

MULTIPLE CHOICE QUESTIONS

For all questions, select the single best answer unless otherwise directed.

1. The membrane potential of a particular cell is at the K⁺ equilibrium. The intracellular concentration for K⁺ is at 150 mmol/L and the extracellular concentration for K⁺ is at 5.5 mmol/L. What is the resting potential?

- A. -70 mv
- B. -90 mv
- C. +70 mv
- D. +90 mv

2. The difference in concentration of H⁺ in a solution of pH 2.0 compared with one of pH 7.0 is

- A. 5-fold
- B. 1/5 as much
- C. 105 fold
- D. 10⁻⁵ as much

3. Transcription refers to

- A. the process where an mRNA is used as a template for protein production.
- B. the process where a DNA sequence is copied into RNA for the purpose of gene expression.
- C. the process where DNA wraps around histones to form a nucleosome.
- D. the process of replication of DNA prior to cell division.

4. The primary structure of a protein refers to

- A. the twist, folds, or twist and folds of the amino acid sequence into stabilized structures within the protein (ie, α -helices and β -sheets).
- B. the arrangement of subunits to form a functional structure.
- C. the amino acid sequence of the protein.
- D. the arrangement of twisted chains and folds within a protein into a stable structure.

5. Fill in the blanks: Glycogen is a storage form of glucose. _____ refers to the process of making glycogen and _____ refers to the process of breakdown of glycogen.

- A. Glycogenolysis, glycogenesis
- B. Glycolysis, glycogenolysis
- C. Glycogenesis, glycogenolysis
- D. Glycogenolysis, glycolysis

6. The major lipoprotein source of the cholesterol used in cells is

- A. chylomicrons
- B. intermediate-density lipoproteins (IDLs)
- C. albumin-bound free fatty acids

- D. LDL
- E. HDL

7. Which of the following produces the most high-energy phosphate compounds?

- A. aerobic metabolism of 1 mol of glucose
- B. anaerobic metabolism of 1 mol of glucose
- C. metabolism of 1 mol of galactose
- D. metabolism of 1 mol of amino acid
- E. metabolism of 1 mol of long-chain fatty acid

8. When LDL enters cells by receptor-mediated endocytosis, which of the following does not occur?

- A. Decrease in the formation of cholesterol from mevalonic acid.
- B. Increase in the intracellular concentration of cholesteryl esters.
- C. Increase in the transfer of cholesterol from the cell to HDL.
- D. Decrease in the rate of synthesis of LDL receptors.
- E. Decrease in the cholesterol in endosomes.

Chapter 2

1. The electrogenic Na, K ATPase plays a critical role in cellular physiology by

- A. using the energy in ATP to extrude 3 Na⁺ out of the cell in exchange for taking two K⁺ into the cell.
- B. using the energy in ATP to extrude 3 K⁺ out of the cell in exchange for taking two Na⁺ into the cell.
- C. using the energy in moving Na⁺ into the cell or K⁺ outside the cell to make ATP.
- D. using the energy in moving Na⁺ outside of the cell or K⁺ inside the cell to make ATP.

2. Cell membranes

- A. contain relatively few protein molecules.
- B. contain many carbohydrate molecules.
- C. are freely permeable to electrolytes but not to proteins.
- D. have variable protein and lipid contents depending on their location in the cell.
- E. have a stable composition throughout the life of the cell.

3. Second messengers

- A. are substances that interact with first messengers outside cells.
- B. are substances that bind to first messengers in the cell membrane.
- C. are hormones secreted by cells in response to stimulation by another hormone.
- D. mediate the intracellular responses to many different hormones and neurotransmitters.
- E. are not formed in the brain.

4. The Golgi complex

- A. is an organelle that participates in the breakdown of proteins and lipids.
- B. is an organelle that participates in posttranslational processing of proteins.
- C. is an organelle that participates in energy production.

- D. is an organelle that participates in transcription and translation.
- E. is a subcellular compartment that stores proteins for trafficking to the nucleus.

5. Endocytosis

- A. includes phagocytosis and pinocytosis, but not clathrin-mediated or caveolae-dependent uptake of extracellular contents.
- B. refers to the merging of an intracellular vesicle with the plasma membrane to deliver intracellular contents to the extracellular milieu.
- C. refers to the invagination of the plasma membrane to uptake extracellular contents into the cell.
- D. refers to vesicular trafficking between Golgi stacks.

6. G protein-coupled receptors

- A. are intracellular membrane proteins that help to regulate movement within the cell.
- B. are plasma membrane proteins that couple the extracellular binding of primary signaling molecules to exocytosis.
- C. are plasma membrane proteins that couple the extracellular binding of primary signaling molecules to the activation of heterotrimeric G proteins.
- D. are intracellular proteins that couple the binding of primary messenger molecules with transcription.

7. Gap junctions are intercellular connections that

- A. primarily serve to keep cells separated and allow for transport across a tissue barrier.
- B. serve as a regulated cytoplasmic bridge for sharing of small molecules between cells.
- C. serve as a barrier to prevent protein movement within the cellular membrane.
- D. are cellular components for constitutive exocytosis that occurs between adjacent cells.

8. F-actin is a component of the cellular cytoskeleton that

- A. provides a structural component for cell movement.
- B. is defined as the "functional" form of actin in the cell.
- C. refers to the actin subunits that provide the molecular building blocks of the extended actin molecules found in the cell.
- D. provide the molecular architecture for cell to cell communication.

Chapter 3

1. In an experiment, a scientist treats a group of mice with an antiserum that substantially depletes the number of circulating neutrophils. Compared with untreated control animals, the mice with reduced numbers of neutrophils were found to be significantly more susceptible to death induced by bacterial inoculation. The increased mortality can be ascribed to a relative deficit in which of the following?

- A. Acquired immunity
- B. Oxidants
- C. Platelets
- D. Granulocyte/macrophage colony stimulating factor (GM-CSF)
- E. Integrins

2. A 20-year-old college student comes to the student health center in April complaining of runny nose and congestion, itchy eyes, and wheezing. She reports that similar symptoms have occurred at the same time each year, and that she

obtains some relief from over-the-counter antihistamine drugs, although they make her too drowsy to study. Her symptoms can most likely be attributed to inappropriate synthesis of which of the following antibodies specific for tree pollen?

- A. IgA
- B. IgD
- C. IgE
- D. IgG
- E. IgM

3. If a nasal biopsy were performed on the patient described in Question 2 while symptomatic, histologic examination of the tissue would most likely reveal degranulation of which of the following cell types?

- A. Dendritic cells
- B. Lymphocytes
- C. Neutrophils
- D. Monocytes
- E. Mast cells

4. A biotechnology company is working to design a new therapeutic strategy for cancer that involves triggering an enhanced immune response to cellular proteins that are mutated in the disease.

Which of the following immune cells or processes will most likely not be required for a successful therapy?

- A. Cytotoxic T cells
- B. Antigen presentation in the context of MHC-II
- C. Proteosomal degradation
- D. Gene rearrangements producing T cell receptors
- E. The immune synapse

5. The ability of the blood to phagocytose pathogens and mount a respiratory burst is increased by

- A. interleukin-2 (IL-2)
- B. granulocyte colony-stimulating factor (G-CSF)
- C. erythropoietin
- D. interleukin-4 (IL-4)
- E. interleukin-5 (IL-5)

6. Cells responsible for innate immunity are activated most commonly by

- A. glucocorticoids
- B. pollen
- C. carbohydrate sequences in bacterial cell walls
- D. eosinophils
- E. thrombopoietin

7. A patient suffering from an acute flare in his rheumatoid arthritis undergoes a procedure where fluid is removed from his swollen and inflamed knee joint.

Biochemical analysis of the inflammatory cells recovered from the removed fluid would most likely reveal a decrease in which of the following proteins?

- A. Interleukin 1
- B. Tumor necrosis factor- α
- C. Nuclear factor- κ B
- D. IkBa

E. von Willbrand factor

Chapter 4

1. Which of the following statements about glia is true?

- A. Microglia arise from macrophages outside of the nervous system and are physiologically and embryologically similar to other neural cell types.
- B. Glia do not undergo proliferation.
- C. Protoplasmic astrocytes produce substances that are tropic to neurons to help maintain the appropriate concentration of ions and neurotransmitters by taking up K^+ and the neurotransmitters glutamate and GABA.
- D. Oligodendrocytes and Schwann cells are involved in myelin formation around axons in the peripheral and central nervous systems, respectively.
- E. Macroglia are scavenger cells that resemble tissue macrophages and remove debris resulting from injury, infection, and disease.

2. A 13-year-old girl was being seen by her physician because of experiencing frequent episodes of red, painful, warm extremities. She was diagnosed with primary erythromelalgia, which may be due to a peripheral nerve sodium channelopathy.

Which part of a neuron has the highest concentration of Na^+ channels per square micrometer of cell membrane?

- A. dendrites
- B. cell body near dendrites
- C. initial segment
- D. axonal membrane under myelin
- E. none of Ranvier

3. A 45-year-old female office worker had been experiencing tingling in her index and middle fingers and thumb of her right hand. Recently, her wrist and hand had become weak. Her physician ordered a nerve conduction test to evaluate her for carpal tunnel syndrome. Which one of the following nerves has the slowest conduction velocity?

- A. A α fibers
- B. A β fibers
- C. A γ fibers
- D. B fibers
- E. C fibers

4. Which of the following is *not* correctly paired?

- A. Synaptic transmission: Antidromic conduction
- B. Molecular motors: Dynein and kinesin
- C. Fast axonal transport: ~400 mm/day
- D. Slow axonal transport: 0.5–10 mm/day
- E. Nerve growth factor: Retrograde transport

5. A 32-year-old female received an injection of a local anesthetic for a tooth extraction. Within 2 h, she noted palpitations, diaphoresis, and dizziness. Which of the following ionic changes is correctly matched with a component of the action potential?

- A. Opening of voltage-gated K⁺ channels: After hyperpolarization
- B. A decrease in extracellular Ca²⁺ : Repolarization
- C. Opening of voltage-gated Na⁺ channels: Depolarization
- D. Rapid closure of voltage-gated Na⁺ channels: Resting membrane potential
- E. Rapid closure of voltage-gated K⁺ channels: Relative refractory period

6. A man falls into a deep sleep with one arm under his head. This arm is paralyzed when he awakens, but it tingles, and pain sensation in it is still intact. The reason for the loss of motor function without loss of pain sensation is that in the nerves to his arm,

- A. fibers are more susceptible to hypoxia than B fibers.
- B. A fibers are more sensitive to pressure than C fibers.
- C. C fibers are more sensitive to pressure than A fibers.
- D. Motor nerves are more affected by sleep than sensory nerves.
- E. Sensory nerves are nearer the bone than motor nerves and hence are less affected by pressure.

7. Which of the following statements about nerve growth factor is *not* true?

- A. It is made up of three polypeptide subunits.
- B. It is responsible for the growth and maintenance of adrenergic neurons in the basal forebrain and the striatum.
- C. It is necessary for the growth and development of the sympathetic nervous system.
- D. It is picked up by nerves from the organs they innervate.
- E. It can express both p75N TR and Trk A receptors.

8. A 20-year old female student awakens one morning with severe pain and blurry vision in her left eye; the symptoms abate over several days. About 6 months later, on a morning after playing volleyball with friends, she notices weakness but not pain in her right leg; the symptoms intensify while taking a hot shower. Which of the following is most likely to be the case?

- A. The two episodes described are not likely to be related.
- B. She may have primary-progressive multiple sclerosis.
- C. She may have relapsing-remitting multiple sclerosis.
- D. She may have a lumbar disk rupture.
- E. She may have Guillain-Barre syndrome.

1. The action potential of skeletal muscle

- A. has a prolonged plateau phase.
- B. spreads inward to all parts of the muscle via the T tubules.
- C. causes the immediate uptake of Ca^{2+} into the lateral sacs of the sarcoplasmic reticulum.
- D. is longer than the action potential of cardiac muscle.
- E. is not essential for contraction.

2. The functions of tropomyosin in skeletal muscle include

- A. sliding on actin to produce shortening.
- B. releasing Ca^{2+} after initiation of contraction.
- C. binding to myosin during contraction.
- D. acting as a "relaxing protein" at rest by covering up the sites where myosin binds to actin.
- E. generating ATP, which it passes to the contractile mechanism.

3. The cross-bridges of the sarcomere in skeletal muscle are made up of

- A. actin.
- B. myosin.
- C. troponin.
- D. tropomyosin.
- E. myelin.

4. The contractile response in skeletal muscle

- A. starts after the action potential is over.
- B. does not last as long as the action potential.
- C. produces more tension when the muscle contracts isometrically than when the muscle contracts isotonicly.
- D. produces more work when the muscle contracts isometrically than when the muscle contracts isotonicly.
- E. decreases in magnitude with repeated stimulation.

5. Gap junctions

- A. are absent in cardiac muscle.
- B. are present but of little functional importance in cardiac muscle.
- C. are present and provide the pathway for rapid spread of excitation from one cardiac muscle fiber to another.
- D. are absent in smooth muscle.
- E. connect the sarcotubular system to individual skeletal muscle cells.

Chapter 6

1. Which of the following electrophysiological events is correctly paired with the change in ionic currents causing the event?

- A. Fast inhibitory postsynaptic potentials (IPSPs) and closing of Cl^- channels.
- B. Fast excitatory postsynaptic potentials (EPSPs) and an increase in Ca^{2+} conductance.
- C. End plate potential and an increase in Na^+ conductance.
- D. Presynaptic inhibition and closure of voltage-gated K^+ channels.
- E. Slow EPSPs and an increase in K^+ conductance.

2. Which of the following physiological processes is not correctly paired with a structure?

- A. Electrical transmission: gap junction
- B. Negative feedback inhibition: Renshaw cell
- C. Synaptic vesicle docking and fusion: presynaptic nerve terminal
- D. End plate potential: muscarinic cholinergic receptor
- E. Action potential generation: initial segment

3. Initiation of an action potential in skeletal muscle

- A. requires spatial facilitation.
- B. requires temporal facilitation.
- C. is inhibited by a high concentration of Ca²⁺ at the neuromuscular junction.
- D. requires the release of norepinephrine.
- E. requires the release of acetylcholine.

4. A 35-year-old woman sees her physician to report muscle weakness in the extraocular eye muscles and muscles of the extremities. She states that she feels fine when she gets up in the morning, but the weakness begins soon after she becomes active. The weakness is improved by rest. Sensation appears normal. The physician treats her with an anticholinesterase inhibitor, and she notes immediate return of muscle strength. Her physician diagnoses her with

- A. Lambert–Eaton syndrome.
- B. myasthenia gravis.
- C. multiple sclerosis.
- D. Parkinson disease.
- E. muscular dystrophy.

5. A 55-year-old female had an autonomic neuropathy which disrupted the sympathetic nerve supply to the pupillary dilator muscle of her right eye. While having her eyes examined, the ophthalmologist placed phenylephrine in her eyes. The right eye became much more dilated than the left eye.

This suggests that

- A. the sympathetic nerve to the right eye had regenerated.
- B. the parasympathetic nerve supply to the right eye remained intact and compensated for the loss of the sympathetic nerve.
- C. phenylephrine blocked the pupillary constrictor muscle of the right eye.
- D. denervation supersensitivity had developed.
- E. the left eye also had nerve damage and so was not responding as expected.

6. A 47-year-old female was admitted to the hospital after reporting that she had been experiencing nausea and vomiting for about two days and then developed severe muscle weakness and neurological symptoms including ptosis and dysphagia.

She indicated she had eaten at a restaurant the evening before the symptoms began. Lab tests were positive for *Clostridium botulinum*. Neurotoxins block the reuptake

- A. of neurotransmitters into presynaptic terminals.
- B. such as tetanus toxin bind reversibly to the presynaptic membrane at the neuromuscular junction.
- C. reach the cell body of the motor neuron by diffusion into the spinal cord.
- D. exert all of their adverse effects by acting centrally rather than peripherally.
- E. such as botulinum toxin prevent the release of acetylcholine from motor neurons due to cleavage of either synaptosome-associated proteins or vesicle-associated membrane proteins.

Chapter 7

1. Which of the following statements about neurotransmitters is true?

- A. All neurotransmitters are derived from amino acid precursors.
- B. Small molecule neurotransmitters include dopamine, histamine, ATP, glycine, enkephalin, and norepinephrine.
- C. Large molecule transmitters include ATP, cannabinoids, substance P, and vasopressin.
- D. Norepinephrine can act as a neurotransmitter in the periphery and a neuromodulator in the CNS.
- E. Nitrous oxide is a neurotransmitter in the CNS.

2. Which of the following statements is *not* true?

- A. Neuronal glutamate is synthesized in glia by the enzymatic conversion from glutamine and then diffuses into the neuronal terminal where it is sequestered into vesicles until released by an influx of Ca^{2+} into the cytoplasm after an action potential reaches the nerve terminal.
- B. After release of serotonin into the synaptic cleft, its actions are terminated by reuptake into the presynaptic nerve terminal, an action that can be blocked by tricyclic antidepressants.
- C. Norepinephrine is the only small-molecule transmitter that is synthesized in synaptic vesicles instead of being transported into the vesicle after its synthesis.
- D. Each nicotinic cholinergic receptor is made up of five subunits that form a central channel which, when the receptor is activated, permits the passage of Na^{+} and other cations.
- E. GABA transaminase converts glutamate to GABA; the vesicular GABA transporter transports both GABA and glycine into synaptic vesicles.

3. Which of the following receptors is correctly identified as an ionotropic or a G protein-coupled receptor (GPCR)?

- A. Neurokinin receptor: ionotropic
- B. Nicotinic receptor: GPCR
- C. GABA A receptor: ionotropic
- D. NMDA receptor: GPCR
- E. Glycine: GPCR

4. A 27-year-old male was brought to the emergency room and presented with symptoms of opioid intoxication.

He was given an intravenous dose of naloxone. Endogenous opioids

- A. bind to both ionotropic receptors and GPCR.
- B. include morphine, endorphins, and dynorphins.
- C. show the following order of affinity for δ receptors: dynorphins > endorphins.
- D. show the following order of affinity for μ receptors: dynorphins > endorphins.
- E. show the following order of affinity for κ receptors: endorphins > enkephalins.

5. A 38-year-old woman was sent to a psychiatrist after she reported to her primary care physician that she had difficulty sleeping (awakening at 4 am frequently for the past few months) and a lack of appetite causing a weight loss of over 20 lbs. She also said she no longer enjoyed going out with her friends or doing volunteer service for underprivileged children.

What type of drug is her doctor most likely to suggest as an initial step in her therapy?

- A. Serotonergic A receptor antagonist.
- B. An inhibitor of neuronal uptake of serotonin.
- C. An inhibitor of monoamine oxidase.
- D. An amphetamine-like drug.

E. A drug that causes an increase in both serotonin and dopamine.

6. A 55-year-old woman had been on long-term treatment with phenelzine for her depression. One night she was at a party where she consumed Chianti wine, aged cheddar cheese, processed meats, and dried fruits. She then developed a severe headache, chest pain, rapid heartbeat, enlarged pupils, increased sensitivity to light, and nausea. What is the most likely cause of these symptoms?

- A. The foods were contaminated with botulinum toxin.
- B. She had a myocardial infarction.
- C. She experienced a migraine headache.
- D. She had an adverse reaction to the mixture of alcohol with her antidepressant.
- E. She had a hypertensive crisis from eating foods high in tyramine while taking a monoamine oxidase inhibitor for her depression.

Chapter 8

1. A 28-year-old male was seen by a neurologist because he had experienced prolonged episodes of tingling and numbness in his right arm. He underwent a neurological exam to evaluate his sensory nervous system. Which of the following receptors is correctly paired with the type of stimulus to which it is most apt to respond?

- A. Pacinian corpuscle and motion.
- B. Meissner's corpuscle and deep pressure.
- C. Merkel cells and warmth.
- D. Ruffini corpuscles and sustained pressure.
- E. Muscle spindle and tension.

2. Nociceptors

- A. are activated by strong pressure, severe cold, severe heat, and chemicals.
- B. are absent in visceral organs.
- C. are specialized structures located in the skin and joints.
- D. are innervated by group II afferents.
- E. are involved in acute but not chronic pain.

3. A generator potential

- A. always leads to an action potential.
- B. increases in amplitude as a more intense stimulus is applied.
- C. is an all-or-none phenomenon.
- D. is unchanged when a given stimulus is applied repeatedly over time.
- E. all of the above.

4. Sensory systems code for the following attributes of a stimulus:

- A. modality, location, intensity, and duration
- B. threshold, receptive field, adaptation, and discrimination
- C. touch, taste, hearing, and smell
- D. threshold, laterality, sensation, and duration
- E. sensitization, discrimination, energy, and projection

5. Which of the following are correctly paired?

- A. Neuropathic pain and withdrawal reflex
- B. First pain and dull, intense, diffuse, and unpleasant feeling

- C. Physiological pain and allodynia
- D. Second pain and C fibers
- E. Nociceptive pain and nerve damage

6. A 32-year-old female experienced the sudden onset of a severe cramping pain in the abdominal region. She also became nauseated. Visceral pain

- A. shows relatively rapid adaptation.
- B. is mediated by B fibers in the dorsal roots of the spinal nerves.
- C. is poorly localized.
- D. resembles "fast pain" produced by noxious stimulation of the skin.
- E. causes relaxation of nearby skeletal muscles.

7. A ventrolateral cordotomy is performed that produces relief of pain in the right leg. It is effective because it interrupts the

- A. left dorsal column.
- B. left ventrolateral spinothalamic tract.
- C. right ventrolateral spinothalamic tract.
- D. right medial lemniscal pathway.
- E. a direct projection to the primary somatosensory cortex.

8. Which of the following CNS regions is *not* correctly paired with a neurotransmitter or a chemical involved in pain modulation?

- A. Periaqueductal gray matter and morphine
- B. Nucleus raphe magnus and norepinephrine
- C. Spinal dorsal horn and enkephalin
- D. Dorsal root ganglion and opioids
- E. Spinal dorsal horn and serotonin

9. A 47-year-old female experienced migraine headaches that were not relived by her current pain medications. Her doctor prescribed one of the newer analgesic agents that exert their effects by targeting synaptic transmission in nociception and peripheral sensory transduction. Which of the following drugs is correctly paired with the type of receptor it acts on to exert its antinociceptive effects?

- A. Topiramate and Na⁺ channel
- B. Ziconotide and NMDA receptors
- C. Naloxone and opioid receptors
- D. Lidocaine and TRPV1 channels
- E. Gabapentin and Nav1.8

10. A 40-year-old man loses his right hand in a farm accident. Four years later, he has episodes of severe pain in the missing hand (phantom limb pain). A detailed PET scan study of his cerebral cortex might be expected to show

- A. expansion of the right hand area in his right primary somatosensory cortex.
- B. expansion of the right-hand area in his left primary somatosensory cortex.
- C. a metabolically inactive spot where his hand area in his left primary somatosensory cortex would normally be.
- D. projection of fibers from neighboring sensory areas into the right-hand area of his right primary somatosensory cortex.
- E. projection of fibers from neighboring sensory areas into the right-hand area of his left primary somatosensory cortex.

11. A 50-year-old woman undergoes a neurological exam that indicates loss of pain and temperature sensitivity, vibratory sense, and proprioception in the left leg. These symptoms could be explained by

- A. a tumor on the right medial lemniscal pathway in the sacral spinal cord.
- B. a peripheral neuropathy.
- C. a tumor on the left medial lemniscal pathway in the sacral spinal cord.
- D. a tumor affecting the right posterior paracentral gyrus.
- E. a large tumor in the right lumbar ventrolateral spinal cord.

Chapter 9

1. A visual exam in an 80-year-old man shows he has a reduced ability to see objects in the upper and lower quadrants of the left visual fields of both eyes but some vision remains in the central regions of the visual field. The diagnosis is

- A. central scotoma.
- B. heteronymous hemianopia with macular sparing.
- C. lesion of the optic chiasm.
- D. homonymous hemianopia with macular sparing.
- E. retinopathy.

2. A 45-year-old female who had never needed to wear glasses experienced difficulty reading a menu in a dimly-lit restaurant. She then recalled that as of late she needed to have the newspaper closer to her eyes in order to read it. A friend recommended she purchase reading glasses. Visual accommodation involves

- A. increased tension on the lens ligaments.
- B. a decrease in the curvature of the lens.
- C. relaxation of the sphincter muscle of the iris.
- D. contraction of the ciliary muscle.
- E. increased intraocular pressure.

3. A 28-year-old male with severe myopia made an appointment to see his ophthalmologist when he began to notice flashing lights and floaters in his visual field. He was diagnosed with a retinal detachment. The retina

- A. is epithelial tissue that contains photoreceptors.
- B. lines the anterior one-third of the choroid.
- C. has an inner nuclear layer that contains bipolar cells, horizontal cells, and amacrine cells.
- D. contains ganglion cells whose axons form the oculomotor nerve.
- E. contains an optic disk where visual acuity is greatest.

4. A 62-year-old Caucasian woman experienced a rapid onset of blurry vision along with loss of central vision. A comprehensive eye exam showed that she had wet age-related macular degeneration. The fovea of the eye

- A. has the lowest light threshold.
- B. is the region of highest visual acuity.
- C. contains only red and green cones.
- D. contains only rods.
- E. is situated over the head of the optic nerve.

5. Which of the following parts of the eye has the greatest concentration of rods?

- A. Ciliary body
- B. Iris
- C. Optic disk
- D. Fovea
- E. Parafoveal region

6. Which of the following is *not* correctly paired?

- A. Rhodopsin: retinal and opsin
- B. Obstruction of the canal of Schlemm: elevated intraocular pressure
- C. Myopia: convex lenses
- D. Astigmatism: nonuniform curvature of the cornea
- E. Inner segments of rods and cones: synthesis of the photosensitive compounds

7. The correct sequence of events involved in phototransduction in rods and cones in response to light is:

- A. activation of transducin, decreased release of glutamate, structural changes in rhodopsin, closure of Na⁺ channels, and decrease in intracellular cGMP.
- B. decreased release of glutamate, activation of transducin, closure of Na⁺ channels, decrease in intracellular cGMP, and structural changes in rhodopsin.
- C. structural changes in rhodopsin, decrease in intracellular cGMP, decreased release of glutamate, closure of Na⁺ channels, and activation of transducin.
- D. structural changes in rhodopsin, activation of transducin, decrease in intracellular cGMP, closure of Na⁺ channels, and decreased release of glutamate.
- E. activation of transducin, structural changes in rhodopsin, closure of Na⁺ channels, decrease in intracellular cGMP, and decreased release of glutamate.

8. A 25-year-old medical student spent a summer volunteering in the sub-Saharan region of Africa. There he noted a high incidence of people reporting difficulty with night vision due to a lack of vitamin A in their diet. Vitamin A is a precursor for the synthesis of

- A. rods and cones.
- B. retinal.
- C. rod transducin.
- D. opsin.
- E. cone transducin.

9. An 11-year-old male was having difficulty reading the graphs that his teacher was showing at the front of classroom. His teacher recommended he be seen by an ophthalmologist. Not only was he asked to look at a Snellen letter chart for visual acuity but he was also asked to identify numbers in an Ishihara chart. He responded that he merely saw a bunch of dots. Abnormal color vision is 20 times more common in men than women because most cases are caused by an abnormal

- A. dominant gene on the Y chromosome.
- B. recessive gene on the Y chromosome.
- C. dominant gene on the X chromosome.
- D. recessive gene on the X chromosome.
- E. recessive gene on chromosome 22

10. Which of the following is *not* involved in color vision?

- A. Activation of a pathway that signals differences between S cone responses and the sum of L and M cone responses
- B. Geniculate layers 3-6

- C. P pathway
- D. Area V3A of visual cortex
- E. Area V8 of visual cortex

11. A 56-year-old female was diagnosed with a tumor near the base of the skull, impinging on her optic tract. Which of the following statements about the central visual pathway is correct?

- A. The fibers from each temporal hemiretina decussate in the optic chiasm, so that the fibers in the optic tracts are those from the temporal half of one retina and the nasal half of the other.
- B. In the geniculate body, the fibers from the nasal half of one retina and the temporal half of the other synapse on the cells whose axons form the geniculocalcarine tract.
- C. Layers 2 and 3 of the visual cortex contain clusters of cells called globs that contain a high concentration of cytochrome oxidase.
- D. Complex cells have a preferred orientation of a linear stimulus and, compared to simple cells, are more dependent on the location of the stimulus within the visual field.
- E. The visual cortex is arranged in horizontal columns that are concerned with orientation.



Chapter 10

1. A 45-year-old woman visited her physician after experiencing sudden onset of vertigo, tinnitus and hearing loss in her left ear, nausea, and vomiting. This was the second episode in the past few months. She was referred to an otolaryngologist to rule out Meniere's disease. Which of the following statements correctly describe the functions of the external, middle, or inner ear?

- A. Sound waves are funneled through the external ear to the external auditory meatus and then they pass inward to the tympanic membrane.
- B. The cochlea of the inner ear contains receptors for hearing, semicircular canals contain receptors that respond to head tilt, and the otolith organs contain receptors that respond to rotation.
- C. Contraction of the tensor tympani and stapedius muscles of the middle ear cause the manubrium of the malleus to be pulled outward and the footplate of the stapes to be pulled inward.
- D. Sound waves are transformed by the eardrum and auditory ossicles into movements of the foot plate of the malleus.
- E. The semicircular canals, the utricle, and the saccule of the middle ear are concerned with equilibrium.

2. A 45-year-old male with testicular cancer underwent chemotherapy treatment with cisplatin. He reported several adverse side effects including changes in taste, numbness and tingling in his fingertips, and reduced sound clarity. When the damage to the outer hair cells is greater than the damage to the inner hair cells,

- A. perception of vertical acceleration is disrupted.
- B. K⁺ concentration in endolymph is decreased.
- C. K⁺ concentration in perilymph is decreased.
- D. there is severe hearing loss.
- E. affected hair cells fail to shorten when exposed to sound.

3. Which of the following statements is correct?

- A. The motor protein for inner hair cells is prestin.
- B. The auditory ossicles function as a lever system to convert the resonant vibrations of the tympanic membrane into movements of the stapes against the endolymph-filled scala tympani.
- C. The loudness of a sound is directly correlated with the amplitude of a sound wave, and pitch is inversely correlated with the frequency of the sound wave.
- D. Conduction of sound waves to the fluid of the inner ear via the tympanic membrane and the auditory ossicles is called bone conduction.
- E. High-pitched sounds generate waves that reach maximum height near the base of the cochlea; low-pitched sounds generate waves that peak near the apex.

4. A 40-year-old male, employed as a road construction worker for nearly 20 years, went to his physician to report that he recently began to notice difficulty hearing during normal conversations. A Weber test showed that sound from a vibrating tuning fork was localized to the right ear. A Schwabach test showed that bone conduction was below normal. A Rinne test showed that both air and bone conduction were abnormal, but air conduction lasted longer than bone conduction. The diagnosis was:

- A. sensorial deafness in both ears.
- B. conduction deafness in the right ear.
- C. sensorial deafness in the right ear.
- D. conduction deafness in the left ear.
- E. sensorineural deafness in the left ear.

5. What would the diagnosis be if a patient had the following test results? Weber test showed that sound from a vibrating tuning fork was louder than normal; Schwabach test showed that bone conduction was better than normal; and Rinne test showed that air conduction did not outlast bone conduction.

- A. Sensorial deafness in both ears.
- B. Conduction deafness in both ears.
- C. Normal hearing.
- D. Both sensorial and conduction deafness.
- E. A possible tumor on the eighth cranial nerve.

6. The auditory pathway

- A. and vestibular pathway contains a synapse in the cerebellum.
- B. and vestibular pathway project to the same regions of the cerebral cortex.
- C. is comprised of afferent fibers of the eighth cranial nerve, the dorsal and ventral cochlear nuclei, the superior colliculi, the lateral geniculate body, and the auditory cortex.
- D. is comprised of afferent fibers of the eighth cranial nerve, the dorsal and ventral cochlear nuclei, the inferior colliculi, the medial geniculate body, and the auditory cortex.
- E. is not subject to plasticity like the visual pathways.

7. A healthy male medical student volunteered to undergo evaluation of the function of his vestibular system for a class demonstration. The direction of his nystagmus is expected to be vertical when he is rotated

- A. after warm water is put in one of his ears.
- B. with his head tipped backward.
- C. after cold water is put in both of his ears.
- D. with his head tipped sideways.
- E. with his head tipped forward.

8. In the utricle, tip links in hair cells are involved in

- A. formation of perilymph.

- B. depolarization of the stria vascularis.
- C. movements of the basement membrane.
- D. perception of sound.
- E. regulation of distortion-activated ion channels.

9. Postrotatory nystagmus is caused by continued movement of

- A. aqueous humor over the ciliary body in the eye.
- B. cerebrospinal fluid over the parts of the brain stem that contain the vestibular nuclei.
- C. endolymph in the semicircular canals, with consequent bending of the cupula and stimulation of hair cells.
- D. endolymph toward the helicotrema.
- E. perilymph over hair cells that have their processes embedded in the tectorial membrane.

10. A patient enters the hospital for evaluation of deafness. He is found to also have an elevated plasma renin, although his blood pressure is 118/75 mm Hg. Mutation of what single gene may explain these findings?

- A. The gene for barttin
- B. The gene for Na⁺ channel
- C. The gene for renin
- D. The gene for cystic fibrosis transmembrane conductance regulator
- E. The gene for tyrosine hydroxylase



Chapter 11

1. A young boy was diagnosed with congenital anosmia, a rare disorder in which an individual is born without the ability to smell. Odorant receptors are

- A. located in the olfactory bulb.
- B. located on dendrites of mitral and tufted cells.
- C. located on neurons that project directly to the olfactory cortex.
- D. located on neurons in the olfactory epithelium that project to mitral cells and from there directly to the olfactory cortex.
- E. located on sustentacular cells that project to the olfactory bulb.

2. A 37-year-old female was diagnosed with multiple sclerosis.

One of the potential consequences of this disorder is diminished taste sensitivity. Taste receptors

- A. for sweet, sour, bitter, salt, and umami are spatially separated on the surface of the tongue.
- B. are synonymous with taste buds.
- C. are a type of chemoreceptor.
- D. are innervated by afferents in the facial, trigeminal, and glossopharyngeal nerves.
- E. all of the above

3. Which of the following does *not* increase the ability to discriminate many different odors?

- A. Many different receptors.
- B. Pattern of olfactory receptors activated by a given odorant.
- C. Projection of different mitral cell axons to different parts of the brain.
- D. High β -arrestin content in olfactory neurons.
- E. Sniffing.

4. As a result of an automobile accident, a 10-year-old boy suffered damage to the brain including the periamygdaloid, piriform, and entorhinal cortices. Which of the following sensory deficits is he most likely to experience?

- A. Visual disturbance
- B. Hyperosmia
- C. Auditory problems
- D. Taste and odor abnormalities
- E. No major sensory deficits

5. Which of the following are *incorrectly* paired?

- A. ENaC : Sour taste
- B. Gustducin : Bitter taste
- C. T1R3 family of GPCR : Sweet taste
- D. Heschel sulcus : Smell
- E. Ebner glands : Taste acuity

6. A 9-year-old boy had frequent episodes of uncontrollable nose bleeds. At the advice of his physician, he underwent surgery to correct a problem in his nasal septum. A few days after the surgery, he told his mother he could not smell the cinnamon rolls she was baking in the oven. Which of the following is true about olfactory transmission?

- A. An olfactory sensory neuron expresses a wide range of odorant receptors.
- B. Lateral inhibition within the olfactory glomeruli reduces the ability to distinguish between different types of odorant receptors.
- C. Conscious discrimination of odors is dependent on the pathway to the orbitofrontal cortex.
- D. Olfaction is closely related to gustation because odorant and gustatory receptors use the same central pathways.
- E. All of the above.

7. A 31-year-old female is a smoker who has had poor oral hygiene for most of her life. In the past few years she has noticed a reduced sensitivity to the flavors in various foods which she used to enjoy eating. Which of the following is *not* true about gustatory sensation?

- A. The sensory nerve fibers from the taste buds on the anterior two-thirds of the tongue travel in the chorda tympani branch of the facial nerve.
- B. The sensory nerve fibers from the taste buds on the posterior third of the tongue travel in the petrosal branch of the glossopharyngeal nerve.
- C. The pathway from taste buds on the left side of the tongue is transmitted ipsilaterally to the cerebral cortex.
- D. Sustentacular cells in the taste buds serve as stem cells to permit growth of new taste buds.
- E. The pathway from taste receptors includes synapses in the nucleus of the tractus solitarius in the brain stem and ventral posterior medial nucleus in the thalamus.

8. A 20-year-old woman was diagnosed with Bell palsy (damage to facial nerve). Which of the following symptoms is she likely to exhibit?

- A. Loss of sense of taste
- B. Facial twitching
- C. Droopy eyelid
- D. Ipsilateral facial paralysis
- E. All of the above

Chapter 12

1. When dynamic γ -motor neurons are activated at the same time as α -motor neurons to muscle,

- A. prompt inhibition of discharge in spindle Ia afferents takes place.
- B. clonus is likely to occur.
- C. the muscle will not contract.
- D. the number of impulses in spindle Ia afferents is smaller than when a discharge alone is increased.
- E. the number of impulses in spindle Ia afferents is greater than when a discharge alone is increased.

2. The inverse stretch reflex

- A. occurs when Ia spindle afferents are inhibited.
- B. is a monosynaptic reflex initiated by activation of the Golgi tendon organ.
- C. is a disynaptic reflex with a single interneuron inserted between the afferent and efferent limbs.
- D. is a polysynaptic reflex with many interneurons inserted between the afferent and efferent limbs.
- E. uses type II afferent fibers from the Golgi tendon organ.

3. Withdrawal reflexes are *not*

- A. initiated by nociceptive stimuli.
- B. prepotent.
- C. prolonged if the stimulus is strong.
- D. an example of a flexor reflex.
- E. accompanied by the same response on both sides of the body.

4. While exercising, a 42-year-old female developed sudden onset of tingling in her right leg and an inability to control movement in that limb. A neurological exam showed a hyperactive knee jerk reflex and a positive Babinski sign. Which of the following is *not* characteristic of a reflex?

- A. Reflexes can be modified by impulses from various parts of the CNS.
- B. Reflexes may involve simultaneous contraction of some muscles and relaxation of others.
- C. Reflexes are chronically suppressed after spinal cord transection.
- D. Reflexes involve transmission across at least one synapse.
- E. Reflexes often occur without conscious perception.

5. Increased neural activity before a skilled voluntary movement is *first* seen in the

- A. spinal motor neurons.
- B. precentral motor cortex.
- C. midbrain.
- D. cerebellum.
- E. cortical association areas.

6. A 58-year-old woman was brought to the emergency room of her local hospital because of a sudden change of consciousness. All four limbs were extended,

suggestive of decerebrate rigidity. A brain CT showed a rostral pontine hemorrhage. Which of the following describes components of the central pathway responsible for control of posture?

- A. The tectospinal pathway terminates on neurons in the dorsolateral area of the spinal ventral horn that innervate limb muscles.
- B. The medullary reticulospinal pathway terminates on neurons in the ventromedial area of the spinal ventral horn that innervate axial and proximal muscles.
- C. The pontine reticulospinal pathway terminates on neurons in the dorsomedial area of the spinal ventral horn that innervate limb muscles.
- D. The medial vestibular pathway terminates on neurons in the dorsomedial area of the spinal ventral horn that innervate axial and proximal muscles.
- E. The lateral vestibular pathway terminates on neurons in the dorsolateral area of the spinal ventral horn that innervate axial and proximal muscles.

7. A 38-year-old female had been diagnosed with a metastatic brain tumor. She was brought to the emergency room of her local hospital because of irregular breathing and progressive loss of consciousness. She also showed signs of decerebrate posturing. Which of the following is *not* true about decerebrate rigidity?

- A. It involves hyperactivity in extensor muscles of all four limbs.
- B. The excitatory input from the reticulospinal pathway activates γ -motor neurons which indirectly activate α -motor neurons.
- C. It is actually a type of spasticity due to inhibition of the stretch reflex.
- D. It resembles what ensues after uncal herniation.
- E. Lower extremities are extended with toes pointed inward

8. Which of the following describes a connection between components of the basal ganglia?

- A. The subthalamic nucleus releases glutamate to excite the globus pallidus, internal segment.
- B. The substantia nigra pars reticulata releases dopamine to inhibit the striatum.
- C. The substantia nigra pars compacta releases dopamine to excite the globus pallidus, external segment.
- D. The striatum releases acetylcholine to excite the substantia nigra pars reticulata.
- E. The globus pallidus, external segment releases glutamate to excite the striatum.

9. A 60-year old male was diagnosed 15 years ago with Parkinson disease. He has been taking Sinemet and, until recently, has been able to continue to work and help with routine jobs around the house. Now his tremor and rigidity interfere with these activities. His physician has suggested that he undergo deep brain stimulation therapy. The therapeutic effect of L-dopa in patients with Parkinson disease eventually wears off because

- A. antibodies to dopamine receptors develop.
- B. inhibitory pathways grow into the basal ganglia from the frontal lobe.
- C. there is an increase in circulating α synuclein.
- D. the normal action of nerve growth factor (NGF) is disrupted.
- E. the dopaminergic neurons in the substantia nigra continue to degenerate.

10. An 8-year-old girl was brought to her pediatrician because her parents noted frequent episodes of gait unsteadiness and speech difficulties. Her mother was concerned because of a family history of Friedreich's ataxia. Which of the following is a correct description of connections involving cerebellar neurons?

- A. Basket cells release glutamate to activate Purkinje cells.

- B. Climbing fiber inputs exert a strong excitatory effect on Purkinje cells, and mossy fiber inputs exert a strong inhibitory effect on Purkinje cells.
- C. Granule cells release glutamate to excite basket cells and stellate cells.
- D. The axons of Purkinje cells are the sole output of the cerebellar cortex, and they release glutamate to excite the deep cerebellar nuclei.
- E. Golgi cells are inhibited by mossy fiber collaterals.

11. After falling down a flight of stairs, a young woman is found to have partial loss of voluntary movement on the right side of her body and loss of pain and temperature sensation on the left side below the midthoracic region. It is probable that she has a lesion

- A. transecting the left half of the spinal cord in the lumbar region.
- B. transecting the left half of the spinal cord in the upper thoracic region.
- C. transecting sensory and motor pathways on the right side of the pons.
- D. transecting the right half of the spinal cord in the upper thoracic region.
- E. transecting the dorsal half of the spinal cord in the upper thoracic region.

12. At the age of 30, a male postal worker reported weakness in his right leg. Within a year the weakness had spread to his entire right side. A neurological examination revealed flacid paralysis, muscular atrophy, fasciculations, hypotonia, and hyporeflexia of muscles in the right arm and leg. Sensory and cognitive function tests were normal. Which of the following diagnosis is likely?

- A. A large tumor in the left primary motor cortex.
- B. A cerebral infarct in the region of the corona radiata.
- C. A vestibulocerebellar tumor.
- D. Damage to the basal ganglia.
- E. Amyotrophic lateral sclerosis.



Chapter 13

1. A 26-year-old male developed hypertension after he began taking amphetamine to boost his energy and to suppress his appetite. Which of the following drugs would be expected to mimic the effects of increased sympathetic discharge on blood vessels?

- A. Phenylephrine
- B. Trimethaphan
- C. Atropine
- D. Reserpine
- E. Albuterol

2. A 35-year-old female was diagnosed with multiple system atrophy and had symptoms indicative of failure of sympathetic nerve activity. Which of the following statements about the sympathetic nervous system is correct?

- A. All postganglionic sympathetic nerves release norepinephrine from their terminals.
- B. Cell bodies of preganglionic sympathetic neurons are located in the intermediolateral column of the thoracic and sacral spinal cord.
- C. The sympathetic nervous system is required for survival.
- D. Acetylcholine is released from all sympathetic preganglionic nerve terminals.

E. The sympathetic nervous system adjusts pupillary diameter by relaxing the pupillary constrictor muscle.

3. A 45-year-old male had a meal containing wild mushrooms that he picked in a field earlier in the day. Within a few hours after eating, he developed nausea, vomiting, diarrhea, urinary urgency, vasodilation, sweating, and salivation. Which of the following statements about the parasympathetic nervous system is correct?

- A. Postganglionic parasympathetic nerves release acetylcholine to activate muscarinic receptors on sweat glands.
- B. Parasympathetic nerve activity affects only smooth muscles and glands.
- C. Parasympathetic nerve activity causes contraction of smooth muscles of the gastrointestinal wall and relaxation of the gastrointestinal sphincter.
- D. Parasympathetic nerve activity causes contraction of the radial muscle of the eye to allow accommodation for near vision.
- E. An increase in parasympathetic activity causes an increase in heart rate.

4. Which of the following is correctly paired?

- A. Sinoatrial node: Nicotinic cholinergic receptors
- B. Autonomic ganglia: Muscarinic cholinergic receptors
- C. Pilomotor smooth muscle: β 2 -adrenergic receptors
- D. Vasculature of some skeletal muscles: Muscarinic cholinergic receptors
- E. Sweat glands: α 2 -adrenergic receptors

5. A 57-year-old male had severe hypertension that was found to result from a tumor compressing on the surface of the medulla. Which one of the following statements about pathways involved in the control of sympathetic nerve activity is correct?

- A. Preganglionic sympathetic nerves receive inhibitory input from the rostral ventrolateral medulla.
- B. The major source of excitatory input to preganglionic sympathetic nerves is the paraventricular nucleus of the hypothalamus.
- C. The activity of sympathetic preganglionic neurons can be affected by the activity of neurons in the amygdala.
- D. Unlike the activity in δ -motor neurons, sympathetic preganglionic neurons are not under any significant reflex control.
- E. Under resting conditions, the sympathetic nervous system is not active; it is active only during stress giving rise to the term "flight or fight" response.

6. A 53-year-old female with diabetes was diagnosed with diabetic autonomic neuropathy a few years ago. She recently noted abdominal distension and a feeling of being full after eating only a small portion of food, suggesting the neuropathy had extended to her enteric nervous system to cause gastroparesis. Which of the following statements about the enteric nervous system is correct?

- A. The enteric nervous system is a subdivision of the parasympathetic nervous system for control of gastrointestinal function.
- B. The myenteric plexus is a group of motor neurons located within circular layer of muscle in a portion of the gastrointestinal tract.
- C. The submucosal plexus is a group of sensory neurons located between the circular muscle and the luminal mucosa of the gastrointestinal tract.
- D. Neurons comprising the enteric nervous system are located only in the stomach and intestine.
- E. The enteric nervous system can function independent of the autonomic innervation to the gastrointestinal tract.

Chapter 14

1. In a healthy, alert adult sitting with their eyes closed, the dominant EEG rhythm observed with electrodes over the occipital lobes is

- A. delta (0.5–4 Hz).
- B. theta (4–7 Hz).
- C. alpha (8–13 Hz).
- D. beta (18–30 Hz).
- E. fast, irregular low-voltage activity.

2. A 35-year-old male spent the evening in a sleep clinic to determine whether he had obstructive sleep apnea. The tests showed that NREM sleep accounted for over 30% of his total sleep time. Which of the following pattern of changes in central neurotransmitters or neuromodulators are associated with the transition from NREM to wakefulness?

- A. Decrease in norepinephrine, increase in serotonin, increase in acetylcholine, decrease in histamine, and decrease in GABA.
- B. Decrease in norepinephrine, increase in serotonin, increase in acetylcholine, decrease in histamine, and increase in GABA.
- C. Decrease in norepinephrine, decrease in serotonin, increase in acetylcholine, increase in histamine, and increase in GABA.
- D. Increase in norepinephrine, increase in serotonin, decrease in acetylcholine, increase in histamine, and decrease in GABA.
- E. Increase in norepinephrine, decrease in serotonin, decrease in acetylcholine, increase in histamine, and decrease in GABA.

3. A gamma rhythm (30–80 Hz)

- A. is characteristic of seizure activity.
- B. is seen in an individual who is awake but not focused.
- C. may be a mechanism to bind together sensory information into a single percept and action.
- D. is independent of thalamocortical loops.
- E. is generated in the hippocampus.

4. For the past several months, a 67-year-old female experienced difficulty initiating and/or maintaining sleep several times a week. A friend suggested that she take melatonin to regulate her sleep–wake cycle. Melatonin secretion would probably not be increased by

- A. stimulation of the superior cervical ganglia.
- B. intravenous infusion of tryptophan.
- C. intravenous infusion of epinephrine.
- D. stimulation of the optic nerve.
- E. induction of pineal hydroxyindole-O-methyltransferase.

5. A 10-year-old boy was diagnosed with childhood absence epilepsy. His EEG showed a bilateral synchronous, symmetrical 3-Hz spike-and-wave discharge. Absence seizures

- A. are a form of nonconvulsive generalized seizures accompanied by momentary loss of consciousness.
- B. are a form of complex partial seizures accompanied by momentary loss of consciousness.
- C. are a form of nonconvulsive generalized seizures without a loss of consciousness.
- D. are a form of simple partial seizures without a loss of consciousness.
- E. are a form of convulsive generalized seizures accompanied by momentary loss of consciousness.

6. A 57-year-old professor at a medical school experienced numerous episodes of a sudden loss of muscle tone and an irresistible urge to sleep in the middle of the afternoon. He was diagnosed with narcolepsy which

- A. is characterized by a sudden onset of NREM sleep.
- B. has a familial incidence associated with a class II antigen of the major histocompatibility complex.
- C. may be due to the presence of an excessive number of orexin-producing neurons in the hypothalamus.
- D. is often effectively treated with dopamine receptor agonists.
- E. is the most common cause of daytime sleepiness.



Chapter 15

1. A 17-year-old male suffered a traumatic brain injury as a result of a motor cycle accident. He was unconscious and was rushed to the emergency room of the local hospital. A CT scan was performed and appropriate interventions were taken.

About

6 months later he still had memory deficits. Which of the following is correctly paired to show the relationship between a brain area and a type of memory?

- A. Hippocampus and implicit memory
- B. Neocortex and associative learning
- C. Medial temporal lobe and declarative memory
- D. Angular gyrus and procedural memory
- E. Striatum and priming

2. The optic chiasm and corpus callosum are sectioned in a dog, and with the right eye covered, the animal is trained to bark when it sees a red square. The right eye is then uncovered and the left eye covered. The animal will now

- A. fail to respond to the red square because the square does not produce impulses that reach the right occipital cortex.
- B. fail to respond to the red square because the animal has bitemporal hemianopia.
- C. fail to respond to the red square if the posterior commissure is also sectioned.
- D. respond to the red square only after retraining.
- E. respond promptly to the red square in spite of the lack of input to the left occipital cortex.

3. A 32-year-old male had medial temporal lobe epilepsy for over 10 years. This caused bilateral loss of hippocampal function. As a result, this individual might be expected to experience a

- A. disappearance of remote memories.
- B. loss of working memory.
- C. loss of the ability to encode events of the recent past into long-term memory.
- D. loss of the ability to recall faces and forms but not the ability to recall printed or spoken words.

E. production of inappropriate emotional responses when recalling events of the recent past.

4. A 70-year-old woman fell down a flight of stairs, hitting her head on the concrete sidewalk. The trauma caused a severe intracranial hemorrhage. The symptoms she might experience are dependent on the area of the brain most affected. Which of the following is *incorrectly* paired?

- A. Damage to the parietal lobe of the representational hemisphere: Unilateral inattention and neglect
- B. Loss of cholinergic neurons in the nucleus basalis of Meynert and related areas of the forebrain: Loss of recent memory
- C. Damage to the mammillary bodies: Loss of recent memory
- D. Damage to the angular gyrus in the categorical hemisphere: Nonfluent aphasia
- E. Damage to Broca's area in the categorical hemisphere: Slow speech

5. The representational hemisphere is better than the categorical hemisphere at

- A. language functions.
- B. recognition of objects by their form.
- C. understanding printed words.
- D. understanding spoken words.
- E. mathematical calculations.

6. A 67-year-old female suffered a stroke that damaged the posterior end of the superior temporal gyrus . A lesion of Wernicke's area in the categorical hemisphere causes her to

- A. lose her short-term memory.
- B. experience nonfluent aphasia in which she speaks in a slow, halting voice.
- C. experience *deja vu*.
- D. talk rapidly but make little sense, which is characteristic of fluent aphasia.
- E. lose the ability to recognize faces, which is called prosopagnosia.

7. Which of the following is most likely *not* involved in production of LTP?

- A. NO
- B. Ca²⁺
- C. NMDA receptors
- D. Membrane hyperpolarization
- E. Membrane depolarization

8. A 79-year-old woman has been experiencing difficulty finding her way back home after her morning walks. Her husband has also noted that she takes much longer to do routine chores around the home and often appears to be confused. He is hoping that this is just due to "old age" but fears it may be a sign of Alzheimer disease. Which of the following is the definitive sign of this disease?

- A. Loss of short-term memory.
- B. The presence of intracellular neurofibrillary tangles and extracellular neuritic plaques with a core of β -amyloid peptides.
- C. A mutation in genes for amyloid precursor protein (APP) on chromosome 21.
- D. Rapid reversal of symptoms with the use of acetylcholinesterase inhibitors.
- E. A loss of cholinergic neurons in the nucleus basalis of Meynert.

Chapter 17

1. Thirst is stimulated by

- A. increases in plasma osmolality and volume.
- B. an increase in plasma osmolality and a decrease in plasma volume.
- C. a decrease in plasma osmolality and an increase in plasma volume.
- D. decreases in plasma osmolality and volume.
- E. injection of vasopressin into the hypothalamus.

2. When an individual is naked in a room in which the air temperature is 21°C (69.8°F) and the humidity 80%, the greatest amount of heat is lost from the body by

- A. elevated metabolism.
- B. respiration.
- C. urination.
- D. vaporization of sweat.
- E. radiation and conduction.

In questions 3–8, select A if the item is associated with (a) below, B if the item is associated with (b) below, C if the item is associated with both (a) and (b), and D if the item is associated with neither (a) nor (b).

(a) V 1A vasopressin receptors

(b) V 2 vasopressin receptors

- 3. Activation of G_s
- 4. Vasoconstriction
- 5. Increase in intracellular inositol triphosphate
- 6. Movement of aquaporin
- 7. Proteinuria
- 8. Milk ejection

Chapter 18

1. A neuroscientist is studying communication between the hypothalamus and pituitary in a rat model. She interrupts blood flow through the median eminence and then measures circulating levels of pituitary hormones following appropriate physiological stimulation. Secretion of which of the following hormones will be unaffected by the experimental manipulation?

- A. Growth hormone
- B. Prolactin
- C. Thyroid stimulating hormone
- D. Follicle-stimulating hormone
- E. Vasopressin

2. Which of the following pituitary hormones is an opioid peptide?

- A. α -melanocyte-stimulating hormone (α -MSH)
- B. β -MSH
- C. ACTH
- D. Growth hormone
- E. β -endorphin

3. During childbirth, a woman suffers a serious hemorrhage and goes into shock. After she recovers, she displays symptoms of hypopituitarism. Which of the following will not be expected in this patient?

- A. Cachexia
- B. Infertility

- C. Pallor
- D. Low basal metabolic rate
- E. Intolerance to stress

4. A scientist finds that infusion of growth hormone into the median eminence of the hypothalamus in experimental animals inhibits the secretion of growth hormone and concludes that this proves that growth hormone feeds back to inhibit GHRH secretion. Do you accept this conclusion?

No, because growth

- A. hormone does not cross the blood–brain barrier.
- B. No, because the infused growth hormone could be stimulating dopamine secretion.
- C. No, because substances placed in the median eminence could be transported to the anterior pituitary.
- D. Yes, because systemically administered growth hormone inhibits growth hormone secretion.
- E. Yes, because growth hormone binds GHRH, inactivating it.

5. The growth hormone receptor

- A. activates G s .
- B. requires dimerization to exert its effects.
- C. must be internalized to exert its effects.
- D. resembles the IGF-I receptor.
- E. resembles the ACTH receptor.

Chapter 19

1. A 40-year-old woman comes to her primary care physician complaining of nervousness and an unexplained weight loss of 20 pounds over the past 3 months despite her impression that she is eating all the time. On physical examination, her eyes are found to be protruding, her skin is moist and warm, and her fingers have a slight tremor. Compared to a normal individual, a biopsy of her thyroid gland would most likely reveal which of the following:

- A. Decreased numbers of reabsorption lacunae
- B. Decreased evidence of endocytosis
- C. A decrease in the cross-sectional area occupied by colloid
- D. Increased levels of NIS in the basolateral membrane of thyrocytes
- E. Decreased evidence of lysosomal activity

2. Which of the following is *not* essential for normal biosynthesis of thyroid hormones?

- A. Iodine
- B. Ferritin
- C. Thyroglobulin
- D. Protein synthesis
- E. TSH

3. Increasing intracellular I – due to the action of NIS is an example of

- A. Endocytosis
- B. Passive diffusion
- C. Na + and K + cotransport
- D. Primary active transport
- E. Secondary active transport

4. The metabolic rate is *least* affected by an increase in the plasma level of

- A. TSH
- B. TRH
- C. TBG
- D. Free T₄
- E. Free T₃

5. In which of the following conditions is it *most* likely that the TSH response to TRH will be reduced?

- A. Hypothyroidism due to tissue resistance to thyroid hormone
- B. Hypothyroidism due to disease destroying the thyroid gland
- C. Hyperthyroidism due to circulating antithyroid antibodies with TSH activity
- D. diffuse hyperplasia of thyrotropes of the anterior pituitary
- E. Iodine deficiency

6. Hypothyroidism due to disease of the thyroid gland is associated with increased plasma levels of

- A. Cholesterol
- B. Albumin
- C. RT₃
- D. Iodide
- E. TBG

7. A young woman has puffy skin and a hoarse voice. Her plasma TSH concentration is low but increases markedly when she is given TRH. She probably has

- A. hyperthyroidism due to a thyroid tumor.
- B. hypothyroidism due to a primary abnormality in the thyroid gland.
- C. hypothyroidism due to a primary abnormality in the pituitary gland.
- D. hypothyroidism due to a primary abnormality in the hypothalamus.
- E. hyperthyroidism due to a primary abnormality in the hypothalamus.

8. The enzyme primarily responsible for the conversion of T₄ to T₃ in the periphery is

- A. D₁ thyroid deiodinase
- B. D₂ thyroid deiodinase
- C. D₃ thyroid deiodinase
- D. Thyroid peroxidase
- E. None of the above

9. Which of the following would be *least* affected by injections of TSH?

- A. Thyroidal uptake of iodine
- B. Synthesis of thyroglobulin
- C. Cyclic adenosine monophosphate (AMP) in thyroid cells
- D. Cyclic guanosine monophosphate (GMP) in thyroid cells
- E. Size of the thyroid

10. Thyroid hormone receptors bind to DNA in which of the following forms?

- A. A heterodimer with the prolactin receptor
- B. A heterodimer with the growth hormone receptor
- C. A heterodimer with the retinoid X receptor
- D. A heterodimer with the insulin receptor

E. A heterodimer with the progesterone receptor

Chapter 20

1. Which of the following is produced only by large amounts of glucocorticoids?

- A. Normal responsiveness of fat depots to norepinephrine
- B. Maintenance of normal vascular reactivity
- C. Increased excretion of a water load
- D. Inhibition of the inflammatory response
- E. Inhibition of ACTH secretion

2. Which of the following are incorrectly paired?

- A. Gluconeogenesis : Cortisol
- B. Free fatty acid mobilization: Dehydroepiandrosterone
- C. Muscle glycogenolysis: Epinephrine
- D. Kaliuresis : Aldosterone
- E. Hepatic glycogenesis: Insulin

3. Which of the following hormones has the shortest plasma half-life?

- A. Corticosterone
- B. Renin
- C. Dehydroepiandrosterone
- D. Aldosterone
- E. Norepinephrine

4. Mole for mole, which of the following has the greatest effect on Na⁺ excretion?

- A. Progesterone
- B. Cortisol
- C. Vasopressin
- D. Aldosterone
- E. Dehydroepiandrosterone

5. Mole for mole, which of the following has the greatest effect on plasma osmolality?

- A. Progesterone
- B. Cortisol
- C. Vasopressin
- D. Aldosterone
- E. Dehydroepiandrosterone

6. The secretion of which of the following would be least affected by a decrease in extracellular fluid volume?

- A. CRH
- B. Arginine vasopressin
- C. Dehydroepiandrosterone
- D. Estrogens
- E. Aldosterone

7. A young man presents with a blood pressure of 175/110 mm Hg. He is found to have a high circulating aldosterone but a low circulating cortisol. Glucocorticoid treatment lowers his circulating aldosterone and lowers his blood pressure to 140/85 mm Hg. He probably has an abnormal

- A. 17 α -hydroxylase.
- B. 21 β -hydroxylase.
- C. 3 β -hydroxysteroid dehydrogenase.
- D. aldosterone synthase.
- E. cholesterol desmolase.

8. A 32-year-old woman presents with a blood pressure of 155/96 mm Hg. In response to questioning, she admits that she loves licorice and eats some at least three times a week. She probably has a low level of

- A. type 2 11 β -hydroxysteroid dehydrogenase activity.
- B. ACTH.
- C. 11 β -hydroxylase activity.
- D. glucuronyl transferase.
- E. norepinephrine.

9. In its action in cells, aldosterone

- A. increases transport of ENaCs from the cytoplasm to the cell membrane.
- B. does not act on the cell membrane.
- C. binds to a receptor excluded from the nucleus.
- D. may activate a heat shock protein.
- E. also binds to glucocorticoid receptors.

Chapter 21

1. A patient with parathyroid deficiency 10 days after inadvertent damage to the parathyroid glands during thyroid surgery would probably have

- A. low plasma phosphate and Ca²⁺ levels and tetany.
- B. low plasma phosphate and Ca²⁺ levels and tetanus.
- C. a low plasma Ca²⁺ level, increased muscular excitability, and spasm of the muscles of the upper extremity (Trousseau sign).
- D. high plasma phosphate and Ca²⁺ levels and bone demineralization.
- E. increased muscular excitability, a high plasma Ca²⁺ level, and bone demineralization.

2. In an experiment, a rat is infused with a small volume of a calcium chloride solution, or sodium chloride as a control.

Compared to the control condition, which of the following would result from the calcium load?

- A. Bone demineralization.
- B. Increased formation of 1,25 dihydroxycholecalciferol.
- C. Decreased secretion of calcitonin.
- D. Decreased blood coagulability.
- E. Increased formation of 24,25 dihydroxycholecalciferol.

3. Which of the following is *not* involved in regulating plasma Ca²⁺ levels?

- A. Kidneys
- B. Skin
- C. Liver
- D. Lungs
- E. Intestine

4. 1, 25-Dihydroxycholecalciferol affects intestinal Ca²⁺ absorption through a mechanism that

- A. includes alterations in the activity of genes.
- B. activates adenylyl cyclase.
- C. decreases cell turnover.
- D. changes gastric acid secretion.
- E. involves degradation of apical calcium channels.

5. Which of the following would you expect to find in a patient whose diet has been low in calcium for 2 months?

- A. Increased formation of 24, 25 dihydroxycholecalciferol.
- B. Decreased amounts of calcium-binding protein in intestinal epithelial cells.
- C. Increased parathyroid hormone secretion.
- D. A high plasma calcitonin concentration.
- E. Increased plasma phosphate.

6. A mouse is engineered to lack a transcription factor necessary for the normal development of osteoclasts. Compared to normal littermate mice, which of the following would be reduced in the knock-out animals?

- A. Phosphate deposition in trabecular bone
- B. Hydroxyapatite levels in bone
- C. Osteoblast proliferation
- D. Secretion of acid proteases
- E. Bone collagen

7. The skeleton of a normal male college student would be expected to display which of the following features, relative to that of his 7-year-old brother?

- A. Merging of cortical bone and trabecular bone.
- B. Differentiation of osteoclasts and osteoblasts.
- C. An extended amount of proliferating cartilage that contributes to bone elongation.
- D. A meeting of the lacunae with the trabecular bone.
- E. Ephyses that are united with the bone shaft.

Chapter 22

1. If a young woman has high plasma levels of T₃, cortisol, and renin activity but her blood pressure is only slightly elevated and she has no symptoms or signs of thyrotoxicosis or Cushing syndrome, the most likely explanation is that

- A. she has been treated with TSH and ACTH.
- B. she has been treated with T₃ and cortisol.
- C. she is in the third trimester of pregnancy.
- D. she has an adrenocortical tumor.
- E. she has been subjected to chronic stress.

2. In humans, fertilization usually occurs in the

- A. vagina.
- B. cervix.
- C. uterine cavity.

- D. uterine tubes.
- E. abdominal cavity.

3. Which of the following is *not* a steroid?

- A. 17 α -hydroxyprogesterone
- B. Estrone
- C. Relaxin
- D. Pregnenolone
- E. Etiocholanolone

4. Which of the following probably triggers the onset of labor?

- A. ACTH in the fetus
- B. ACTH in the mother
- C. Prostaglandins
- D. Oxytocin
- E. Placental renin



Chapter 23

1. Full development and function of the seminiferous tubules require

- A. somatostatin.
- B. LH.
- C. oxytocin.
- D. FSH.
- E. androgens and FSH.

2. In human males, testosterone is produced mainly by the

- A. Leydig cells.
- B. Sertoli cells.
- C. seminiferous tubules.
- D. epididymis.
- E. vas deferens

3. Nitric oxide synthase contributes to erection by:

- A. raising cAMP levels that relax smooth muscles and increase blood flow.
- B. blocking phosphodiesterases to increase cGMP levels that release smooth muscle and increase blood flow.
- C. activating soluble guanylate cyclases to increase cGMP levels that relax smooth muscle and increase blood flow.
- D. raising intracellular Ca²⁺ concentrations that relax smooth muscles and increase blood flow.

4. Testosterone is produced

- A. in the testes after reduction of dihydrotestosterone.
- B. in Leydig cells from cholesterol and pregnenolone precursors.
- C. by leutinizing hormone in Leydig cells.
- D. as a precursor for several membrane lipids.

Chapter 24

1. Which of the following are incorrectly paired?

- A. B cells: insulin
- B. D cells: somatostatin
- C. A cells: glucagons
- D. Pancreatic exocrine cells: chymotrypsinogen
- E. F cells: gastrin

2. Which of the following are *incorrectly* paired?

- A. Epinephrine: increased glycogenolysis in skeletal muscle
- B. Insulin: increased protein synthesis
- C. Glucagon: increased gluconeogenesis
- D. Progesterone: increased plasma glucose level
- E. Growth hormone: increased plasma glucose level

3. Which of the following would be *least* likely to be seen 14 days after a rat is injected with a drug that kills all of its pancreatic B cells?

- A. A rise in the plasma H⁺ concentration
- B. A rise in the plasma glucagon concentration
- C. A fall in the plasma HCO₃⁻ concentration
- D. A fall in the plasma amino acid concentration
- E. A rise in plasma osmolality

4. When the plasma glucose concentration falls to low levels, a number of different hormones help combat the hypoglycemia.

After intravenous administration of a large dose of insulin, the return of a low blood sugar level to normal is delayed in

- A. adrenal medullary insufficiency.
- B. glucagon deficiency.
- C. combined adrenal medullary insufficiency and glucagon deficiency.
- D. thyrotoxicosis.
- E. acromegaly.

5. Insulin increases the entry of glucose into

- A. all tissues.
- B. renal tubular cells.
- C. the mucosa of the small intestine.
- D. most neurons in the cerebral cortex.
- E. skeletal muscle.

6. Glucagon increases glycogenolysis in liver cells but ACTH does not because

- A. cortisol increases the plasma glucose level.
- B. liver cells have an adenylyl cyclase different from that in adrenocortical cells.
- C. ACTH cannot enter the nucleus of liver cells.
- D. the membranes of liver cells contain receptors different from those in adrenocortical cells.
- E. liver cells contain a protein that inhibits the action of ACTH.

7. A meal rich in proteins containing the amino acids that stimulate insulin secretion but low in carbohydrates does not cause hypoglycemia because

- A. the meal causes a compensatory increase in T₄ secretion.
- B. cortisol in the circulation prevents glucose from entering muscle.
- C. glucagon secretion is also stimulated by the meal.
- D. the amino acids in the meal are promptly converted to glucose.
- E. insulin does not bind to insulin receptors if the plasma concentration of amino acids is elevated.

Chapter 25

1. Water is absorbed in the jejunum, ileum, and colon and excreted in the feces. Arrange these in order of the amount of water absorbed or excreted from greatest to smallest.

- A. Colon, jejunum, ileum, feces
- B. Feces, colon, ileum, jejunum
- C. Jejunum, ileum, colon, feces
- D. Colon, ileum, jejunum, feces
- E. Feces, jejunum, ileum, colon

2. Following a natural disaster in Haiti, there is an outbreak of cholera among displaced persons living in a tent encampment. The affected individuals display severe diarrheal symptoms because of which of the following changes in intestinal transport?

- A. Increased Na⁺ -K⁺ cotransport in the small intestine.
- B. Increased K⁺ secretion into the colon.
- C. Reduced K⁺ absorption in the crypts of Lieberkuhn.
- D. Increased Na⁺ absorption in the small intestine.
- E. Increased Cl⁻ secretion into the intestinal lumen.

3. A 50-year-old man presents to his physician complaining of severe epigastric pain, frequent heartburn, and unexplained weight loss of 20 pounds over a 6-month period. He claims to have obtained no relief from over-the-counter H₂ antihistamine drugs. He is referred to a gastroenterologist, and upper endoscopy reveals erosions and ulcerations in the proximal duodenum and an increased output of gastric acid in the fasting state. The patient is most likely to have a tumor secreting which of the following hormones?

- A. Secretin
- B. Somatostatin
- C. Motilin
- D. Gastrin
- E. Cholecystokinin

4. Which of the following has the highest pH?

- A. Gastric juice
- B. Colonic luminal contents
- C. Pancreatic juice
- D. Saliva
- E. Contents of the intestinal crypts

5. A 60-year-old woman undergoes total pancreatectomy because of the presence of a tumor. Which of the following outcomes would *not* be expected after she recovers from the operation?

- A. Steatorrhea
- B. Hyperglycemia
- C. Metabolic acidosis
- D. Weight gain
- E. Decreased absorption of amino acids

Chapter 26

1. Maximum absorption of short-chain fatty acids produced by bacteria occurs in the

- A. stomach.
- B. duodenum.
- C. jejunum.
- D. ileum.
- E. colon.

2. A premenopausal woman who is physically active seeks advice from her primary care physician regarding measures she can take to ensure adequate availability of dietary calcium to ensure bone health later in life. Which of the following dietary components should enhance calcium uptake?

- A. Protein
- B. Oxalates
- C. Iron
- D. Vitamin D
- E. Sodium

3. A decrease in which of the following would be expected in a child exhibiting a congenital absence of enterokinase?

- A. Incidence of pancreatitis
- B. Glucose absorption
- C. Bile acid reabsorption
- D. Gastric pH
- E. Protein assimilation

4. In Hartnup disease (a defect in the transport of neutral amino acids), patients do not become deficient in these amino acids due to the activity of

- A. PepT1.
- B. brush border peptidases.
- C. Na⁺, K⁺ ATPase.
- D. cystic fibrosis transmembrane conductance regulator (CFTR).
- E. trypsin.

5. A newborn baby is brought to the pediatrician suffering from severe diarrhea that worsens with meals. The symptoms diminish when nutrients are delivered intravenously. The child most likely has a mutation in which of the following intestinal transporters?

- A. Na⁺, K⁺ ATPase
 - B. NHE3
 - C. SGLT1
 - D. H⁺, K⁺ ATPase
 - E. NKCC1
-

Chapter 27

1. In infants, defecation often follows a meal. The cause of colonic contractions in this situation is

- A. histamine.
- B. increased circulating levels of CCK.
- C. the gastrocolic reflex.
- D. increased circulating levels of somatostatin.
- E. the enterogastric reflex.

2. The symptoms of the dumping syndrome (discomfort after meals in patients with intestinal short circuits such as anastomosis of the jejunum to the stomach) are caused in part by

- A. increased blood pressure.
- B. increased secretion of glucagon.
- C. increased secretion of CCK.
- D. hypoglycemia.
- E. hyperglycemia.

3. Gastric pressures seldom rise above the levels that breach the lower esophageal sphincter, even when the stomach is filled with a meal, due to which of the following processes?

- A. Peristalsis
- B. Gastroileal reflex
- C. Segmentation
- D. Stimulation of the vomiting center
- E. Receptive relaxation

4. The migrating motor complex is triggered by which of the following?

- A. Motilin
- B. NO
- C. CCK
- D. Somatostatin
- E. Secretin

5. A patient is referred to a gastroenterologist because of persistent difficulties with swallowing. Endoscopic examination reveals that the lower esophageal sphincter fails to fully open as the bolus reaches it, and a diagnosis of achalasia is made. During the examination, or in biopsies taken from the sphincter region, a decrease would be expected in which of the following?

- A. Esophageal peristalsis
- B. Expression of neuronal NO synthase
- C. Acetylcholine receptors
- D. Substance P release
- E. Contraction of the crural diaphragm

Chapter 28

1. A patient suffering from severe ulcerative colitis undergoes a total colectomy with formation of a stoma. After a full recovery from surgery, and compared to his condition prior to surgery, which of the following would be expected to be decreased?

- A. Ability to absorb lipids
- B. Ability to clot the blood
- C. Circulating levels of conjugated bile acids
- D. Urinary urea
- E. Urinary urobilinogen

2. A surgeon is studying new methods of liver transplantation. She performs a complete hepatectomy in an experimental animal. Before the donor liver is grafted, a rise would be expected in the blood level of

- A. glucose.
- B. fibrinogen.
- C. 25-hydroxycholecalciferol.
- D. conjugated bilirubin.
- E. estrogens.

3. Which of the following cell types protects against sepsis secondary to translocation of intestinal bacteria?

- A. Hepatic stellate cell
- B. Cholangiocyte
- C. Kupffer cell
- D. Hepatocyte
- E. Gallbladder epithelial cell

4. P450s (CYPs) are highly expressed in hepatocytes. In which of the following do they *not* play an important role?

- A. Bile acid formation
- B. Carcinogenesis
- C. Steroid hormone formation
- D. Detoxification of drugs
- E. Glycogen synthesis

5. A 40-year-old woman comes to her primary care physician complaining of severe, episodic abdominal pain that is particularly intense after she ingests a fatty meal. An imaging procedure reveals that her gallbladder is acutely dilated, and a diagnosis of cholelithiasis is made. A gallstone lodged in which location will also increase her risk of pancreatitis?

- A. Left hepatic duct
- B. Right hepatic duct
- C. Cystic duct
- D. Common bile duct
- E. Sphincter of Oddi

6. Compared to hepatic bile, gallbladder bile contains a reduced concentration of which of the following?

- A. Bile acids
- B. Sodium ions
- C. Protons
- D. Glucose
- E. Protons

Chapter 29

1. Question is based on One Figure of Book (NO Chance n FCPS -1 exam)

2. Which of the following normally has a slowly depolarizing "prepotential"?

- A. Sinoatrial node
- B. Atrial muscle cells
- C. Bundle of His
- D. Purkinje fibers
- E. Ventricular muscle cells

3. In second-degree heart block the ventricular rate.

- A. is lower than the atrial rate.
- B. the ventricular ECG complexes are distorted.
- C. there is a high incidence of ventricular tachycardia.
- D. stroke volume is decreased.
- E. cardiac output is increased.

4. Currents caused by opening of which of the following channels contribute to the repolarization phase of the action potential of ventricular muscle fibers?

- A. Na⁺ channels
- B. Cl⁻ channels
- C. Ca²⁺ channels
- D. K⁺ channels
- E. HCO₃⁻ channels

5. In complete heart block

- A. fainting may occur because the atria are unable to pump blood into the ventricles.
- B. ventricular fibrillation is common.
- C. the atrial rate is lower than the ventricular rate.
- D. fainting may occur because of prolonged periods during which the ventricles fail to contract.

Chapter 30

1. The second heart sound is caused by

- A. closure of the aortic and pulmonary valves.
- B. vibrations in the ventricular wall during systole.
- C. ventricular filling.
- D. closure of the mitral and tricuspid valves.
- E. retrograde flow in the vena cava.

2. The fourth heart sound is caused by

- A. closure of the aortic and pulmonary valves.
- B. vibrations in the ventricular wall during systole.
- C. ventricular filling.
- D. closure of the mitral and tricuspid valves.
- E. retrograde flow in the vena cava.

3. The dicrotic notch on the aortic pressure curve is caused by

- A. closure of the mitral valve.
- B. closure of the tricuspid valve.
- C. closure of the aortic valve.
- D. closure of the pulmonary valve.
- E. rapid filling of the left ventricle.

4. During exercise, a man consumes 1.8 L of oxygen per minute. His arterial O₂ content is 190 mL/L, and the O₂ content of his mixed venous blood is 134 mL/L. His cardiac output is approximately

- A. 3.2 L/min.
- B. 16 L/min.
- C. 32 L/min.
- D. 54 L/min.
- E. 160 mL/min.

5. The work performed by the left ventricle is substantially greater than that performed by the right ventricle, because in the left ventricle

- A. the contraction is slower.
- B. the wall is thicker.
- C. the stroke volume is greater.
- D. the preload is greater.
- E. the afterload is greater.

6. Starling's law of the heart

- A. does not operate in the failing heart.
- B. does not operate during exercise.
- C. explains the increase in heart rate produced by exercise.
- D. explains the increase in cardiac output that occurs when venous return is increased.
- E. explains the increase in cardiac output when the sympathetic nerves supplying the heart are stimulated.

Chapter 31

1. Which of the following has the highest *total* cross-sectional area in the body?

- A. Arteries
- B. Arterioles
- C. Capillaries
- D. Venules
- E. Veins

2. Lymph flow from the foot is

- A. increased when an individual rises from the supine to the standing position.**
- B. increased by massaging the foot.
 - C. increased when capillary permeability is decreased.
 - D. decreased when the valves of the leg veins are incompetent.
 - E. decreased by exercise.

3. The pressure in a capillary in skeletal muscle is 35 mm Hg at the arteriolar end and 14 mm Hg at the venular end. The interstitial pressure is 0 mm Hg. The colloid osmotic pressure is 25 mm Hg in the capillary and 1 mm Hg in the interstitium. The net force producing fluid movement across the capillary wall at its arteriolar end is

- A. 3 mm Hg out of the capillary.
- B. 3 mm Hg into the capillary.
- C. 10 mm Hg out of the capillary.
- D. 11 mm Hg out of the capillary.
- E. 11 mm Hg into the capillary.

4. The velocity of blood flow

- A. is higher in the capillaries than the arterioles.
- B. is higher in the veins than in the venules.
- C. is higher in the veins than the arteries.
- D. falls to zero in the descending aorta during diastole.
- E. is reduced in a constricted area of a blood vessel.

5. When the radius of the resistance vessels is increased, which of the following is increased?

- A. Systolic blood pressure
- B. Diastolic blood pressure
- C. Viscosity of the blood
- D. Hematocrit
- E. Capillary blood flow

6. A 30-year-old patient comes to her primary care physician complaining of headaches and vertigo. A blood test reveals a hematocrit of 55%, and a diagnosis of polycythemia is made.

Which of the following would also be increased?

- A. Mean blood pressure
- B. Radius of the resistance vessels
- C. Radius of the capacitance vessels
- D. Central venous pressure
- E. Capillary blood flow

7. A pharmacologist discovers a drug that stimulates the production of VEGF receptors. He is excited because his drug might be of value in the treatment of

- A. coronary artery disease.
- B. cancer.
- C. emphysema.

- D. diabetes insipidus.
- E. dysmenorrhea.

8. Why is the dilator response to injected acetylcholine changed to a constrictor response when the endothelium is damaged?

- A. More Na⁺ is generated.
- B. More bradykinin is generated.
- C. The damage lowers the pH of the remaining layers of the artery.
- D. The damage augments the production of endothelin by the endothelium.
- E. The damage interferes with the production of NO by the endothelium.

Chapter 32

1. When a pheochromocytoma (tumor of the adrenal medulla) suddenly discharges a large amount of epinephrine into the circulation, the patient's heart rate would be expected to

- A. increase, because the increase in blood pressure stimulates the carotid and aortic baroreceptors.
- B. increase, because epinephrine has a direct chronotropic effect on the heart.
- C. increase, because of increased tonic parasympathetic discharge to the heart.
- D. decrease, because the increase in blood pressure stimulates the carotid and aortic chemoreceptors.
- E. decrease, because of increased tonic parasympathetic discharge to the heart.

2. A 65-year-old male had been experiencing frequent episodes of syncope as he got out of bed in the mornings. He was diagnosed with orthostatic hypotension due to a malfunction in his baroreceptor reflex. Activation of the baroreceptor reflex

- A. is primarily involved in short-term regulation of systemic blood pressure.
- B. leads to an increase in heart rate because of inhibition of the vagal cardiac motor neurons.
- C. inhibits neurons in the CVLM.
- D. excites neurons in the RVLM.
- E. occurs only under situations in which blood pressure is markedly elevated.

3. A 45-year-old female had a blood pressure of 155/95 when she was at her physician's office for a physical. It was her first time to see this physician and her first physical in over 10 years. The doctor suggested that she begin monitoring her pressure at home. Sympathetic nerve activity would be expected to increase

- A. if glutamate receptors were activated in the NTS.
- B. if GABA receptors were activated in the RVLM.
- C. if glutamate receptors were activated in the CVLM.
- D. during stress.
- E. when one transitions from an erect to a supine posture.

4. Which of the following neurotransmitters are correctly matched with an autonomic pathway?

- A. GABA is released by NTS neurons projecting to the RVLM.
- B. Glutamate is released by CVLM neurons projecting to the IML.

- C. GABA is released by NTS neurons projecting to the nucleus ambiguus.
- D. GABA is released by CVLM neurons projecting to the RVLM.
- E. Glutamate is released by CVLM neurons projecting to the NTS.

5. A 53-year-old woman with chronic lung disease was experiencing difficulty breathing. Her arterial P_{O_2} and P_{CO_2} were 50 and 60 mm Hg, respectively. Which one of the following statements about chemoreceptors is correct?

- A. Peripheral chemoreceptors are very sensitive to small increases in arterial P_{CO_2} .
- B. Activation of arterial chemoreceptors leads to a fall in arterial pressure.
- C. Peripheral chemoreceptors are located in the NTS.
- D. Central chemoreceptors can be activated by an increase in intracranial pressure that compromises blood flow in the medulla.
- E. Central chemoreceptors are activated by increases in tissue pH.

6. A 55-year-old man comes to his primary care physician complaining of erectile dysfunction. He is given a prescription for Viagra, and on follow-up, reports that his ability to sustain an erection has been improved markedly by this treatment. The action of which of the following vasoactive mediators would primarily be increased in this patient?

- A. Histamine
- B. Endothelin-1
- C. Prostacyclin
- D. Nitric oxide
- E. Atrial natriuretic peptide

Chapter 33

1. Blood in which of the following vessels normally has the lowest P_{O_2} ?

- A. Maternal artery
- B. Maternal uterine vein
- C. Maternal femoral vein
- D. Umbilical artery
- E. Umbilical vein

2. The pressure differential between the heart and the aorta is least in the A. left ventricle during systole.

- B. left ventricle during diastole.
- C. right ventricle during systole.
- D. right ventricle during diastole.
- E. left atrium during systole.

3. Injection of tissue plasminogen activator (t-PA) would probably be most beneficial

- A. after at least 1 year of uncomplicated recovery following occlusion of a coronary artery.
- B. after at least 2 months of rest and recuperation following occlusion of a coronary artery.
- C. During the second week after occlusion of a coronary artery.
- D. During the second day after occlusion of a coronary artery.
- E. During the second hour after occlusion of a coronary artery.

4. Which of the following organs has the greatest blood flow per 100 g of tissue?

- A. Brain
- B. Heart muscle
- C. Skin
- D. Liver
- E. Kidneys

5. Which of the following does *not* dilate arterioles in the skin?

- A. Increased body temperature
- B. Epinephrine
- C. Bradykinin
- D. Substance P
- E. Vasopressin

6. A baby boy is brought to the hospital because of convulsions. In the course of a workup, his body temperature and plasma glucose are found to be normal, but his cerebrospinal fluid glucose is 12 mg/dL (normal, 65 mg/dL). A possible explanation of his condition is

- A. constitutive activation of GLUT 3 in neurons.
- B. SGLT 1 deficiency in astrocytes.
- C. GLUT 5 deficiency in cerebral capillaries.
- D. GLUT 1 55K deficiency in cerebral capillaries.
- E. GLUT 1 45K deficiency in microglia.

Chapter 34

1. On the summit of Mt. Everest, where the barometric pressure is about 250 mm Hg, the partial pressure of O₂ in mm Hg is about

- A. 0.1
- B. 0.5
- C. 5
- D. 50
- E. 100

2. The forced vital capacity is

- A. the amount of air that normally moves into (or out of) the lung with each respiration.
- B. the amount of air that enters the lung but does not participate in gas exchange.
- C. the amount of air expired after maximal expiratory effort.
- D. the largest amount of gas that can be moved into and out of the lungs in 1 min.

3. The tidal volume is

- A. the amount of air that normally moves into (or out of) the lung with each respiration.
- B. the amount of air that enters the lung but does not participate in gas exchange.
- C. the amount of air expired after maximal expiratory effort.
- D. the amount of gas that can be moved into and out of the lungs in 1 min.

4. Which of the following is responsible for the movement of O₂ from the alveoli into the blood in the pulmonary capillaries?

- A. Active transport
- B. Filtration
- C. Secondary active transport
- D. Facilitated diffusion
- E. Passive diffusion

5. Airway resistance

- A. is increased if the lungs are removed and inflated with saline.
- B. does not affect the work of breathing.
- C. is increased in paraplegic patients.
- D. is increased in following bronchial smooth muscle contraction.
- E. makes up 80% of the work of breathing.

6. Surfactant lining the alveoli

- A. helps prevent alveolar collapse.
- B. is produced in alveolar type I cells and secreted into the alveolus.
- C. is increased in the lungs of heavy smokers.
- D. is a glycolipid complex.

Chapter 35

1. Most of the CO₂ transported in the blood is

- A. dissolved in plasma.
- B. in carbamino compounds formed from plasma proteins.
- C. in carbamino compounds formed from hemoglobin.
- D. bound to Cl⁻.
- E. in HCO₃⁻.

2. Which of the following has the greatest effect on the ability of blood to transport oxygen?

- A. Capacity of the blood to dissolve oxygen
- B. Amount of hemoglobin in the blood
- C. pH of plasma
- D. CO₂ content of red blood cells
- E. Temperature of the blood

3. Which of the following is true of the system?



- A. Reaction 2 is catalyzed by carbonic anhydrase.
- B. Because of reaction 2, the pH of blood declines during hyperventilation.
- C. Reaction 1 occurs in the red blood cell.
- D. Reaction 1 occurs primarily in plasma.
- E. The reactions move to the right when there is excess H⁺ in the tissues.

4. In comparing uncompensated respiratory acidosis and uncompensated metabolic acidosis which one of the following is true?

- A. Plasma pH change is always greater in uncompensated respiratory acidosis compared to uncompensated metabolic acidosis.
- B. There are no compensation mechanisms for respiratory acidosis, whereas there is respiratory compensation for metabolic acidosis.
- C. Uncompensated respiratory acidosis involves changes in plasma [HCO₃⁻], whereas plasma [HCO₃⁻] is unchanged in uncompensated metabolic acidosis.

D. Uncompensated respiratory acidosis is associated with a change in P_{CO_2} , whereas in uncompensated metabolic acidosis P_{CO_2} is constant.

Chapter 36

1. The main respiratory control neurons

- A. send out regular bursts of impulses to expiratory muscles during quiet respiration.
- B. are unaffected by stimulation of pain receptors.
- C. are located in the pons.
- D. send out regular bursts of impulses to inspiratory muscles during quiet respiration.
- E. are unaffected by impulses from the cerebral cortex.

2. Intravenous lactic acid increases ventilation. The receptors responsible for this effect are located in the

- A. medulla oblongata.
- B. carotid bodies.
- C. lung parenchyma.
- D. aortic baroreceptors.
- E. trachea and large bronchi.

3. Spontaneous respiration ceases after

- A. transection of the brain stem above the pons.
- B. transection of the brain stem at the caudal end of the medulla.
- C. bilateral vagotomy.
- D. bilateral vagotomy combined with transection of the brain stem at the superior border of the pons.
- E. transection of the spinal cord at the level of the first thoracic segment.

4. The following physiologic events that occur in vivo are listed in random order: (1) decreased CSF pH; (2) increased arterial pCO_2 ; (3) increased CSF pCO_2 ; (4) stimulation of medullary chemoreceptors; (5) increased alveolar pCO_2 .

What is the usual sequence in which they occur when they affect respiration?

- A. 1, 2, 3, 4, 5
- B. 4, 1, 3, 2, 5
- C. 3, 4, 5, 1, 2
- D. 5, 2, 3, 1, 4
- E. 5, 3, 2, 4, 1

5. The following events that occur in the carotid bodies when they are exposed to hypoxia are listed in random order:

(1) depolarization of type I glomus cells; (2) excitation of afferent nerve endings; (3) reduced conductance of hypoxiasensitive K^+ channels in type I glomus cells; (4) Ca^{2+} entry into type I glomus cells; (5) decreased K^+ efflux.

What is the usual sequence in which they occur on exposure to hypoxia?

- A. 1, 3, 4, 5, 2
- B. 1, 4, 2, 5, 3
- C. 3, 4, 5, 1, 2

- D. 3, 1, 4, 5, 2
- E. 3, 5, 1, 4, 2

6. Injection of a drug that stimulates the carotid bodies would be expected to cause

- A. a decrease in the pH of arterial blood.
- B. a decrease in the P_{CO_2} of arterial blood.
- C. an increase in the HCO_3^- concentration of arterial blood.
- D. an increase in urinary Na^+ excretion.
- E. an increase in plasma Cl^- .

7. Variations in which of the following components of blood or CSF do *not* affect respiration?

- A. Arterial HCO_3^- concentration
- B. Arterial H^+ concentration
- C. Arterial Na^+ concentration
- D. CSF CO_2 concentration
- E. CSF H^+ concentration

Chapter 37

1. In the presence of vasopressin, the greatest fraction of filtered water is absorbed in the

- A. proximal tubule.
- B. loop of Henle.
- C. distal tubule.
- D. cortical collecting duct.
- E. medullary collecting duct.

2. In the absence of vasopressin, the greatest fraction of filtered water is absorbed in the

- A. proximal tubule.
- B. loop of Henle.
- C. distal tubule.
- D. cortical collecting duct.
- E. medullary collecting duct.

3. If the clearance of a substance which is freely filtered is less than that of inulin,

- A. there is net reabsorption of the substance in the tubules.
- B. there is net secretion of the substance in the tubules.
- C. the substance is neither secreted nor reabsorbed in the tubules.
- D. the substance becomes bound to protein in the tubules.
- E. the substance is secreted in the proximal tubule to a greater degree than in the distal tubule.

4. Glucose reabsorption occurs in the

- A. proximal tubule.
- B. loop of Henle.
- C. distal tubule.
- D. cortical collecting duct.

E. medullary collecting duct.

5. On which of the following does aldosterone exert its greatest Effect?

- A. Glomerulus
- B. Proximal tubule
- C. Thin portion of the loop of Henle
- D. Thick portion of the loop of Henle
- E. Cortical collecting duct

6. What is the clearance of a substance when its concentration in the plasma is 10 mg/dL, its concentration in the urine is 100 mg/ dL, and urine flow is 2 mL/min?

- A. 2 mL/min
- B. 10 mL/min
- C. 20 mL/min
- D. 200 mL/min
- E. Clearance cannot be determined from the information given.

7. As urine flow increases during osmotic diuresis

- A. the osmolality of urine falls below that of plasma.
- B. the osmolality of urine increases because of the increased amounts of nonreabsorbable solute in the urine.
- C. the osmolality of urine approaches that of plasma because plasma leaks into the tubules.
- D. the osmolality of urine approaches that of plasma because an increasingly large fraction of the excreted urine is isotonic proximal tubular fluid.
- E. the action of vasopressin on the renal tubules is inhibited.

Chapter 38

1. Dehydration increases the plasma concentration of all the following hormones *except*

- A. vasopressin.
- B. angiotensin II.
- C. aldosterone.
- D. norepinephrine.
- E. atrial natriuretic peptide.

2. In a patient who has become dehydrated, body water should be replaced by intravenous infusion of

- A. distilled water.
- B. 0.9% sodium chloride solution.
- C. 5% glucose solution.
- D. hyperoncotic albumin.
- E. 10% glucose solution.

3. Renin is secreted by

- A. cells in the macula densa.
- B. cells in the proximal tubules.
- C. cells in the distal tubules.

- D. granular cells in the juxtaglomerular apparatus.
- E. cells in the peritubular capillary bed.

4. Erythropoietin is secreted by

- A. cells in the macula densa.
- B. cells in the proximal tubules.
- C. cells in the distal tubules.
- D. granular cells in the juxtaglomerular apparatus.
- E. cells in the peritubular capillary bed.

5. When a woman who has been on a low-sodium diet for 8 days is given an intravenous injection of captopril, a drug that inhibits angiotensin-converting enzyme, one would expect

- A. her blood pressure to rise because her cardiac output would fall.
- B. her blood pressure to rise because her peripheral resistance would fall.
- C. her blood pressure to fall because her cardiac output would fall.
- D. her blood pressure to fall because her peripheral resistance would fall.
- E. her plasma renin activity to fall because her circulating angiotensin I level would rise.

6. Which of the following would *not* be expected to increase renin secretion?

- A. Administration of a drug that blocks angiotensin-converting enzyme
- B. Administration of a drug that blocks AT1 receptors
- C. Administration of a drug that blocks β adrenergic receptors
- D. Constriction of the aorta between the celiac artery and the renal arteries
- E. Administration of a drug that reduces ECF volume

7. Which of the following is *least* likely to contribute to the beneficial effects of angiotensin-converting enzyme inhibitors in the treatment of congestive heart failure?

- A. Vasodilation
- B. Decreased cardiac growth
- C. Decreased cardiac afterload
- D. Increased plasma renin activity
- E. Decreased plasma aldosterone

Chapter 39

1. Which of the following is the principal buffer in interstitial fluid?

- A. Hemoglobin
- B. Other proteins
- C. Carbonic acid
- D. H_2PO_4
- E. Compounds containing histidine

2. Increasing alveolar ventilation increases the blood pH because

- A. it activates neural mechanisms that remove acid from the blood.
- B. it makes hemoglobin a stronger acid.
- C. it increases the PO_2 of the blood.
- D. it decreases the P_{CO_2} in the alveoli.
- E. the increased muscle work of increased breathing generates more CO_2 .

3. In uncompensated metabolic alkalosis

- A. the plasma pH, the plasma HCO_3^- concentration, and the arterial pCO_2 are all low.
- B. the plasma pH is high and the plasma HCO_3^- concentration and arterial P_{CO_2} are low.
- C. the plasma pH and the plasma HCO_3^- concentration are low and the arterial P_{CO_2} is normal.
- D. the plasma pH and the plasma HCO_3^- concentration are high and the arterial pCO_2 is normal.
- E. the plasma pH is low, the plasma HCO_3^- concentration is high, and the arterial pCO_2 is normal.

4. In a patient with a plasma pH of 7.10, the $[\text{HCO}_3^-]/[\text{H}_2\text{CO}_3]$ ratio in plasma is

- A. 20.
- B. 10.
- C. 2.
- D. 1.
- E. 0.1.

Answers to Multiple Choice Questions

Chapter 1

1. B 2. C 3. B 4. C 5. C 6. D 7. E 8. E

Chapter 2

1. A 2. D 3. D 4. B 5. C 6. C 7. B 8. A

Chapter 3

1. B 2. C 3. E 4. B 5. B 6. C 7. D

Chapter 4

1. C 2. E 3. E 4. A 5. C 6. B 7. B 8. C

Chapter 5

1. B 2. D 3. B 4. C 5. C

Chapter 6

1. C 2. D 3. E 4. B 5. D 6. E

Chapter 7

1. D 2. A 3. C 4. C 5. B 6. E

Chapter 8

1. D 2. A 3. B 4. A 5. D 6. C 7. B 8. C
9. A 10. E 11. D

Chapter 9

1. D 2. D 3. C 4. B 5. E 6. C 7. D 8. B
9. D 10. D 11. B

Chapter 10

1. A 2. E 3. E 4. E 5. B 6. D 7. D 8. E
9. C 10. A

Chapter 11

1. D 2. C 3. D 4. D 5. D 6. C 7. D 8. E

Chapter 12

1. E 2. C 3. E 4. C 5. E 6. B 7. C 8. A
9. E 10. C 11. D 12. E

Chapter 13

1. A 2. D 3. C 4. D 5. C 6. E

Chapter 14

1. C 2. D 3. C 4. D 5. A 6. B

Chapter 15

1. C 2. E 3. C 4. D 5. B 6. D 7. D 8. B

Chapter 16

No multiple choice questions

Chapter 17

1. B 2. E 3. B 4. A 5. A 6. B 7. D 8. D

Chapter 18

1. E 2. E 3. A 4. C 5. B

Chapter 19

1. C 2. B 3. E 4. C 5. C 6. A 7. D 8. A
9. D 10. C

Chapter 20

1. D 2. B 3. E 4. D 5. C 6. D 7. D 8. A 9.
A

Chapter 21

1. C 2. E 3. D 4. A 5. C 6. D 7. E

Chapter 22

1. C 2. D 3. C 4. A

Chapter 23

1. E 2. A 3. C 4. B

Chapter 24

1. E 2. D 3. D 4. C 5. E 6. D 7. C

Chapter 25

1. C 2. E 3. D 4. C 5. D

Chapter 26

1. E 2. D 3. E 4. A 5. C

Chapter 27

1. C 2. D 3. E 4. A 5. B

Chapter 28

1. E 2. E 3. C 4. E 5. E 6. B

Chapter 29

1. C 2. A 3. A 4. D 5. D

Chapter 30

1. A 2. C 3. C 4. C 5. E 6. D

Chapter 31

1. C 2. B 3. D 4. B 5. E 6. A 7. A 8. E

Chapter 32

1. B 2. A 3. D 4. D 5. D

Chapter 33

1. D 2. A 3. E 4. E 5. E 6. D

Chapter 34

1. D 2. C 3. A 4. E 5. D 6. A

Chapter 35

1. E 2. B 3. D 4. D

Chapter 36

1. D 2. B 3. B 4. D 5. E 6. B 7. C

Chapter 37

1. A 2. A 3. A 4. A 5. E 6. C 7. D

Chapter 38

1. E 2. C 3. D 4. E 5. D 6. C 7. D

Chapter 39

1. C 2. D 3. D 4. B