Chapter 2: Structure and Function of Cells of the Nervous System

Topic	Question Type	Factual	Conceptual	Application
Introduction	Multiple Choice	1-5		
	Fill-In	1-4		
	Essay			
Cells of the Nervous System	Multiple Choice	8-11,15-24,28,29,33,36-40	6,7,12,13,25-27,30-32, 35,38,41-43	14,34,44
	Fill-In	5-8		
	Essay			
Communication Within a Neuron	Multiple Choice	45,50,51,54-64,67,70,71,73	46-49, 52,53,65,66,68,69,72,74-80	
	Fill-In	9-13		
	Essay	1-4,6	5,7	
Communication Between Neurons	Multiple Choice	81,87,88,91,93,96,97,100,103, 105-109	82-86,90,92,94,95,98,99,104	89,101,102
	Fill-In	14-20		
	Essay	9	8,10,11	

Multiple-Choice Questions

2.1-1. The primary symptom shown by Kathryn D. was
a. severe nausea.
b. inability to sleep.
c. muscle weakness.
d. distortions of memory.
e. difficulty in recognizing facial displays of emotion.
Difficulty: 1
Question ID: 2.1-1
Page Ref: 28
Topic: Opening Vignette
Skill: Factual
Answer: c. muscle weakness.
Rationale: Muscle weakness associated with a muscle disorder was the primary symptom shown by Kathryn D.

2.1-2. _____ neurons gather information from the environment related to light, odors, and contact of our skin with objects.
a. Sensory
b. Motor
c. Inter-
d. Relay inter-
e. Local inter-
Difficulty: 2
Question ID: 2.1-2
Page Ref: 28
Topic: Introduction
Skill: Factual
Answer: a. Sensory
Rationale: Sensory neurons gather information from the environment.

2.1-3. _____ neurons function to contract muscles.
a. Sensory
b. Motor
c. Inter-
d. Relay
e. Local
Difficulty: 1
Question ID: 2.1-3

Page Ref: 28
Topic: Introduction
Skill: Factual
Answer: b. Motor
Rationale: Motor neurons function to contract body muscles.

2.1-4. _____ are located only within the central nervous system.
a. Sensory
b. Motor
c. Relay interneurons
d. Projection neurons
e. Schwann cells
Difficulty: 2
Question ID: 2.1-4
Page Ref: 28
Topic: Introduction
Skill: Factual
Answer: c. Relay interneurons
Rationale: Relay interneurons are located only within the central nervous system.

2.1-5. Which of the following is correct regarding neurons?
a. All neurons are sensory neurons.
b. Motor neurons gather sensory information from the environment.
c. The number of neurons in the human nervous system is estimated at more than 100 billion.
d. The term "motor" refers to a mechanical engine.
e. Interneurons are found outside the brain and spinal cord.
Difficulty: 2
Question ID: 2.1-5
Page Ref: 28-29
Topic: Introduction
Skill: Factual
Answer: c. The number of neurons in the human nervous system is estimated at more than 100 billion.
Rationale: The number of neurons in the human nervous system is estimated at more than 100 billion.

2.1-6. The _____ system is defined as comprised of the brain and spinal cord.
a. peripheral nervous
b. central nervous
c. enteric nervous

d. human nervous
e. local circuit
Difficulty: 2
Question ID: 2.1-6
Page Ref: 29
Topic: Introduction
Skill: Conceptual
Answer: b. central nervous
Rationale: The brain and spinal cord comprise the central nervous system.

2.1-7. The _____ system is that portion of the nervous system that lies outside of the brain and spinal cord.
a. extraspinal
b. central nervous
c. enteric nervous
d. human nervous
e. peripheral nervous
Difficulty: 2
Question ID: 2.1-7
Page Ref: 29
Topic: Introduction
Skill: Conceptual
Answer: e. peripheral nervous system
Rationale: The peripheral nervous system lies outside the brain and spinal cord.

2.1-8. The nucleus of the nerve cell is located within the
a. soma.
b. axon.
c. axon terminals.
d. dendrites.
e. mitochondria.
Difficulty: 1
Question ID: 2.1-8
Page Ref: 29
Topic: Cells of the Nervous System
Skill: Factual
Answer: a. soma.
Rationale: The soma of the neuron contains the cell nucleus.

2.1-9. The most common neuron type in the central nervous system is the _____ neuron.

a. multipolar
b. apolar
c. sensory
d. bipolar
e. motor
Difficulty: 2
Question ID: 2.1-9
Page Ref: 30
Topic: Neurons
Skill: Factual
Answer: a. multipolar
Rationale: The multipolar neuron is the most common neuron in the central nervous system.

2.1-10. The portion of a neuron that carries information toward the cell body is the
a. dendrite.
b. axon terminal.
c. presynaptic membrane.
d. soma.
e. glial membrane.
Difficulty: 1
Question ID: 2.1-10
Page Ref: 29
Topic: Neurons
Skill: Factual Answer: a. dendrite.
Rationale: The dendrite carries information from the synapse toward the cell body.

2.1-11. The physical gap that carries a neural message between two nerve cells is the
a. glial junction.
b. axon contact
c. synapse.
d. dendritic apposition.
e. neural gap.
Difficulty: 1
Question ID: 2.1-11
Page Ref: 29
Topic: Neurons
Skill: Factual
Answer: c. synapse.
Rationale: The synapse is the physical gap that carries a neural message between two nerve cells.

2.1-12. Synapses are most commonly formed between a(n) _____ and a(n) _____.
a. axon terminal; dendrite
b. dendrite; soma
c. soma; glial
d. glial; dendrite
e. dendrite; axon terminal
Difficulty: 2
Question ID: 2.1-12
Page Ref: 29
Topic: Neurons
Skill: Conceptual
Answer: a. axon terminal;dendrite
Rationale: Synapses are most commonly formed between an axon terminal and a dendrite.

2.1-13. A key function of the _____ nerve cell is to transmit sensory information.
a. apolar
b. multipolar
c. glial fiber
d. bipolar
e. heteropolar
Difficulty: 3
Question ID: 2.1-13
Page Ref: 30
Topic: Neurons
Skill: Conceptual
Answer: d: bipolar
Rationale: An important function of bipolar cells is to transmit sensory information to the brain.

2.1-14. Loss of dendritic branches on _____ would be expected to impair the ability to sense temperature and touch.
a. bipolar neurons
b. multipolar neurons
c. unipolar neurons
d. apolar neurons
e. motor neurons
Difficulty: 3
Question ID: 2.1-14
Page Ref: 30
Topic: Neurons

Skill: Applied
Answer: c. unipolar neurons
Rationale: Damage to unipolar neurons would be expected to impair touch and temperature sensing.

2.1-15. The membrane of a nerve cell is comprised of
a. protein molecules.
b. vesicle remnants.
c. a double layer of lipid molecules.
d. cytoplasm.
e. a single layer of lipid molecules interfaced with a layer of protein molecules.
Difficulty: 1
Question ID: 2.1-15
Page Ref: 31
Topic: Neurons
Skill: Factual
Answer: c. a double layer of lipid molecules.
Rationale: The neuron membrane is a comprised of a double layer of lipid molecules.

2.1-16. Neurotransmitter molecules are most commonly secreted from the
a. glial cell.
b. dendrite.
c. axon terminal.
d. dendritic apposition.
e. soma.
Difficulty: 1
Question ID: 2.1-16
Page Ref: 31
Topic: Neurons
Skill: Factual
Answer: c. axon terminal.
Rationale: The axon terminal secretes neurotransmitter molecules into the synapse.

22.1-17. A key function of specialized lipid molecules located in the nerve cell is to
a. detect the presence of hormones outside the cell.
b. form the membrane.
c. form channels to carry ions in and out of the cell.
d. transport molecules into the cell.
e. transport vesicles within the neuron.
Difficulty: 1

Question ID: 2.1-17
Page Ref: 31
Topic: Neurons
Skill: Factual
Answer: b. form the membrane.
Rationale: The neuron membrane is formed by specialized lipid molecules.

2.1-18. Match up the internal cell structure with the function most closely associated with that structure:
a. nucleolus; production of cytoplasm
b. ribosomes; production of DNA
c. lipid bilayer; production of ribosomes
d. nucleolus; production of ribosomes
e. mRNA; production of cytoplasm
Difficulty: 2
Question ID: 2.1-18
Page Ref: 32
Topic: Neurons
Skill: Factual
Answer: d. nucleolus; production of ribosomes
Rationale: The nucleolus is involved in the production of ribosomes.

2.1-19. Which of the following structures is the site of production of proteins?
a. vesicles
b. ribosomes
c. genes
d. myeline.
e. the nucleolus
Difficulty: 2
Question ID: 2.1-19
Page Ref: 32
Topic: Neurons
Skill: Factual
Answer: b. ribosomes
Rationale: Ribosomes located outside of the nucleus cause protein production.

2.1-20. Which of the following represents a correct match between a neuronal organelle and its function?
a. mitochondria; extraction of energy
b. Golgi apparatus; extraction of energy

c. endoplasmic reticulum; breakdown of proteins
d. microtubules; transport of chemicals through the cell membrane
e. mitochondria; formation of vesicles
Difficulty: 2
Question ID: 2.1-20
Page Ref: 34
Topic: Neurons
Skill: Factual
Answer: a. mitochondria; extraction of energy
Rationale: Mitochondria within the neuron soma are involved in the extraction of energy for the cell.

2.1-21. Match the correct function with the neuronal organelle:
a. mitochondria; production of fat-like molecules
b. mitochondria; formation of vesicles
c. endoplasmic reticulum; breakdown of proteins
d. microtubules; transport of molecules between the soma and the axon terminals
e. Golgi apparatus; extraction of energy for cell use
Difficulty: 1
Question ID: 2.1-21
Page Ref: 35
Topic: Neurons
Skill: Factual
Answer: d. microtubules; transport of molecules between the soma and the axon terminals
Rationale: The transport of molecules between the soma and the axon terminals is handled by the microtubules.

2.1-22. Proteins are produced within the neuron cytoplasm by
a. mitochondria.
b. ribosomes.
c. lysosomes.
d. the cytoskeleton.
e. nucleoli.
Difficulty: 1
Question ID: 2.1-22
Page Ref: 34
Topic: Neurons
Skill: Factual
Answer: b. ribosomes.
Rationale: Proteins are produced within the neuron cytoplasm by ribosomes.

2.1-23. Which of the following is true of the human genome?
a. Humans have about 95,000,000 genes.
b. Much of the genome contains “junk” DNA.
c. Non-coding “junk” RNA sequences that do not produce protein has no known function.
d. The human genome has not been fully sequenced.
e. Nearly 10% of the genes of the human genome code for proteins.
Difficulty: 3
Question ID: 2.1-23
Page Ref: 33
Topic: Neurons
Skill: Factual
Answer: b: Much of the human genome contains “junk” DNA.
Rationale: Much of the genome contains “junk” DNA that does not code for specific proteins.

2.1.24. Surplus substances within the cytoplasm are degraded by
a. mitochondria.
b. ribosomes.
c. lysosomes.
d. the cytoskeleton.
e. cytoskeletal proteins.
Difficulty: 1
Question ID: 2.1-24
Page Ref: 35
Topic: Neurons
Skill: Factual
Answer: c. lysosomes.
Rationale: Lysosomes degrade surplus structures within the cell cytoplasm.

2.1-25. A key function of lysosomes is to
a. move vesicles from the soma to the axon terminal.
b. produce proteins.
c. degrade surplus cellular materials.
d. provide energy to the neuron.
e. transport vesicles within the neuron.
Difficulty: 1
Question ID: 2.1-25
Page Ref: 35
Topic: Neurons
Skill: Conceptual

Answer: c. degrade surplus cellular materials.
Rationale: Lysosomes degrade surplus cellular material within the neuron cytoplasm.

2.1-26. Which of the following is correct regarding axoplasmic transport?
a. The dynein molecule is involved in anterograde axoplasmic transport.
b. Retrograde axoplasmic transport involves moving substances from the soma to the axon terminals.
c. The kinesin molecule is involved in retrograde axoplasmic transport.
d. Retrograde transport is half as fast as anterograde axoplasmic transport.
e. Transport of materials occurs only in one direction.
Difficulty: 3
Question ID: 2.1-26
Page Ref: 35
Topic: Neurons
Skill: Conceptual
Answer: d. Retrograde transport is half as fast as anterograde axoplasmic transport.
Rationale: Retrograde transport is half as fast as anterograde axoplasmic transport for the movement of materials within the neuron.

2.1-27. Which of the following is correct regarding axoplasmic transport?
a. Dendrograde transport involves moving substances from the dendrites to the soma.
b. Retrograde transport involves moving substances from the soma to the axon terminals.
c. The kinesin molecule is involved in anterograde transport.
d. Retrograde transport is twice as fast as anterograde transport.
e. The dynein molecule is involved in anterograde transport.
Difficulty: 3
Question ID: 2.1-27
Page Ref: 35
Topic: Neurons
Skill: Conceptual
Answer: c. The kinesin molecule is involved in anterograde transport.
Rationale: The kinesin molecule is involved in anterograde transport for the movement of materials within the neuron.

2.1-28. Movement of cargo from one end of the axon to the other involves _____ along the _____ .
a. axoplasmic transport; myelin sheath
b. facilitated diffusion; exterior of the cell membrane
c. facilitated diffusion; neurofilaments
d. protein synthesis; microtubules

e. axoplasmic transport; microtubules
Difficulty: 2
Question ID: 2.1-28
Page Ref: 35
Topic: Neurons
Skill: Factual
Answer: e. axoplasmic transport; microtubules
Rationale: The axoplasmic transport of molecules between the soma and the axon terminals is handled by the microtubules.

2.1-29. Neurons of the central nervous system are provided nutrients, oxygen, and physical support by _____ cells.
a. Schwann
b. glial or neuroglial
c. Golgi
d. stem
e. microtubule
Difficulty: 1
Question ID: 2.1-29
Page Ref: 35
Topic: Supporting Cells
Skill: Factual
Answer: b. glial or neuroglial
Rationale: Neuroglial cells provide nutrients, oxygen, and physical support to neurons.

2.1-30. Which of the following is a key a function of the glial cells?
a. Protection of the outer surface of the brain.
b. Removal of physical debris from the brain.
c. Secretion of CSF in the brain.
d. Movement of vesicles along the axon.
e. The conduction of action potentials.
Difficulty: 2
Question ID: 2.1-30
Page Ref: 35
Topic: Supporting Cells
Skill: Conceptual
Answer: b: Removal of physical debris from the brain.
Rationale: The glial cells aid in the removal of physical debris from the brain.

2.1-31. Which of the following is true of neurons?

a. Neurons have a high metabolic rate.
b. The dendrites store nutrients and oxygen for the neuron.
c. Dead neurons are consumed by other neurons.
d. Neurons make up 29% of the volume of the brain.
e. Neurons can survive for hours without oxygen.
Difficulty: 2
Question ID: 2.1-31
Page Ref: 35
Topic: Supporting Cells
Skill: Conceptual
Answer: a. Neurons have a high metabolic rate.
Rationale: Neurons have a high metabolic rate, which requires a dedicated source of oxygen and nutrients.

2.1-32. Nerve cells are able to rapidly metabolize fuel because
a. of their capacity to store glucose in the cytoplasm.
b. neurons receive lactate from astrocytes.
c. glial cells can transfer ATP into neurons.
d. brain blood vessels can convert glucose into lactate for neuron use.
e. glial cell mitochondria process fuel for the neuron.
Difficulty: 2
Question ID: 2.1-32
Page Ref: 36
Topic: Supporting Cells
Skill: Conceptual
Answer: b. neurons receive lactate from astrocytes.
Rationale: Glial cells convert glucose to lactate, which is then supplied to the neuron.

2.1-33. The _____ are the key supply source of energy for neurons.
a. phagocytes
b. Schwann cells
c. dendrocytes
d. astrocytes
e. microtubules
Difficulty: 1
Question ID: 2.1-33
Page Ref: 36
Topic: Supporting Cells
Skill: Factual
Answer: d. astrocytes

Rationale: Astrocyes are the key supply source of rapid energy for neurons.

2.1-34. A drug that specifically killed the _____ cells would be expected to alter the physical and nutritional support of brain cells.
a. phagocyte
b. Schwann
c. microglia
d. astrocyte
e. microtubule
Difficulty: 1
Question ID: 2.1-34
Page Ref: 36
Topic: Supporting Cells
Skill: Applied
Answer: d. astrocyte
Rationale: Damage to astrocytes would be expected to alter the physical and nutritional support of brain cells.

2.1-35. The process of phagocytosis involves
a. the removal of neuronal debris.
b. the transfer of lactate from a glial cell to a neuron.
c. the wrapping of fatty material around an axon membrane.
d. structural support of a nerve cell.
e. the degradation of transmitter molecules within the synapse.
Difficulty: 1
Question ID: 2.1-35
Page Ref: 36
Topic: Supporting Cells
Skill: Conceptual
Answer: a. the removal of neuronal debris.
Rationale: Phagocytosis refers to the removal and destruction of debris from a neuron.

2.1-36. The scar tissue generated in the brain by _____ cells acts to impede the regrowth of nerve cells.
a. astrocytes
b. microglia
c. Schwann cells
d. axon terminals
e. phagocytes
Difficulty: 2

Question ID: 2.1-36
Page Ref: 36-37
Topic: Supporting Cells
Skill: Factual
Answer: a. astrocytes
Rationale: Astrocytes form scar tissue in brain that acts to impede the regrowth of nerve cells.

2.1-37. Myelination of brain nerve axon membranes is accomplished by
a. oligodendrocytes.
b. microglia.
c. astrocytes.
d. neurocytes.
e. Schwann cells.
Difficulty: 1
Question ID: 2.1-37
Page Ref: 37
Topic: Supporting Cells
Skill: Factual
Answer: a. oligodendrocytes
Rationale: Oligodendrocytes form the myelin sheath around axons in the brain.

2.1-38. A key feature for the diagnosis of multiple sclerosis in Dr. C. was
a. focal damage to a single brain region evident in a CT scan.
b. diverse neurological symptoms that appeared at different times.
c. the excess production of myelin in the nervous system.
d. the occurrence of small strokes that impair brain function.
e. an autoimmune disease that attacks the myelin found in the peripheral nervous system.
Difficulty: 1
Question ID: 2.1-38
Page Ref: 38
Topic: Supporting Cells
Skill: Conceptual
Answer: b. diverse neurological symptoms that appeared at different times.
Rationale: The clue that allowed for the diagnosis of multiple sclerosis in Dr. C was her display of diverse neurological symptoms that appeared at different times.

2.1-39. The _____ mediates the inflammatory reaction that follows brain damage.
a. Schwann cell
b. phagocyte
c. dendrocyte

d. astrocyte
e. microglia
Difficulty: 1
Question ID: 2.1-39
Page Ref: 38
Topic: Supporting Cells
Skill: Factual
Answer: e. microglia
Rationale: The inflammatory reaction that follows brain damage results from the action of microglia.

2.1-40. Which of the following is true of Schwann cells?
a. Schwann cells provide myelin for peripheral nerve cells.
b. Schwann cells are found within the brain.
c. A single Schwann cell wraps multiple segments around a peripheral nerve cell.
d. A single Schwann cells can myelinate up to 50 segments of axon membrane.
e. Schwann cells remove the cellular debris left by dead neurons in brain.
Difficulty: 3
Question ID: 2.1-40
Page Ref: 39
Topic: Supporting Cells
Skill: Factual
Answer: a. Schwann cells provide myelin for peripheral nerve cells.
Rationale: Schwann cells form myelin sheaths for peripheral axons.

2.1-41. Regrowth of a damaged axon can occur more readily in the peripheral nervous system than in the brain because
a. Schwann cells form barriers to axon regrowth.
b. Schwann cells form cylinders through which new axons can grow and reinnervate a target cell nerve cell.
c. Schwann cells generate a chemical signal that instructs nerve cells to die.
d. Astrocytes form cylinders through which new axons can grow and reinnervate a target cell nerve cell.
e. Oligodendroglia form barriers to axon regrowth.
Difficulty: 2
Question ID: 2.1-41
Page Ref: 39
Topic: Supporting Cells
Skill: Conceptual
Answer: b. Schwann cells form cylinders through which new axons can grow and reinnervate a

target cell nerve cell.
Rationale: Regrowth of a damaged axon can occur more readily in the peripheral nervous system than in the brain because Schwann cells form cylinders through which new axons can grow and reinnervate a target cell nerve cell.

2.1-42. The presence of a barrier between the bloodstream and the brain is suggested by the observation that
a. all cells of the body are stained by a dye injected into the bloodstream.
b. injection of dye into the bloodstream stains all cells but those of the brain and spinal cord.
c. the gut is stained by a dye injected into the brain ventricles.
d. injection of dye into the spinal cord stains the cells of the gut.
e. injection of dye into the gut stains the cells of the spinal cord.
Difficulty: 3
Question ID: 2.1-42
Page Ref: 39
Topic: The Blood-Brain Barrier
Skill: Conceptual
Answer: b. injection of dye into the bloodstream stains all cells but those of the brain and spinal cord.
Rationale: The presence of a blood-brain barrier was inferred from the observation injection of dye into the bloodstream stains all cells except those of the brain and spinal cord.

2.1-43. Which of the following is true of the blood-brain barrier?
a. The barrier is uniform, protecting all brain structures.
b. The barrier pumps glucose out of the brain into the bloodstream.
c. The barrier functions to regulate the chemical composition of the extracellular fluid surrounding the brain cells.
d. The barrier is formed by cells that line the capillaries of the brain.
e. The ventricles have a blood-brain barrier.
Difficulty: 2
Question ID: 2.1-43
Page Ref: 39-40
Topic: The Blood-Brain Barrier
Skill: Conceptual
Answer: c. The barrier functions to regulate the chemical composition of the extracellular fluid surrounding the brain cells.
Rationale: The blood-brain barrier functions to regulate the chemical composition of the extracellular fluid surrounding the brain cells.

2.1-44. Activation of cells within the _____ by a poison in the blood would be predicted to

produce _____.
a. nucleus accumbens; visual hallucinations
b. hippocampus; locomotion
c. hypothalamus; vomiting
d. area postrema; vomiting
e. hippocampus; vomiting
Difficulty: 2
Question ID: 2.1-44
Page Ref: 40
Topic: The Blood-Brain Barrier
Skill: Applied
Answer: d. area postrema; vomiting
Rationale: Cells within the area postrema control emesis; blood-borne poisons can thus trigger vomiting which can evacuate the stomach.

2.1-45. The normal order of activation during neuronal transmission is
a. axon --> dendrite --> cell body --> axon terminals.
b. axon terminals --> cell body --> axon --> dendrite.
c. dendrite --> cell body --> axon --> terminal button.
d. cell body --> axon --> dendrite --> axon terminal.
e. dendrite --> axon terminal --> cell body --> axon.
Difficulty: 2
Question ID: 2.1-45
Page Ref: 41
Topic: Neural Communication: An Overview
Skill: Factual
Answer: c. dendrite --> cell body --> axon --> terminal button.
Rationale: Neuronal transmission starts with the dendrite and in turn involves the cell body, the axon, and then finally the axon terminal button.

2.1-46. The simplest version of a withdrawal from pain reflex is a
a. pain receptor that synapses onto an interneuron, which in turn activates a motor neuron in the spinal cord.
b. pain receptor that projects to the thalamus, which then projects to motor cortex and then back down to the spinal cord.
c. motor neuron within the spinal cord that is spontaneously active.
d. sensory neuron in the visual cortex that synapses onto a motor neuron in the spinal cord.
e. motor neuron that activates sensory fibers.
Difficulty: 1
Question ID: 2.1-46

Page Ref: 41
Topic: Neural Communication: An Overview
Skill: Conceptual
Answer: a. pain receptor that synapses onto an interneuron, which in turn activates a motor neuron in the spinal cord.
Rationale: The simplest reflex involves a pain receptor that synapses onto an interneuron, which in turn activates a motor neuron within the spinal cord.

2.1-47. A key function of the giant squid axon is the
a. integration of sensory messages regarding the environment.
b. planning of feeding-related movements.
c. contraction of the squid mantle, which propels the squid away from danger.
d. coordination of general sensory-motor function.
e. contraction of the oral region to produce chewing movements.
Difficulty: 2
Question ID: 2.1-47
Page Ref: 43
Topic: Measuring Electrical Potentials of Axons
Skill: Conceptual
Answer: c. contraction of the squid mantle, which propels the squid away from danger.
Rationale: The giant squid axon controls the contraction of the squid mantle, which moves the squid away from sources of danger.

2.1-48. The function of a _____ in a giant squid physiology experiment is to _____.
a. microelectrode; inject potassium ions into the axon
b. voltmeter; stimulate the interior of the axon
c. microelectrode; compare the electric charge of the interior with that of the exterior
d. voltmeter; compare the electric charge of the interior with that of the exterior
e. microelectrode; dampen the electric charge within the axon
Difficulty: 2
Question ID: 2.1-48
Page Ref: 43
Topic: Measuring Electrical Potentials of Axons
Skill: Conceptual
Answer: d: voltmeter; compare the electric charge of the interior with that of the exterior
Rationale: The voltmeter compares the electric charge of the interior with that of the exterior.

2.1-49. The interior of a neuron at rest
a. has the same ionic concentrations as the outside.
b. is at the same voltage potential as the outside.

c. has a higher sodium concentration than outside.
d. is negatively charged relative to the outside.
e. has a lower potassium concentration than outside.
Difficulty: 2
Question ID: 2.1-49
Page Ref: 43-44
Topic: Measuring Electrical Potentials of Axons
Skill: Conceptual
Answer: d. is negatively charged relative to the outside.
Rationale: The interior of the axon membrane is negatively charged relative to the outside of the membrane.

2.1-50. The difference in electrical charge between the inside and the outside of the axon membrane is defined as the _____ potential.
a. membrane
b. local
c. glial
d. action
e. axon Difficulty: 1
Question ID: 2.1-50
Page Ref: 43
Topic: Measuring Electrical Potentials of Axons
Skill: Factual
Answer: a. membrane
Rationale: The membrane potential is defined as the difference in electrical charge between the inside and the outside of the axon membrane.

2.1-51. The _____ potential is defined as the difference in electrical charge between the inside and the outside of an undisturbed axon membrane.
a. resting membrane
b. local
c. resting
d. action
e. axon
Difficulty: 2
Question ID: 2.1-51
Page Ref: 43
Topic: Measuring Electrical Potentials of Axons
Skill: Factual
Answer: a. resting membrane

Rationale: The resting membrane potential is defined as the difference in electrical charge between the inside and the outside of an undisturbed axon membrane.

2.1-52. A change in the axon membrane potential from -70 mV to -90 mV would be termed a(n)
a. depolarization.
b. threshold potential.
c. action potential.
d. hyperpolarization.
e. excitatory local potential.
Difficulty: 1
Question ID: 2.1-52
Page Ref: 44
Topic: Measuring Electrical Potentials of Axons
Skill: Conceptual
Answer: d. hyperpolarization.
Rationale: A hyperpolarization refers to a movement of the resting membrane potential in a more negative direction.

2.1-53. A neuron membrane potential moves from -90 mV to -80 mV in response to a brief stimulation. We would term this change in potential as a(n)
a. depolarization.
b. resting potential.
c. action potential.
d. hyperpolarization.
e. inhibitory local potential.
Difficulty: 1
Question ID: 2.1-53
Page Ref: 44
Topic: Measuring Electrical Potentials of Axons
Skill: Conceptual
Answer: a. depolarization.
Rationale: A depolarization refers to a movement of the resting membrane potential in a more positive direction (towards 0 mV).

2.1-54. A(n) _____ will be recorded from a nerve cell whose membrane potential rises above threshold.
a. action potential
b. local potential
c. downward shift of the threshold of excitation
d. upward shift of the membrane threshold

e. long-term change in the membrane potential
Difficulty: 1
Question ID: 2.1-54
Page Ref: 44
Topic: Measuring Electrical Potentials of Axons
Skill: Factual
Answer: a. action potential
Rationale: An action potential is initiated when the resting membrane potential reaches threshold.

2.1-55. The _____ is the voltage level at which an action potential is triggered in a patch of axon membrane.
a. resting membrane potential
b. hyperpolarization event
c. threshold of excitation
d. rate level
e. refractory period
Difficulty: 1
Question ID: 2.1- 55
Page Ref: 44
Topic: Measuring Electrical Potentials of Axons
Skill: Factual
Answer: c. threshold of excitation
Rationale: The threshold of excitation is that value of membrane potential at which an action potential is triggered.

2.1-56. A cup of sugar is dumped into a gallon of hot water. After 30 minutes, we will expect that the process of _____ will ensure that the sugar molecules are evenly distributed throughout the water.
a. retrograde transport
b. diffusion
c. anterograde transport
d. electrostatic pressure
e. salinity
Difficulty: 1
Question ID: 2.1-56
Page Ref: 45
Topic: The Membrane Potential: Balance of Two Forces
Skill: Factual
Answer: b. diffusion

Rationale: Molecules are distributed evenly throughout a medium via the process of diffusion.

2.1-57. A substance that forms oppositely charged particles when dissolved into water would be termed a(n)
a. ion.
b. molecule.
c. electrolyte.
d. cation.
e. anion.
Difficulty: 1
Question ID: 2.1-57
Page Ref: 45
Topic: The Membrane Potential: Balance of Two Forces
Skill: Factual
Answer: c. electrolyte.
Rationale: An ion is a charged particle.

2.1-58. _____ are charged particles formed when an electrolyte dissolves in water.
a. Ions
b. Solvents
c. Transmitters
d. Electrons
e. Solutes
Difficulty: 1
Question ID: 2.1-58
Page Ref: 45
Topic: The Membrane Potential: Balance of Two Forces
Skill: Factual
Answer: a. Ions
Rationale: A charged particle is known as an ion.

2.1-59. _____ are positively charged ionic particles.
a. Transmitters
b. Solvents
c. Electrolytes
d. Cations
e. Anions
Difficulty: 1
Question ID: 2.1-59
Page Ref: 45

Topic: The Membrane Potential: Balance of Two Forces
Skill: Factual
Answer: d. Cations
Rationale: A positively charged particle is defined as a cation.

2.1-60. _____ are negatively charged particles.
a. Transmitters
b. Solvents
c. Electrolytes
d. Cations
e. Anions
Difficulty: 1
Question ID: 2.1-60
Page Ref: 45
Topic: The Membrane Potential: Balance of Two Forces
Skill: Factual
Answer: e. Anions
Rationale: A negatively charged particle is defined as a cation.

2.1-61. The process by which similarly charged particles repel each other and are thus moved within a medium is termed
a. diffusion.
b. carrier-mediated transport.
c. refraction.
d. electrostatic pressure.
e. diffraction.
Difficulty: 2
Question ID: 2.1-61
Page Ref: 45
Topic: The Membrane Potential: Balance of Two Forces
Skill: Factual
Answer: d. electrostatic pressure.
Rationale: The process by which similarly charged particles repel each other and are thus moved within a medium is known as electrostatic pressure.

2.1-62. Which of the following is true of ion distribution across the axon membrane?
a. Chloride ions are more concentrated inside the axon membrane.
b. Potassium ions are more concentrated outside the cell membrane.
c. The action potential is the balance point between diffusion and electrostatic pressure.
d. Sodium ions are more concentrated outside the axon membrane.

e. Sodium ions are more concentrated inside the axon membrane.
Difficulty: 1
Question ID: 2.1-62
Page Ref: 45
Topic: The Membrane Potential: Balance of Two Forces
Skill: Factual
Answer: d. Sodium ions are more concentrated outside the axon membrane.
Rationale: Sodium ions are more concentrated outside the axon membrane

2.1-63. Movement of _____ ions _____ the axon would be induced by the force of diffusion.
a. chloride; out of
b. sodium; into
c. potassium; into
d. organic; into
e. sodium; out of
Difficulty: 1
Question ID: 2.1-63
Page Ref: 45
Topic: The Membrane Potential: Balance of Two Forces
Skill: Factual
Answer: b. sodium; into
Rationale: The force of diffusion would tend to force sodium ions into the axon.

2.1-64. Sodium ions move out of the axon because of
a. the opening of sodium channels.
b. the opening of voltage-gated channels.
c. kinesin.
d. electrostatic pressure.
e. the sodium-potassium transporter.
Difficulty: 2
Question ID: 2.1-64
Page Ref: 46
Topic: The Membrane Potential: Balance of Two Forces
Skill: Factual
Answer: e. the sodium-potassium transporter.
Rationale: The sodium-potassium transporter acts to move sodium ions out of the axon.

2.1-65. As a consequence of the activity of the sodium-potassium transporters,
a. extracellular sodium concentrations are kept low.

b. intracellular sodium concentrations are kept very high.
c. extracellular potassium concentrations are kept very high.
d. intracellular sodium concentrations are kept low.
e. very little energy is required to maintain ionic differences across the membrane.
Difficulty: 2
Question ID: 2.1-65
Page Ref: 46
Topic: The Membrane Potential: Balance of Two Forces
Skill: Conceptual
Answer: d. intracellular sodium concentrations are kept low.
Rationale: The sodium-potassium transporter acts to move sodium ions out of the axon thus keeping intracellular sodium concentrations at a low level.

2.1-66. Which of the following is true regarding the action potential (AP)?
a. The AP is conducted along the dendrite.
b. The AP is conducted faster in unmyelinated nerve cells
c. The AP is an all-or-none electrical event
d. The AP amplitude is higher for an intense signal.
e. The AP amplitude depends on its location along the axon.
Difficulty: 2
Question ID: 2.1-66
Page Ref: 49, 51
Topic: Conduction of the Action Potential
Skill: Conceptual
Answer: c. The AP is an all-or-none electrical event.
Rationale: The action potential is an all-or-none event.

2.1-67. The specialized protein molecules located in the axon membrane that can open or close are termed
a. receptors.
b. voltage transporters.
c. autoreceptors.
d. ion channels.
e. sodium-potassium transporters.
Difficulty: 2
Question ID: 2.1-67
Page Ref: 47
Topic: The Action Potential
Skill: Factual
Answer: d. ion channels.

Rationale: Ion channels are proteins located in the axon membrane that open or close thus allowing ions to enter or leave the neuron.

2.1-68. Which of the following is true of the action potential?
a. More sodium channels are opened at a lower voltage level than are the potassium channels.
b. The action potential requires 10 msec for completion.
c. The action potential requires the activity of the sodium-potassium transporters during the rising phase.
d. More potassium channels are opened at a lower voltage than are sodium channels.
e. The overshoot is due to a prolonged change in sodium conductance.
Difficulty: 2
Question ID: 2.1-68
Page Ref: 47
Topic: The Action Potential
Skill: Conceptual
Answer: a. More sodium channels are opened at a lower voltage level than are the potassium channels.
Rationale: The upswing of the action potential occurs because more sodium channels are opened at a lower voltage level than are the potassium channels.

2.1-69. Sodium ions will be pushed into a resting neuron by the forces of
a. inactivation of potassium channels; diffusion.
b. electrostatic pressure; sodium-potassium pump activation.
c. sodium-potassium pump activation; diffusion.
d. ion channel inactivation; diffusion.
e. diffusion; electrostatic pressure.
Difficulty: 2
Question ID: 2.1-69
Page Ref: 45
Topic: The Membrane Potential: The Balance of Two Forces
Skill: Conceptual
Answer: e. diffusion; electrostatic pressure.
Rationale: The forces of diffusion and electrostatic pressure push sodium ions into the axon interior.

2.1-70. Match the ion channel action with its resulting change in membrane potential:

a. entry of a negative ion; hyperpolarization
b. entry of a positive ion; hyperpolarization
c. exit of a positive ion; depolarization

d. exit of a negative ion; hyperpolarization
e. inactivation of sodium-potassium transporters; depolarization
Difficulty: 3
Question ID: 2.1-70
Page Ref: 44-47
Topic: Measuring Electrical Potentials of Axons; The Membrane Potential: Balance of Two Forces; The Action Potential
Skill: Factual
Answer: a. entry of a negative ion; hyperpolarization
Rationale: Hyperpolarization is produced by the entry of a negative ion into the axon.

2.1-71. Which of the following events restores the membrane potential from the peak of the action potential back down to the resting level?
a. Sodium ions move into the cell.
b. Potassium ions move out of the cell.
c. Potassium ions move into the cell.
d. Chloride ions move into the cell.
e. Protein anions move out of the cell.
Difficulty: 2
Question ID: 2.1-71
Page Ref: 48
Topic: Action Potential
Skill: Factual
Answer: b. Potassium ions move out of the cell.
Rationale: The movement of potassium ions out of the axon moves the membrane potential back to resting levels.

2.1-72. Which of the following sets of terms do NOT belong together?
a. saltatory conduction; faster conduction speeds in smaller neurons
b. open sodium channels; membrane depolarization
c. saltatory conduction; slower conduction speeds in smaller neurons
d. open potassium channels; membrane repolarization
e. sodium-potassium pump; restoration of the normal concentrations of these ions
Difficulty: 3
Question ID: 2.1-72
Page Ref: 49-50
Topic: Conduction of the Action Potential
Skill: Conceptual
Answer: c. saltatory conduction; slower conduction speeds in smaller neurons
Rationale: Saltatory conduction results in more rapid conduction speeds in smaller neurons

2.1-73. Which of the following is consistent with the "all-or-none" law?
a. The action potential will diminish to near 0 mV when transmitted down a long axon.
b. The action potential fires at the same rate regardless of the inputs to the neuron.
c. The action potential is conducted more rapidly down the axon as it reaches the axon terminal.
d. The action potential is produced whenever the membrane potential reaches threshold.
e. The action potential travels only in one direction.
Difficulty: 2
Question ID: 2.1-73
Page Ref: 48
Topic: The Action Potential
Skill: Factual
Answer: d. The action potential is produced whenever the membrane potential reaches threshold.
Rationale: The fact that an AP occurs when threshold is reached but not below the threshold is consistent with the notion of all-or-none.

2.1-74. The nervous system codes for variation in the intensity of incoming sensory stimuli by variations in the _____ of a neuron.
a. repolarization rate
b. resting membrane potential
c. speed of conduction of action potentials
d. total amplitude of the action potential
e. firing rate
Difficulty: 2
Question ID: 2.1-74
Page Ref: 49
Topic: Conduction of the Action Potential
Skill: Conceptual
Answer: e. firing rate
Rationale: More intense stimuli produce a faster rate of firing in a given sensory neuron.

2.1-75. Depolarizations of the axon membrane that are below the threshold of activation
a. involve activation of the sodium-potassium pump.
b. remain the same size at each point along the membrane.
c. are just smaller versions of the action potential.
d. decrease in size as they sweep along the membrane.
e. are not conducted along the membrane.
Difficulty: 2
Question ID: 2.1-75

Page Ref: 51
Topic: Communication Between Neurons
Skill: Conceptual
Answer: d. decrease in size as they sweep along the membrane.
Rationale: Local potentials decrease in size as they sweep along the membrane.

2.1-76. Among the cable properties of axons are the fact that
a. subthreshold signals degrade with distance from the point of stimulation.
b. a high rate of firing produces a stronger response in muscle.
c. subthreshold signals grow in size with distance.
d. subthreshold signals remain constant in size along the axon membrane.
e. subthreshold signals grow in size as time passes.
Difficulty: 1
Question ID: 2.1-76
Page Ref: 50
Topic: Conduction of the Action Potential
Skill: Conceptual
Answer: a. subthreshold signals degrade with distance from the point of stimulation.
Rationale: Subthreshold local potentials degrade with distance from the point of stimulation.

2.1-77. In a myelinated axon, ions can enter and leave the axonal membrane only at
a. the terminal buttons.
b. the soma.
c. the nodes of Ranvier.
d. the segment of membrane under the Schwann cell wrapping.
e. every point along the axonal membrane.
Difficulty: 2
Question ID: 2.1-77
Page Ref: 50
Topic: Conduction of the Action Potential
Skill: Conceptual
Answer: c. the nodes of Ranvier.
Rationale: Ions enter/leave the myelinated axon only at the nodes of Ranvier.

2.1-78. Which of the following is an important advantage associated with saltatory conduction?
a. More sodium ions have to be pumped out of the cell after an action potential.
b. Myelin allows the nerve cell to recycle neurotransmitter molecules.
c. Less transmitter is required to send a message across the next synapse.
d. Myelin speeds up the velocity at which an axon can conduct an action potential.
e. Myelin requires that nerve cell axons be larger in order to conduct a signal rapidly.

Difficulty: 3
Question ID: 2.1-78
Page Ref: 50
Topic: Conduction of the Action Potential
Skill: Conceptual
Answer: d. Myelin speeds up the velocity at which an axon can conduct an action potential.
Rationale: Myelin and saltatory conduction speed up the velocity at which an axon can conduct an action potential.

2.1-79. Which of the following was suggested as an advantage associated with myelination?
a. Myelin changes the height of the action potential.
b. Myelin increases the energy requirements of the nerve cell.
c. Myelin slows down conduction speed.
d. Myelin reduces the threshold for induction of an action potential.
e. Myelin speeds up axon conduction speed.
Difficulty: 2
Question ID: 2.1-79
Page Ref: 50
Topic: Conduction of the Action Potential
Skill: Conceptual
Answer: e. Myelin speeds up axon conduction speed.
Rationale: Myelin makes for more rapid communication of nerve signals.

2.1-80. Saltatory conduction is rapid because
a. cable properties carry the signal under the myelin sheath.
b. myelinated cells have more leakage through the membrane.
c. myelinated axons are larger in diameter.
d. myelinated cells have more ion channels per unit area than do non-myelinated cells.
e. myelinated fibers have a lower threshold of activation.
Difficulty: 2
Question ID: 2.1-80
Page Ref: 50
Topic: Conduction of the Action Potential
Skill: Conceptual
Answer: a. cable properties carry the signal under the myelin sheath.
Rationale: Saltatory conduction is rapid because the membrane potential does not have to depolarize each successive patch of membrane.

2.1-81. The term _____ is derived from the word meaning “little bladder.”
a. vesicle

b. neurite
c. cisternae
d. mitochondria
e. storage pool
Difficulty: 1
Question ID: 2.1-81
Page Ref: 52
Topic: Structure of Synapses
Skill: Factual
Answer: a. vesicle
Rationale: The term *vesicle* means "little bladder."

2.1-82. Which of the following is true of receptors?
a. The effects of hormones do not involve receptor activation.
b. Neurotransmitters act on binding sites on receptors to exert their effects.
c. Receptors are insensitive to drugs.
d. Neuromodulators are ligands that come from outside the body.
e. Hormone receptors are found in all tissues except brain.
Difficulty: 3
Question ID: 2.1-82
Page Ref: 56
Topic: Activation of Receptors
Skill: Conceptual
Answer: b. Neurotransmitters act on binding sites on receptors to exert their effects.
Rationale: Neurotransmitter molecules act on binding sites on receptors to exert their effects on the postsynaptic membrane.

2.1-83. Signals are carried across the synapse by
a. direct electrical connections between the two cells.
b. the secretion of transmitter molecules into the synapse.
c. the transfer of ions from one cell to another.
d. carrier molecules.
e. the sodium-potassium pump.
Difficulty: 2
Question ID: 2.1-83
Page Ref: 54
Topic: Release of Neurotransmitter
Skill: Conceptual
Answer: b. the secretion of transmitter molecules into the synapse.
Rationale: The signal from the presynaptic axon terminal is carried across the synapse by

secretion of a transmitter into the synapse.

2.1-84. Communication of neural signals across the synapse involves
a. the opening of transmitter -gated channels in the axon terminal.
b. voltage changes that open chloride channels in the presynaptic membrane.
c. vesicles that take up transmitter molecules into the axon terminal .
d. the binding of transmitter at postsynaptic receptors triggering membrane potentials.
e. direct electrical contact of the pre- and post-synaptic membranes.
Difficulty: 2
Question ID: 2.1-84
Page Ref: 54
Topic: Release of Neurotransmitter
Skill: Conceptual
Answer: d. the binding of transmitter at postsynaptic receptors triggering membrane potentials.
Rationale: Communication of neural signals across the synapse involves the release of a transmitter from the axon terminal, which binds to receptors on the postsynaptic membrane.

2.1-85. The largest number of small vesicles would be expected to be located within the _____ of a neuron.
a. dendritic spines
b. soma
c. postsynaptic membrane
d. release zone
e. axon hillock
Difficulty: 1
Question ID: 2.1-85
Page Ref: 53
Topic: Structure of Synapses
Skill: Conceptual
Answer: d. release zone
Rationale: The largest number of small vesicles would be expected to be located within the release zone of a neuron.

2.1-86. A large, dense-core vesicle found in the axon terminal is likely to contain
a. peptide neurotransmitters
b. neurotransmitter receptors.
c. enzymes that degrade transmitter molecules
d. synthesis peptides.
e. nonpeptide transmitter molecules.
Difficulty: 2

Question ID: 2.1-86
Page Ref: 53
Topic: Structure of Synapses
Skill: Conceptual
Answer: a. peptides.
Rationale: Peptide transmitters are located within large dense-core vesicles of the axon terminal.

2.1-87. Synaptic vesicles are produced in the _____.
a. neuron soma
b. dendrites
c. glial cells
d. neuron lysosomes
e. astrocytes
Difficulty: 2
Question ID: 2.1-87
Page Ref: 53
Topic: Structure of Synapses
Skill: Factual
Answer: a. neuron soma
Rationale: Synaptic vesicles are manufactured in the soma of the nerve cell.

2.1-88. Neurotransmitter release from the presynaptic membrane is triggered by the
a. activation of the sodium-potassium pumps.
b. arrival of an EPSP at the axon terminal.
c. influx of calcium ions into the axon terminal.
d. hyperpolarization of the axon membrane.
e. opening of channels within the microtubules.
Difficulty: 2
Question ID: 2.1-88
Page Ref: 55
Topic: Release of Neurotransmitter
Skill: Factual
Answer: c. influx of calcium ions into the axon terminal.
Rationale: Influx of calcium ions into the axon terminal triggers neurotransmitter release from the presynaptic membrane.

2.1-89. Placing neurons and their synaptic contacts into a medium containing no calcium ions would be expected to
a. decrease the time required to move sodium ions out of the axon terminal.
b. enhance the voltage changes associated with the action potential.

c. increase the number of transmitter molecules released from the axon terminal.
d. prolong the refractory period of the action potential.
e. prevent the release of neurotransmitter into the synapse.
Difficulty: 3
Question ID: 2.1-89
Page Ref: 55
Topic: Release of Neurotransmitter
Skill: Applied
Answer: e. prevent the release of neurotransmitter into the synapse.
Rationale: Maintaining a neuron is a low calcium medium would be expected to prevent the release of neurotransmitter into the synapse.

2.1-90. In order to produce a depolarization or hyperpolarization of the postsynaptic membrane, neurotransmitters
a. diffuse widely in the brain to exert changes in metabolism.
b. act through ionotropic receptors to activate a second-messenger. c. are released into the synapse from the cisternae.
d. open ion channels in the postsynaptic membrane. e. alter ion channel activity for minutes.
Difficulty: 1
Question ID: 2.1-90
Page Ref: 56
Topic: Activation of Receptors
Skill: Conceptual
Answer: d. open ion channels in the postsynaptic membrane.
Rationale: Neurotransmitters act to produce postsynaptic membrane potentials by opening or closing ion channels.

2.1-91. After a vesicle fuses with the presynaptic membrane and releases its contents into the synaptic cleft, the membrane is
a. destroyed by astrocytes.
b. incorporated into the postsynaptic membrane.
c. recycled to form new vesicles.
d. degraded and the debris removed from the axon terminal.
e. incorporated into the mitochondria.
Difficulty: 1
Question ID: 2.1-91
Page Ref: 55
Topic: Release of Neurotransmitter
Skill: Factual
Answer: c. recycled to form new vesicles.

Rationale: The membrane of vesicles are recycled.

2.1-92. Match up the correct receptor type and effect.
a. metabotropic; direct opening of an ion channel
b. ionotropic; more time required to open an ion channel
c. metabotropic; G protein activation leads to activation of a second-messenger
d. metabotropic; rapid opening of a single ion channel
e. metabotropic; rapid short-lived effects on ion channels
Difficulty: 3
Question ID: 2.1-92
Page Ref: 56-57
Topic: Activation of Receptors
Skill: Conceptual
Answer: c. metabotropic; G protein activation leads to activation of a second-messenger
Rationale: Metabotropic receptors act via G proteins which in turn act via activation/inactivation of a second-messenger molecule.

2.1-93. With regard to release of neurotransmitter in the brain, "kiss and run" refers to the situation in which the vesicle
a. releases most of its contents into the cleft and the vesicle remains attached to the presynaptic membrane.
b. closes before releasing any molecules and then moves to the cell interior.
c. remains open until the next action potential.
d. releases most of its contents into the cleft after which the vesicle breaks away from the presynaptic membrane and is refilled.
e. merges completely with the presynaptic membrane.
Difficulty: 2
Question ID: 2.1-93
Page Ref: 55
Topic: Release of Neurotransmitter
Skill: Factual
Answer: d. releases most of its contents into the cleft after which the vesicle breaks away from the presynaptic membrane and is refilled.
Rationale: "Kiss and run" refers to the situation in which a released vesicle releases most of its contents into the cleft after which the vesicle breaks away from the presynaptic membrane and is refilled.

2.1-94. Match up the correct receptor type and effect:
a. ionotropic; direct opening of an ion channel
b. ionotropic; more time required to open an ion channel

c. ionotropic; G protein activation leads to activation of a second-messenger
d. metabotropic; second-messenger effects are specific to neuronal communication
e. metabotropic; rapid short-lived effects on ion channels
Difficulty: 3
Question ID: 2.1-94
Page Ref: 56
Topic: Activation of Receptors
Skill: Conceptual
Answer: a. ionotropic; direct opening of an ion channel
Rationale: Activation of an ionotropic receptor results in the direct opening of a single ion channel.

2.1-95. Which of the following is true of metabotropic receptors?
a. Metabotropic receptors conserve energy.
b. Metabotropic receptors are slower than ionotropic receptors.
c. Metabotropic receptors control a single ion channel.
d. Metabotropic receptors are closely associated with an ion channel.
e. Metabotropic receptors are faster than ionotropic receptors.
Difficulty: 3
Question ID: 2.1-95
Page Ref: 57
Topic: Activation of Receptors
Skill: Conceptual
Answer: b. Metabotropic receptors are slower than ionotropic receptors.
Rationale: Metabotropic receptors are slower than ionotropic receptors because these involve the action of second messengers.

2.1-96. An EPSP will be produced when a ligand
a. opens a sodium channel.
b. closes a sodium channel.
c. opens a potassium channel.
d. closes a calcium channel.
e. closes a chloride channel.
Difficulty: 2
Question ID: 2.1-96
Page Ref: 57
Topic: Postsynaptic Potentials
Skill: Factual
Answer: a. opens a sodium channel.
Rationale: Opening a sodium channel will produce an EPSP.

2.1-97. An IPSP will be produced when a ligand
a. closes a sodium channel.
b. opens a sodium channel.
c. opens a potassium channel.
d. closes a calcium channel.
e. opens a calcium channel.
Difficulty: 2
Question ID: 2.1-97
Page Ref: 57
Topic: Postsynaptic Potentials
Skill: Factual
Answer: c. opens a potassium channel.
Rationale: Opening a chloride channel will produce an IPSP.

2.1-98. Which of the following will "neutralize" an EPSP?
a. further opening a sodium channel
b. allowing intracellular anions to leave the cell
c. closing a potassium channel
d. opening a chloride channel
e. opening a calcium channel
Difficulty: 4
Question ID: 2.1-98
Page Ref: 58
Topic: Postsynaptic Potentials
Skill: Conceptual
Answer: d. opening a chloride channel
Rationale: Opening a chloride channel will neutralize an EPSP.

2.1-99. The postsynaptic potentials induced by most neurotransmitters are ended by
a. disruption of the postsynaptic receptor.
b. enzymatic degradation of the transmitter molecule.
c. inhibition of transmitter synthesis.
d. facilitation of transmitter release.
e. reuptake of the molecule into the axon terminal.
Difficulty: 2
Question ID: 2.1-99
Page Ref: 58
Topic: Termination of Postsynaptic Potentials
Skill: Conceptual
Answer: e. reuptake of the molecule into the axon terminal.

Rationale: The reuptake process is the most common means of terminating a postsynaptic potential.

2.1-100. The postsynaptic potentials induced by acetylcholine are ended via
a. disruption of the nicotinic postsynaptic receptor.
b. enzymatic degradation via acetylcholinesterase.
c. inhibition of acetylcholine synthesis.
d. facilitation of acetylcholine release.
e. reuptake of acetylcholine.
Difficulty: 2
Question ID: 2.1-100
Page Ref: 59
Topic: Termination of Postsynaptic Potentials
Skill: Factual
Answer: b. enzymatic degradation via acetylcholinesterase.
Rationale: The postsynaptic action of ACh is ended by enzymatic degradation via acetylcholinesterase.

2.1-101. A drug that inactivates the enzyme acetylcholinesterase would be expected to
a. prolong the effects of acetylcholine in the synapse.
b. terminate the effects of acetylcholine in the synapse.
c. speed up the synthesis of acetylcholine.
d. impair the synthesis of acetylcholine.
e. activate the presynaptic autoreceptor for acetylcholine.
Difficulty: 3
Question ID: 2.1-101
Page Ref: 59
Topic: Termination of Postsynaptic Potentials
Skill: Applied
Answer: a. prolong the effects of acetylcholine in the synapse.
Rationale: The effects of acetylcholine in the synapse would be prolonged by a drug that inactivates the enzyme acetylcholinesterase.

2.1-102. Dr. Mary Walker used _____ to treat the muscle weakness associated with the disease _____.
a. atropine; myasthenia gravis
b. physostigmine; multiple sclerosis
c. acetylcholinesterase; diabetes
d. acetylcholinesterase; multiple sclerosis
e. physostigmine; myasthenia gravis

Difficulty: 3
Question ID: 2.1-102
Page Ref: 59
Topic: Termination of Postsynaptic Potentials
Skill: Applied
Answer: e. physostigmine; myasthenia gravis
Rationale: Physostigmine is used to treat the muscle weakness associated with the disease myasthenia gravis.

2.1-103. Autoreceptors are located on the _____ and detect _____.
a. presynaptic membrane; the transmitter released by that neuron
b. presynaptic membrane; a different transmitter released by another neuron
c. presynaptic membrane; the presence of calcium ions in the synapse
d. postsynaptic membrane; the presence of calcium ions located in the synapse
e. presynaptic membrane; the amount of second messenger activity in the postsynaptic cell
Difficulty: 2
Question ID: 2.1-103
Page Ref: 60
Topic: Autoreceptors
Skill: Factual
Answer: a. presynaptic membrane; the transmitter released by that neuron
Rationale: Autoreceptors located on the presynaptic membrane detect the transmitter released by that neuron and in turn dampen the release of that transmitter.

2.1-104. Autoreceptors
a. are sensitive to neuropeptides.
b. control the release of calcium ions from the axon terminal.
c. mostly facilitate neuron function.
d. are metabotropic.
e. control the formation of new dendritic spines.
Difficulty: 2
Question ID: 2.1-104
Page Ref: 60
Topic: Autoreceptors
Skill: Conceptual
Answer: d. are metabotropic.
Rationale: Autoreceptors are of the metabotropic type.

2.1-105. Presynaptic facilitation is associated with _____ synapses and involves a(n) _____ in the amount of transmitter released per action potential.

a. axodendritic; decrease
b. axosomatic; increase
c. gap junction; decrease
d. axoaxonic; increase
e. gap junction; increase
Difficulty: 2
Question ID: 2.1-105
Page Ref: 61
Topic: Other Types of Synapses
Skill: Factual
Answer: d. axoaxonic; increase
Rationale: Presynaptic facilitation is associated with axoaxonic synapses and involves an increase in the amount of transmitter released per action potential

2.1-106. Action potentials are generated at the _____ and are conducted along the _____.
a. axon hillock; axon
b. axon; dendrite
c. terminal buttons; dendrite
d. dendrite; glial membrane
e. axon button; glial membrane
Difficulty: 2
Question ID: 2.1- 106
Page Ref: 60
Topic: Effects of Postsynaptic Potentials: Neural Integration
Skill: Factual
Answer: a. axon hillock; axon
Rationale: Actions potentials are conducted along the axon after initiation at the axon hillock.

2.1-107. Neuromodulators
a. are usually amino acids.
b. directly elicit postsynaptic potentials.
c. are usually found in small vesicles in the axon terminal buttons.
d. diffuse widely to affect many neurons.
e. mostly involve presynaptic receptors
Difficulty: 2
Question ID: 2.1-107
Page Ref: 62
Topic: Nonsynaptic Chemical Communication
Skill: Factual
Answer: d. diffuse widely to affect many neurons

Rationale: Neuromodulators diffuse widely to affect many neurons in brain.

2.1-108. Neuromodulators are
a. rarely of a peptide form.
b. secreted from neurons, but dispersed widely in the brain.
c. inevitably inhibitory.
d. secreted from a neuron and only affect an adjacent neuron.
e. typically secreted in very small amounts compared to neurotransmitters.
Difficulty: 1
Question ID: 2.1-108
Page Ref: 62
Topic: Nonsynaptic Chemical Communication
Skill: Factual
Answer: b. are secreted from neurons, but dispersed widely in the brain.
Rationale: Neuromodulators are secreted from neurons, but dispersed widely in the brain.

2.1-109. Most _____ are secreted into the extracellular fluid from endocrine glands or tissues.
a. neurotransmitters
b. neuropeptides
c. modulators
d. hormones
e. pheromones
Difficulty: 1
Question ID: 2.1-109
Page Ref: 62-63
Topic: Nonsynaptic Chemical Communication
Skill: Factual
Answer: d. hormones
Rationale: Most hormones are secreted into the extracellular fluid from endocrine glands or tissues.

Fill-in-the-Blank Questions

2.2-1. _____ was the primary symptom shown by Kathryn D.
Difficulty: 1
Question ID: 2.2-1
Page Ref: 28
Topic: Introduction

Skill: Factual
Answer: Muscle weakness

2.2-2. Motor neurons control the activity of the _____.
Difficulty: 1
Question ID: 2.2-2
Page Ref: 28
Topic: Introduction
Skill: Factual
Answer: muscles

2.2-3. The central nervous system consists of the _____ and the _____.
Difficulty: 1
Question ID: 2.2-3
Page Ref: 29
Topic: Introduction
Skill: Factual
Answer: brain; spinal cord

2.2-4. _____ neurons are the most common type in the central nervous system.
Difficulty: 1
Question ID: 2.2-4
Page Ref: 30
Topic: Neurons
Skill: Factual
Answer: multipolar

2.2-5. The cell membrane is formed by a dual layer of _____ molecules.
Difficulty: 2
Question ID: 2.2-5
Page Ref: 31
Topic: Neurons
Skill: Factual
Answer: lipid

2.2-6. _____ are bead-like structures that extract energy from nutrients.
Difficulty: 2
Question ID: 2.2-6
Page Ref: 34
Topic: Neurons

Skill: Factual
Answer: Mitochondria

2.2-7. The myelin sheath surrounding axons in brain is formed by _____.
Difficulty: 3
Question ID: 2.2-7
Page Ref: 37
Topic: Supporting Cells
Skill: Factual
Answer: oligodendrocytes or oligodendroglia

2.2-8. Some chemicals are excluded from the brain due to selective permeability of the _____ barrier.
Difficulty: 2
Question ID: 2.2-8
Page Ref: 39
Topic: The Blood-Brain Barrier
Skill: Factual
Answer: blood-brain

2.2-9. In a neuron at rest, the interior of the cell is more _____ charged than is the exterior of the cell.
Difficulty: 1
Question ID: 2.2-9
Page Ref: 44
Topic: Measuring Electrical Potentials of Axons
Skill: Conceptual
Answer: negatively

2.2-10. The process of _____ ensures that ions will distribute themselves evenly through a solvent.
Difficulty: 2
Question ID: 2.2-10
Page Ref: 45
Topic: The Membrane Potential: Balance of Two Forces
Skill: Factual
Answer: diffusion

2.2-11. As it conducts along the axon membrane toward the terminal buttons, a subthreshold depolarization _____ in size.

Difficulty: 2
Question ID: 2.2-11
Page Ref: 50
Topic: Conduction of the Action Potential
Skill: Factual
Answer: decreases

2.2-12. In a myelinated axon, ions enter or leave the axon membrane only at the _____.
Difficulty: 2
Question ID: 2.2-12
Page Ref: 49-50
Topic: Conduction of the Action Potential
Skill: Factual
Answer: node of Ranvier

2.2-13. _____ speeds up the velocity at which an axon can conduct an action potential.
Difficulty: 1
Question ID: 2.2-13
Page Ref: 50
Topic: Conduction of the Action Potential
Skill: Factual
Answer: Myelin

2.2-14. The term _____ is derived from the word meaning "little bladder."
Difficulty: 1
Question ID: 2.2-14
Page Ref: 52
Topic: Structure of Synapses
Skill: Factual
Answer: vesicle

2.2-15. A large, dense-core vesicle is most likely to contain a _____.
Difficulty: 2
Question ID: 2.2-15
Page Ref: 53
Topic: Structure of Synapses
Skill: Factual
Answer: neuropeptide

2-2-16. The ion _____ is required for the release of neurotransmitter from the presynaptic

terminal.
Difficulty: 1
Question ID: 2.2-16
Page Ref: 55
Topic: Release of Neurotransmitter
Skill: Factual
Answer: calcium

2.2-17. _____ receptors involve the direct opening of an ion channel, whereas metabotropic receptors involve the action of second messenger molecules inside the postsynaptic cell.
Difficulty: 2
Question ID: 2.2-17
Page Ref: 56-57
Topic: Activation of Receptors
Skill: Factual
Answer: Ionotropic

2.2-18. A _____ myelinated fiber will conduct action potentials more rapidly than will a thin myelinated fiber.
Difficulty: 2
Question ID: 2.2-18
Page Ref: 50
Topic: Conduction of the Action Potential
Skill: Factual
Answer: large

2.2-19. The effects of acetylcholine are prolonged by drugs that inactivate the enzyme _____.
Difficulty: 3
Question ID: 2.2-19
Page Ref: 59
Topic: Termination of Postsynaptic Potentials
Skill: Factual
Answer: ACHe or acetylcholinesterase

2.2-20. _____ are metabotropic receptors located in the presynaptic membrane that provide negative feedback onto transmitter release.
Difficulty: 2
Question ID: 2.2-20
Page Ref: 60

Topic: Autoreceptors
Skill: Factual
Answer: Autoreceptors

Essay Questions

2.3-1. Describe the organelles that comprise the neuron soma.
Difficulty: 2
Question ID: 2.3-1
Page Ref: 34-35
Topic: Neurons
Skill: Factual
Answer: The organelles lie within the cytoplasm of the neuron. The soma organelles include

- Ribosomes produce proteins.
- Endoplasmic reticulum: Rough ER contains the ribosomes (produces proteins). Smooth ER synthesizes lipids.
- Microtubules: Responsible for transport around the interior of the neuron.
- Mitochondria: Provide energy to the neuron.
- Lysosomes: Degrade surplus cellular materials.
- Golgi apparatus: Package the products of a secretory cell.

2.3-2. Compare and contrast the general functions of the three glial cell types in the brain.
Difficulty: 2
Question ID: 2.3-2
Page Ref: 35-39
Topic: Supporting Cells
Skill: Factual
Answer: Oligodendrocytes form CNS myelin, which speeds up neural conduction speed. Astroglia provide support and nutrition for neurons. Microglia are involved in brain immune function.

2.3-3. Explain how changes in ion movements can result in an action potential.
Difficulty: 2
Question ID: 2.3-4
Page Ref: 44
Topic: The Action Potential
Skill: Factual
Answer: At rest, the interior of the axon membrane has more negative charges relative to the exterior. Movement of positive charges (sodium) into the axon results in the action potential (a

rapid reversal of the membrane potential).

2.3-4. What property of the neuron membrane produces the "all-or-none" law?
Difficulty: 3
Question ID: 2.3-5
Page Ref: 47-49
Topic: Conduction of the Action Potential
Skill: Conceptual
Answer: Voltage-gated ion channels of the axon membrane remain closed until the membrane potential reaches threshold (a fixed voltage). If the membrane potential reaches threshold, an action potential occurs; if not, no action potential occurs.

2.3-5. Explain what is meant by decremental conduction.
Difficulty: 2
Question ID: 2.3-6
Page Ref: 50
Topic: Conduction of the Action Potential
Skill: Factual
Answer: A subthreshold local potential degrades in size as it sweeps along the axon membrane (non-myelinated).

2.3-6. Explain how the presence of myelin on an axon speeds up conduction velocity.
Difficulty: 3
Question ID: 2.3-7
Page Ref: 49-50
Topic: Conduction of the Action Potential
Skill: Conceptual
Answer: In saltatory conduction, the axon is wrapped in a fatty membrane called myelin, which insulates the membrane from the extracellular fluid. In this case, the action potential does not have to depolarize every segment of membrane, only those at the widely separated nodes of Ranvier (gaps between the myelin segments).

2.3-7. Contrast ionotropic and metabotropic receptors.
Difficulty: 1
Question ID: 2.3-8
Page Ref: 56-57
Topic: Activation of Receptors
Skill: Conceptual
Answer: Ionotropic receptors directly control ion channels, whereas metabotropic receptors use a series of intermediate steps, involving G-proteins, to modulate distant ion channels.

2.3-8. What would you expect to happen if the enzyme AChE were to be disabled in your body?
Difficulty: 2
Question ID: 2.3-9
Page Ref: 59
Topic: Termination of Postsynaptic Potentials
Skill: Factual
Answer: The ACh activity in your body would greatly increase, because AChE normally serves to degrade ACh. Later, this would lead to overstimulation of cholinergic receptors.

2.3-9. Explain why the termination step of the neural communication process is a key target for therapeutic drugs.
Difficulty: 3
Question ID: 2.3-10
Page Ref: 58-59
Topic: Termination of Postsynaptic Potentials
Skill: Conceptual
Answer: The postsynaptic action of many neurotransmitters is terminated via reuptake of the molecule through the membrane transporter or through enzymatic inactivation. A drug that blocks such a transporter would be expected to raise the synaptic levels of that neurotransmitter, as would a drug that blocks the enzymatic degradation step. For a disease or disorder that is thought to result from a low synaptic activity of that transmitter, blockade of the reuptake or enzymatic process would generate a beneficial effect.

2.3.10. Explain how autoreceptors dampen neuronal activity.
Difficulty: 2
Question ID: 2.3-11
Page Ref: 60-61
Topic: Autoreceptors
Skill: Conceptual
Answer: Autoreceptors are sensitive to the transmitter released by a particular neuron. Activation of the autoreceptor produces negative feedback -- either reduced cell firing or reduced synthesis/release of the transmitter. The net effect is to modulate the amount of transmitter in the synapse (and at the postsynaptic receptors).