: C
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

111. Which of the following is true of the axon terminals of neurons?

a. They supply the cell with nutrients and oxygen.
b. They release neurotransmitters from vesicles.
c. The provide insulation to the cell.
d. They send electrical impulses.
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

112. The release of neurotransmitter from axon terminals into the synaptic cleft depends on _____.
a. the entry of calcium ions into the axon terminal
b. reversal of the sodium-potassium pump
c. the inflow of chloride ions
d. the opening of nodes of Ranvier
Ans: A
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

113. _____ are released from axon terminals and are detected by protein receptors on an adjacent neuron.
a. Hormones
b. Neurotoxins
c. Pheromones
d. Neurotransmitters
Ans: D
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

114. The neurotransmitter fits into a very precisely shaped location on the postsynaptic neuron called a _____.
a. ion channel
b. receptor
c. neurotransmitter cleft
d. synaptic cleft
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells

Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

115. The relationship between a neurotransmitter and its receptor is akin to a _____.
a. key fitting into a lock
b. hammer hitting a wall
c. bubble bursting
d. pebble traveling down a stream
Ans: A
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Comprehension
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Medium

116. Which of the following is prompted by a neurotransmitter docking with a receptor site?
a. Ionic exchanges are induced between neurons.
b. An action potential is initiated.
c. Ion channels open, directly or indirectly.
d. Ion channels fuse with the cell membrane.
Ans: C
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

117. Neurotransmitters that open ion channels do so by docking on _____.
a. a chemical receptor
b. an electrical receptor
c. an ion channel
d. a vesicle
Ans: A
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

118. The change in a neuron’s potential caused by the arrival of neurotransmitter is called _____.
a. the presynaptic reversal potential
b. the postsynaptic potential
c. axonic integration

d. neural potentiation
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Excitation and Inhibition
Difficulty Level: Easy

119. _____ indirectly result in ion channels opening following binding of neurotransmitter.
a. Ionotropic receptors
b. Metabotropic receptors
c. Calcium ions
d. Chloride channels
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

120. Immediate reactions are prompted by neurotransmitter binding at a(n) _____.
a. ionotropic receptor
b. metabotropic receptor
c. calcium ion
d. chloride channel
Ans: A
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

121. You are about to cross the road when suddenly you see a truck speeding toward you. This type of information should be processed by _____ in order to ensure that you respond quickly.
a. inhibitory signals
b. action potentials
c. metabotropic receptors
d. ionotropic receptors
Ans: D
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Application
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Hard

122. Brian is studying for the licensing exam to become a social worker. He needs to retain the information from that exam for many years to be effective at his job. In order for that to occur, this information should be processed by _____.
a. inhibitory signals
b. action potentials
c. metabotropic receptors
d. ionotropic receptors
Ans: C
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Application
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Hard

123. While action potentials provide simple all-or-none responses, synapses have responses that are _____.
a. faster
b. less variable
c. constant
d. more complex
Ans: D
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

124. Excitatory postsynaptic signals result in partial depolarization, while inhibitory postsynaptic signals result in _____.
a. hyperpolarization
b. hypopolarization
c. an increased chance of an action potential occurring
d. a cell's membrane becoming closer to zero in charge
Ans: A
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Comprehension
Answer Location: Excitation and Inhibition
Difficulty Level: Medium

125. The type of postsynaptic potential produced by a neurotransmitter depends on which neurotransmitter is released and _____.
a. whether the receptor is chemical or electrical
b. the number of receptors that are activated
c. the type of receptor that it binds to

d. the amount of neurotransmitter present in the synapse
Ans: C
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Knowledge
Answer Location: Excitation and Inhibition
Difficulty Level: Easy

126. If the resting potential of a membrane changed from −70 mV to −75 mV, this would be _____.
a. hypopolarization
b. hyperpolarization
c. an action potential
d. part of an EPSP
Ans: B
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Application
Answer Location: Excitation and Inhibition
Difficulty Level: Hard

127. If the resting potential of a membrane were to change from −70 mV to −65 mV, this would be _____.
a. hyperpolarization
b. an action potential
c. part of an EPSP
d. part of an IPSP
Ans: C
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Application
Answer Location: Excitation and Inhibition
Difficulty Level: Hard

128. Which of the following occurs during an EPSP?
a. Chloride ions leave the cell.
b. Sodium ions leave the cell.
c. Sodium ions enter the cell.
d. Potassium ions enter the cell.
Ans: C
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Knowledge
Answer Location: Excitation and Inhibition
Difficulty Level: Easy

129. Which of the following occurs during an IPSP?
a. Chloride ions leave the cell.
b. Sodium ions leave the cell.
c. Sodium ions enter the cell.
d. Potassium ions leave the cell.
Ans: D
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Knowledge
Answer Location: Excitation and Inhibition
Difficulty Level: Easy

130. Most neurons fire spontaneously. IPSPs _____ the rate of firing.
a. increase
b. decrease
c. have no impact on
d. speed up
Ans: B
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Comprehension
Answer Location: Excitation and Inhibition
Difficulty Level: Medium

131. What is one function of hyperpolarization in the nervous system?
a. This serves to stimulate action potentials.
b. This serves to excite neurons.
c. This serves to keep excitatory signals in check.
d. This serves to provide continued firing of neurons, regardless of the stimuli.
Ans: C
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Comprehension
Answer Location: Excitation and Inhibition
Difficulty Level: Medium

132. Which of the following is one reason why chemical signals sent through the synapse lead to greater complexity than the signals of action potentials?
a. Chemical signals at the synapse are all-or-none events.
b. Chemical signals sent through the synapse can be either excitatory or inhibitory.
c. Chemical signals always result in hypopolarization.
d. Chemical signals always result in hyperpolarization.
Ans: B
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Comprehension

Answer Location: Excitation and Inhibition
Difficulty Level: Medium

133. Where do graded potentials get converted into action potentials on the neuron?
a. dendritic spines
b. synaptic cleft
c. soma
d. axon hillock
Ans: D
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Knowledge
Answer Location: Excitation and Inhibition
Difficulty Level: Easy

134. When your Aunt Desirae skeptically asks you how a stimulant can slow down and calm a hyperactive child, you answer that stimulants _____.
a. act to stimulate underactive frontal areas of the brain
b. exert placebo effects
c. have no such effect
d. act as depressants on hyperactive children
Ans: A
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Application
Answer Location: Excitation and Inhibition
Difficulty Level: Hard

135. Which of the following influences the rate at which a neuron fires?
a. the number of terminals of nearby interneurons
b. the number of postsynaptic receptors on this neuron
c. the number of autoreceptors on this neuron
d. the relative strength of excitatory and inhibitory inputs it receives
Ans: D
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Comprehension
Answer Location: Excitation and Inhibition
Difficulty Level: Medium

136. An excitatory synapse will produce hypopolarization potentials of as little as _____.
a. 0.01–0.02 mV
b. 0.2–0.4 mV
c. 1–2 mV
d. 10–12 mV

Ans: B
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Knowledge
Answer Location: Postsynaptic Integration
Difficulty Level: Easy

137. A typical neuron in the brain receives input from how many other neurons?
a. 1,000
b. 10,000
c. 100,000
d. 1,000,000
Ans: A
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Knowledge
Answer Location: Postsynaptic Integration
Difficulty Level: Easy

138. If different postsynaptic potentials occur at the same time but from different inputs, _____ will occur.
a. simultaneous summation
b. temporal summation
c. an IPSP
d. spatial summation
Ans: D
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Knowledge
Answer Location: Postsynaptic Integration
Difficulty Level: Easy

139. At the last home football game, Joel started a taunting chant that slowly spread to more and more fans. Eventually, all those in the stadium picked up the chant and made a roar so deafening that the opposition had to call a timeout. What Joel and fellow fans performed is analogous to the process of _____ at axon hillocks.
a. temporal summation
b. spatial summation
c. spatial integration
d. all-or-none law
Ans: B
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Application
Answer Location: Postsynaptic Integration
Difficulty Level: Hard

140. If postsynaptic potentials arrive from the same input and a short time apart, _____ will occur.
a. synaptic summation
b. spatial summation
c. temporal summation
d. IPSP
Ans: C
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Knowledge
Answer Location: Postsynaptic Integration
Difficulty Level: Easy

141. Kerry wanted her son Alex to clean up his room for several days. Frustrated from the lack of response from Alex, she started asking him to clean his room every 3 minutes. Finally, he cleaned up his room because he didn't want to hear his mother's repeated requests anymore. His response is analogous to the process of _____ at axon hillocks.
a. temporal summation
b. spatial summation
c. neural propagation
d. all-or-none law
Ans: A
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Application
Answer Location: Postsynaptic Integration
Difficulty Level: Hard

142. Since neurons algebraically summate IPSPs and EPSPs to "decide" whether to fire, neurons have been referred to as _____.
a. summators
b. data analysis cells
c. responders
d. integrators
Ans: D
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Knowledge
Answer Location: Excitation and Inhibition
Difficulty Level: Easy

143. Which of the following mechanisms of terminating transmitter action involves the reabsorption of a neurotransmitter by the axon terminals?
a. deactivation

b. diffusion
c. reuptake
d. active recycling by glial cells
Ans: C
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Terminating Synaptic Activity
Difficulty Level: Easy

144. While listening to drug users describe the subjective effects of cocaine, BJ took a few notes to himself to remember that cocaine's effects are due to blocking the _____.
a. effects of serotonin
b. reuptake of norepinephrine and dopamine
c. degradation of dopamine
d. reuptake of dopamine
Ans: D
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Terminating Synaptic Activity
Difficulty Level: Easy

145. Selective serotonin reuptake inhibitors are used to treat depression and have which effect on the nervous system?
a. They increase the availability of serotonin at the synapse.
b. They decrease the amount of serotonin in a synapse.
c. They increase reuptake of serotonin.
d. They synthesize more serotonin.
Ans: A
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Application
Answer Location: Terminating Synaptic Activity
Difficulty Level: Hard

146. The muscle disorder myasthenia gravis can be treated by _____.
a. reducing acetylcholine function in the brain
b. reducing the activity of acetylcholinesterase
c. removing acetylcholine receptors on muscles
d. growing additional acetylcholine receptors on muscles
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Comprehension
Answer Location: Terminating Synaptic Activity

Difficulty Level: Medium

147. Which of the following is true of antidepressant MAO inhibitors?
a. MAO inhibitors reduce the activity of depressants.
b. MAO inhibitors increase the amount of monoamine oxidase in the synapse.
c. MAO inhibitors increase the amount of degrading enzymes in the synapse.
d. MAO inhibitors increase the amount of serotonin, norepinephrine, epinephrine, and dopamine in the synapse.
Ans: D
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Comprehension
Answer Location: Terminating Synaptic Activity
Difficulty Level: Medium

148. The primary function of an axoaxonic synapse is to _____.
a. block the opening of sodium ion channels during an EPSP
b. modulate the amount of transmitter released from the axon terminals
c. block the opening of potassium ion channels during an IPSP
d. modify the synthesis of presynaptic neurotransmitters
Ans: B
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Knowledge
Answer Location: Regulating Synaptic Activity
Difficulty Level: Easy

149. Axodendritic synapses result in hypopolarization or hyperpolarization of a neuron, while _____ synapses increase or decrease the release of neurotransmitter into the synapse.
a. axoaxonic
b. presynaptic
c. axosomatic
d. postsynaptic
Ans: A
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Comprehension
Answer Location: Regulating Synaptic Activity
Difficulty Level: Medium

150. Which of the following is true of autoreceptors?
a. Autoreceptors are located on postsynaptic membranes.
b. Autoreceptors typically produce EPSPs.
c. Autoreceptors detect the amount of neurotransmitter in the synaptic cleft.
d. Autoreceptors are cell receptors that facilitate enzymes.

Ans: C
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Knowledge
Answer Location: Regulating Synaptic Activity
Difficulty Level: Easy

151. An autoreceptor alters the output of _____.
a. the postsynaptic neuron
b. the presynaptic neuron
c. the sodium-potassium pump
d. the sodium channels
Ans: B
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Knowledge
Answer Location: Regulating Synaptic Activity
Difficulty Level: Easy

152. What function of glial cells shows why they should be considered “active partners in neural transmission”?
a. Glial cells repair damaged neurons.
b. Glial cells myelinate axons in the central nervous system.
c. Glial cells myelinate axons in the peripheral nervous system.
d. Glial cells release gliotransmitters into the synapse.
Ans: D
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Comprehension
Answer Location: Regulating Synaptic Activity
Difficulty Level: Medium

153. Nicotinic and muscarinic receptors are two types of _____ receptors.
a. dopamine
b. acetylcholine
c. serotonin
d. tobacco
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Neurotransmitters
Difficulty Level: Easy

154. Muscles contain _____ receptors.
a. excitatory nicotinic

b. excitatory muscarinic
c. inhibitory nicotinic
d. inhibitory muscarinic
Ans: A
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Neurotransmitters
Difficulty Level: Easy

155. Which of the following is true about neurotransmitters?
a. Neurotransmitters are either universally excitatory or universally inhibitory.
b. Each neurotransmitter has one receptor type at which it binds.
c. Every neurotransmitter can be both inhibitory and excitatory.
d. Neurotransmitters can have different effects on postsynaptic neurons depending on which receptor they bind to.
Ans: D
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Comprehension
Answer Location: Neurotransmitters
Difficulty Level: Medium

156. Dale's principle, a recently discounted theory about synaptic function, stated that a neuron _____.
a. never responded to its own autoreceptors
b. released multiple neurotransmitters
c. only released a single neurotransmitter
d. could be either electrical or chemical at its synapses
Ans: C
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Neurotransmitters
Difficulty Level: Easy

157. Presynaptic neurons can release multiple neurotransmitters at different times through the process of _____, in which vesicles containing different neurotransmitters have different levels of sensitivity to calcium.
a. corelease
b. reuptake
c. cotransmission
d. autoreceptors
Ans: C
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells

Cognitive Domain: Knowledge
Answer Location: Neurotransmitters
Difficulty Level: Easy

158. Contrary to Dale's principle, presynaptic neurons show a great deal of flexibility in releasing different neurotransmitters from different _____.
a. coreleases
b. axon terminals
c. dendritic spines
d. somas
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Neurotransmitters
Difficulty Level: Easy

159. A drug that mimics the effects of a neurotransmitter is called a(n) _____.
a. agonist
b. antagonist
c. receptor blocker
d. cotransmitter
Ans: A
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Neurotransmitters
Difficulty Level: Easy

160. Harry came home to find his brother unconscious from an overdose of hydrocodone. When the paramedics arrived, they administered naloxone, because this drug is an opiate _____.
a. agonist
b. antagonist
c. synthetic
d. enzyme
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Application
Answer Location: Neurotransmitters
Difficulty Level: Hard

161. Smoking cigarettes can impact a person's mood and behavior because an active ingredient in cigarettes acts as a(n) _____ at a receptor for acetylcholine.
a. enzyme

b. gliotransmitter
c. antagonist
d. agonist
Ans: D
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Application
Answer Location: Neurotransmitters
Difficulty Level: Hard

162. The effect of acetylcholine on muscles can be prevented by the antagonist _____.
a. tetanus
b. curare
c. nicotine
d. muscarine
Ans: B
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Neurotransmitters
Difficulty Level: Easy

163. By stimulating taste pathways in the brains of rats who were not exposed to sucrose but using firing patterns of neurons that were recorded from rats who were drinking a sucrose solution, researchers determined that _____.
a. neural firing patterns are random
b. neural firing patterns can encode visual but not taste stimuli
c. neural firing patterns can encode taste stimuli
d. neurons do not synchronize their firing rates
Ans: C
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Comprehension
Answer Location: Coding of Neural Messages
Difficulty Level: Medium

164. Which of the following is true of the firing patterns of neurons?
a. Neurons can fire action potentials with varying intervals between spikes.
b. The firing patterns of neurons contain no information.
c. The firing patterns of neurons account for all of the complexity that is seen in brain communication.
d. Neurons do not fire action potentials in patterns.
Ans: A
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Knowledge

Answer Location: Coding of Neural Messages
Difficulty Level: Easy

165. Which of the following is an accurate statement about neural networks?
a. Neural networks have not been found to exist in the brain.
b. Neural networks are made up of only sensory neurons.
c. Neural networks are responsible for a lot of the processing that is done in the brain.
d. Neural networks must be made of neurons that are distributed throughout many brain regions.
Ans: C
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Knowledge
Answer Location: Neural Networks
Difficulty Level: Easy

True/False

1. The most numerous type of neuron in the central nervous system is the interneuron.
Ans: T
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Other Types of Neurons
Difficulty Level: Easy

2. Neurons gather information, process it, and control muscle movements.
Ans: T
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Neurons
Difficulty Level: Easy

3. The resting potential of a neuron is +70 mV.
Ans: F
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

4. The sodium-potassium pumps of a neuron are major consumers of energy.
Ans: T
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication

Cognitive Domain: Knowledge
Answer Location: The Resting Potential
Difficulty Level: Easy

5. Local potentials decay as they spread.
Ans: T
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Ion Channels and Local Potentials
Difficulty Level: Easy

6. The relative refractory period precedes the absolute refractory period.
Ans: F
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Knowledge
Answer Location: Refractory Periods
Difficulty Level: Easy

7. The myelin sheath is formed by either oligodendrocytes or Schwann cells.
Ans: T
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

8. Myelinated axons require more energy to transmit action potentials than unmyelinated axons.
Ans: F
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Myelination and Conduction Speed
Difficulty Level: Easy

9. All synapses use chemical neurotransmitters.
Ans: F
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Easy

10. All neurotransmitters have an excitatory effect on postsynaptic neurons.
Ans: F

Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Comprehension
Answer Location: Excitation and Inhibition
Difficulty Level: Medium

11. An inhibitory message received by a neuron decreases the likelihood that it will send a message down its axon.
Ans: T
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Comprehension
Answer Location: Excitation and Inhibition
Difficulty Level: Medium

12. Spatial summation, by definition, can only occur on a multipolar neuron.
Ans: T
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Comprehension
Answer Location: Postsynaptic Integration
Difficulty Level: Medium

13. Reuptake and inactivation are two mechanisms that prolong synaptic responses.
Ans: F
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Comprehension
Answer Location: Terminating Synaptic Activity
Difficulty Level: Medium

14. The signal sent to neurons via the synapse can only be influenced by the amount and type of neurotransmitter that is released by the presynaptic neuron.
Ans: F
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Comprehension
Answer Location: Regulating Synaptic Activity
Difficulty Level: Medium

15. Dale’s principle has been disproven through scientific investigations of the nervous system.
Ans: T
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Knowledge

Answer Location: Neurotransmitters
Difficulty Level: Easy

Essay

1. Identify the principal structures of a neuron and describe the functions of each.
Ans: Neurons contain a cell body or soma, which contains much of the machinery of the cell. The nucleus is within the cell body and contains the chromosomes of the cell. The dendrites of a neuron receive signals from presynaptic neurons. The axon of a neuron extends from the cell body and is responsible for carrying signals to the end of the neuron. At the end of the neuron are the axon terminals, which contain vesicles in which neurotransmitter is packaged. Signals are sent from the axon terminal to postsynaptic neurons via the synapse, which is the space between neurons.
Learning Objective: 2-2: Name the structures of neurons
Cognitive Domain: Knowledge
Answer Location: Basic Structure: The Motor Neuron
Difficulty Level: Easy

2. Explain the two forces that produce the resting membrane potential.
Ans: Force of diffusion results in ions moving across the cell membrane to areas of low concentration, while electrostatic pressure results in ions being attracted to the side of the cell membrane that carries an opposite charge. At rest, there is a negative charge across the cell membrane because many negatively charged protein anions are trapped inside the cell. Positively charged sodium ions exist in larger concentrations outside the cell membrane but are not able to enter the neuron because the sodium channels are closed, even though both electrostatic pressure and force of diffusion would prompt these ions to enter the neuron. Negatively charged chloride ions exist in greater concentrations outside of the cell membrane and would be repelled from the cell by electrostatic pressure. Positively charged potassium ions exist in greater concentration inside the neuron but do not leave the neuron in large quantities during the resting state because the potassium channels are closed. The sodium-potassium pump also works to maintain the cell's resting membrane potential by returning sodium to the extracellular space and potassium to the intracellular space.
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: The Resting Potential
Difficulty Level: Medium

3. Describe the electrical and chemical events that underlie an action potential.
Ans: Action potentials are generated when the summed signal entering a neuron is excitatory enough to hypopolarize/depolarize the cell membrane approximately 10 mV compared to the resting membrane potential. That excitatory signal comes from neurotransmitters that bind to specific receptors on a neuron. Following that initial graded potential, voltage-gated sodium channels open, and sodium ions enter the

neuron. Since sodium ions carry a positive charge, this prompts the next segment of the axon to become depolarized, and the action potential is propagated down the axon in this manner. The depolarization also opens voltage-gated potassium channels, allowing potassium ions to leave the neuron. Since potassium ions carry a positive charge, this results in hyperpolarization of the cell membrane as the neuron's electrical charge becomes slightly more negative than at rest. Movement of sodium ions into the neuron and potassium ions out of the neuron results in the rapid depolarization and then hyperpolarization of the cell's membrane during the action potential.
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: Action Potential
Difficulty Level: Medium

4. Explain the all-or-none law in the generation of an action potential.
Ans: The all-or-none law means that action potentials either occur or fail to occur, and action potentials occur with the same strength each time they are generated. Action potentials do not differ in strength, even if a signal coming into a neuron differs in strength. Once the threshold potential for the cell membrane is reached, an action potential will always be generated.
Learning Objective: 2-4: Explain the roles of ions and the cell membrane in nervous system communication
Cognitive Domain: Comprehension
Answer Location: Action Potentials
Difficulty Level: Medium

5. Name and describe the functions of three different types of glial cells.
Ans: Oligodendrocytes are glial cells that produce myelin on the axons of neurons in the brain and spinal cord, while Schwann cells are glial cells that produce myelin on axons of neurons in the rest of the nervous system. Myelin serves the function of speeding conduction of signals within neurons and making neurons function more efficiently. Radial glia assist newly generated neurons in reaching the final destination in the brain. Microglia respond to injury and disease in the nervous system by removing waste, and these glial cells also provide energy for to neurons. Astrocytes support synaptic connections between neurons and release gliotransmitters, which can impact neurotransmitter functioning.
Learning Objective: 2-1: Identify the cells of the nervous system
Cognitive Domain: Knowledge
Answer Location: Glial Cells
Difficulty Level: Easy

6. Compare and contrast EPSPs and IPSPs. How do they contribute to triggering an action potential?
Ans: EPSPs (excitatory postsynaptic potentials) are signals that hypopolarize postsynaptic neurons, making the neuron less negative (moving closer to a membrane potential of zero), and making an action potential more likely to occur. IPSPs (inhibitory

postsynaptic potentials) are signals that hyperpolarize postsynaptic neurons, making those neurons more negative in charge (moving farther from a membrane potential of zero), and making action potentials less likely to occur. EPSPs and IPSPs can be summed through temporal and spatial summation to have more complex effects on action potentials being triggered.
Learning Objective: 2-7: Illustrate the ways that excitation and inhibition are important to the functioning of the nervous system
Cognitive Domain: Comprehension
Answer Location: Excitation and Inhibition
Difficulty Level: Medium

7. Describe three different ways that chemical transmission at the synapse results in more complexity than action potentials along an axon.
Ans: Neurotransmitters are not all-or-none events. Instead, neurotransmitters can have effects that vary in intensity and duration, which contributes to complexity in the nervous system. For example, once released into the synapse, the action of a neurotransmitter can be limited through removal of the neurotransmitter from the synapse, which can occur through enzymes that break down the neurotransmitter, reuptake of the neurotransmitter, or absorption by glial cells. The amount of neurotransmitter that is released into a synapse can be modified through axoaxonic synapses, so that inhibitory or excitatory signals from other neurons can impact the amount of calcium that comes into the axon terminal, and thus the amount of neurotransmitter that is released once an action potential reaches the axon terminal. Autoreceptors on a presynaptic neuron can also detect the amount of neurotransmitter in a synapse and adjust release based on this. Glial cells can release gliotransmitters, which can alter release of neurotransmitter by the presynaptic neuron or responses by the postsynaptic neuron. Not all neurotransmitters have the same effects on postsynaptic neurons; some are inhibitory, reducing the chances of an action potential occurring, and others are excitatory, increasing the chances of an action potential occurring. Even the same neurotransmitter can have different effects at different receptors. Through spatial and temporal summation, where the inputs from even thousands of different neurons over a period of time can be added together, any one neuron's activity can be impacted by stimulation or inhibition coming from multiple different sensory inputs. In addition, ionotropic receptors respond quickly to neurotransmitters with direct opening of ion channels, while metabotropic receptors respond more slowly and have less direct impact on ion channels.
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Application
Answer Location: Chemical Transmission at the Synapse
Difficulty Level: Hard

8. Describe two properties of the nervous system that disprove Dale's principle.
Ans: Many neurons have been shown to release multiple different neurotransmitters, such as GABA, glutamate, and dopamine. Multiple different neurotransmitters can be released at different times through corelease (in which the neurotransmitters are

packaged in the same vesicles, but molecules of different size are released at different times) or cotransmission (in which transmitters are packed in separate vesicles and vesicles differ in their sensitivities to calcium). Different neurotransmitters can also be released from different axon terminals of the same neuron.
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Application
Answer Location: Neurotransmitters
Difficulty Level: Hard

9. Contrast the terms agonist and antagonist using acetylcholine as an example.
Ans: An agonist is a chemical that mimics or enhances the function of a neurotransmitter at its receptors, while an antagonist is a chemical that reduces the effects of a neurotransmitter at its receptors. For example, nicotine and muscarine act like acetylcholine at the nicotinic and muscarinic acetylcholine receptors, respectively. The plant toxin curare acts as an antagonist at nicotinic acetylcholine receptors, which is why this toxin produces paralysis.
Learning Objective: 2-5: Demonstrate how neurotransmitters are involved in communication between nervous system cells
Cognitive Domain: Comprehension
Answer Location: Neurotransmitters
Difficulty Level: Medium

10. Explain how greater brain complexity can arise from groups of neurons working together than can occur if neurons only communicated in chains in which each neuron only communicated with one presynaptic and one postsynaptic neuron.
Ans: Groups of neurons working together as networks generate greater complexity because they can create patterns of activity such as bursts in which neurons are extremely active, and those bursts can occur for varying lengths of time. In addition, there can be varying time intervals between high-amplitude activity. These patterns do contain information, as demonstrated in the study of taste perception in rats that was conducted by Patricia Di Lorenzo and Gerald Hecht.
Learning Objective: 2-6: Discuss how neurons work together to generate your experiences of the world
Cognitive Domain: Application
Answer Location: Neural Networks
Difficulty Level: Hard