COMPREHENSIVE MOCK EXAM 3

Supplemental to: Physiology Board Review 2026-2027

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USMLE Step 1 (NBME/FSMB) - 280 single-best-answer questions, five options (A-E), domain-weighted to the 2026 official blueprint

Board-Review Questions

1. A healthy term newborn has a marked increase in arterial oxygen tension after the first breaths. Which change most directly promotes functional closure of the ductus arteriosus?

A. Reduced oxygen tension with increased prostaglandin E2 signaling

B. Increased oxygen tension with reduced prostaglandin E2 signaling

C. Increased pulmonary vascular resistance with persistent right-to-left flow

D. Decreased left atrial pressure with reopening of the foramen ovale

E. Increased placental prostacyclin delivery after umbilical cord clamping

2. Immediately after delivery, pulmonary vascular resistance falls sharply. Which physiologic event is the principal cause of this change?

A. Loss of placental blood flow and reduced venous return

B. Lung expansion and increased alveolar oxygen tension

C. Closure of the ductus venosus and reduced hepatic flow

D. Increased fetal hemoglobin concentration after birth

E. Transient elevation of pulmonary arterial carbon dioxide

3. A premature infant develops respiratory distress shortly after birth because of inadequate surfactant. What is the most important mechanical consequence in the affected alveoli?

A. Lower surface tension and excessive alveolar overdistention

B. Higher lung compliance with reduced work of breathing

C. Reduced elastic recoil with increased functional residual capacity

D. Higher surface tension and increased tendency for alveolar collapse

E. Lower opening pressure because small alveoli become more stable

4. A healthy 2-month-old has a higher resting heart rate than a healthy adult. Which developmental feature best explains why infants depend more strongly on heart rate to raise cardiac output?

A. Greater ability to raise stroke volume because infant ventricles are highly compliant

B. Markedly lower metabolic demand per kilogram than in adults

C. Higher systemic vascular resistance from persistent placental circulation

D. Limited ability to augment stroke volume because of relatively low ventricular compliance

E. Reduced sympathetic responsiveness of the sinoatrial node after birth

5. During normal fetal life, which feature of hemoglobin most directly facilitates transfer of oxygen from maternal to fetal blood across the placenta?

A. Fetal hemoglobin binds 2,3-BPG more strongly and therefore releases oxygen readily

B. Maternal hemoglobin has no cooperative oxygen binding during pregnancy

C. Fetal hemoglobin has lower affinity for 2,3-BPG and therefore higher oxygen affinity

D. Fetal hemoglobin contains more heme groups per tetramer than adult hemoglobin

E. Placental blood flow eliminates the need for an oxygen-affinity difference

6. A patient with chronic kidney disease develops a normocytic anemia. Reduced production of which renal signal is the major physiologic cause?

A. Thrombopoietin from glomerular mesangial cells

B. Hepcidin from renal tubular epithelial cells

C. Erythropoietin from peritubular interstitial cells

D. Transferrin from juxtaglomerular granular cells

E. Granulocyte colony-stimulating factor from podocytes

7. A healthy person ascends rapidly to high altitude. Which change is expected within the first several hours as a compensatory response to hypoxemia?

A. Hypoventilation with a rise in arterial carbon dioxide tension

B. Immediate large increase in red-cell mass from new erythropoiesis

C. Reduced sympathetic activity with a fall in cardiac output

D. Hyperventilation with a fall in arterial carbon dioxide tension

E. Increased renal bicarbonate retention that deepens respiratory alkalosis

8. A patient has a hereditary defect that markedly reduces 2,3-BPG in erythrocytes. What happens to hemoglobin-oxygen binding?

A. The oxygen dissociation curve shifts right and tissue unloading increases

B. Hemoglobin loses cooperative binding and the curve becomes linear

C. The oxygen dissociation curve shifts left and tissue unloading decreases

D. Oxygen affinity falls only in fetal hemoglobin but not adult hemoglobin

E. Arterial oxygen content becomes independent of hemoglobin concentration

9. A febrile patient with metabolic acidosis needs increased oxygen delivery to active tissues. Which combined effect on hemoglobin is expected locally?

A. A leftward oxygen-dissociation shift that impairs oxygen unloading

B. No change in oxygen affinity because temperature and pH effects cancel

C. Conversion of hemoglobin to fetal hemoglobin with higher oxygen affinity

D. A rightward oxygen-dissociation shift that facilitates oxygen unloading

E. Loss of heme iron that reduces oxygen saturation at a given partial pressure

10. A patient with severe carbon monoxide exposure has a normal arterial oxygen tension but profound tissue hypoxia. Which change best accounts for the impaired oxygen delivery?

A. Reduced dissolved oxygen tension with a right shift of oxyhemoglobin

B. Increased hemoglobin concentration with reduced arterial oxygen content

C. Selective loss of plasma bicarbonate with preserved oxygen unloading

D. Increased 2,3-BPG binding that prevents pulmonary oxygen loading

E. Reduced oxygen-carrying capacity plus a left shift of remaining oxyhemoglobin

11. A patient with iron deficiency has a lower hemoglobin concentration but normal lungs and circulation. Which variable can remain normal despite substantially reduced arterial oxygen content?

A. Total arterial oxygen content

B. Oxygen delivery at an unchanged cardiac output

C. Arterial oxygen partial pressure

D. Hemoglobin-bound oxygen concentration

E. Mixed venous oxygen saturation during exertion

12. After acute hemorrhage, a healthy adult develops increased plasma renin activity and sympathetic tone. Which hematologic change is expected over the following several days?

A. Immediate restoration of red-cell mass by splenic contraction alone

B. Suppressed erythropoietin production because renal perfusion falls

C. Reduced marrow erythropoiesis despite persistent tissue hypoxia

D. Abrupt increase in mature erythrocytes without a reticulocyte phase

E. Increased erythropoietin production and reticulocytosis

13. A patient with polycythemia has markedly increased hematocrit. Which hemodynamic consequence follows directly from this change?

A. Decreased blood viscosity and lower systemic resistance

B. Reduced red-cell aggregation with faster low-shear flow

C. Higher plasma volume with no change in vascular resistance

D. Reduced wall shear stress in all vessels regardless of flow rate

E. Increased blood viscosity and greater resistance to flow

14. A patient with severe thrombocytopenia has prolonged bleeding from small cuts but a normal prothrombin time. Which hemostatic function is primarily impaired?

A. Formation of the primary platelet plug

B. Generation of fibrin through the extrinsic coagulation pathway

C. Conversion of fibrinogen to fibrin by thrombin

D. Activation of vitamin K-dependent clotting factors in the liver

E. Cross-linking of fibrin by factor XIII after clot formation

15. Following endothelial injury, platelet adhesion is initiated when a platelet receptor binds von Willebrand factor attached to exposed subendothelium. Which platelet receptor is involved?

A. Glycoprotein IIb/IIIa

B. Protease-activated receptor 1

C. P2Y12 ADP receptor

D. Thromboxane A2 receptor

E. Glycoprotein Ib

16. A drug blocks platelet glycoprotein IIb/IIIa receptors. Which step of primary hemostasis is most directly inhibited?

A. Fibrinogen-mediated platelet aggregation

B. Initial von Willebrand factor-mediated platelet adhesion

C. Thrombin generation through tissue factor activation

D. Hepatic synthesis of vitamin K-dependent factors

E. Vasoconstriction caused by endothelial endothelin release

17. A patient has a congenital deficiency of factor VIII. Which laboratory pattern is expected in the absence of an inhibitor?

A. Normal activated partial thromboplastin time with prolonged prothrombin time

B. Prolongation of both tests from isolated extrinsic-pathway failure

C. Normal coagulation tests because factor VIII acts only in primary hemostasis

D. Shortened activated partial thromboplastin time from excess thrombin generation

E. Prolonged activated partial thromboplastin time with normal prothrombin time

18. A patient begins warfarin therapy. Which clotting factor's activity falls earliest because it has the shortest plasma half-life among the vitamin K-dependent procoagulant factors?

A. Factor II

B. Factor IX

C. Factor VII

D. Factor X

E. Factor XIII

19. A patient receives unfractionated heparin. Its anticoagulant action depends primarily on accelerating the activity of which endogenous inhibitor?

A. Antithrombin activity

B. Activated protein C activity

C. Protein S cofactor activity

D. Tissue factor pathway inhibition

E. Plasminogen activator inhibition

20. A thrombus is undergoing physiologic fibrinolysis. Which enzyme directly cleaves cross-linked fibrin within the clot?

A. Thrombin protease activity

B. Plasmin protease activity

C. Activated factor Xa activity

D. Tissue plasminogen activator activity

E. Activated protein C activity

21. A patient has disseminated intravascular coagulation with widespread thrombin generation. Which combination of changes is most expected?

A. Increased platelets and clotting factors with reduced fibrin degradation

B. Isolated platelet dysfunction without activation of the coagulation cascade

C. Selective factor VIII excess with normal fibrin turnover

D. Suppressed plasmin generation with absent D-dimer formation

E. Consumption of platelets and clotting factors with increased fibrin degradation

22. A patient with hereditary spherocytosis has reduced red-cell membrane surface area relative to volume. Which mechanical consequence follows?

A. Reduced deformability during passage through splenic cords

B. Increased deformability during passage through splenic cords

C. Reduced osmotic fragility in hypotonic solution

D. Increased membrane reserve for shape change

E. Enhanced ability to traverse narrow capillaries without stress

23. A patient with sickle cell disease develops tissue hypoxia and acidosis. Why do these conditions promote polymerization of hemoglobin S?

A. They increase the fraction of oxygenated hemoglobin S

B. They prevent intracellular dehydration of erythrocytes

C. They convert hemoglobin S into fetal hemoglobin

D. They increase the fraction of deoxygenated hemoglobin S

E. They abolish cooperative binding between heme groups

24. A splenectomized patient is especially vulnerable to encapsulated bacteria. Which normal splenic function is most relevant to this susceptibility?

A. Producing neutrophils as the principal adult hematopoietic organ

B. Activating complement exclusively through the alternative pathway

C. Synthesizing all circulating immunoglobulin in red pulp sinusoids

D. Generating thymic T-cell selection within splenic follicles

E. Filtering bloodborne organisms and supporting opsonizing antibody responses

25. A previously immunized person receives a booster dose of the same protein antigen. Compared with the primary response, what feature characterizes the secondary humoral response?

A. More rapid production of higher-affinity antibody by memory B cells

B. Slower production of lower-affinity antibody by naive B cells

C. Exclusive production of IgM without class switching

D. Absence of clonal expansion because antigen is recognized immediately

E. Loss of T-cell help because memory responses are antibody independent

26. A bacterial polysaccharide activates the complement cascade. Which complement fragment is the major opsonin that enhances phagocytosis?

A. C3a

B. C5a

C. C3b

D. C5b

E. C9

27. A patient has recurrent Neisseria infections due to a terminal complement deficiency. Which effector function is impaired?

A. C3b-mediated opsonization of bacterial surfaces

B. C3a-mediated mast-cell degranulation

C. Formation of the C5b-9 membrane attack complex

D. C5a-mediated neutrophil chemotaxis

E. Class switching of B cells to immunoglobulin G

28. A neutrophil follows a concentration gradient of C5a toward an infected tissue. What cellular process does this illustrate?

A. Opsonization

B. Diapedesis

C. Clonal selection

D. Somatic hypermutation

E. Chemotaxis

29. A neutrophil ingests an opsonized bacterium. Which event is essential for the oxidative burst used to kill the organism?

A. NADPH oxidase generates superoxide within the phagosome

B. Myeloperoxidase directly generates superoxide from molecular oxygen

C. Catalase converts superoxide into hypochlorous acid

D. Glutathione peroxidase generates hydrogen peroxide from water

E. Nitric oxide synthase prevents all reactive oxygen production

30. A child has chronic granulomatous disease. Which defect most directly explains recurrent infections with catalase-positive organisms?

A. Failure to synthesize immunoglobulin heavy chains

B. Failure to form C5b-9 membrane attack complexes

C. Failure to generate superoxide during the phagocyte respiratory burst

D. Failure of neutrophils to adhere through integrins

E. Failure of T cells to recognize peptide on MHC molecules

31. A naive CD4-positive T lymphocyte recognizes a peptide antigen. On which molecule must that peptide be displayed for conventional activation of the CD4 cell?

A. Major histocompatibility complex class I

B. CD1 only

C. Immunoglobulin M on erythrocytes

D. Major histocompatibility complex class II

E. Complement receptor 1 on neutrophils

32. A virus infects a nucleated host cell. Which immune interaction most directly allows a cytotoxic T cell to recognize the infected cell?

A. Viral peptide presentation on MHC class II to a CD4 T cell

B. Intact viral protein binding directly to a B-cell Fc receptor

C. C3b binding to the T-cell receptor without antigen processing

D. IgM presentation on an erythrocyte to a natural killer cell

E. Viral peptide presentation on MHC class I to a CD8 T cell

33. A natural killer cell encounters a virus-infected cell that has markedly reduced surface MHC class I expression. What is the likely consequence?

A. Loss of MHC class I prevents natural-killer-cell recognition and protects the cell

B. Reduced MHC class I selectively activates helper T cells instead

C. Loss of inhibitory signaling favors natural-killer-cell cytotoxicity

D. The infected cell becomes resistant to perforin and granzyme release

E. Natural-killer-cell activity requires antigen-specific immunoglobulin gene rearrangement

34. A B lymphocyte undergoes class-switch recombination after T-cell help. What changes as a direct result of this process?

A. The variable region is replaced so antigen specificity is lost

B. The light-chain constant region becomes the principal Fc region

C. The antigen-binding site is removed from the immunoglobulin molecule

D. The antibody heavy-chain constant region changes while antigen specificity is preserved

E. The B cell can no longer differentiate into a plasma cell

35. During germinal-center maturation, B cells accumulate point mutations in immunoglobulin variable regions and clones with stronger antigen binding are selected. What is this process called?

A. V(D)J recombination followed by allelic exclusion

B. Somatic hypermutation followed by affinity maturation

C. Class switching followed by isotype exclusion

D. Negative selection followed by receptor editing

E. Complement fixation followed by immune-complex clearance

36. A peripheral nerve axon is experimentally depolarized to threshold. Which ionic current is chiefly responsible for the rapid upstroke of a typical neuronal action potential?

A. Rapid outward potassium current through delayed-rectifier channels

B. Inward chloride current through ligand-gated chloride channels

C. Rapid inward sodium current through voltage-gated sodium channels

D. Outward calcium current through presynaptic calcium channels

E. Electrogenic sodium-potassium pump current producing immediate depolarization

37. During the absolute refractory period of a neuronal action potential, a second action potential cannot be elicited regardless of stimulus strength. What best explains this period?

A. All potassium channels are permanently closed

B. The sodium-potassium ATPase temporarily stops functioning

C. Ligand-gated chloride channels remain maximally activated

D. Most voltage-gated sodium channels are in the inactivated state

E. Intracellular calcium has fallen below its resting concentration

38. A demyelinating lesion slows conduction in a myelinated axon. Which normal property of myelin most strongly increases conduction velocity?

A. It lowers membrane resistance and increases current leakage across internodes

B. It raises membrane resistance and allows saltatory conduction between nodes

C. It opens sodium channels uniformly along the entire internodal membrane

D. It decreases the axon's length constant while increasing capacitance

E. It prevents depolarizing current from reaching the next node of Ranvier

39. A toxin blocks presynaptic voltage-gated calcium channels at a chemical synapse. Which event is most directly reduced?

A. Axonal sodium-channel activation during the action potential

B. Postsynaptic resting potassium conductance

C. Synthesis of neurotransmitter receptors in the nucleus

D. Reuptake of transmitter by surrounding glial cells

E. Synaptic vesicle fusion and neurotransmitter release

40. An inhibitory postsynaptic potential is produced by opening chloride channels in a mature neuron. What is the main effect on excitability?

A. The membrane depolarizes rapidly to the sodium equilibrium potential

B. The action-potential threshold becomes more negative and easier to reach

C. Potassium influx creates a regenerative depolarizing current

D. Voltage-gated calcium channels open and trigger transmitter release

E. The membrane is stabilized near the chloride equilibrium potential and threshold is harder to reach

41. A patient receives a drug that selectively blocks nicotinic acetylcholine receptors at the neuromuscular junction. Which postsynaptic event is prevented?

A. Release of acetylcholine from the motor-nerve terminal

B. Propagation of the action potential along the motor axon

C. Generation of the motor end-plate depolarization

D. Reuptake of choline into the presynaptic terminal

E. Calcium release from the sarcoplasmic reticulum after muscle depolarization

42. A patient is given an alpha1-adrenergic agonist. Which autonomic response is expected?

A. Relaxation of radial iris muscle with miosis

B. Constriction of arteriolar vascular smooth muscle

C. Decreased tone of the internal urethral sphincter

D. Reduced hepatic glycogenolysis during stress

E. Direct slowing of sinoatrial-node pacemaker firing

43. A beta1-adrenergic agonist increases heart rate. Which intracellular signaling change occurs in sinoatrial nodal cells?

A. Gs activation increases cyclic AMP and pacemaker currents

B. Gi activation lowers cyclic AMP and closes potassium channels

C. Gq activation lowers inositol trisphosphate and intracellular calcium

D. Gs activation suppresses calcium-channel opening throughout diastole

E. Gi activation increases funny current and steepens phase 4 depolarization

44. A muscarinic M2 receptor agonist is applied to the sinoatrial node. Which effect is most likely?

A. Reduced potassium conductance and accelerated phase 4 depolarization

B. Increased potassium conductance and reduced pacemaker firing

C. Increased cyclic AMP through Gs and enhanced funny current

D. Increased inositol trisphosphate through Gq and tachycardia

E. Direct opening of skeletal-muscle nicotinic channels

45. A patient develops Horner syndrome after interruption of cervical sympathetic fibers. Which ocular finding is expected on the affected side?

A. Mydriasis from loss of parasympathetic sphincter contraction

B. Miosis from loss of sympathetic radial iris contraction

C. Cycloplegia from loss of ciliary-muscle parasympathetic input

D. Proptosis from excessive sympathetic orbital smooth-muscle tone

E. Loss of the pupillary light reflex from optic-nerve dysfunction

46. A painful pinprick is applied to the right foot. Which pathway carries the major pain and temperature signal after it enters the spinal cord?

A. Fibers cross near their entry level and ascend in the contralateral anterolateral tract

B. Fibers ascend ipsilaterally in the dorsal columns before crossing in the medulla

C. Fibers remain ipsilateral through the brainstem and cross in the thalamus

D. Fibers ascend bilaterally in corticospinal tracts before reaching cortex

E. Fibers synapse only in dorsal-root ganglia and do not cross centrally

47. Vibration is applied to the left great toe. Before reaching the medulla, the relevant second-order pathway travels where?

A. Contralaterally in the anterolateral tract

B. Ipsilaterally in the lateral corticospinal tract

C. Ipsilaterally in the dorsal columns

D. Bilaterally in the spinocerebellar tracts only

E. Contralaterally in the medial lemniscus within the spinal cord

48. A patient has an acute lesion of the left lateral corticospinal tract at the T10 spinal level. Which motor deficit is expected below the lesion?

A. Contralateral lower-motor-neuron weakness

B. Ipsilateral flaccid paralysis with absent reflexes at all levels

C. Contralateral loss of pain and temperature only

D. Bilateral weakness limited to proximal muscles

E. Ipsilateral upper-motor-neuron weakness

49. A stretch of the patellar tendon causes contraction of the quadriceps. Which receptor initiates the monosynaptic stretch reflex?

A. Golgi tendon organs sensing tendon tension

B. Pacinian corpuscles sensing deep vibration

C. Free nerve endings sensing tissue injury

D. Muscle spindle primary afferents sensing muscle length change

E. Ruffini endings sensing cutaneous stretch

50. During a strong muscle contraction, Golgi tendon organs are activated. What variable do they primarily encode?

A. Absolute muscle length within the muscle belly

B. Joint temperature during repeated movement

C. Muscle tension transmitted through the tendon

D. Cutaneous pressure over the contracting muscle

E. Velocity of motor-axon action potentials

51. A patient with Parkinson disease has reduced spontaneous movement. Loss of nigrostriatal dopamine alters basal ganglia signaling in which net direction?

A. It increases direct-pathway inhibition and suppresses indirect-pathway neurons equally

B. It removes all inhibitory output from the globus pallidus internus

C. It increases thalamocortical excitation by reducing indirect-pathway activity

D. It converts basal ganglia output from inhibitory to purely excitatory signaling

E. It reduces facilitation of movement through the direct pathway and increases indirect-pathway restraint

52. A cerebellar hemisphere lesion causes limb dysmetria. Why are the motor findings typically ipsilateral to the cerebellar lesion?

A. Cerebellar output pathways and descending motor pathways effectively cross twice

B. Cerebellar output never crosses anywhere in the central nervous system

C. The corticospinal tract remains ipsilateral throughout its course

D. Spinocerebellar sensory input is entirely contralateral at every level

E. Cerebellar nuclei project directly to ipsilateral anterior horn cells only

53. A patient with increased intracranial pressure has reduced cerebral perfusion pressure. Which equation defines cerebral perfusion pressure under usual clinical conditions?

A. Intracranial pressure minus mean arterial pressure

B. Mean arterial pressure minus intracranial pressure

C. Mean arterial pressure plus central venous pressure

D. Systolic pressure minus diastolic pressure

E. Cerebral blood flow multiplied by intracranial pressure

54. In a healthy adult, arterial carbon dioxide tension rises from 40 to 55 mm Hg while other variables remain stable. What happens to cerebral blood flow?

A. It decreases because hypercapnia constricts cerebral arterioles

B. It remains fixed because cerebral flow is independent of carbon dioxide

C. It falls only if arterial oxygen saturation also rises

D. It increases because hypercapnia dilates cerebral arterioles

E. It stops autoregulating and becomes zero at this carbon dioxide level

55. A patient with severe hypoxemia has an arterial oxygen tension of 45 mm Hg. What effect does this level of hypoxemia have on cerebral vessels?

A. It produces marked vasoconstriction and reduces blood flow

B. It has no vascular effect until PaO2 reaches zero

C. It directly lowers intracranial pressure by closing capillaries

D. It produces cerebral vasodilation and increases blood flow

E. It suppresses metabolic autoregulation in active cortex

56. A healthy adult is entering rapid-eye-movement sleep. Which physiologic pattern is most characteristic of this stage?

A. High-amplitude delta waves with preserved skeletal-muscle tone

B. Desynchronized cortical EEG with skeletal-muscle atonia

C. Sleep spindles with sustained voluntary motor activity

D. Complete absence of autonomic variability and dreaming

E. Generalized muscle rigidity with synchronous cortical slowing

57. A sleep study shows repeated sleep spindles and K complexes. Which sleep stage is being recorded?

A. N1 non-REM sleep

B. N3 slow-wave sleep

C. N2 non-REM sleep

D. Rapid-eye-movement sleep

E. Quiet wakefulness with eyes closed

58. Light strikes a rod photoreceptor in the retina. What is the immediate electrical response of the photoreceptor?

A. Hyperpolarization caused by closure of cyclic-GMP-gated cation channels

B. Depolarization caused by opening of cyclic-GMP-gated sodium channels

C. Hyperpolarization caused by opening of voltage-gated calcium channels

D. Depolarization caused by increased glutamate release from the photoreceptor

E. No voltage change because phototransduction occurs only in bipolar cells

59. A person walks from bright sunlight into a dark room. Which retinal change contributes to dark adaptation over the next several minutes?

A. Persistent bleaching of rhodopsin increases rod sensitivity

B. Regeneration of rhodopsin increases rod sensitivity

C. Cones permanently suppress rod signaling in darkness

D. Pupil constriction is the sole mechanism of dark adaptation

E. Retinal cyclic GMP remains maximally depleted in rods

60. A patient focuses on a near object after looking at a distant target. Which ocular change increases the refractive power of the lens?

A. Ciliary muscle relaxation increases zonular tension and rounds the lens

B. Radial iris contraction flattens the lens through sympathetic fibers

C. Lens capsule contraction increases zonular tension and flattens the lens

D. Ciliary muscle contraction reduces zonular tension and rounds the lens

E. Extraocular muscle contraction pulls the lens anteriorly to increase power

61. A patient has damage to the right optic tract. Which visual-field defect is expected?

A. Right monocular blindness

B. Bitemporal hemianopia

C. Right nasal hemianopia only

D. Left homonymous hemianopia

E. Left monocular central scotoma only

62. Sound waves enter the external auditory canal. Which middle-ear function normally improves energy transfer from air to cochlear fluid?

A. Impedance matching through tympanic-membrane area and ossicular leverage

B. Elimination of all pressure differences across the tympanic membrane

C. Direct conversion of sound waves into cochlear nerve action potentials

D. Selective amplification of low frequencies by the Eustachian tube

E. Generation of endolymph by contraction of the stapedius muscle

63. A high-frequency tone reaches the cochlea. Where along the basilar membrane is maximal displacement expected?

A. Near the compliant, wide apex of the cochlea

B. Near the stiff, narrow base of the cochlea

C. Equally along the entire basilar membrane

D. Only at the helicotrema regardless of frequency

E. At the round window without basilar-membrane motion

64. Deflection of cochlear hair-cell stereocilia toward the tallest stereocilia opens mechanically gated channels. Which ion enters from endolymph and produces most of the initial depolarization?

A. Sodium

B. Chloride

C. Calcium only

D. Hydrogen

E. Potassium

65. A person turns the head rapidly to the left. Which vestibular sensors primarily detect the angular acceleration initiating this movement?

A. Macular hair cells in the utricle only

B. Macular hair cells in the saccule only

C. Outer hair cells along the cochlear base

D. Crista ampullaris hair cells in the semicircular canals

E. Pacinian corpuscles in the cervical muscles

66. A standing person suddenly accelerates forward in a car. Which vestibular organ is especially important for detecting this horizontal linear acceleration?

A. Utricular macula

B. Saccular macula

C. Posterior semicircular canal

D. Cochlear duct

E. Organ of Corti

67. A patient receives a local anesthetic that preferentially blocks small myelinated and unmyelinated fibers before large motor fibers. Which sensation is often lost early?

A. Fine vibration sensation

B. Proprioceptive position sensation

C. Voluntary skeletal motor control

D. Pain and temperature sensation

E. Deep pressure sensation

68. A patient with a transected spinal cord initially has flaccid paralysis and absent reflexes below the lesion. Several weeks later, reflexes become brisk. What explains the later hyperreflexia?

A. Permanent destruction of all alpha motor neurons below the lesion

B. Progressive loss of sensory afferents from muscle spindles

C. Increased descending cortical inhibition of anterior horn cells

D. Complete failure of interneuronal synaptic transmission in the spinal cord

E. Loss of descending inhibitory modulation increases spinal reflex excitability

69. A skeletal muscle is stimulated at progressively higher frequencies until individual twitches fuse into a sustained contraction. What mechanism best explains temporal summation?

A. Each stimulus recruits a new motor neuron but intracellular calcium returns fully to baseline

B. Cytosolic calcium remains elevated between stimuli so more cross-bridges can cycle

C. Myosin heads stop using ATP as stimulation frequency increases

D. The muscle action potential becomes longer than the mechanical contraction

E. Troponin loses calcium affinity and exposes more actin-binding sites

70. During an isometric contraction of the biceps, muscle tension rises while the joint angle does not change. What happens to overall muscle length?

A. It shortens substantially while tension remains constant

B. It lengthens substantially while tension remains constant

C. It oscillates rapidly because cross-bridges cannot remain attached

D. It becomes independent of sarcomere length and load

E. It remains essentially constant while internal tension increases

71. A muscle shortens while lifting a weight. As the external load is increased, what happens to the maximum velocity of shortening?

A. Maximum shortening velocity decreases as the external load increases

B. Maximum shortening velocity increases linearly as the external load increases

C. Shortening velocity remains constant until maximal isometric force is reached

D. Maximum shortening velocity occurs only at the greatest possible load

E. Shortening velocity depends only on motor-neuron firing rather than load

72. An isolated skeletal muscle is activated at different starting lengths. At which sarcomere condition is active tension maximal?

A. At an extremely short length with maximal thin-filament overlap

B. At an extremely long length with no actin-myosin overlap

C. At an intermediate length with optimal actin-myosin overlap

D. At any length because cross-bridge number is constant

E. Only after passive connective-tissue tension exceeds active force

73. A person performs a prolonged low-intensity postural task. Which motor units are recruited first according to the size principle?

A. Large, fast-fatigable motor units

B. Largest alpha motor neurons with glycolytic fibers

C. Small, fatigue-resistant motor units

D. Motor units are recruited randomly regardless of force demand

E. Only gamma motor neurons until maximal force is needed

74. A biopsy of a postural muscle shows fibers rich in mitochondria, capillaries, and myoglobin. Which functional property is expected?

A. Very rapid glycolytic fatigue with low mitochondrial density

B. High oxidative capacity and resistance to fatigue

C. Minimal oxygen use despite high mitochondrial content

D. Highest shortening velocity because oxidative fibers are always fastest

E. Dependence exclusively on phosphocreatine for sustained contraction

75. During the first few seconds of an all-out sprint, which energy system supplies ATP at the highest immediate rate?

A. Mitochondrial beta-oxidation of fatty acids

B. Hepatic gluconeogenesis from amino acids

C. Ketone-body oxidation in skeletal muscle

D. Stored ATP and phosphocreatine

E. De novo synthesis of glucose from glycerol within muscle

76. During sustained moderate exercise, skeletal-muscle blood flow rises markedly. Which local factor contributes directly to arteriolar dilation in active muscle?

A. Reduced interstitial potassium and reduced carbon dioxide production

B. Increased local oxygen tension with reduced metabolic activity

C. Persistent alpha1-mediated vasoconstriction that overrides metabolites

D. Accumulation of adenosine, potassium, carbon dioxide, and hydrogen ions

E. Decreased endothelial nitric oxide production during shear stress

77. A runner begins exercising. Compared with rest, which change in the arterial-venous oxygen difference is expected as working muscle extracts more oxygen?

A. The arterial-venous oxygen difference widens

B. The arterial-venous oxygen difference narrows toward zero

C. Venous oxygen content rises above arterial oxygen content

D. Arterial oxygen content necessarily doubles

E. Tissue oxygen extraction becomes independent of blood flow

78. A patient sustains a tendon injury. Compared with skeletal muscle, why does tendon generally heal more slowly?

A. Tendon has relatively low vascularity and low cellular turnover

B. Tendon has greater capillary density and faster cell turnover than muscle

C. Tendon lacks extracellular collagen and therefore cannot scar

D. Tendon receives no mechanical load during normal movement

E. Tendon cells cannot synthesize extracellular matrix after injury

79. A mutation impairs hydroxylation of proline and lysine residues during collagen synthesis. Which nutrient deficiency can produce a similar biochemical defect?

A. Vitamin D deficiency

B. Vitamin K deficiency

C. Vitamin C deficiency

D. Vitamin B12 deficiency

E. Vitamin A deficiency

80. A patient has defective lysyl oxidase activity. Which extracellular collagen step is most directly impaired?

A. Translation of preprocollagen on rough endoplasmic reticulum

B. Hydroxylation of proline residues inside the endoplasmic reticulum

C. Cleavage of signal peptide from preprocollagen

D. Covalent cross-linking between collagen molecules

E. Assembly of procollagen triple helices before secretion

81. An osteoclast is actively resorbing bone. Which mechanism acidifies the resorption lacuna?

A. Bicarbonate secretion into the lacuna from osteoblasts

B. Chloride exclusion that makes the lacuna strongly alkaline

C. Proton secretion through osteoclast membrane pumps

D. Passive calcium entry that consumes hydrogen ions

E. Carbonic anhydrase inhibition that increases proton generation

82. Parathyroid hormone indirectly increases osteoclast activity during sustained elevation. Which osteoblast-lineage signal is increased?

A. Increased osteoblastic osteoprotegerin secretion

B. Increased osteoclastic calcitonin-receptor blockade

C. Increased type II collagen production by chondrocytes

D. Increased sclerostin inhibition of osteoblast signaling

E. Increased osteoblastic RANK ligand expression

83. A patient with high calcitonin levels has reduced osteoclast activity. Which direct effect of calcitonin explains this response?

A. Calcitonin activates osteoblast RANK ligand to stimulate osteoclasts

B. Calcitonin increases renal calcium reabsorption as its only action

C. Calcitonin receptor activation inhibits osteoclast-mediated bone resorption

D. Calcitonin raises intestinal calcium absorption by activating vitamin D

E. Calcitonin directly converts osteoclasts into osteoblasts

84. A child with vitamin D deficiency has impaired mineralization of growing bone. Which intestinal transport change contributes to this disorder?

A. Increased absorption of calcium and phosphate

B. Reduced absorption of calcium and phosphate

C. Reduced absorption of sodium but preserved calcium absorption

D. Increased phosphate absorption with complete calcium malabsorption only

E. No intestinal effect because vitamin D acts solely on bone

85. A patient has a fracture and begins forming a reparative callus. Which cell type is primarily responsible for producing new osteoid during bone formation?

A. Osteoclasts

B. Chondroclasts

C. Neutrophils

D. Osteoblasts

E. Mature erythrocytes

86. A healthy adult experiences repeated weight-bearing exercise over months. Which bone response is predicted by mechanotransduction?

A. Bone formation increases along lines of mechanical stress

B. Bone resorption increases exclusively and cortical thickness falls

C. Osteoblast activity becomes independent of mechanical loading

D. Trabecular orientation becomes random despite directional stress

E. All skeletal remodeling stops once epiphyseal plates close

87. A patient has a large area of denuded epidermis after a burn. Loss of which normal skin function most directly increases insensible water loss?

A. Dermal melanocytes normally pump water back into capillaries

B. Eccrine glands normally prevent all evaporation from the skin

C. The keratinized stratum corneum normally limits transepidermal water diffusion

D. Hair follicles form the principal impermeable barrier to water

E. Subcutaneous fat completely blocks water movement through the epidermis

88. During heat exposure, sympathetic activation increases sweating. Which neurotransmitter is released by the postganglionic sympathetic fibers supplying most eccrine sweat glands?

A. Norepinephrine

B. Dopamine

C. Epinephrine

D. Acetylcholine

E. Serotonin

89. On a hot, humid day, a person continues to sweat heavily but body temperature rises. Why does high humidity impair heat loss?

A. It prevents cutaneous vasodilation by blocking nitric oxide

B. It increases radiant heat gain regardless of environmental temperature

C. It stops sweat-gland secretion through sympathetic inhibition

D. It causes conductive heat transfer from the body into the air

E. It reduces the vapor-pressure gradient needed for sweat evaporation

90. A person is immersed in cold water and begins shivering. What is the primary purpose of shivering thermogenesis?

A. Decrease skeletal-muscle metabolism to conserve glycogen

B. Increase heat loss by accelerating cutaneous blood flow

C. Suppress sympathetic activity and lower oxygen consumption

D. Reduce core temperature by increasing evaporative cooling

E. Increase skeletal-muscle ATP turnover and metabolic heat production

91. A person exposed to cold develops pale fingers before any tissue injury occurs. Which physiologic response reduces heat loss from the skin?

A. Parasympathetic vasodilation of cutaneous arterioles

B. Sympathetic alpha-adrenergic vasoconstriction of cutaneous vessels

C. Sympathetic cholinergic dilation of all skin vessels

D. Local histamine release causing sustained hyperemia

E. Inhibition of vascular smooth muscle by low norepinephrine levels

92. A patient has reduced melanin production. What is the normal protective role of melanin in the epidermis?

A. It absorbs and disperses ultraviolet radiation to reduce DNA damage

B. It synthesizes vitamin D by directly converting cholesterol to calcitriol

C. It forms the principal mechanical barrier against water loss

D. It prevents sweating by blocking eccrine-gland ducts

E. It produces collagen fibers that strengthen the dermis

93. A superficial skin injury removes the epidermis but leaves the basement membrane and dermal appendages intact. Which source can repopulate the epidermis?

A. Mature dermal collagen fibers dividing into keratinocytes

B. Circulating erythrocytes differentiating into epidermal cells

C. Subcutaneous adipocytes migrating directly into the stratum corneum

D. Sweat itself depositing new keratin across the wound

E. Basal keratinocytes and epithelial stem cells in skin appendages

94. After several weeks of immobilization in a cast, a patient's calf muscle is smaller. Which adaptation is most likely within the muscle fibers?

A. Reduced myofibrillar protein content and smaller fiber cross-sectional area

B. Increased myofibrillar protein content and larger fiber area

C. Increased mitochondrial biogenesis despite complete unloading

D. Permanent doubling of motor-unit number in the immobilized limb

E. Conversion of skeletal muscle fibers into connective tissue within days

95. A weight lifter performs progressive resistance training for several months. Which cellular adaptation accounts for most of the increase in skeletal-muscle size?

A. Large-scale hyperplasia producing thousands of new muscle fibers

B. Permanent fusion of motor neurons with muscle fibers

C. Replacement of type II fibers by adipocytes

D. Loss of satellite-cell signaling and reduced ribosomal activity

E. Hypertrophy of existing fibers through increased contractile protein synthesis

96. A patient has a genetic defect in dystrophin. Which normal mechanical role of dystrophin is lost in skeletal muscle?

A. Direct hydrolysis of ATP by the myosin head during contraction

B. Binding of calcium to troponin within the thin filament

C. Pumping of calcium into the sarcoplasmic reticulum after contraction

D. Linkage of the intracellular cytoskeleton to the extracellular matrix through a membrane complex

E. Synthesis of acetylcholine at the neuromuscular junction

97. A healthy adult's end-diastolic volume increases while contractility and afterload remain unchanged. What happens to stroke volume according to the Frank-Starling mechanism?

A. Stroke volume increases because greater fiber stretch increases force of contraction

B. Stroke volume decreases because greater filling always reduces contractility

C. Stroke volume remains fixed because preload does not affect cardiac performance

D. Stroke volume falls because end-systolic volume must rise in direct proportion

E. Stroke volume increases only if sympathetic tone also increases

98. An isolated left ventricle is exposed to an acute increase in aortic pressure with preload and contractility initially unchanged. What is the immediate effect?

A. End-systolic volume falls and stroke volume rises

B. End-diastolic volume instantly falls to zero

C. End-systolic volume rises and stroke volume falls

D. Ejection fraction rises because afterload directly increases contractility

E. Stroke volume is unchanged because arterial pressure does not affect ejection

99. A beta1-adrenergic agonist is given to a healthy person. Which ventricular pressure-volume change reflects increased contractility?

A. Higher end-systolic volume at a given preload and afterload

B. Lower end-systolic volume at a given preload and afterload

C. Lower slope of the end-systolic pressure-volume relation

D. Reduced ejection fraction despite unchanged loading conditions

E. Increased end-diastolic pressure caused solely by weaker contraction

100. A patient has a heart rate of 75/min and a stroke volume of 80 mL. What is the cardiac output?

A. 6.0 L/min

B. 0.94 L/min

C. 1.6 L/min

D. 10.7 L/min

E. 60 L/min

101. A patient's oxygen consumption is 250 mL/min. Arterial oxygen content is 200 mL/L and mixed venous oxygen content is 150 mL/L. What is cardiac output by the Fick principle?

A. 1.25 L/min

B. 2 L/min

C. 5 L/min

D. 10 L/min

E. 20 L/min

102. A patient has a blood pressure of 120/75 mm Hg at a normal heart rate. Which value is the best approximation of mean arterial pressure?

A. 75 mm Hg

B. 90 mm Hg

C. 82 mm Hg

D. 98 mm Hg

E. 120 mm Hg

103. A small arteriole decreases its radius by 20% while viscosity and length remain constant. According to Poiseuille's relationship, what happens to resistance?

A. Resistance falls modestly because it varies directly with radius

B. Resistance is unchanged because only vessel length determines resistance

C. Resistance rises linearly in exact proportion to the 20% radius change

D. Resistance rises markedly because it varies inversely with the fourth power of radius

E. Resistance falls because smaller vessels always have lower friction

104. Blood flow through a vessel becomes turbulent. Which change most strongly increases the Reynolds number and favors turbulence?

A. Higher blood viscosity

B. Smaller vessel diameter with unchanged velocity

C. Lower blood density

D. Higher flow velocity

E. Lower flow velocity

105. A patient with severe anemia develops a systolic flow murmur despite structurally normal valves. Which hemodynamic change contributes to turbulence?

A. Increased blood viscosity suppresses laminar flow

B. Reduced flow velocity lowers the Reynolds number

C. Increased erythrocyte mass narrows the valve orifice

D. Decreased cardiac output eliminates viscous forces

E. Reduced blood viscosity increases the Reynolds number

106. A person stands suddenly from a supine position. Before baroreflex compensation occurs, which change is expected?

A. Venous return rises because gravity drives blood toward the heart

B. Venous pooling lowers venous return and stroke volume

C. Stroke volume rises because central blood volume immediately increases

D. Arterial pressure increases because leg veins constrict before the reflex

E. Pulmonary blood volume rises as blood leaves the lower extremities

107. A healthy person stands abruptly and arterial pressure briefly falls. What baroreceptor-mediated response follows?

A. Decreased sympathetic and increased parasympathetic outflow

B. Decreased heart rate with arteriolar dilation

C. Reduced venous tone with reduced myocardial contractility

D. Suppressed renin release and increased vagal firing

E. Increased sympathetic and decreased parasympathetic outflow

108. A massage of the carotid sinus markedly increases baroreceptor firing. Which acute response is expected?

A. Increased sympathetic tone and reduced vagal activity

B. Increased renin release with systemic vasoconstriction

C. Reduced sympathetic tone and increased vagal activity

D. Increased sinoatrial firing through beta1 receptors

E. Increased venous return from alpha1-mediated venoconstriction

109. A healthy person receives a rapid isotonic saline infusion. Which variable most directly increases atrial natriuretic peptide release?

A. Reduced atrial filling from venodilation

B. Atrial wall stretch from increased intravascular volume

C. Low arterial oxygen tension sensed by peripheral chemoreceptors

D. Increased plasma osmolality without a volume change

E. Reduced ventricular afterload with unchanged atrial pressure

110. During ventricular systole, coronary blood flow to the left ventricular subendocardium is reduced. When is left coronary perfusion greatest?

A. Coronary flow is greatest during ventricular diastole

B. Coronary flow is greatest during isovolumetric contraction

C. Coronary flow is greatest at peak ventricular systolic pressure

D. Coronary flow occurs mainly during atrial systole alone

E. Coronary flow remains equal throughout systole and diastole

111. A patient has tachycardia without a change in aortic diastolic pressure. Why can very rapid heart rates reduce left ventricular coronary perfusion?

A. Systolic compression of coronary vessels disappears

B. Aortic pressure necessarily falls to zero during systole

C. Myocardial oxygen consumption becomes independent of heart rate

D. Diastolic filling and coronary perfusion time are shortened

E. Coronary arterioles constrict because local metabolites fall

112. A ventricular myocyte is in phase 2 of its action potential. Which ionic currents create the plateau?

A. Inward sodium current alone with no opposing current

B. Inward calcium current balanced by outward potassium current

C. Outward chloride current balanced by inward potassium current

D. Inward potassium current balanced by outward calcium current

E. Electrogenic sodium-potassium pumping without channel currents

113. A sinoatrial nodal cell spontaneously depolarizes during phase 4. Which current contributes importantly to this pacemaker activity?

A. A persistent fast sodium current identical to ventricular phase 0

B. A sustained outward chloride current that depolarizes the cell

C. The funny inward current activated by hyperpolarization

D. Complete closure of all calcium channels until threshold

E. An inward potassium current through delayed rectifier channels

114. What ionic current produces most of phase 0 depolarization in normal sinoatrial nodal cells?

A. Calcium influx through voltage-gated L-type calcium channels

B. Rapid sodium influx through fast voltage-gated sodium channels

C. Potassium influx through inward rectifier channels

D. Chloride efflux through ligand-gated channels

E. Sodium-potassium ATPase current

115. A first-degree atrioventricular nodal block lengthens the PR interval. Which normal property of the AV node is physiologically important?

A. Fast conduction synchronizes atrial and ventricular contraction exactly

B. Long refractory periods prevent atrial filling during diastole

C. AV nodal cells are the fastest-conducting cells in the heart

D. AV nodal conduction depends exclusively on fast sodium channels

E. Slow conduction allows time for ventricular filling after atrial contraction

116. Which cardiac tissue normally conducts electrical impulses most rapidly?

A. Sinoatrial nodal fibers

B. Atrioventricular nodal fibers

C. Purkinje conducting fibers

D. Ventricular working myocytes

E. Atrial transitional fibers

117. During inspiration in a healthy person, intrathoracic pressure becomes more negative. What happens to systemic venous return?

A. It decreases because thoracic veins are compressed by lower pressure

B. It is unchanged because respiration affects only pulmonary veins

C. It stops transiently because right atrial pressure exceeds peripheral venous pressure

D. It reverses direction because abdominal pressure always falls more than thoracic pressure

E. It increases because the pressure gradient toward the right atrium rises

118. A patient develops an arteriovenous fistula. Which immediate systemic hemodynamic change is expected?

A. Total peripheral resistance increases markedly

B. Venous return decreases because blood bypasses veins

C. Total peripheral resistance decreases

D. Cardiac output decreases because preload falls

E. Mean circulatory filling pressure becomes zero

119. A patient with severe left ventricular systolic failure has elevated left atrial pressure. Which Starling-force change promotes pulmonary edema?

A. Decreased pulmonary capillary hydrostatic pressure

B. Increased pulmonary capillary hydrostatic pressure

C. Increased plasma oncotic pressure

D. Decreased interstitial oncotic pressure from protein accumulation

E. Reduced capillary filtration coefficient throughout the lungs

120. A patient with severe hypoalbuminemia develops peripheral edema. Which Starling-force abnormality is most important?

A. Increased plasma colloid osmotic pressure

B. Reduced interstitial hydrostatic pressure from arteriolar constriction

C. Increased lymphatic return that traps fluid in tissues

D. Reduced plasma colloid osmotic pressure

E. Reduced capillary permeability to water

121. A patient has lymphatic obstruction in one leg. Why does edema develop?

A. Capillary hydrostatic pressure falls enough to force fluid into tissue

B. Plasma oncotic pressure rises locally and draws water outward

C. Arteriolar resistance becomes infinite and stops capillary exchange

D. Interstitial protein and fluid cannot be returned efficiently to the circulation

E. Lymphatic obstruction directly increases red-cell hematocrit in tissue

122. A healthy adult has a tidal volume of 500 mL, an anatomic dead space of 150 mL, and a respiratory rate of 12/min. What is alveolar ventilation?

A. 1.8 L/min

B. 3.0 L/min

C. 4.2 L/min

D. 6.0 L/min

E. 7.8 L/min

123. A patient doubles alveolar ventilation while carbon dioxide production remains constant. What happens to arterial carbon dioxide tension?

A. It falls to approximately one half of its previous value

B. It doubles because more carbon dioxide reaches alveoli

C. It remains unchanged because PaCO2 is independent of ventilation

D. It falls to zero because all carbon dioxide is exhaled

E. It rises slightly because dead-space ventilation necessarily increases

124. A healthy person is at sea level breathing room air. If arterial carbon dioxide tension rises, what happens to alveolar oxygen tension according to the alveolar gas equation?

A. Alveolar oxygen tension rises as arterial carbon dioxide rises

B. Alveolar oxygen tension stays fixed at inspired oxygen tension

C. Alveolar oxygen tension becomes independent of respiratory quotient

D. Alveolar oxygen tension decreases as arterial carbon dioxide rises

E. Alveolar oxygen tension falls only when atmospheric pressure changes

125. A patient has an airway obstruction that blocks ventilation to a lung region while perfusion continues. What ventilation-perfusion relationship develops in that region?

A. The V/Q ratio approaches infinity, resembling dead space

B. The V/Q ratio remains exactly one because perfusion compensates

C. Both ventilation and perfusion must fall to zero simultaneously

D. The region behaves as pure diffusion limitation without shunt physiology

E. The V/Q ratio approaches zero, resembling a physiologic shunt

126. A pulmonary embolus completely blocks blood flow to a ventilated lung region. What is the local ventilation-perfusion relationship?

A. The V/Q ratio approaches zero, creating a true shunt

B. The V/Q ratio remains one because ventilation determines perfusion

C. The V/Q ratio approaches infinity, creating alveolar dead space

D. The region becomes diffusion limited but retains normal perfusion

E. The alveolus immediately collapses and loses all ventilation

127. A patient with interstitial pulmonary fibrosis develops exertional hypoxemia. Which gas-transfer abnormality is most directly produced by thickening of the alveolar-capillary barrier?

A. Increased diffusing capacity from longer capillary transit time

B. Reduced alveolar ventilation caused by increased airway radius

C. Increased pulmonary capillary blood volume in every case

D. Elimination of the alveolar-arterial oxygen gradient

E. Reduced diffusing capacity for oxygen

128. Carbon monoxide is used experimentally to measure pulmonary diffusing capacity. Why is it suitable for this purpose?

A. Its capillary partial pressure remains very low because it binds avidly to hemoglobin

B. It is completely insoluble in blood and cannot cross the alveolar membrane

C. Its blood partial pressure rapidly equals alveolar partial pressure

D. It is metabolized by alveolar cells before entering capillary blood

E. It causes pulmonary vasoconstriction that directly measures membrane thickness

129. A patient with emphysema has reduced pulmonary diffusing capacity. Which structural change explains this finding?

A. Increased alveolar surface area from hyperinflation

B. Thickened pleura with preserved alveolar septa

C. Loss of alveolar surface area available for gas exchange

D. Increased pulmonary capillary recruitment at rest

E. Reduced airway resistance from loss of elastic recoil

130. A patient with asthma has reversible bronchoconstriction. According to airflow mechanics, why does a modest decrease in airway radius greatly increase resistance?

A. Resistance varies approximately with the inverse fourth power of airway radius during laminar flow

B. Resistance varies directly with the fourth power of airway radius

C. Airway resistance is determined only by lung compliance

D. Smaller radii always convert turbulent flow into lower resistance

E. Viscosity becomes irrelevant when airway smooth muscle contracts

131. A healthy person takes a maximal inspiration. Compared with low lung volume, why are intrapulmonary airways generally wider at high lung volume?

A. Radial traction from expanded lung parenchyma pulls the airways open

B. Pleural pressure becomes strongly positive and compresses the airways

C. Airway smooth muscle contracts in response to lung expansion

D. Surfactant directly dilates bronchi through beta2 receptors

E. The chest wall stops exerting any elastic recoil at high volume

132. A patient with pulmonary fibrosis has a stiff lung. Which pressure-volume property is reduced?

A. Reduced lung elastic recoil

B. Reduced transpulmonary pressure

C. Reduced inspiratory work

D. Reduced lung compliance

E. Reduced tendency of lung tissue to recoil

133. A patient with emphysema has loss of elastic tissue. Which pulmonary mechanical change is expected?

A. Increased lung compliance with reduced elastic recoil

B. Reduced lung compliance with increased elastic recoil

C. Increased chest-wall recoil with a smaller residual volume

D. Reduced airway collapse during forced expiration

E. Increased inward recoil that lowers functional residual capacity

134. A normal lung is at functional residual capacity. Which opposing forces are balanced at this volume?

A. Outward recoil of both lungs and chest wall

B. Inward recoil of both lungs and chest wall

C. Inward elastic recoil of the lungs and outward recoil of the chest wall

D. Diaphragmatic contraction and active abdominal-muscle contraction

E. Positive pleural pressure and negative alveolar pressure

135. During quiet inspiration, which pressure change causes air to enter the lungs?

A. Alveolar pressure rises above atmospheric pressure

B. Pleural pressure becomes positive and exceeds alveolar pressure

C. Atmospheric pressure falls because the diaphragm contracts

D. Transpulmonary pressure becomes zero throughout inspiration

E. Alveolar pressure falls slightly below atmospheric pressure

136. During a forced expiration, intrapleural pressure becomes positive. Why can small intrathoracic airways collapse?

A. Alveolar pressure becomes lower than atmospheric pressure throughout expiration

B. Pleural pressure remains negative and pulls airways closed

C. Pressure outside the airway can exceed intraluminal pressure beyond the equal-pressure point

D. Lung elastic recoil disappears only during forced expiration

E. Airway smooth muscle must actively constrict before dynamic compression occurs

137. A patient with obstructive lung disease has difficulty exhaling rapidly. Which spirometric pattern is most typical?

A. Increased FEV1/FVC ratio despite expiratory flow limitation

B. Reduced FEV1/FVC ratio from expiratory flow limitation

C. Normal FEV1 despite a markedly reduced total lung capacity

D. Reduced functional residual capacity in all obstructive disorders

E. Increased FEV1 out of proportion to the measured FVC

138. A patient with a restrictive interstitial lung disorder undergoes spirometry. Which pattern is expected?

A. Reduced total lung capacity with a normal or increased FEV1/FVC ratio

B. Increased total lung capacity with a reduced FEV1/FVC ratio

C. Increased residual volume with normal vital capacity in every case

D. Normal total lung capacity with isolated increased airway resistance

E. Markedly reduced FEV1/FVC ratio as the defining abnormality

139. A healthy person hypoventilates after receiving an opioid. Which acid-base disturbance appears first?

A. Acute respiratory alkalosis

B. Acute respiratory acidosis

C. Primary metabolic acidosis

D. Primary metabolic alkalosis

E. Mixed metabolic alkalosis with respiratory alkalosis

140. A substance is freely filtered at the glomerulus and neither reabsorbed nor secreted by the renal tubules. Its clearance equals which physiologic variable?

A. Glomerular filtration rate

B. Renal plasma flow

C. Renal blood flow

D. Filtration fraction

E. Urine flow rate

141. A substance is filtered and almost completely removed from renal plasma by filtration plus proximal tubular secretion during one pass. At low plasma concentrations, its clearance approximates what?

A. Glomerular filtration rate only

B. Effective renal plasma flow

C. Renal blood flow without hematocrit correction

D. Filtration fraction

E. Free-water clearance

142. A patient has a glomerular filtration rate of 120 mL/min and renal plasma flow of 600 mL/min. What is the filtration fraction?

A. 0.02

B. 0.50

C. 5.0

D. 0.20

E. 720

143. Moderate constriction of the efferent arteriole occurs while systemic pressure is unchanged. Which initial change is most likely?

A. Glomerular capillary hydrostatic pressure falls and GFR tends to decrease

B. Glomerular capillary hydrostatic pressure rises and GFR tends to increase

C. Bowman-space hydrostatic pressure falls to zero

D. Renal plasma flow rises because efferent resistance falls

E. Filtration fraction necessarily falls because GFR cannot change

144. Constriction of the afferent arteriole occurs in one kidney. What happens to renal plasma flow and glomerular filtration rate in that kidney?

A. Both renal plasma flow and GFR decrease

B. Both renal plasma flow and GFR increase

C. Renal plasma flow decreases while GFR always increases

D. Renal plasma flow increases while GFR decreases

E. Neither variable changes because autoregulation is absolute

145. A patient's plasma albumin concentration rises substantially without a change in arterial pressure. What effect does this have on glomerular filtration?

A. Increased glomerular capillary oncotic pressure tends to raise GFR

B. Reduced Bowman-space oncotic pressure raises GFR markedly

C. Increased plasma protein directly raises filtration coefficient

D. Increased glomerular capillary oncotic pressure tends to reduce GFR

E. Albumin has no influence on net filtration pressure

146. Most filtered sodium and water are reabsorbed in which nephron segment under normal conditions?

A. Proximal tubule

B. Thin descending limb

C. Thick ascending limb

D. Distal convoluted tubule

E. Collecting duct

147. A patient has a normal plasma glucose concentration. Why is essentially no glucose excreted in the urine?

A. Filtered glucose is reabsorbed by sodium-glucose cotransport in the proximal tubule

B. Glucose is not filtered because albumin blocks it at the glomerulus

C. Glucose is reabsorbed primarily in the thick ascending limb

D. Collecting ducts secrete insulin that destroys filtered glucose

E. The distal tubule converts all filtered glucose to glycogen

148. Plasma glucose rises above the renal transport maximum. Why does glucose begin to appear in urine?

A. Glomerular filtration of glucose suddenly stops

B. Filtered load exceeds the maximal tubular reabsorptive capacity

C. Proximal sodium-glucose transport reverses and actively secretes glucose

D. Insulin directly opens a glomerular glucose pore

E. Distal nephron water reabsorption creates glucose de novo

149. Which nephron segment reabsorbs sodium, potassium, and chloride through the NKCC2 cotransporter and is normally impermeable to water?

A. Thin descending limb of the loop of Henle

B. Early proximal tubule

C. Cortical collecting duct

D. Thick ascending limb of the loop of Henle

E. Inner medullary collecting duct

150. Why is the thick ascending limb called a diluting segment?

A. It reabsorbs water more rapidly than sodium chloride

B. It reabsorbs solute while remaining relatively impermeable to water

C. It secretes sodium chloride into tubular fluid

D. It contains aquaporin-2 channels even without ADH

E. It equilibrates tubular fluid completely with the medullary interstitium

151. Antidiuretic hormone increases water reabsorption in principal cells of the collecting duct by which mechanism?

A. Insertion of aquaporin-1 channels into the basolateral membrane only

B. Inhibition of cyclic AMP formation through V1 receptors

C. Direct activation of epithelial sodium channels without water channels

D. Insertion of aquaporin-2 water channels into the apical membrane

E. Removal of urea transporters from the inner medullary collecting duct

152. A patient lacks antidiuretic hormone. What happens to collecting-duct water permeability?

A. It becomes maximal, producing a small volume of concentrated urine

B. It remains high because aquaporin-2 is constitutively apical

C. It becomes irrelevant because water is reabsorbed only in proximal tubules

D. It remains low, producing a large volume of dilute urine

E. It increases only when plasma osmolality falls

153. A dehydrated patient has high ADH levels. Which medullary process helps maintain the osmotic gradient required to concentrate urine?

A. Complete exclusion of urea from the renal medulla

B. Active water secretion by the thick ascending limb

C. Urea recycling from the inner medullary collecting duct into the medulla

D. Sodium secretion from the medullary interstitium into vasa recta

E. High cortical blood flow that washes solute into the medulla

154. The vasa recta preserve the medullary osmotic gradient while supplying blood to the renal medulla. Which mechanism is responsible?

A. Active sodium pumping from descending vasa recta into cortex

B. Complete impermeability of vasa recta to water and solutes

C. High-speed blood flow that prevents equilibration with interstitium

D. Countercurrent exchange with slow hairpin blood flow

E. Filtration of plasma directly into the loop of Henle

155. A patient develops metabolic acidosis. Which renal response helps increase net acid excretion over the next several days?

A. Reduced ammoniagenesis and reduced hydrogen-ion secretion

B. Increased bicarbonate excretion despite systemic acidosis

C. Suppressed proximal glutamine metabolism

D. Reduced titratable acid excretion with alkaline urine

E. Increased ammonium production and excretion

156. A patient with respiratory acidosis has had elevated arterial carbon dioxide for several days. Which renal compensation is expected?

A. Increased bicarbonate reabsorption and generation with greater hydrogen-ion excretion

B. Increased bicarbonate excretion with reduced hydrogen-ion secretion

C. Reduced ammonium excretion and lower plasma bicarbonate

D. Immediate normalization of $PaCO_2$ through renal ventilation

E. No renal response because kidneys cannot compensate respiratory disorders

157. A patient with prolonged vomiting develops metabolic alkalosis and volume depletion. Why can renal bicarbonate excretion remain limited?

A. Volume depletion suppresses all proximal sodium and bicarbonate reabsorption

B. Volume and chloride depletion enhance sodium reabsorption and promote maintenance of alkalosis

C. Chloride depletion increases bicarbonate secretion by beta-intercalated cells

D. Low aldosterone levels increase distal hydrogen-ion secretion

E. Renal bicarbonate handling is independent of extracellular volume

158. A meal enters the stomach and causes gastric distention. Which neural mechanism can increase gastric acid secretion in response?

A. Sympathetic reflexes inhibit histamine release and increase parietal secretion

B. Somatic motor neurons release norepinephrine directly onto parietal cells

C. Enteric neurons suppress gastrin release whenever the stomach is distended

D. Vagal activation lowers intracellular calcium in parietal cells

E. Vagovagal reflexes increase cholinergic stimulation of parietal and enterochromaffin-like cells

159. A parietal cell secretes hydrochloric acid into the gastric lumen. Which apical transporter is directly responsible for hydrogen-ion secretion?

A. Na+/K+ ATPase

B. Na+/H+ exchanger

C. H+/K+ ATPase

D. Cl-/HCO3- exchanger

E. Na+/glucose cotransporter

160. A patient takes a proton-pump inhibitor. Which gastric-cell process is directly inhibited?

A. Gastrin synthesis by antral G cells

B. Final common pathway of acid secretion by parietal cells

C. Histamine synthesis by enterochromaffin-like cells

D. Pepsinogen synthesis by chief cells

E. Bicarbonate secretion by pancreatic duct cells

161. Acidic chyme enters the duodenum. Which hormone is released and promotes pancreatic bicarbonate secretion?

A. Secretin

B. Gastrin

C. Cholecystokinin

D. Motilin

E. Somatostatin

162. Fatty acids enter the duodenum after a meal. Which hormone most directly stimulates gallbladder contraction and pancreatic enzyme secretion?

A. Secretin release

B. Gastrin release

C. Ghrelin release

D. Aldosterone release

E. Cholecystokinin release

163. Between meals, a healthy person develops cyclic waves of gastrointestinal motor activity that clear residual contents. Which hormone is associated with this migrating motor complex?

A. Insulin

B. Secretin

C. Somatostatin

D. Leptin

E. Motilin

164. A patient has resection of the terminal ileum. Absorption of which substance is most directly impaired?

A. Iron and folate exclusively

B. Glucose and galactose exclusively

C. Vitamin B12-intrinsic factor complexes and bile acids

D. Amino acids and small peptides exclusively

E. Short-chain fatty acids produced in the colon

165. Dietary glucose is absorbed across the apical membrane of small-intestinal enterocytes mainly by which process?

A. Sodium-glucose cotransport driven by the sodium gradient

B. Simple diffusion through the lipid bilayer

C. Chloride-glucose exchange driven by chloride secretion

D. Primary active transport by an apical glucose ATPase

E. Endocytosis of glucose through brush-border vesicles

166. A patient drinks an oral rehydration solution containing glucose and sodium. Why can this treatment promote water absorption during secretory diarrhea?

A. Glucose directly blocks intestinal chloride channels in every diarrheal illness

B. Sodium absorption requires no transporter and is driven only by gravity

C. Water is actively pumped by enterocytes using ATP

D. Sodium-glucose cotransport remains functional and creates osmotic water absorption

E. Secretory diarrhea eliminates all apical sodium transport

167. A patient lacks pancreatic lipase. Which digestive step is most impaired?

A. Hydrolysis of dietary starch into oligosaccharides

B. Activation of gastric pepsin from secreted pepsinogen

C. Pancreatic hydrolysis of dietary triglycerides

D. Absorption of vitamin B12 complexes in the terminal ileum

E. Hepatic synthesis and secretion of conjugated bile acids

168. A patient has obstruction of bile flow into the intestine. Which nutrient class is most likely to be malabsorbed?

A. Simple carbohydrates such as monosaccharides

B. Water-soluble vitamins such as vitamin C

C. Dietary amino acids and small peptides

D. Sodium and chloride in intestinal fluid

E. Dietary lipids and fat-soluble vitamins

169. Why do bile salts enhance absorption of long-chain fatty acids?

A. They form micelles that keep lipid digestion products soluble in the intestinal lumen

B. They hydrolyze triglycerides directly through intrinsic lipase activity

C. They actively transport fatty acids through an ATP-dependent membrane pump

D. They prevent pancreatic enzymes from reaching dietary fat

E. They convert long-chain fatty acids into glucose before absorption

170. A chylomicron formed in an intestinal enterocyte contains absorbed long-chain triglyceride. Where does it enter the circulation first?

A. Portal venous capillaries directly

B. Hepatic sinusoids directly

C. Intestinal lymphatic lacteals

D. Inferior vena cava through mesenteric veins

E. Renal lymphatics before reaching the thoracic duct

171. Short-chain fatty acids are produced by colonic bacteria from dietary fiber. How are they primarily absorbed?

A. They enter the portal circulation without requiring chylomicron formation

B. They must be packaged into chylomicrons before leaving colonocytes

C. They are absorbed only through lymphatic lacteals

D. They cannot cross colonic epithelium and are excreted unchanged

E. They require intrinsic factor for transport into portal blood

172. A patient has pancreatic exocrine insufficiency. Which nutrient digestion is most vulnerable because there is no major alternative source of the required enzyme?

A. Starch digestion by salivary and pancreatic amylases

B. Protein digestion by gastric and intestinal proteases

C. Triglyceride digestion by pancreatic lipase

D. Brush-border digestion of common disaccharides

E. Nucleic-acid digestion by intestinal nucleotidases

173. A healthy person eats a protein-rich meal. Which gastric hormone increases in response to peptides and amino acids and stimulates acid secretion?

A. Gastrin secretion

B. Secretin secretion

C. Somatostatin secretion

D. Peptide YY secretion

E. Glucagon-like peptide 1 secretion

174. A low gastric pH suppresses further acid secretion. Which hormone released from gastric D cells mediates an important part of this negative feedback?

A. Gastrin

B. Motilin

C. Somatostatin

D. Cholecystokinin

E. Ghrelin

175. A patient has an intact enteric nervous system but both extrinsic autonomic inputs to the gut are experimentally removed. Which statement is most accurate?

A. All gastrointestinal motility immediately ceases

B. Peristalsis requires direct somatic motor innervation

C. Enteric neurons can sense lumen contents but cannot control smooth muscle

D. Only sympathetic fibers can coordinate local secretory reflexes

E. The intestine can still generate coordinated local reflexes and motility

176. A bolus distends a segment of small intestine. Which pattern characterizes the peristaltic reflex?

A. Relaxation behind the bolus and contraction ahead of it

B. Simultaneous contraction on both sides of the bolus

C. Contraction behind the bolus and relaxation ahead of it

D. Simultaneous relaxation throughout the entire intestine

E. Only circular-muscle relaxation with no longitudinal-muscle response

177. A patient has increased colonic mass movements after breakfast. Which physiologic reflex contributes to this response?

A. The enterogastric reflex always abolishes colonic motility after meals

B. The gastrocolic reflex increases colonic motility after gastric distention

C. The rectoanal inhibitory reflex contracts the internal anal sphincter after rectal distention

D. The vomiting reflex activates descending colonic peristalsis

E. The ileogastric reflex opens the pylorus and suppresses colon activity

178. Rectal distention initiates defecation. Which normal reflex response occurs in the internal anal sphincter?

A. It contracts strongly through somatic pudendal motor fibers

B. It remains tonically closed until voluntary cortical inhibition stops

C. It relaxes through the rectoanal inhibitory reflex

D. It relaxes only after the external anal sphincter contracts maximally

E. It is skeletal muscle and therefore has no enteric reflex control

179. A patient has severe diarrhea and loses large quantities of bicarbonate-rich intestinal fluid. Which primary acid-base disturbance is expected?

A. Normal-anion-gap metabolic acidosis

B. High-anion-gap metabolic acidosis

C. Metabolic alkalosis

D. Respiratory acidosis

E. Respiratory alkalosis

180. A peptide hormone binds a receptor on the surface of its target cell. Why do many peptide hormones require membrane receptors rather than intracellular receptors?

A. They are stored in the nucleus and can bind only nuclear receptors

B. They are hydrophobic and therefore cannot remain in plasma

C. They are hydrophilic and do not readily diffuse through the lipid bilayer

D. They are synthesized from cholesterol and require carrier proteins

E. They enter cells freely but are destroyed before reaching the cytosol

181. A steroid hormone enters a target cell and binds its receptor. Which mechanism most directly mediates many of its longer-term effects?

A. The receptor directly opens a ligand-gated sodium channel

B. The hormone is stored in secretory granules for rapid exocytosis

C. The receptor phosphorylates extracellular collagen without entering the nucleus

D. The hormone-receptor complex alters transcription of specific genes

E. The hormone increases cyclic AMP only at the cell surface

182. A hormone acts through a Gs-coupled receptor. Which intracellular change is expected?

A. Decreased adenylyl cyclase activity and decreased cyclic AMP

B. Activation of phospholipase C with decreased inositol trisphosphate

C. Direct opening of nuclear DNA without second messengers

D. Inhibition of protein kinase A despite increased cyclic AMP

E. Increased adenylyl cyclase activity and increased cyclic AMP

183. A hormone acts through a Gq-coupled receptor. Which signaling pathway is activated?

A. Adenylyl cyclase generates cyclic AMP and activates protein kinase A

B. Guanylyl cyclase generates cyclic GMP and closes all calcium channels

C. Tyrosine phosphatase directly degrades intracellular calcium

D. Phospholipase C generates IP3 and DAG, increasing intracellular calcium and protein kinase C activity

E. JAK-STAT signaling occurs without membrane phospholipid turnover

184. A patient is given insulin. Which receptor type mediates its direct cellular effects?

A. A receptor tyrosine kinase

B. A Gs-coupled seven-transmembrane receptor

C. A Gq-coupled seven-transmembrane receptor

D. An intracellular steroid receptor

E. A ligand-gated chloride channel

185. After a carbohydrate-rich meal, insulin increases glucose uptake into skeletal muscle. Which transporter is recruited to the cell membrane?

A. GLUT1

B. GLUT2

C. GLUT3

D. GLUT4

E. SGLT1

186. During an overnight fast, glucagon concentration rises. Which hepatic process is stimulated?

A. Glycogen synthesis and glycolysis

B. Fatty-acid synthesis with reduced glucose output

C. Glucose uptake through insulin-dependent GLUT4

D. Protein synthesis with suppression of amino-acid catabolism

E. Glycogenolysis and gluconeogenesis

187. A patient has a prolonged fast with low insulin and high glucagon. Which adipose-tissue process increases?

A. Lipoprotein lipase activity driven by high insulin in adipose tissue

B. Hormone-sensitive lipase activity and release of free fatty acids

C. Glucose uptake through abundant insulin-stimulated GLUT4

D. Triglyceride synthesis from excess malonyl-CoA

E. Suppression of fatty-acid delivery to the liver

188. A healthy person drinks a glucose solution. Why is the insulin response greater after oral glucose than after the same glucose concentration delivered intravenously?

A. Oral glucose bypasses the liver and reaches beta cells at a higher concentration

B. Intravenous glucose stimulates glucagon more strongly than insulin

C. Intestinal absorption suppresses all sympathetic input to pancreatic beta cells

D. Oral glucose directly enters beta cells through sodium-glucose cotransporters

E. Gut incretin hormones enhance glucose-stimulated insulin secretion

189. Glucose enters a pancreatic beta cell after a meal. Which event directly links increased intracellular glucose metabolism to insulin granule exocytosis?

A. ATP opens potassium channels, hyperpolarizing the cell and closing calcium channels

B. ATP closes potassium channels, depolarizing the cell and opening voltage-gated calcium channels

C. Glucose directly opens chloride channels and prevents depolarization

D. Calcium exits the cell and triggers granule fusion from the extracellular surface

E. Sodium-potassium ATPase inhibition is the normal physiologic trigger for insulin release

190. A healthy person becomes hypoglycemic during fasting. Which hormone is one of the earliest counterregulatory defenses against further decline in plasma glucose?

A. Increased insulin secretion

B. Increased atrial natriuretic peptide secretion

C. Increased glucagon secretion

D. Increased calcitonin secretion

E. Increased aldosterone secretion

191. Thyroid-stimulating hormone binds its receptor on thyroid follicular cells. Which second messenger is prominently activated?

A. Increased intracellular cyclic AMP

B. Increased intracellular cyclic GMP

C. Increased IP3 without cyclic AMP signaling

D. Direct nuclear-receptor activation by TSH

E. Reduced intracellular calcium through Gi signaling

192. Most circulating thyroid hormone is protein bound. Which fraction is biologically active and available to enter target cells?

A. Only hormone bound to thyroxine-binding globulin

B. Only hormone bound to albumin

C. Only reverse T3

D. The free unbound fraction

E. Only hormone contained within erythrocytes

193. A patient has increased thyroxine-binding globulin but normal thyroid function. After a new steady state is reached, which pattern is expected?

A. Decreased total T4 with increased free T4

B. Increased total T4 with normal free T4

C. Normal total T4 with persistently decreased free T4

D. Increased free T4 with suppressed binding protein

E. Absent thyroid-stimulating hormone because total T4 is high

194. Thyroid hormone increases basal metabolic rate in many tissues. Which cellular effect contributes to this response?

A. Permanent inhibition of mitochondrial oxygen consumption

B. Increased expression of metabolic enzymes and sodium-potassium ATPase

C. Reduced sensitivity to catecholamines in the cardiovascular system

D. Suppressed protein synthesis in all tissues

E. Direct closure of all mitochondrial proton channels

195. A patient's plasma cortisol peaks in the early morning under a normal sleep-wake schedule. Which hypothalamic-pituitary signal directly stimulates adrenal cortisol secretion?

A. Thyroid-stimulating hormone

B. Growth hormone

C. Prolactin

D. Antidiuretic hormone

E. Adrenocorticotropic hormone

196. A patient receives high-dose glucocorticoid therapy for several weeks. What happens to endogenous ACTH secretion?

A. It increases because exogenous glucocorticoids stimulate CRH release

B. It remains unchanged because cortisol does not regulate ACTH

C. It oscillates randomly because feedback exists only at the adrenal gland

D. It increases only because adrenal androgens fall

E. It decreases because glucocorticoids exert negative feedback on the hypothalamus and pituitary

197. A patient with severe hypotension activates the renin-angiotensin-aldosterone system. Which direct action of angiotensin II stimulates aldosterone release?

A. Binding to adrenal zona glomerulosa receptors increases aldosterone synthesis

B. Binding to pituitary lactotroph receptors increases prolactin

C. Binding to thyroid follicular cells increases thyroxine synthesis

D. Binding to pancreatic beta cells directly releases insulin

E. Binding to adrenal medulla suppresses catecholamine secretion

198. Aldosterone acts on principal cells of the cortical collecting duct. Which transport change is expected?

A. Reduced epithelial sodium-channel activity with potassium retention

B. Increased aquaporin-2 insertion independent of ADH

C. Direct inhibition of basolateral sodium-potassium ATPase

D. Reduced lumen-negative potential and reduced sodium reabsorption

E. Increased epithelial sodium-channel activity with increased potassium secretion

199. Parathyroid hormone rises in response to hypocalcemia. Which renal effect helps increase plasma calcium?

A. Decreased distal tubular calcium reabsorption

B. Increased distal tubular calcium reabsorption

C. Increased proximal phosphate reabsorption

D. Reduced activation of vitamin D in the kidney

E. Increased urinary calcium excretion as the principal response

200. Parathyroid hormone decreases proximal tubular phosphate reabsorption. What is the resulting effect on plasma phosphate?

A. Plasma phosphate tends to fall because urinary phosphate excretion increases

B. Plasma phosphate rises because urinary phosphate excretion decreases

C. Plasma phosphate remains fixed because kidneys do not regulate phosphate

D. Plasma phosphate rises solely because calcium reabsorption decreases

E. Plasma phosphate falls only if intestinal absorption becomes zero

201. Active vitamin D increases plasma calcium partly through which action?

A. Blocking intestinal calcium transport

B. Increasing renal calcium excretion as its dominant effect

C. Suppressing all osteoblast differentiation

D. Eliminating parathyroid hormone receptors

E. Increasing intestinal calcium absorption

202. Growth hormone stimulates production of insulin-like growth factor 1. Which organ is a major source of circulating IGF-1?

A. Chromaffin cells of the adrenal medulla

B. Hepatic parenchymal cells in the liver

C. Neurosecretory cells of the posterior pituitary

D. Parafollicular C cells of the thyroid gland

E. Epithelial cells lining the renal pelvis

203. A hypothalamic lesion interrupts dopamine delivery to the anterior pituitary. What happens to prolactin secretion?

A. Prolactin secretion falls because dopamine normally stimulates lactotrophs

B. Prolactin remains unchanged because it is controlled only by ACTH

C. Prolactin falls because posterior-pituitary oxytocin is lost

D. Prolactin increases only if thyroid hormone also rises

E. Prolactin secretion increases because tonic dopaminergic inhibition is lost

204. A breastfeeding infant suckles at the nipple. Which hormone is responsible for milk ejection from the breast?

A. Anterior-pituitary prolactin release

B. Anterior-pituitary follicle-stimulating hormone release

C. Posterior-pituitary oxytocin release

D. Adrenal cortical cortisol release

E. Adrenal cortical aldosterone release

205. During the early follicular phase of the menstrual cycle, follicle-stimulating hormone promotes which ovarian process?

A. Luteal progesterone production by the corpus luteum

B. Theca-cell aromatization of estrogen into androgen

C. Regression of all antral follicles before selection

D. Granulosa-cell proliferation and aromatization of theca-derived androgens

E. Direct suppression of estrogen synthesis in granulosa cells

206. Luteinizing hormone stimulates ovarian theca interna cells. Which product is generated for subsequent aromatization in granulosa cells?

A. Prolactin

B. Oxytocin

C. Thyroxine

D. Cortisol

E. Androgens

207. A woman approaches midcycle and has sustained high estradiol concentrations. What endocrine event is triggered by this change?

A. Negative feedback completely suppresses luteinizing hormone

B. Follicle-stimulating hormone falls to zero and ovulation is prevented

C. Positive feedback produces a surge of luteinizing hormone

D. Progesterone abruptly rises before any luteinization occurs

E. Gonadotropin-releasing hormone secretion stops for the remainder of the cycle

208. After ovulation, which hormone produced by the corpus luteum is chiefly responsible for converting the endometrium to a secretory state?

A. Progesterone

B. Estradiol only

C. Follicle-stimulating hormone

D. Prolactin

E. Oxytocin

209. A woman records basal body temperature throughout her cycle. Why does temperature rise slightly after ovulation?

A. Estradiol sharply lowers hypothalamic temperature set point after ovulation

B. Follicle-stimulating hormone directly increases skeletal-muscle heat production

C. Luteinizing hormone suppresses cutaneous vasoconstriction for two weeks

D. Ovulation eliminates circadian thermoregulation until menstruation

E. Progesterone has a thermogenic effect during the luteal phase

210. If fertilization does not occur, what event most directly initiates menstruation?

A. Corpus luteum regression causes progesterone and estrogen withdrawal

B. Persistent corpus luteum function maintains high progesterone indefinitely

C. A midcycle LH surge directly sheds the endometrium

D. Rising hCG causes spiral arteries to constrict

E. Follicle-stimulating hormone destroys the endometrium enzymatically

211. In early pregnancy, human chorionic gonadotropin maintains production of which hormone before placental steroidogenesis is fully established?

A. Prolactin from the posterior pituitary

B. Thyroxine from the fetal thyroid

C. Cortisol from the maternal adrenal medulla

D. Aldosterone from ovarian granulosa cells

E. Progesterone from the corpus luteum

212. During normal pregnancy, maternal systemic vascular resistance falls. Which hemodynamic change generally accompanies this fall?

A. Cardiac output decreases and arterial pressure rises markedly

B. Stroke volume falls to compensate for increased vascular resistance

C. Plasma volume decreases because the placenta sequesters all added blood

D. Cardiac output increases while arterial pressure often falls slightly in midpregnancy

E. Heart rate falls substantially below the prepregnancy baseline

213. Maternal ventilation increases during pregnancy under the influence of progesterone. Which arterial blood-gas change is expected?

A. Higher $PaCO_2$ with uncompensated respiratory acidosis

B. Lower $PaCO_2$ with mild compensated respiratory alkalosis

C. No change in $PaCO_2$ because tidal volume cannot rise

D. Lower PaO_2 with severe metabolic alkalosis

E. Higher bicarbonate without any renal compensation

214. Near term, uterine contractions cause cervical stretch that leads to further oxytocin release and stronger contractions. What type of control system is this?

A. Negative feedback

B. Feed-forward inhibition

C. Tonic inhibition

D. Positive feedback

E. Ultradian suppression

215. A breastfeeding mother has suppressed ovulation for several months. Which endocrine mechanism contributes?

A. Oxytocin increases GnRH pulse frequency

B. Elevated prolactin suppresses hypothalamic GnRH pulsatility

C. Prolactin directly triggers the midcycle LH surge

D. Suckling causes persistent high estradiol positive feedback

E. Lactation increases ovarian androgen synthesis enough to induce ovulation

216. In the seminiferous tubules, which cell responds primarily to follicle-stimulating hormone and supports spermatogenesis?

A. Interstitial testicular Leydig cells

B. Seminiferous-tubule Sertoli cells

C. Prostatic glandular epithelial cells

D. Epididymal duct smooth-muscle cells

E. Seminal-vesicle stromal cells

217. Luteinizing hormone acts on testicular Leydig cells. What is the principal endocrine product?

A. Inhibin B

B. Follicle-stimulating hormone

C. Prolactin

D. Testosterone

E. Oxytocin

218. A healthy man develops penile erection after parasympathetic activation. Which local mediator causes relaxation of cavernosal smooth muscle?

A. Nitric oxide with increased cyclic GMP

B. Norepinephrine with increased alpha1 signaling

C. Angiotensin II with increased intracellular calcium

D. Endothelin with increased phospholipase C activity

E. Acetylcholine acting only through skeletal-muscle nicotinic receptors

219. A patient loses 2 L of isotonic extracellular fluid from acute hemorrhage before significant fluid shifts occur. Which body-fluid compartment changes most directly?

A. Intracellular fluid volume decreases because extracellular osmolality rises markedly

B. Intracellular fluid volume increases because extracellular osmolality falls markedly

C. Total body water remains unchanged because isotonic fluid cannot be lost

D. Extracellular fluid volume decreases with little initial change in osmolality

E. Both compartments expand because interstitial fluid moves into plasma

220. A patient drinks a large amount of pure water rapidly. Before renal excretion restores balance, what change occurs?

A. Extracellular osmolality rises and water leaves cells

B. Extracellular volume falls because water cannot enter plasma

C. Intracellular volume falls while plasma sodium concentration rises

D. No fluid shift occurs because water cannot cross cell membranes

E. Extracellular osmolality falls and water shifts into cells

221. A patient loses hypotonic sweat during prolonged exercise without replacing fluid. Which overall change is expected?

A. Extracellular volume rises and osmolality falls, pushing water into cells

B. Extracellular volume falls and extracellular osmolality rises, pulling water out of cells

C. Extracellular osmolality remains unchanged because sweat is isotonic to plasma

D. Intracellular volume rises because sodium is lost faster than water in typical sweat

E. Both compartments expand because ADH is released

222. A patient receives several liters of isotonic saline. Which immediate fluid-distribution effect is expected?

A. Extracellular fluid volume expands with minimal change in intracellular volume

B. Intracellular fluid volume expands preferentially

C. Extracellular osmolality falls enough to cause marked cell swelling

D. Plasma sodium concentration rises dramatically because saline is hypertonic

E. Total body water decreases because saline suppresses ADH

223. A patient receives hypertonic saline. What happens to cell volume before renal compensation?

A. Cells shrink as water moves into the hypertonic extracellular compartment

B. Cells swell as sodium rapidly enters every cell

C. Cell volume remains fixed because water is membrane impermeable

D. Cells lyse because extracellular osmolality falls

E. Cells swell only because plasma proteins become more concentrated

224. A patient's arterial pH is 7.25, bicarbonate is reduced, and PaCO2 is also reduced. Which primary disorder with compensation is most likely?

A. Respiratory acidosis with renal compensation

B. Metabolic alkalosis with respiratory compensation

C. Metabolic acidosis with respiratory compensation

D. Respiratory alkalosis with renal compensation

E. A normal acid-base state because both bicarbonate and PaCO2 are low

225. A patient has metabolic acidosis with bicarbonate of 12 mEq/L. Using Winter's formula, which PaCO2 is closest to the expected compensatory value?

A. 12 mm Hg

B. 40 mm Hg

C. 52 mm Hg

D. 26 mm Hg

E. 70 mm Hg

226. A patient has sodium 140 mEq/L, chloride 104 mEq/L, and bicarbonate 12 mEq/L. What is the calculated anion gap using potassium-free convention?

A. 8 mEq/L

B. 24 mEq/L

C. 12 mEq/L

D. 36 mEq/L

E. 128 mEq/L

227. A patient with severe lactic acidosis has an elevated anion gap. What accounts for the rise?

A. Measured chloride rises exactly in place of every bicarbonate ion

B. Serum sodium falls to zero as lactate accumulates

C. Albumin disappears from plasma during acidemia

D. Unmeasured lactate anions accumulate as bicarbonate is consumed buffering hydrogen ions

E. Renal bicarbonate generation directly creates unmeasured cations

228. A patient is in early septic shock with warm extremities. Which hemodynamic pattern is most typical at this stage?

A. High systemic vascular resistance with markedly reduced cardiac output in every case

B. Low systemic vascular resistance with normal or increased cardiac output

C. Low cardiac output caused solely by bradycardia

D. Normal systemic vascular resistance with absent inflammatory vasodilation

E. High systemic vascular resistance with no change in venous capacitance

229. A patient with acute hemorrhage has cool clammy skin and tachycardia. Which compensatory response helps preserve arterial pressure?

A. Parasympathetic vasodilation increases skin blood flow

B. Atrial natriuretic peptide increases sodium excretion and reduces volume

C. Sympathetic vasoconstriction increases systemic vascular resistance and venous return

D. Baroreceptor firing rises and suppresses sympathetic tone

E. Renin secretion falls because renal perfusion is reduced

230. A patient with cardiogenic shock has a failing left ventricle. Which hemodynamic pattern is most expected?

A. Increased cardiac output with low filling pressures and vasodilation

B. Reduced filling pressures because ventricular failure unloads the atria

C. Low systemic vascular resistance as the defining compensatory response

D. Normal venous pressure because shock affects only arterial circulation

E. Reduced cardiac output with elevated filling pressures and increased systemic vascular resistance

231. A patient with severe anaphylaxis becomes hypotensive within minutes. Which mechanism contributes importantly to the fall in effective circulating volume?

A. Reduced vascular permeability traps all fluid intravascularly

B. Increased plasma oncotic pressure draws interstitial fluid into capillaries

C. Generalized venoconstriction eliminates vascular capacitance

D. Histamine directly increases red-cell production within minutes

E. Increased vascular permeability allows plasma fluid to move into the interstitium

232. A person exercises dynamically at moderate intensity. Which integrated cardiovascular response is expected?

A. Cardiac output falls and total peripheral resistance rises

B. Heart rate falls while skeletal-muscle blood flow decreases

C. Stroke volume must fall to zero as venous return increases

D. Cardiac output rises and total peripheral resistance usually falls

E. Mean arterial pressure always doubles because arterioles constrict in working muscle

233. During strenuous dynamic exercise, oxygen consumption increases. According to the Fick principle, which pair of changes can support the rise?

A. Lower cardiac output and narrower arterial-venous oxygen difference

B. Lower heart rate and reduced tissue oxygen extraction

C. Higher venous oxygen content with unchanged cardiac output only

D. Reduced skeletal-muscle perfusion and reduced oxygen extraction

E. Higher cardiac output and wider arterial-venous oxygen difference

234. A trained endurance athlete has a lower resting heart rate than before training. Which adaptation contributes?

A. Decreased stroke volume requires a lower heart rate to preserve output

B. Resting cardiac output must increase severalfold after endurance training

C. Vagal tone is reduced while sympathetic tone is chronically maximal

D. Increased stroke volume permits the same resting cardiac output at a lower heart rate

E. Blood volume falls substantially, reducing venous return

235. A person acclimatizes to high altitude for several weeks. Which adaptation improves blood oxygen-carrying capacity?

A. Reduced erythropoietin lowers hematocrit

B. Increased erythropoietin stimulates an increase in red-cell mass

C. Reduced 2,3-BPG shifts hemoglobin left and improves tissue unloading

D. Renal bicarbonate retention restores the initial respiratory alkalosis

E. Pulmonary ventilation returns below sea-level baseline

236. During early high-altitude acclimatization, renal bicarbonate excretion increases. Why is this response useful?

A. It causes metabolic alkalosis that suppresses ventilation

B. It compensates respiratory alkalosis and permits sustained hyperventilation

C. It increases $PaCO_2$ and reverses peripheral chemoreceptor stimulation

D. It prevents oxygen unloading by shifting hemoglobin far left

E. It directly increases atmospheric oxygen pressure

237. A patient has fever due to inflammatory cytokines. How does fever differ physiologically from hyperthermia?

A. Hyperthermia raises the hypothalamic set point more than fever

B. Fever always results from failure of sweating rather than cytokines

C. Fever raises the hypothalamic temperature set point, whereas hyperthermia does not

D. Hyperthermia requires prostaglandin E2 production in the hypothalamus

E. Fever cannot cause chills because the set point is unchanged

238. A febrile patient develops chills while body temperature is already elevated. Why do chills occur?

A. The raised hypothalamic set point makes the current body temperature feel relatively too low

B. The hypothalamic set point has fallen below the current body temperature

C. Sweating is maximal and directly triggers skeletal-muscle shivering

D. Peripheral vasodilation causes the brain to sense excessive heat

E. Rapid peripheral vasodilation lowers skin temperature enough to trigger compensatory shivering

239. A patient with heat stroke has a core temperature above 40 C and altered mental status. Which heat-loss mechanism is most limited when ambient temperature exceeds skin temperature?

A. Evaporation becomes impossible whenever ambient temperature exceeds skin temperature

B. Conduction becomes the only physiologic route of heat loss in dry air

C. Sweating stops automatically once ambient temperature exceeds skin temperature

D. Cutaneous blood flow must fall to maximize environmental heat transfer

E. Radiation and convection can no longer provide net heat loss, leaving evaporation crucial

240. A patient has severe insulin deficiency and increased ketone-body production. Which organ produces most circulating ketone bodies during this state?

A. Skeletal-muscle ketone-body synthesis

B. Cerebral ketone-body synthesis

C. Adipose-tissue ketone-body synthesis

D. Erythrocyte ketone-body synthesis

E. Hepatic mitochondrial ketogenesis

241. During prolonged fasting, the brain increasingly uses ketone bodies. What is one physiologic advantage of this adaptation?

A. It eliminates all need for hepatic fatty-acid oxidation

B. It forces erythrocytes to stop using glucose

C. It reduces the requirement for glucose derived from muscle-protein breakdown

D. It prevents renal ammonium production during fasting

E. It converts the brain into a major producer of ketone bodies

242. A patient with severe hypovolemia has increased renin and ADH. What is the shared physiologic goal of these responses?

A. Increase sodium and water excretion to reduce preload

B. Reduce systemic vascular tone and suppress thirst

C. Lower extracellular fluid volume while preserving urine output

D. Promote natriuresis through atrial stretch

E. Preserve effective circulating volume and arterial pressure

243. A patient has prolonged severe hypoperfusion and elevated lactate. Why does lactate production increase when cellular oxygen delivery becomes inadequate?

A. Lactate is produced only by complete mitochondrial oxidation of pyruvate

B. NADH must be generated from NAD+ to stop glycolysis

C. Beta-oxidation directly converts fatty acids into lactate in mitochondria

D. The citric-acid cycle accelerates and releases lactate as its final product

E. Pyruvate is reduced to lactate to regenerate NAD+ for glycolysis

244. A patient's mitochondrial electron transport chain is inhibited. Which change occurs in oxidative phosphorylation?

A. Proton-motive force and ATP synthesis fall as electron flow is blocked

B. Proton-motive force rises indefinitely while oxygen consumption increases

C. ATP synthase generates more ATP because protons cannot return to the matrix

D. NADH oxidation accelerates despite blocked electron transport

E. Oxygen becomes unnecessary for regeneration of oxidized electron carriers

245. An uncoupling agent increases proton permeability of the inner mitochondrial membrane. What is the expected effect?

A. Oxygen consumption stops while ATP production rises

B. ATP production and oxygen consumption both rise in fixed proportion

C. Oxygen consumption can increase while ATP production falls and heat generation rises

D. Heat generation falls because proton flow is blocked

E. Electron transport stops because NADH cannot be oxidized

246. A screening test is evaluated in 100 people with disease; 90 test positive. Among 200 people without disease, 40 test positive. What is the sensitivity?

A. 20%

B. 90%

C. 69%

D. 80%

E. 95%

247. In the same study, 160 of 200 people without disease test negative. What is the specificity?

A. 20%

B. 40%

C. 90%

D. 80%

E. 94%

248. A diagnostic test with fixed sensitivity and specificity is moved from a low-prevalence population to a high-prevalence population. Which predictive value generally increases?

A. Negative predictive value

B. Positive predictive value

C. Sensitivity

D. Specificity

E. False-positive rate must increase

249. A highly sensitive screening test is negative in a patient. Why can this result be useful for ruling out disease?

A. A highly sensitive test has relatively few false-positive results

B. Sensitivity rises automatically when disease prevalence falls

C. A negative result guarantees zero post-test probability

D. Sensitivity measures the probability of disease given a positive result

E. A highly sensitive test has relatively few false-negative results

250. A cohort study finds disease in 20% of exposed participants and 10% of unexposed participants. What is the relative risk?

A. 0.5

B. 1.0

C. 2.0

D. 10

E. 20

251. In a randomized trial, an outcome occurs in 12% of the control group and 8% of the treatment group. What is the absolute risk reduction?

A. 1.5 percentage points

B. 8 percentage points

C. 4 percentage points

D. 12 percentage points

E. 33 percentage points

252. Using the trial in which absolute risk reduction is 0.04, what is the number needed to treat?

A. 4

B. 8

C. 12

D. 40

E. 25

253. A study reports a relative risk of 0.78 with a 95% confidence interval of 0.61 to 0.99. Which interpretation is most appropriate?

A. The result is not significant because the point estimate is below 1.0

B. The result proves the treatment is clinically important in every patient

C. The null value for relative risk is 0, so the interval includes the null

D. The result is statistically significant at the 0.05 level because the interval excludes 1.0

E. A confidence interval cannot be used to assess statistical significance

254. A trial reports p = 0.03 for its primary comparison. What does this p value mean?

A. The null hypothesis itself has a 3% probability of being true

B. The treatment has a 97% probability of working in an individual patient

C. Under the null hypothesis, results this extreme would occur about 3% of the time

D. Three percent of treated patients failed because of random sampling error

E. The probability that an identical study will replicate is exactly 97%

255. Investigators reject a true null hypothesis. What type of statistical error has occurred?

A. Type II error

B. Selection bias

C. Type I error

D. Confounding

E. Effect modification

256. A study fails to reject a false null hypothesis. What type of statistical error has occurred?

A. Type I error

B. Type II error

C. Recall bias

D. Lead-time bias

E. Verification bias

257. Researchers want to increase the power of a study without changing the true effect size. Which change generally helps?

A. Decrease the sample size

B. Increase the sample size

C. Use a stricter alpha while keeping all else fixed

D. Increase measurement variability

E. Reduce the number of observed outcome events

258. A case-control study asks participants to remember past dietary exposures. Cases recall their past diet more intensively than controls. What bias is most likely?

A. Lead-time bias

B. Length-time sampling bias

C. Berkson selection bias

D. Differential recall bias

E. Observer-expectancy bias

259. Coffee drinking appears associated with myocardial infarction, but smokers both drink more coffee and have higher infarction risk. Smoking is acting as what?

A. A mediator necessarily

B. A confounder

C. A randomization variable

D. A type I error

E. A sampling frame

260. A competent adult with severe anemia refuses a recommended blood transfusion after the risks and alternatives are explained. What is the most appropriate next step?

A. Administer the transfusion because the physician believes it is beneficial

B. Respect the informed refusal and continue discussing acceptable alternatives

C. Ask the family to override the patient's decision

D. Seek a court order solely because the refusal may increase risk

E. Document incapacity based only on disagreement with the treatment plan

261. A patient with limited English proficiency needs to consent to an invasive procedure. Her adult daughter offers to interpret. What is the best approach?

A. Use the daughter because family interpretation is always equivalent

B. Proceed with written English materials only

C. Ask another patient who speaks the language to interpret

D. Delay all care indefinitely until the patient learns English

E. Use a qualified medical interpreter for the consent discussion

262. A physician realizes that a medication error caused a temporary adverse effect that has now resolved. What should the physician do?

A. Avoid disclosure because the effect resolved completely

B. Change the medical record so the error is not visible

C. Tell only the patient's family and ask them not to inform the patient

D. Disclose the error honestly, explain its consequences, and describe the plan for ongoing care

E. Wait to disclose unless the patient specifically discovers the error

263. A patient asks, 'Am I dying?' after receiving a serious diagnosis. Which initial response best supports patient-centered communication?

A. Immediately provide a precise survival estimate without exploring the question

B. Reassure the patient that everything will be fine regardless of prognosis

C. Ask what the patient understands and what concerns are most important right now

D. Change the subject to avoid increasing anxiety

E. Tell the family first and let them decide what the patient should know

264. A competent patient tells the physician that she does not want details of her test results and asks that her spouse receive the information instead. What is the best response?

A. Respect the patient's preference and clarify what information may be shared with the spouse

B. Insist on disclosing all details directly because patients cannot decline information

C. Refuse to communicate with the spouse under any circumstances

D. Tell the spouse everything without confirming the patient's permission

E. Document that the patient lacks decision-making capacity because she avoids details

265. A patient with fluctuating delirium refuses a high-risk procedure. Which element is essential when assessing decision-making capacity?

A. Assume incapacity solely because the patient is currently hospitalized

B. Use chronological age alone as the decisive capacity criterion

C. Ask whether the patient agrees with the physician recommendation

D. Assess understanding, appreciation, reasoning, and ability to communicate a choice

E. Require a perfect cognitive-screening score before recognizing capacity

266. An unconscious patient needs immediate lifesaving treatment, and no surrogate can be reached. What permits treatment to proceed?

A. Emergency treatment can proceed under implied consent when delay threatens life or major function

B. Treatment must wait until a court appoints a guardian

C. Any hospital employee may sign permanent consent for the patient

D. The physician may proceed only if the patient has previously signed a research consent

E. Life-saving care is prohibited whenever written consent is unavailable

267. A patient previously completed a valid advance directive refusing prolonged mechanical ventilation in an irreversible condition. The patient now lacks capacity and meets that condition. What should guide care?

A. Ignore the directive because current incapacity cancels prior autonomy

B. Follow whichever treatment the physician personally prefers

C. Let the most vocal family member override the patient's written wishes

D. Honor the patient's documented prior preferences unless there is a compelling reason they no longer apply

E. Continue every life-sustaining treatment until a court specifically orders withdrawal

268. A surrogate must choose between two treatments for a patient who never expressed preferences. Which decision standard is most appropriate?

A. Use the surrogate's personal preferences as the controlling standard

B. Choose the least expensive option regardless of clinical effect

C. Use the patient's best interests when the patient's own values and wishes are unknown

D. Always request the most aggressive treatment available

E. Use the physician's religious beliefs as the primary guide

269. A teenager requests confidential counseling about contraception and asks that her parents not be told. What is the best general communication approach?

A. Promise absolute confidentiality in every circumstance without exceptions

B. Explain confidentiality and its limits, then provide lawful confidential adolescent care

C. Disclose all details to the parents immediately without discussing confidentiality

D. Refuse private discussion unless a parent remains in the examination room

E. Record the confidential discussion only in the parent medical record

270. A child has bruises in multiple stages of healing and the caregiver's explanation is inconsistent with the injuries. What is the physician's primary responsibility?

A. Wait for definitive proof before taking any protective action

B. Ensure the child's immediate safety and follow mandatory reporting requirements for suspected abuse

C. Confront the caregiver publicly before documenting the injuries

D. Discharge the child because reporting is the family's responsibility

E. Promise the caregiver that no outside agency will be contacted

271. A patient discloses intimate-partner violence but is not in immediate danger and has decision-making capacity. Which response is most appropriate?

A. Validate the concern, assess immediate safety, offer resources, and support the patient's choices

B. Insist that the patient leave the partner immediately as a condition of care

C. Contact the partner to obtain the other side of the story

D. Promise secrecy without explaining any legally required exceptions

E. Recommend joint counseling with the partner before offering individual safety planning

272. A patient begins crying after hearing a new diagnosis. Which physician response is most therapeutic?

A. Immediately change to technical details so emotion does not interfere

B. Acknowledge the emotion and allow space before continuing the discussion

C. Tell the patient not to cry because treatment options exist

D. Leave the room without explanation until the patient stops crying

E. Ask a family member to finish the medical discussion instead

273. A patient repeatedly misses appointments because she cannot reliably reach the clinic by public transportation. Which clinician response best addresses the problem?

A. Label the patient noncompliant and terminate care for repeated missed visits

B. Explore the transportation barrier and arrange feasible access support

C. Assume that repeated missed visits mean the patient does not value care

D. Increase medication doses without discussing the access problem

E. Require a written statement accepting blame for the missed appointments

274. A patient says, 'I know smoking is harmful, but I am not ready to quit.' Which response best reflects motivational interviewing?

A. Lecture the patient until agreement to quit is obtained

B. Warn that continued smoking proves the patient does not care about health

C. Avoid discussing smoking again until the patient independently quits

D. Ask permission to discuss smoking and explore the patient's own reasons for and against change

E. Prescribe cessation medication without asking about goals or preferences

275. A physician notices that a colleague is repeatedly confused at work and smells of alcohol while caring for patients. What is the best action?

A. Ignore the impairment signs in order to preserve the collegial relationship

B. Use institutional or physician-health channels promptly to protect patients

C. Confront the colleague only after a patient experiences serious harm

D. Post the suspected impairment publicly on social media

E. Quietly rewrite the colleague orders without reporting the impairment

276. A medical student is asked by a patient to perform a procedure the student has never done independently. Which response is most appropriate?

A. Perform the procedure alone to avoid appearing inexperienced

B. Claim prior experience so the patient remains confident

C. Explain the student's role and obtain appropriate supervision before participating

D. Refuse all future procedures because trainees should never participate

E. Ask another student to supervise because formal supervision is unnecessary

277. A patient's family asks the physician to hide a cancer diagnosis because they fear the patient will lose hope. The patient has capacity and previously asked for full information. What is the best response?

A. Explore the family's concern while honoring the patient's stated preference for truthful disclosure

B. Agree to conceal the diagnosis because family wishes override a competent patient

C. Tell the family they can choose what information the patient receives

D. Avoid both the patient and family until they resolve the disagreement

E. Document that truth-telling is optional whenever prognosis is serious

278. A competent patient asks that no medical information be shared with an estranged sibling who calls the clinic. What should the physician do?

A. Maintain confidentiality and do not disclose information without the patient's authorization

B. Disclose the diagnosis because siblings are automatically entitled to medical information

C. Give limited details because family relationships override confidentiality

D. Confirm the diagnosis but withhold treatment details

E. Ask the sibling to promise not to share the information and then disclose it

279. A patient asks the physician to falsify a disability form so the patient can obtain benefits. What is the most appropriate response?

A. Alter the disability form because patient advocacy permits inaccurate documentation

B. Ask the patient to write the false statements and then sign the completed form

C. Terminate all future medical care because the request itself was unethical

D. Decline falsification and document the patient actual medical limitations accurately

E. Submit the requested disability form without reviewing its factual statements

280. A patient with terminal illness asks whether stopping dialysis would be considered suicide. Which response best reflects standard ethical reasoning?

A. A competent patient may refuse or discontinue a burdensome life-sustaining treatment after informed discussion

B. Stopping any life-sustaining treatment is ethically identical to physician-assisted suicide

C. Dialysis can never be stopped once it has been initiated

D. Only a court may authorize discontinuation of dialysis in a competent adult

E. The physician must abandon the patient if dialysis is refused

Answers

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1. B. At birth, lung expansion raises arterial oxygen tension and removal of the placenta lowers circulating prostaglandin E2. Both effects constrict ductal smooth muscle and produce functional ductal closure. Persistent low oxygen tension or prostaglandin signaling instead favors ductal patency.

2. B. Aeration of the lungs recruits pulmonary capillaries and raises alveolar oxygen tension, causing pulmonary vasodilation and a major fall in pulmonary vascular resistance. Loss of the placenta increases systemic vascular resistance, but it is not the main cause of the pulmonary fall.

3. D. Surfactant lowers surface tension, especially at low lung volumes, and stabilizes small alveoli. Deficiency therefore increases surface tension, decreases compliance, raises the work required to inflate the lung, and promotes atelectasis.

4. D. Infant myocardium is less compliant and has a more limited capacity to increase stroke volume. Because cardiac output equals heart rate times stroke volume, increases in heart rate are therefore especially important for meeting changes in metabolic demand.

5. C. Fetal hemoglobin contains gamma chains that bind 2,3-BPG poorly. This shifts its oxygen dissociation curve to the left relative to adult hemoglobin and helps fetal blood acquire oxygen from maternal blood in the placenta.

6. C. Renal peritubular interstitial fibroblast-like cells sense tissue hypoxia and increase erythropoietin production. Chronic kidney disease reduces this endocrine response, impairing marrow erythroid proliferation and causing a typically normocytic anemia.

7. D. Low inspired oxygen stimulates peripheral chemoreceptors and increases ventilation. The immediate result is a fall in arterial carbon dioxide and respiratory alkalosis; renal bicarbonate loss and increased erythropoiesis occur later.

8. C. 2,3-BPG binds deoxygenated beta chains and stabilizes the low-affinity T state of adult hemoglobin. Reduced 2,3-BPG therefore increases oxygen affinity, shifts the curve left, and impairs unloading to peripheral tissues.

9. D. Increased temperature, increased carbon dioxide, and lower pH all decrease hemoglobin oxygen affinity through the Bohr effect and related conformational changes. The curve shifts right, promoting oxygen release where metabolic activity is greatest.

10. E. Carbon monoxide binds hemoglobin with very high affinity, reducing available oxygen-binding sites. It also increases the oxygen affinity of remaining sites, shifting the dissociation curve left and impairing tissue unloading despite a potentially normal PaO2.

11. C. PaO2 reflects dissolved oxygen and alveolar gas exchange, not the amount of hemoglobin available to carry oxygen. Anemia can therefore markedly reduce arterial oxygen content while PaO2 and hemoglobin saturation remain normal.

12. E. Reduced oxygen delivery after blood loss activates renal hypoxia sensing and erythropoietin secretion. Erythropoietin stimulates erythroid progenitors, producing a reticulocyte response over subsequent days rather than an immediate restoration of red-cell mass.

13. E. Rising hematocrit increases whole-blood viscosity, particularly in larger vessels and at lower shear rates. Greater viscosity increases resistance to flow and can impair microvascular perfusion despite increased oxygen-carrying capacity.

14. A. Platelets mediate primary hemostasis by adhering, activating, and aggregating at sites of endothelial injury. Severe thrombocytopenia therefore causes mucocutaneous bleeding and defective primary plug formation, while standard coagulation times may remain normal.

15. E. Platelet glycoprotein Ib binds von Willebrand factor that has attached to exposed collagen, initiating platelet adhesion. Glycoprotein IIb/IIIa is subsequently activated and binds fibrinogen to mediate platelet aggregation.

16. A. Activated glycoprotein IIb/IIIa receptors bind fibrinogen, which bridges adjacent platelets and produces aggregation. Blocking this receptor impairs the final common pathway of platelet aggregation rather than initial adhesion.

17. E. Factor VIII functions in the intrinsic pathway as a cofactor for factor IXa. Its deficiency prolongs the activated partial thromboplastin time while leaving the tissue-factor-dependent prothrombin time relatively normal.

18. C. Factor VII has the shortest half-life of the major vitamin K-dependent procoagulant factors, so the prothrombin time rises early after warfarin initiation. Protein C also falls rapidly, which explains the transient early prothrombotic tendency.

19. A. Heparin binds antithrombin and markedly accelerates its inhibition of several activated coagulation factors, especially thrombin and factor Xa. This is the central mechanism of unfractionated heparin anticoagulation.

20. B. Tissue plasminogen activator converts plasminogen to plasmin. Plasmin is the active protease that digests fibrin and generates fibrin-degradation products such as D-dimer.

21. E. Disseminated intravascular coagulation causes pathologic systemic coagulation, consuming platelets and clotting factors. Secondary fibrinolysis generates fibrin-degradation products, so thrombosis and bleeding can occur simultaneously.

22. A. Spherocytes have a reduced surface-area-to-volume ratio and less membrane reserve for deformation. They are therefore less able to traverse the narrow splenic microcirculation and are preferentially trapped and removed.

23. D. Deoxygenated hemoglobin S exposes hydrophobic interactions that permit polymer formation. Hypoxia, acidosis, and dehydration therefore favor sickling by increasing deoxygenated HbS concentration and promoting polymerization.

24. E. The spleen removes opsonized particles and bloodborne microbes through its macrophage-rich filtration system and supports humoral responses to polysaccharide antigens. Loss of these functions increases risk from encapsulated organisms.

25. A. Memory B cells formed during the primary response react rapidly on re-exposure. They have undergone class switching and affinity maturation, so the secondary response is faster, larger, and typically dominated by higher-affinity immunoglobulin.

26. C. C3b covalently coats microbial surfaces and is recognized by complement receptors on phagocytes, making it a major opsonin. C3a and C5a are inflammatory mediators, while C5b through C9 participate in membrane attack complex formation.

27. C. The terminal complement components C5b through C9 assemble into the membrane attack complex, which is particularly important for killing Neisseria. Deficiency of these components predisposes to recurrent invasive Neisseria infection.

28. E. Chemotaxis is directed leukocyte migration along a chemical concentration gradient. C5a is a potent chemoattractant; diapedesis refers specifically to transendothelial passage rather than directional migration within tissue.

29. A. The respiratory burst begins when NADPH oxidase transfers electrons to oxygen, generating superoxide. Superoxide is converted to hydrogen peroxide, which myeloperoxidase can then use to produce hypochlorous acid in neutrophil granules.

30. C. Chronic granulomatous disease results from defective NADPH oxidase, so phagocytes cannot generate a normal respiratory burst. Catalase-positive organisms destroy their own hydrogen peroxide, depriving affected phagocytes of an alternative source of reactive oxygen intermediates.

31. D. CD4 T cells recognize extracellularly derived peptides displayed by MHC class II molecules on professional antigen-presenting cells. CD8 T cells instead recognize peptide presented by MHC class I.

32. E. Endogenous proteins, including viral proteins made within infected cells, are processed and presented on MHC class I. CD8 cytotoxic T cells recognize these peptide-MHC I complexes and can then induce apoptosis of the infected cell.

33. C. Normal MHC class I engages inhibitory receptors on natural killer cells. Cells that downregulate MHC I, as can occur during viral infection or malignant transformation, lose this inhibitory signal and become more susceptible to NK-cell killing.

34. D. Class switching changes the heavy-chain constant region, allowing the same antigen-binding variable region to be expressed as IgG, IgA, or IgE. Antigen specificity is therefore retained while Fc-mediated effector functions change.

35. B. Activated germinal-center B cells undergo somatic hypermutation in immunoglobulin variable regions. Selection of clones with higher-affinity receptors produces affinity maturation, improving antibody binding during the evolving immune response.

36. C. Once threshold is reached, voltage-gated sodium channels open rapidly and sodium enters down its electrochemical gradient, creating the steep depolarizing phase of the neuronal action potential. Delayed potassium-channel opening is responsible mainly for repolarization.

37. D. After opening, many voltage-gated sodium channels enter an inactivated state and cannot reopen until membrane repolarization resets them. This channel-state transition accounts for the absolute refractory period.

38. B. Myelin increases membrane resistance and decreases membrane capacitance, allowing depolarizing current to spread farther and faster along internodes. Action potentials are regenerated mainly at nodes of Ranvier, producing saltatory conduction.

39. E. Arrival of an action potential opens presynaptic voltage-gated calcium channels. Calcium entry triggers SNARE-dependent vesicle fusion, so blocking this influx directly reduces quantal neurotransmitter release.

40. E. Opening chloride conductance tends to hold the membrane near the chloride equilibrium potential and shunts depolarizing current. This makes it more difficult for excitatory inputs to bring the axon hillock to action-potential threshold.

41. C. Nicotinic receptors on skeletal muscle are ligand-gated cation channels. Acetylcholine binding opens them and creates the end-plate potential; receptor blockade prevents this depolarization even if acetylcholine is normally released.

42. B. Alpha1 receptors couple mainly to Gq and increase intracellular calcium in smooth muscle. Activation causes vasoconstriction and contraction of structures such as the radial iris and internal sphincters.

43. A. Beta1 receptors couple to Gs, increasing adenylyl cyclase activity and cyclic AMP. In pacemaker cells, this enhances funny current and calcium currents, steepening phase 4 depolarization and increasing heart rate.

44. B. Cardiac M2 receptors couple to Gi and also activate acetylcholine-sensitive potassium channels. The resulting hyperpolarization and reduced cyclic AMP slow phase 4 depolarization and decrease sinoatrial-node firing.

45. B. Sympathetic fibers activate alpha1 receptors in the iris dilator muscle. Loss of this input leaves parasympathetic constrictor tone relatively unopposed, producing miosis along with ptosis and reduced facial sweating.

46. A. Pain and temperature afferents synapse in the dorsal horn, and second-order neurons cross through the anterior white commissure within a few segments. They then ascend contralaterally in the anterolateral system.

47. C. Fine touch, vibration, and conscious proprioception ascend ipsilaterally in the dorsal columns. These fibers synapse in the gracile or cuneate nuclei and cross in the medulla to form the medial lemniscus.

48. E. Corticospinal fibers cross at the pyramidal decussation in the caudal medulla. A spinal-cord lesion therefore affects already crossed fibers and produces ipsilateral upper-motor-neuron signs below the lesion.

49. D. Muscle spindles detect muscle length and the velocity of stretch. Ia afferents make a direct excitatory synapse on alpha motor neurons supplying the same muscle, creating the monosynaptic stretch reflex.

50. C. Golgi tendon organs lie in series with muscle fibers and respond to tension generated during contraction or stretch. Their Ib afferents participate in reflex circuits that can reduce excessive muscle force.

51. E. Dopamine normally stimulates D1 receptors in the direct pathway and inhibits D2 neurons in the indirect pathway, both effects favoring movement. Dopamine loss therefore decreases direct-pathway facilitation and enhances indirect-pathway suppression of thalamocortical motor activity.

52. A. Many cerebellar circuits involve paired crossings: cerebellar output crosses to the contralateral motor cortex, and corticospinal fibers later cross again before reaching spinal motor neurons. The net effect is ipsilateral coordination of the body.

53. B. Cerebral perfusion pressure is approximated as mean arterial pressure minus intracranial pressure, or minus central venous pressure if that is higher. A rise in intracranial pressure therefore reduces the pressure gradient driving cerebral blood flow unless arterial pressure increases.

54. D. Carbon dioxide readily affects brain extracellular pH. Hypercapnia increases hydrogen ion concentration and causes cerebral vasodilation, increasing cerebral blood flow; hypocapnia has the opposite effect.

55. D. When arterial oxygen tension falls substantially, especially below about 50 mm Hg, cerebral arterioles dilate. This raises cerebral blood flow and helps preserve oxygen delivery to neural tissue.

56. B. REM sleep resembles wakefulness on EEG, with low-amplitude mixed-frequency activity, but descending brainstem mechanisms produce profound skeletal-muscle atonia. Dreaming and autonomic variability are also prominent.

57. C. N2 sleep is defined by sleep spindles and K complexes. N3 is dominated by high-amplitude delta activity, while REM sleep has desynchronized EEG activity with rapid eye movements and muscle atonia.

58. A. Light activates rhodopsin, transducin, and phosphodiesterase, lowering cyclic GMP. Cyclic-GMP-gated cation channels close, reducing the dark current and hyperpolarizing the photoreceptor, which decreases glutamate release.

59. B. Bright light bleaches photopigment. In darkness, rhodopsin regenerates and rods progressively recover sensitivity, allowing vision at low light levels; pupil dilation contributes but does not account for the full adaptation.

60. D. Parasympathetic contraction of the ciliary muscle decreases tension on the zonular fibers. The elastic lens becomes more convex, increasing refractive power for near vision as part of the accommodation response.

61. D. Each optic tract carries information from the contralateral visual hemifield. The right optic tract therefore carries the left visual field from both eyes, so a right tract lesion produces left homonymous hemianopia.

62. A. The tympanic membrane and ossicular chain concentrate force from a relatively large membrane area onto the small oval window and provide lever action. This impedance matching helps transmit acoustic energy from air into cochlear fluid.

63. B. The cochlear base is relatively stiff and narrow and resonates with high frequencies. The wider, more compliant apex responds preferentially to low frequencies, creating the tonotopic organization of the cochlea.

64. E. Endolymph has an unusually high potassium concentration and a positive electrical potential. Opening mechanotransduction channels therefore drives potassium into hair cells, depolarizing them and subsequently opening voltage-gated calcium channels.

65. D. Semicircular canals detect angular acceleration. Head rotation causes relative movement of endolymph, deflecting the cupula and hair cells of the crista ampullaris; the otolith organs primarily sense linear acceleration and head tilt.

66. A. The utricular macula is oriented mainly in the horizontal plane and responds to horizontal linear acceleration and head tilt. The saccule is more sensitive to vertical linear acceleration.

67. D. Small-diameter A-delta and C fibers carry much of pain and temperature sensation and are relatively susceptible to local anesthetic blockade. Large myelinated motor and proprioceptive fibers generally require greater exposure for comparable conduction block.

68. E. Spinal shock causes transient suppression of reflexes after acute cord injury. With time, spinal circuits recover but remain disconnected from important descending inhibitory influences, producing exaggerated reflexes and other upper-motor-neuron signs.

69. B. Mechanical contraction lasts much longer than the skeletal-muscle action potential. Repeated stimuli arriving before calcium is fully resequestered maintain a higher cytosolic calcium concentration, so additional cross-bridges form and force summates.

70. E. In an isometric contraction the muscle develops force without meaningful change in overall length. Cross-bridge cycling and elastic-element stretch can occur internally, but the external load is not moved through a shortening distance.

71. A. The force-velocity relationship of skeletal muscle is inverse during concentric contraction: shortening velocity is greatest at low load and falls as load rises. At the maximal isometric force, shortening velocity reaches zero.

72. C. Active tension depends on the number of productive actin-myosin cross-bridges. An intermediate sarcomere length provides optimal overlap; very short or very long lengths reduce the number of effective cross-bridges.

73. C. The size principle recruits smaller alpha motor neurons first. Their slow oxidative muscle fibers are fatigue resistant and suited for low-force sustained activity; larger fast motor units are added as force requirements increase.

74. B. Slow oxidative fibers contain abundant mitochondria, capillaries, and myoglobin, supporting aerobic ATP production and fatigue resistance. They are commonly recruited for posture and endurance rather than maximal rapid force.

75. D. Intramuscular ATP and phosphocreatine can regenerate ATP extremely rapidly but have limited capacity. Anaerobic glycolysis contributes increasingly as the effort continues, whereas oxidative pathways dominate longer-duration exercise.

76. D. Active muscle produces vasodilator metabolites, including adenosine, potassium, carbon dioxide, and hydrogen ions. Together with endothelial mechanisms, these signals overcome sympathetic vasoconstriction locally and increase perfusion to match metabolic demand.

77. A. Working muscle removes a larger fraction of delivered oxygen, lowering venous oxygen content. The difference between arterial and venous oxygen content therefore widens, contributing to the increase in whole-body oxygen consumption by the Fick principle.

78. A. Dense regular connective tissue has relatively sparse vascularity and cellularity. Limited blood supply and slower matrix turnover contribute to prolonged tendon healing compared with more vascular tissues.

79. C. Ascorbate is required by prolyl and lysyl hydroxylases during collagen maturation. Deficiency weakens collagen triple-helix stability and connective-tissue integrity, producing findings such as poor wound healing and bleeding gums.

80. D. Lysyl oxidase is a copper-dependent extracellular enzyme that oxidatively deaminates selected lysine and hydroxylysine residues, enabling covalent cross-links that strengthen collagen fibrils.

81. C. Osteoclasts generate hydrogen ions and pump them across the ruffled border into the sealed resorption compartment. Acid dissolves hydroxyapatite, while proteolytic enzymes degrade the organic matrix.

82. E. Parathyroid hormone acts on osteoblast-lineage cells to increase RANK ligand and reduce the relative inhibitory effect of osteoprotegerin. RANK ligand promotes osteoclast differentiation and activation, increasing bone resorption.

83. C. Calcitonin binds receptors on osteoclasts and suppresses their resorptive activity. Its role in day-to-day calcium regulation in adults is modest compared with parathyroid hormone and vitamin D, but the direct osteoclast effect is clear.

84. B. Active vitamin D increases intestinal absorption of both calcium and phosphate. Deficiency reduces the supply of these minerals for hydroxyapatite formation and can produce defective mineralization in growing bone.

85. D. Osteoblasts synthesize osteoid, including type I collagen and other matrix proteins, and promote mineralization. Osteoclasts resorb bone rather than form the new organic matrix.

86. A. Bone is a dynamic tissue that adapts to mechanical loading. Osteocytes sense strain and influence remodeling so that bone formation and architecture are reinforced in regions subjected to repeated stress.

87. C. The stratum corneum is a lipid-rich, keratinized barrier that greatly limits passive water loss. Extensive disruption of this barrier increases evaporative fluid loss and contributes to volume depletion after major burns.

88. D. Most sympathetic postganglionic fibers are adrenergic, but eccrine sweat glands are a classic exception. Their postganglionic sympathetic fibers release acetylcholine onto muscarinic receptors to stimulate sweating.

89. E. Evaporation depends on a water-vapor pressure gradient between moist skin and the surrounding air. High humidity narrows that gradient, so sweat evaporates less effectively and provides less cooling even if secretion remains high.

90. E. Shivering consists of involuntary skeletal-muscle contractions that markedly increase ATP turnover and oxidative metabolism. Much of the chemical energy is released as heat, helping restore core temperature.

91. B. Cold exposure increases sympathetic vasoconstrictor outflow to skin, reducing cutaneous blood flow and limiting convective heat transfer from the core to the environment. This response preserves core temperature at the expense of peripheral warmth.

92. A. Melanin made by melanocytes is transferred to keratinocytes, where it forms supranuclear caps and absorbs ultraviolet radiation. This reduces UV-induced DNA injury, although it does not eliminate skin-cancer risk.

93. E. Epidermal regeneration depends on proliferative basal keratinocytes and epithelial stem cells associated with appendages such as hair follicles. Preservation of these structures allows re-epithelialization after superficial injury.

94. A. Disuse decreases mechanical loading and contractile activity, shifting muscle protein balance toward net loss. Myofibrils and fiber cross-sectional area decline, producing disuse atrophy that can be improved with progressive reloading.

95. E. Adult resistance training enlarges skeletal muscle mainly by hypertrophy of existing fibers, driven by increased protein synthesis and remodeling of myofibrils. Satellite cells can contribute nuclei, but widespread creation of new fibers is not the dominant mechanism.

96. D. Dystrophin links actin in the muscle cytoskeleton to a transmembrane protein complex connected to the extracellular matrix. Loss of this mechanical bridge makes the sarcolemma vulnerable to contraction-induced injury.

97. A. Within the physiologic range, increased ventricular filling stretches sarcomeres toward a more favorable operating length and increases calcium sensitivity. The ventricle therefore ejects a larger stroke volume without requiring an increase in intrinsic contractility.

98. C. A higher aortic pressure increases afterload, so the ventricle must generate more pressure before and during ejection. With unchanged contractility, less blood is ejected, increasing end-systolic volume and reducing stroke volume on that beat.

99. B. Increased contractility steepens the end-systolic pressure-volume relationship and allows the ventricle to eject more completely. End-systolic volume falls and ejection fraction rises for a given preload and afterload.

100. A. Cardiac output equals heart rate multiplied by stroke volume. Seventy-five beats per minute times 80 mL per beat equals 6000 mL/min, or 6.0 L/min.

101. C. By the Fick principle, cardiac output equals oxygen consumption divided by the arterial-venous oxygen-content difference. The difference is 50 mL/L, so 250 mL/min divided by 50 mL/L equals 5 L/min.

102. B. At ordinary heart rates, mean arterial pressure is approximately diastolic pressure plus one third of pulse pressure. The pulse pressure is 45 mm Hg, so 75 + 15 is about 90 mm Hg.

103. D. For laminar flow in a cylindrical tube, resistance is proportional to viscosity and length and inversely proportional to radius to the fourth power. Even a modest reduction in radius can therefore cause a large increase in resistance.

104. D. The Reynolds number increases with fluid density, vessel diameter, and velocity and decreases with viscosity. Higher velocity therefore favors turbulence, which helps explain murmurs and bruits in high-flow or narrowed regions.

105. E. Anemia lowers blood viscosity and often increases cardiac output. Both effects can raise the Reynolds number, making turbulent flow more likely even when valve anatomy is normal.

106. B. Standing causes gravity-dependent pooling in the leg and splanchnic veins. Central venous pressure, ventricular filling, and stroke volume transiently fall, which can reduce arterial pressure until baroreflex compensation develops.

107. E. Reduced stretch of carotid sinus and aortic arch baroreceptors decreases afferent firing to the medulla. The reflex response increases sympathetic activity and reduces parasympathetic activity, raising heart rate, contractility, arteriolar resistance, and venous tone.

108. C. Increased carotid sinus stretch is interpreted as increased arterial pressure. Medullary reflex pathways reduce sympathetic outflow and enhance vagal activity, slowing the heart and reducing peripheral vascular tone.

109. B. Atrial natriuretic peptide is released in response to atrial distention. It promotes natriuresis and vasodilation while suppressing renin-angiotensin-aldosterone signaling, helping oppose volume expansion.

110. A. Systolic contraction compresses intramyocardial coronary vessels, especially in the left ventricular subendocardium. Left coronary flow therefore occurs predominantly during diastole, when ventricular wall tension and extravascular compression are lower.

111. D. The left coronary circulation is perfused mainly during diastole. Tachycardia disproportionately shortens diastole, reducing the time available for coronary flow while simultaneously increasing myocardial oxygen demand.

112. B. During the ventricular plateau, L-type calcium channels provide an inward current while several potassium currents carry charge outward. Their approximate balance produces the prolonged phase 2 action potential.

113. C. Pacemaker cells have an unstable resting potential. Hyperpolarization-activated funny channels carry a mixed inward current that contributes to spontaneous phase 4 depolarization, along with calcium and changing potassium conductances.

114. A. Unlike atrial and ventricular myocytes, nodal cells have a relatively depolarized maximum diastolic potential that keeps many fast sodium channels unavailable. Their phase 0 upstroke therefore depends mainly on L-type calcium current.

115. E. The AV node conducts slowly because its action-potential upstroke is calcium dependent and cell-to-cell coupling is relatively limited. This delay allows atrial systole to contribute to ventricular filling before ventricular contraction begins.

116. C. Purkinje fibers have large diameters and abundant gap junctions, allowing very rapid conduction. This distributes activation through the ventricles efficiently and promotes coordinated ventricular contraction.

117. E. Inspiration lowers right atrial and intrathoracic venous pressure while often raising abdominal pressure. The resulting pressure gradient favors movement of systemic venous blood into the thorax and increases right-sided filling.

118. C. An arteriovenous fistula provides a low-resistance pathway from arteries to veins, lowering total peripheral resistance. Venous return and, after compensation, cardiac output usually increase.

119. B. Elevated left atrial and pulmonary venous pressures raise pulmonary capillary hydrostatic pressure. This favors net fluid filtration from capillaries into the interstitium and, when lymphatic capacity is exceeded, into alveoli.

120. D. Albumin contributes most of the plasma oncotic pressure that draws water toward the vascular space. Marked hypoalbuminemia lowers this opposing force to filtration, favoring movement of fluid into the interstitium.

121. D. Lymphatics normally return filtered fluid and escaped plasma proteins to the circulation. Obstruction causes protein-rich interstitial fluid to accumulate, raising interstitial oncotic pressure and producing persistent edema.

122. C. Alveolar ventilation equals respiratory rate times tidal volume minus dead-space volume. Twelve breaths per minute multiplied by 350 mL of fresh alveolar ventilation per breath equals 4200 mL/min, or 4.2 L/min.

123. A. $PaCO_2$ varies approximately inversely with alveolar ventilation when carbon dioxide production is constant. Doubling effective alveolar ventilation therefore reduces $PaCO_2$ to about one half its previous value.

124. D. The simplified alveolar gas equation is $PAO_2 = PIO_2 - PaCO_2/R$. With inspired oxygen and respiratory quotient unchanged, a rise in $PaCO_2$ lowers calculated alveolar oxygen tension.

125. E. When ventilation is absent but blood flow persists, V/Q approaches zero. Blood leaving that region remains poorly oxygenated, creating shunt-like physiology that responds less completely to supplemental oxygen than simple V/Q mismatch.

126. C. A ventilated but unperfused alveolus contributes to physiologic dead space. With perfusion approaching zero while ventilation persists, the local V/Q ratio tends toward infinity.

127. E. Fick's law for diffusion predicts that transfer decreases as membrane thickness rises. Fibrosis thickens the diffusion barrier and lowers diffusing capacity, which can become clinically important during exercise when capillary transit time is shortened.

128. A. Carbon monoxide binds hemoglobin so strongly that its dissolved capillary partial pressure stays near zero during the test. Uptake therefore remains diffusion limited, making transfer dependent on membrane and capillary properties captured by DLCO.

129. C. Emphysema destroys alveolar septa and the associated capillary bed, reducing the surface area available for diffusion. DLCO therefore falls even though total lung volumes may be increased.

130. A. For laminar flow, Poiseuille's relationship makes resistance inversely proportional to radius to the fourth power. Airway geometry is more complex than a rigid tube, but radius remains a dominant determinant of resistance.

131. A. Expansion of surrounding lung tissue increases radial traction on intrapulmonary airways. This raises airway caliber and lowers resistance, one reason resistance is greater at low lung volumes.

132. D. Compliance is the change in volume per change in distending pressure. Fibrotic lungs are stiff, so a larger pressure change produces a smaller volume change; compliance decreases while elastic recoil increases.

133. A. Destruction of elastic tissue makes emphysematous lungs easier to inflate but less able to recoil. Compliance increases, elastic recoil decreases, and small airways are more prone to dynamic collapse during forced expiration.

134. C. Functional residual capacity is the passive equilibrium volume of the respiratory system. The lungs tend to recoil inward while the chest wall tends to spring outward, and these forces are balanced when respiratory muscles are relaxed.

135. E. Inspiratory muscle contraction expands the thorax and lowers pleural pressure, increasing transpulmonary pressure and lung volume. As alveoli expand, alveolar pressure falls slightly below atmospheric pressure, driving airflow inward.

136. C. During forced expiration, pressure falls along the airway toward the mouth. Beyond the equal-pressure point, surrounding pleural pressure can exceed airway luminal pressure, producing dynamic compression that is exaggerated when elastic recoil is reduced.

137. B. Obstruction disproportionately reduces the volume exhaled in the first second, so FEV1 falls more than FVC and the FEV1/FVC ratio decreases. Air trapping often raises residual volume.

138. A. Restriction reduces lung volumes, including total lung capacity and often vital capacity. FEV1 and FVC both fall, but their ratio is generally normal or elevated because flow is not disproportionately impaired.

139. B. Hypoventilation reduces carbon dioxide excretion, increasing PaCO2 and carbonic acid. The immediate disturbance is respiratory acidosis; renal bicarbonate retention develops later if hypercapnia persists.

140. A. For a freely filtered substance with no tubular handling, the amount excreted equals the amount filtered. Clearance therefore equals glomerular filtration rate, the principle underlying the use of inulin as a reference marker.

141. B. Para-aminohippurate is filtered and avidly secreted, so most PAH entering the kidney is cleared from plasma in one pass at low concentrations. Its clearance therefore approximates effective renal plasma flow.

142. D. Filtration fraction is glomerular filtration rate divided by renal plasma flow. Here, 120/600 equals 0.20, meaning about 20% of plasma entering the renal circulation is filtered at the glomeruli.

143. B. Moderate efferent arteriolar constriction raises upstream glomerular capillary pressure and tends to preserve or increase GFR even while renal plasma flow falls. Very severe constriction can eventually reduce GFR because plasma oncotic pressure rises markedly.

144. A. Afferent constriction reduces blood delivery into the glomerular capillary bed. Both renal plasma flow and glomerular capillary hydrostatic pressure fall, so GFR decreases.

145. D. Plasma proteins generate colloid osmotic pressure that opposes filtration across glomerular capillaries. A higher plasma protein concentration therefore raises this opposing force and tends to reduce net filtration pressure and GFR.

146. A. The proximal tubule reabsorbs roughly two thirds of filtered sodium and water along with most filtered bicarbonate, glucose, and amino acids. Water follows solute so tubular fluid remains approximately iso-osmotic through much of this segment.

147. A. Glucose is freely filtered but normally reabsorbed almost completely in the proximal tubule through sodium-glucose cotransporters on the apical membrane and facilitated transport basolaterally.

148. B. The filtered load equals GFR times plasma glucose concentration. Once this load exceeds the maximal capacity of proximal tubular glucose transport, not all filtered glucose can be reabsorbed and glucosuria results.

149. D. The thick ascending limb uses the Na-K-2Cl cotransporter and has very low water permeability. Solute reabsorption without water dilutes tubular fluid and helps establish the medullary osmotic gradient.

150. B. Active NaCl reabsorption in the water-impermeable thick ascending limb lowers tubular fluid osmolality. This segment therefore produces dilute tubular fluid while also contributing to the corticomedullary osmotic gradient.

151. D. ADH binds V2 receptors on principal cells, activates Gs and cyclic AMP signaling, and promotes insertion of aquaporin-2 channels into the apical membrane. Water then exits basolaterally through constitutive aquaporins.

152. D. Without ADH, few aquaporin-2 channels are present in the apical membrane of collecting-duct principal cells. Water permeability stays low, so tubular fluid cannot equilibrate with the hypertonic medullary interstitium and dilute urine is excreted.

153. C. ADH increases urea permeability in the inner medullary collecting duct. Urea diffuses into the medullary interstitium and can recycle into thin limbs, contributing substantially to inner-medullary hypertonicity.

154. D. The hairpin arrangement and slow blood flow of the vasa recta allow passive countercurrent exchange. Solute and water movements minimize washout of the corticomedullary gradient while still providing medullary perfusion.

155. E. Chronic acidosis stimulates renal ammoniagenesis from glutamine. Ammonia buffers secreted hydrogen ions as ammonium in the tubular lumen, permitting greater net acid excretion while generating new bicarbonate for the blood.

156. A. Chronic hypercapnia stimulates renal acid secretion, ammonium excretion, and generation or retention of bicarbonate. Plasma bicarbonate rises, partially buffering the respiratory acidosis without correcting the primary elevation in $PaCO_2$.

157. B. Contraction of extracellular volume activates sodium-retaining systems and increases proximal bicarbonate reabsorption. Chloride depletion also limits bicarbonate secretion in the collecting duct, so alkalosis can persist until volume and chloride are restored.

158. E. Gastric distention activates vagovagal and local enteric reflexes. Acetylcholine stimulates parietal cells directly and promotes histamine release from enterochromaffin-like cells, while vagal signaling also supports gastrin release.

159. C. The gastric proton pump exchanges intracellular hydrogen ions for luminal potassium using ATP. Chloride follows through channels, while basolateral chloride-bicarbonate exchange contributes to the postprandial alkaline tide.

160. B. Proton-pump inhibitors irreversibly inhibit the parietal-cell H^+/K^+ ATPase, the final step in gastric acid secretion. They do not primarily block gastrin or histamine production, although secondary feedback changes can occur.

161. A. Duodenal S cells release secretin in response to acid. Secretin stimulates pancreatic and biliary ductal bicarbonate secretion, helping neutralize gastric acid and create a suitable pH for intestinal enzymes.

162. E. Cholecystokinin is released from duodenal and jejunal I cells in response to fats and amino acids. It contracts the gallbladder, relaxes the sphincter of Oddi, and stimulates pancreatic acinar enzyme secretion.

163. E. Motilin contributes to the fasting migrating motor complex, a recurring pattern of coordinated contractions that sweeps through the stomach and small intestine between meals.

164. C. The terminal ileum contains receptors for intrinsic factor-bound vitamin B12 and is also the principal site for active bile-acid reabsorption. Resection can therefore cause B12 deficiency and bile-acid loss.

165. A. SGLT1 uses the inward sodium electrochemical gradient to cotransport glucose and galactose across the apical membrane. The gradient is maintained by basolateral Na+/K+ ATPase, and glucose exits basolaterally through facilitated diffusion.

166. D. Coupled sodium-glucose absorption in the small intestine often remains intact during secretory diarrhea. Solute uptake creates an osmotic gradient that promotes water absorption, which is the physiologic basis of oral rehydration therapy.

167. C. Pancreatic lipase, aided by colipase, hydrolyzes triglycerides to monoglycerides and free fatty acids. These products join bile-salt micelles and can then approach the enterocyte membrane for absorption.

168. E. Bile salts emulsify dietary fat and form mixed micelles that facilitate absorption of lipids and vitamins A, D, E, and K. Severe reduction in luminal bile salts therefore causes fat malabsorption and steatorrhea.

169. A. Amphipathic bile salts surround lipid digestion products and form mixed micelles, increasing their solubility in the aqueous intestinal environment and delivering them close to the enterocyte brush border.

170. C. Long-chain lipids are re-esterified and packaged into chylomicrons, which are too large to enter ordinary intestinal capillaries efficiently. They enter lacteals and travel through lymph to the thoracic duct before reaching systemic blood.

171. A. Short-chain fatty acids are relatively water soluble and can be absorbed by colonocytes and delivered to portal blood without the chylomicron pathway used for long-chain triglyceride products.

172. C. Pancreatic lipase is particularly important for efficient fat digestion, and severe pancreatic insufficiency commonly causes steatorrhea. Carbohydrate and protein digestion have more redundancy from salivary, gastric, brush-border, and other pancreatic enzymes.

173. A. Antral G cells release gastrin in response to peptides, gastric distention, and vagal stimulation. Gastrin stimulates acid secretion directly and especially through histamine release from enterochromaffin-like cells.

174. C. Acid stimulates D-cell somatostatin release. Somatostatin inhibits gastrin release and directly suppresses parietal and enterochromaffin-like cell activity, limiting further acid secretion.

175. E. The enteric nervous system contains sensory neurons, interneurons, and motor neurons capable of organizing local motility and secretory reflexes independently. Extrinsic autonomic input modulates these functions but is not required for every local reflex.

176. C. The peristaltic reflex propels contents aborally by causing ascending contraction on the oral side and descending relaxation on the anal side. Enteric neural circuits coordinate these opposing motor responses.

177. B. Gastric distention after a meal can increase colonic motor activity through the gastrocolic reflex. This helps explain the common urge to defecate after eating, particularly in the morning.

178. C. The internal anal sphincter is smooth muscle. Rectal distention triggers enteric-mediated relaxation of the internal sphincter, while the external sphincter remains under voluntary somatic control through the pudendal nerve.

179. A. Lower gastrointestinal secretions contain bicarbonate. Large stool losses remove base from the body, producing a hyperchloremic, normal-anion-gap metabolic acidosis as chloride rises to maintain electroneutrality.

180. C. Peptide hormones are generally water soluble and cannot cross the plasma membrane by simple diffusion. They therefore signal through membrane receptors and intracellular second-messenger pathways.

181. D. Steroid hormones are lipophilic and commonly bind intracellular receptors. The activated receptor complex regulates transcription, changing protein synthesis over minutes to hours rather than relying only on rapid membrane signaling.

182. E. Gs activates adenylyl cyclase, increasing cyclic AMP and typically protein kinase A activity. Many endocrine receptors, including TSH, ACTH, FSH, LH, PTH, and glucagon receptors, use this pathway.

183. D. Gq activates phospholipase C, which cleaves PIP2 into IP3 and DAG. IP3 releases calcium from intracellular stores, while DAG activates protein kinase C.

184. A. The insulin receptor is a transmembrane receptor tyrosine kinase. Ligand binding activates receptor autophosphorylation and downstream signaling pathways that regulate glucose uptake, metabolism, growth, and gene expression.

185. D. Insulin signaling causes GLUT4-containing vesicles to translocate to the plasma membrane in skeletal muscle and adipose tissue, increasing facilitated glucose uptake. Exercise can also promote GLUT4 translocation through insulin-independent signaling.

186. E. Glucagon acts primarily on the liver through Gs-coupled receptors, increasing cyclic AMP. It promotes glycogen breakdown and gluconeogenesis while inhibiting pathways that consume or store glucose.

187. B. Low insulin and counterregulatory hormones activate adipose lipolysis. Hormone-sensitive lipase releases free fatty acids and glycerol, providing substrates for hepatic ketogenesis and gluconeogenesis during fasting.

188. E. The incretin effect reflects hormones such as GLP-1 and GIP released from the intestine after nutrient ingestion. They amplify glucose-dependent insulin secretion, making the insulin response to oral glucose greater than to matched intravenous glucose.

189. B. Glucose metabolism raises the ATP/ADP ratio, which closes ATP-sensitive potassium channels. Membrane depolarization then opens voltage-gated calcium channels, and calcium influx triggers insulin-containing granule exocytosis.

190. C. Falling glucose suppresses insulin and stimulates glucagon and epinephrine. Glucagon rapidly increases hepatic glucose production, making it an important early counterregulatory response to hypoglycemia.

191. A. The TSH receptor couples predominantly to Gs, activating adenylyl cyclase and cyclic AMP. This stimulates thyroid hormone synthesis, secretion, and trophic effects on the thyroid gland.

192. D. Only free thyroid hormone can readily enter target tissues and participate in feedback regulation. Binding proteins provide a circulating reservoir and influence total hormone concentration without necessarily changing the free concentration.

193. B. More binding protein initially lowers free hormone transiently, stimulating TSH and thyroid output until free T4 returns to normal. The new equilibrium has a larger protein-bound pool and therefore increased total T4 with normal free T4.

194. B. Thyroid hormone acts through nuclear receptors to alter gene transcription. It increases metabolic enzyme activity and Na+/K+ ATPase expression and enhances adrenergic responsiveness, raising oxygen consumption and heat production in many tissues.

195. E. Hypothalamic CRH stimulates pituitary ACTH, which acts on the adrenal cortex to promote cortisol synthesis. The axis has a circadian rhythm, with cortisol typically highest in the early morning.

196. E. Glucocorticoids inhibit CRH and ACTH secretion by negative feedback. Prolonged therapy can therefore suppress the hypothalamic-pituitary-adrenal axis and cause adrenal cortical atrophy.

197. A. Angiotensin II acts on AT1 receptors in zona glomerulosa cells to stimulate aldosterone synthesis. Hyperkalemia is another major direct stimulus for aldosterone release.

198. E. Aldosterone increases ENaC and Na+/K+ ATPase expression and activity in principal cells. Enhanced sodium reabsorption makes the lumen more negative and promotes potassium secretion through apical potassium channels.

199. B. PTH increases calcium reabsorption in the distal nephron, decreases proximal phosphate reabsorption, and stimulates renal 1-alpha-hydroxylase to increase calcitriol production. Together these actions support restoration of ionized calcium.

200. A. PTH inhibits proximal sodium-phosphate cotransport, producing phosphaturia. Although PTH can mobilize phosphate from bone, the renal effect is strong enough that plasma phosphate generally falls.

201. E. Calcitriol increases expression of intestinal calcium-transport proteins and also enhances phosphate absorption. It supports mineral availability for bone while participating in endocrine feedback with PTH.

202. B. Growth hormone acts on many tissues, but the liver is a major source of circulating IGF-1. IGF-1 mediates important growth-promoting actions and contributes to negative feedback on the growth-hormone axis.

203. E. Unlike most pituitary hormones, prolactin is under dominant tonic inhibition by hypothalamic dopamine. Interruption of the pituitary stalk or dopamine signaling therefore increases prolactin release.

204. C. Suckling activates a neuroendocrine reflex that releases oxytocin from the posterior pituitary. Oxytocin contracts myoepithelial cells around mammary alveoli and ducts, producing milk let-down; prolactin primarily supports milk production.

205. D. FSH acts on granulosa cells, promoting follicular growth and aromatase expression. Theca cells respond primarily to LH and produce androgen precursors that granulosa cells convert to estrogens.

206. E. LH stimulates theca cells to synthesize androgens from cholesterol. These androgens diffuse to granulosa cells, where FSH-induced aromatase converts them into estrogens.

207. C. Moderately elevated estrogen usually exerts negative feedback, but sustained high estradiol late in the follicular phase switches to positive feedback on the hypothalamic-pituitary axis. The resulting LH surge triggers ovulation and luteinization.

208. A. Progesterone from the corpus luteum acts on an estrogen-primed endometrium to promote glandular secretion and stromal changes that support implantation. Withdrawal of progesterone contributes to menstruation if pregnancy does not occur.

209. E. Progesterone secreted by the corpus luteum raises basal body temperature by a small but measurable amount. The sustained postovulatory temperature rise can therefore provide retrospective evidence that ovulation occurred.

210. A. Without embryonic hCG, the corpus luteum regresses. Falling progesterone and estrogen destabilize the endometrium, promote spiral-artery changes and prostaglandin activity, and lead to menstrual shedding.

211. E. hCG binds LH receptors and rescues the corpus luteum from regression. Continued luteal progesterone production maintains the endometrium during early pregnancy until the placenta assumes sufficient steroid production.

212. D. Pregnancy is characterized by vasodilation and reduced systemic vascular resistance. Plasma volume, heart rate, stroke volume, and cardiac output generally increase, while blood pressure often falls modestly during midpregnancy before moving toward baseline later.

213. B. Progesterone increases ventilatory drive, raising minute ventilation and lowering maternal PaCO2. The kidneys compensate by excreting bicarbonate, producing a mild chronic respiratory alkalosis that also favors fetal-to-maternal CO2 transfer.

214. D. Cervical stretch stimulates oxytocin release, which strengthens uterine contractions and produces additional cervical stretch. This self-amplifying loop is a classic physiologic example of positive feedback and ends with delivery.

215. B. Frequent suckling elevates prolactin and alters hypothalamic signaling, reducing GnRH pulsatility. LH and FSH secretion fall, which can suppress follicular development and ovulation during lactational amenorrhea.

216. B. FSH acts on Sertoli cells, which nourish developing germ cells, produce androgen-binding protein and inhibin B, and help maintain the seminiferous-tubule environment. LH acts primarily on Leydig cells to stimulate testosterone synthesis.

217. D. LH stimulates Leydig-cell steroidogenesis and testosterone production. Testosterone supports spermatogenesis through high local concentrations and mediates systemic androgen effects.

218. A. Parasympathetic and endothelial signaling releases nitric oxide in erectile tissue. Nitric oxide activates guanylyl cyclase, increases cyclic GMP, relaxes cavernosal smooth muscle, and permits arterial filling and venous compression.

219. D. Loss of isotonic fluid decreases extracellular volume without materially changing extracellular osmolality. Because there is little osmotic gradient across cell membranes, intracellular volume changes minimally at first.

220. E. Adding free water dilutes extracellular solute and lowers extracellular osmolality. Water then moves into the intracellular compartment until osmolalities equilibrate, expanding both compartments and lowering plasma sodium concentration.

221. B. Sweat is usually hypotonic relative to plasma, so proportionally more water than solute is lost. Extracellular volume contracts and osmolality rises, causing water to shift from cells into extracellular fluid until osmotic equilibrium is restored.

222. A. Isotonic saline remains primarily in the extracellular compartment and does not create a major osmotic gradient across cell membranes. It therefore expands plasma and interstitial volumes with little immediate effect on cell volume.

223. A. Hypertonic saline raises extracellular effective osmolality. Water moves out of cells to equilibrate osmolality, reducing intracellular volume and expanding extracellular volume.

224. C. A low pH with reduced bicarbonate indicates a primary metabolic acidosis. Appropriate respiratory compensation increases ventilation and lowers PaCO2, partially limiting the fall in pH.

225. D. Winter's formula estimates expected PaCO2 as 1.5 times bicarbonate plus 8, plus or minus 2. For bicarbonate 12, the estimate is 18 + 8 = 26 mm Hg; a substantially different PaCO2 suggests an additional respiratory disorder.

226. B. The anion gap is Na - (Cl + HCO3). Here it is 140 - (104 + 12) = 24 mEq/L, which is elevated compared with a typical normal value near 8 to 12 mEq/L depending on the laboratory.

227. D. In high-anion-gap metabolic acidosis, added acids consume bicarbonate while their conjugate bases remain as unmeasured anions. Lactate is one such anion, increasing the calculated gap rather than producing an equivalent rise in chloride.

228. B. Early distributive septic shock often features profound vasodilation and reduced systemic vascular resistance. Cardiac output may be preserved or increased, producing warm extremities despite inadequate effective tissue perfusion.

229. C. Reduced effective circulating volume lowers baroreceptor firing and activates sympathetic output. Arteriolar vasoconstriction supports pressure, venoconstriction mobilizes venous blood, and tachycardia and contractility help maintain cardiac output.

230. E. Pump failure reduces forward output and raises upstream filling pressures. Baroreflex and neurohormonal compensation increase systemic vascular resistance, which may preserve pressure but also increases afterload on the failing heart.

231. E. Anaphylactic mediators cause vasodilation and increased endothelial permeability. Plasma fluid shifts into tissues, reducing effective intravascular volume while tissue edema develops.

232. D. Dynamic exercise increases sympathetic drive, heart rate, contractility, venous return, and cardiac output. Metabolic vasodilation in active skeletal muscle lowers resistance in a large vascular bed, so total peripheral resistance usually falls despite sympathetic vasoconstriction elsewhere.

233. E. Whole-body oxygen consumption equals cardiac output times the arterial-venous oxygen-content difference. Exercise raises cardiac output and increases oxygen extraction by working tissues, widening the A-V oxygen difference.

234. D. Endurance training increases plasma volume, ventricular filling, and stroke volume and often increases resting vagal influence. Because cardiac output equals heart rate times stroke volume, a larger stroke volume permits a lower resting heart rate.

235. B. Persistent hypoxemia stimulates renal erythropoietin and increases erythropoiesis over days to weeks. Red-cell mass and hemoglobin concentration rise, increasing oxygen-carrying capacity despite low ambient oxygen pressure.

236. B. Hypoxemia stimulates hyperventilation, producing respiratory alkalosis that initially restrains further ventilation. Renal bicarbonate loss lowers plasma bicarbonate and pH toward normal, allowing ventilation to remain elevated.

237. C. Pyrogenic cytokines promote prostaglandin E2 signaling that raises the hypothalamic set point. The body then conserves and generates heat until it reaches the new set point; in hyperthermia, temperature rises without a regulated upward shift in set point.

238. A. When the set point rises during fever, the existing body temperature is below the newly desired level. Vasoconstriction and shivering are therefore activated to raise temperature, producing the sensation of chills.

239. E. When the environment is hotter than the skin, radiation and convection may result in heat gain rather than loss. Evaporation of sweat becomes the major physiologic route for dissipating heat, provided humidity permits evaporation.

240. E. Low insulin and high counterregulatory hormones increase hepatic fatty-acid delivery and beta-oxidation. Excess acetyl-CoA is converted to ketone bodies in liver mitochondria, which then export them for use by other tissues.

241. C. As fasting continues, the brain adapts to oxidize ketone bodies, reducing its glucose requirement. This decreases the need for gluconeogenesis from amino acids and helps preserve skeletal muscle protein.

242. E. Volume depletion activates sympathetic, renin-angiotensin-aldosterone, thirst, and ADH pathways. Together they increase vascular tone and conserve sodium and water, supporting effective circulating volume and perfusion pressure.

243. E. When oxidative phosphorylation cannot reoxidize NADH adequately, lactate dehydrogenase converts pyruvate to lactate while regenerating NAD+. This permits glycolysis to continue producing a limited amount of ATP without sufficient oxygen.

244. A. Electron transport pumps protons out of the mitochondrial matrix and generates the gradient that drives ATP synthase. Blocking electron flow reduces proton pumping, oxygen consumption, and ATP production while reduced electron carriers accumulate.

245. C. Uncouplers dissipate the proton gradient without capturing its energy as ATP. Electron transport and oxygen consumption may accelerate in an attempt to restore the gradient, but ATP yield falls and more energy is released as heat.

246. B. Sensitivity is the proportion of people with disease who test positive. Ninety of 100 diseased participants are true positives, so sensitivity is 90/100, or 90%.

247. D. Specificity is the proportion of people without disease who test negative. There are 160 true negatives among 200 nondiseased participants, so specificity is 160/200, or 80%.

248. B. As disease prevalence rises, a positive test is more likely to represent true disease, so positive predictive value increases. Negative predictive value generally falls, while sensitivity and specificity are properties of the test under the studied conditions rather than direct functions of prevalence.

249. E. High sensitivity means most people who truly have the disease test positive, so false negatives are uncommon. A negative result on a highly sensitive test can therefore substantially reduce the likelihood of disease when applied appropriately.

250. C. Relative risk is incidence in the exposed group divided by incidence in the unexposed group. Here, 0.20/0.10 equals 2.0, indicating twice the risk among exposed participants.

251. C. Absolute risk reduction equals control event rate minus treatment event rate. Twelve percent minus 8% equals 4 percentage points, or 0.04.

252. E. Number needed to treat is the reciprocal of absolute risk reduction. One divided by 0.04 equals 25, meaning 25 patients would need treatment to prevent one additional outcome over the study period.

253. D. For a relative risk, the null value is 1.0. A two-sided 95% confidence interval that excludes 1.0 corresponds approximately to statistical significance at alpha 0.05, although statistical significance alone does not establish clinical importance.

254. C. A p value is calculated under the assumption that the null hypothesis and statistical model are true. It describes how compatible the observed data are with that null model; it is not the posterior probability that the null hypothesis itself is true.

255. C. A type I error is a false-positive conclusion: rejecting the null hypothesis when it is actually true. Its probability is controlled by the chosen alpha level under the statistical assumptions.

256. B. A type II error is a false-negative statistical conclusion: failing to detect a real effect. Statistical power equals 1 minus beta, where beta is the probability of a type II error for a specified effect size.

257. B. Larger samples reduce standard error and improve the ability to distinguish a true effect from sampling variability. Power also increases with larger effect sizes, lower variability, and sometimes a less stringent alpha threshold.

258. D. Recall bias occurs when the accuracy or completeness of remembered past exposures differs between comparison groups. It is a particular concern in retrospective designs such as case-control studies.

259. B. A confounder is associated with both the exposure and outcome and can create or distort the observed exposure-outcome association if not controlled. Smoking can therefore confound an apparent relationship between coffee intake and myocardial infarction.

260. B. A competent adult may refuse recommended treatment, even when refusal carries substantial risk. The clinician should confirm understanding and voluntariness, document the discussion, and continue to offer medically appropriate alternatives that fit the patient's preferences.

261. E. Meaningful informed consent requires accurate communication. A qualified medical interpreter is preferred because this supports accuracy, confidentiality, and patient autonomy; family members can provide support but should not routinely replace professional interpretation for important consent discussions.

262. D. Patients should be informed about clinically meaningful errors that affect their care. Disclosure should be timely and factual, include known consequences and corrective steps, and avoid concealment or alteration of the medical record.

263. C. An open-ended response explores what the patient is asking, what they understand, and what fears or goals are driving the question. This creates a foundation for honest prognostic discussion tailored to the patient's informational preferences.

264. A. Autonomy includes the right to receive information as well as, within limits, the right not to receive it. The clinician should confirm the patient's preference and authorization for sharing information with the designated person.

265. D. Capacity is decision specific and includes the abilities to understand relevant information, appreciate how it applies personally, reason about options, and communicate a stable choice. Agreement with the clinician is not required.

266. A. In a true emergency, necessary treatment may be provided when the patient lacks capacity and no surrogate is available if delaying care would risk death or serious harm. The exception is limited to care reasonably necessary for the emergency.

267. D. Advance directives extend patient autonomy into periods of incapacity. When the directive clearly applies to the current clinical situation, clinicians should use it to guide decisions while also communicating with the surrogate and family.

268. C. When prior wishes or values are known, substituted judgment is preferred. If they cannot be determined, the surrogate and clinicians should use a best-interests standard focused on the patient's likely benefits, burdens, dignity, and welfare.

269. B. Adolescent confidentiality supports access to important preventive and reproductive care, but its exact legal scope varies. Clinicians should explain confidentiality and its safety-related limits, encourage supportive family involvement when appropriate, and follow applicable law.

270. B. Clinicians generally report reasonable suspicion of child abuse rather than waiting for certainty. Immediate medical needs and safety come first, followed by careful documentation and use of the required protective-reporting process.

271. A. A trauma-informed response avoids coercion, assesses immediate safety, documents appropriately, and offers resources and safety planning. The clinician should respect the competent patient's autonomy while following jurisdiction-specific reporting requirements where they apply.

272. B. Naming or acknowledging emotion and allowing a pause communicates empathy and helps the patient process difficult news. Information can then be paced according to the patient's readiness rather than delivered without regard to emotional response.

273. B. Social determinants can directly affect access and adherence. Identifying the specific barrier allows the care team to consider transportation support, telehealth when appropriate, scheduling changes, or other realistic solutions rather than attributing the problem to motivation alone.

274. D. Motivational interviewing uses collaboration, open questions, reflective listening, and elicitation of the patient's own motivations rather than confrontation. Respecting autonomy can reduce resistance and support movement toward change.

275. B. Potential clinician impairment is a patient-safety issue. The concern should be addressed promptly through appropriate institutional or professional mechanisms that can protect patients and connect the clinician with assessment and treatment.

276. C. Trainees should be transparent about their role and work within their competence under appropriate supervision. Patients should not be misled about experience, and supervision protects both patient safety and educational integrity.

277. A. The physician should acknowledge the family's concern and explore cultural or emotional reasons for the request, but a competent patient's expressed preference for information should guide disclosure. Respectful communication can often address fear without sacrificing autonomy.

278. A. Confidentiality protects patient information from disclosure to unauthorized people, including relatives. Unless a recognized exception applies, clinicians should share information only with the patient's permission or as otherwise legally authorized.

279. D. Physicians should advocate for patients while maintaining truthful professional documentation. The clinician can explain the ethical and legal limits, decline falsification, and accurately describe genuine diagnoses and functional limitations.

280. A. Competent patients may refuse or discontinue medical treatments, including life-sustaining therapies, when informed about likely consequences and alternatives. The intent is to respect treatment preferences while continuing symptom management and supportive care.