

COMPREHENSIVE MOCK EXAM 6

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), physiology-focused and domain-weighted to the official Step 1 content specifications

Board-Review Questions

1. A patient has primary hypothyroidism. Which feedback pattern is expected before treatment?
 - A. Low thyroid hormone removes negative feedback, producing increased TRH and increased TSH.
 - B. High thyroid hormone is required to stimulate TSH release from the pituitary.
 - C. TSH remains fixed because thyroid hormone does not participate in hypothalamic-pituitary feedback.
 - D. Low thyroid hormone increases negative feedback, producing low TRH and low TSH.
 - E. TRH falls while TSH rises because hypothalamic and pituitary feedback always move in opposite directions.

2. A healthy adult begins quiet inspiration. Which pressure change causes air to enter the lungs?
 - A. Pleural pressure becomes positive and directly pushes air from the atmosphere into alveoli.
 - B. Pleural pressure becomes more negative, expanding alveoli until alveolar pressure falls slightly below atmospheric pressure.
 - C. Air enters only after expiratory muscles raise intra-abdominal pressure above atmospheric pressure.
 - D. Alveolar pressure rises above atmospheric pressure because diaphragmatic contraction compresses the lungs.
 - E. Intrapleural pressure equals atmospheric pressure throughout inspiration while alveolar volume increases independently.

3. A peripheral axon is depolarized from resting potential to threshold. Which membrane event produces the rapid upstroke of a typical neuronal action potential?
 - A. Closing of all sodium channels while chloride rapidly leaves the cell.
 - B. Opening of voltage-gated potassium channels with a large inward potassium current.
 - C. Opening of ligand-gated calcium channels along the entire axon as the principal regenerative current.
 - D. Activation of the sodium-potassium ATPase strongly enough to depolarize the membrane within milliseconds.

E. Opening of voltage-gated sodium channels with a large inward sodium current.

4. A 24-year-old runner has a hemoglobin concentration of 15 g/dL and arterial oxygen saturation of 98%. If dissolved oxygen is ignored, which variable most strongly determines arterial oxygen content?

A. The amount of hemoglobin available to bind oxygen multiplied by its oxygen saturation.

B. The erythrocyte sodium concentration multiplied by the hematocrit.

C. The plasma bicarbonate concentration multiplied by the arterial carbon dioxide tension.

D. The mixed venous oxygen tension alone, because it determines the oxygen loaded in the lungs.

E. The arterial oxygen tension alone, because nearly all oxygen is dissolved freely in plasma.

5. A skeletal muscle fiber is depolarized at the motor end plate. Which event couples the muscle action potential to calcium release from the sarcoplasmic reticulum?

A. Calcium first enters through voltage-gated L-type channels in large amounts and is the only source of contractile calcium in skeletal muscle.

B. Voltage-sensitive dihydropyridine receptors in T tubules mechanically activate ryanodine receptors in the sarcoplasmic reticulum.

C. Ryanodine receptors open sodium channels in the T tubule to generate the end-plate potential.

D. Nicotinic receptors directly release calcium from the sarcoplasmic reticulum without a muscle action potential.

E. The sodium-potassium ATPase binds troponin and directly exposes actin-binding sites after depolarization.

6. A healthy adult receives a rapid isotonic fluid bolus. Venous return and end-diastolic volume increase without a change in contractility. Which mechanism raises stroke volume?

A. Lower aortic pressure is required for the ventricle to respond to increased preload.

B. Reduced end-diastolic fiber length increases calcium sensitivity and lowers end-systolic volume.

C. Reduced venous return increases ventricular filling time and therefore raises stroke volume.

D. Greater sarcomere length at end diastole increases force generation through the Frank-Starling mechanism.

E. Higher afterload directly increases the velocity of ventricular shortening at any preload.

7. A child develops a cytokine-mediated fever and begins shivering while the measured temperature is still rising. How does the elevated hypothalamic set point explain the shivering?

A. Core temperature is above the new set point, so sweating and cutaneous vasodilation are activated immediately.

B. Prostaglandin E2 directly contracts skeletal muscle independently of hypothalamic thermoregulation.

C. Fever abolishes hypothalamic temperature sensing, so shivering occurs randomly.

D. Core temperature is below the newly elevated set point, so heat-conserving and heat-generating responses are activated.

E. Shivering is caused only by peripheral muscle hypoxia and is unrelated to the temperature set point.

8. A healthy person sees and smells food before eating. Which pathway mediates much of the cephalic phase of gastric acid secretion?

A. Sympathetic norepinephrine is the dominant stimulatory signal to parietal cells before food enters the stomach.

B. Vagal efferents stimulate parietal cells directly and also increase gastrin and histamine release.

C. Somatic motor neurons release acetylcholine into the gastric lumen to activate apical acid pumps.

D. Secretin released from the duodenum is the main hormone driving cephalic acid secretion.

E. Vagal activity suppresses gastrin and histamine until nutrients physically distend the stomach.

9. A patient with decision-making capacity refuses a recommended blood transfusion after the physician explains the risks and benefits. What is the most appropriate response?

A. Discharge the patient immediately without further counseling because refusal ends the therapeutic relationship.

B. Administer the transfusion anyway because preventing medical harm overrides a competent adult's refusal.

- C.** Ask the family to overrule the patient even though the patient retains decision-making capacity.
- D.** Declare the patient incompetent solely because the decision differs from the physician's recommendation.
- E.** Respect the informed refusal, document the discussion, and continue to offer acceptable alternatives and supportive care.

10. In a validation cohort, 270 of 300 participants known to have a disease obtain a positive result. Which value is the test sensitivity?

- A.** 50%, because half of all test outcomes are considered positive by definition.
- B.** It cannot be calculated without knowing the number of people without disease.
- C.** 10%, because 20 of the affected patients tested negative.
- D.** 90%, because sensitivity is the proportion of affected patients who test positive.
- E.** 80%, because sensitivity equals the positive predictive value in every population.

11. A patient has a TSH-secreting pituitary adenoma. Which pattern of thyroid hormones and TSH is most likely?

- A.** Free thyroid hormone is high while TSH is completely absent because thyroid hormone cannot be stimulated by pituitary tissue.
- B.** TSH is suppressed and free thyroid hormone is low because the pituitary tumor cannot secrete TSH.
- C.** TSH is high while free thyroid hormone must be low in every pituitary disorder.
- D.** Both TSH and thyroid hormone are low because pituitary tumors always destroy all thyrotrophs.
- E.** Both TSH and free thyroid hormone are elevated despite normal negative-feedback physiology.

12. A patient with pulmonary fibrosis has stiff lungs. Which change in the static pressure-volume relationship is expected?

- A.** Lung compliance is decreased, so a larger transpulmonary pressure is required for a given volume change.
- B.** The lungs become infinitely compliant, eliminating the need for inspiratory muscle work.

- C.** Compliance is unchanged because only airway resistance determines the pressure-volume relationship.
- D.** Lung compliance is increased, so less transpulmonary pressure is required despite extensive fibrosis.
- E.** Elastic recoil is decreased, making forced expiration more difficult because the lungs collapse too easily.

13. Immediately after the peak of a neuronal action potential, the axon enters an absolute refractory period. What best explains this period?

- A.** The sodium-potassium ATPase temporarily stops working, preventing restoration of ion gradients.
- B.** Voltage-gated sodium channels are inactivated and cannot reopen until the membrane repolarizes.
- C.** Ligand-gated chloride channels remain continuously open until a second stimulus arrives.
- D.** All extracellular sodium has been depleted from the local interstitial fluid by the first action potential.
- E.** Voltage-gated potassium channels are permanently closed and therefore prevent any membrane current.

14. A patient with severe iron-deficiency anemia has a normal PaO₂ and normal arterial oxygen saturation. Which physiologic variable is nevertheless reduced?

- A.** Alveolar oxygen tension, because anemia directly lowers the inspired oxygen fraction.
- B.** Arterial oxygen content, because there are fewer hemoglobin binding sites despite normal saturation.
- C.** Hemoglobin oxygen affinity, because iron deficiency uniformly shifts the dissociation curve far to the right.
- D.** Pulmonary capillary diffusion capacity for oxygen, because low hemoglobin destroys the alveolar membrane.
- E.** The fraction of hemoglobin molecules saturated with oxygen, because PaO₂ cannot remain normal in anemia.

15. Cytosolic calcium rises in a contracting skeletal muscle fiber. Which protein binds calcium to permit cross-bridge cycling?

- A.** Troponin I, which binds calcium and moves actin away from myosin.
- B.** Tropomyosin, which hydrolyzes ATP and pulls the thin filament toward the M line.
- C.** Titin, which binds calcium and directly phosphorylates the myosin light chain.
- D.** Troponin C, which shifts tropomyosin away from myosin-binding sites on actin.
- E.** Dystrophin, which binds calcium and initiates myosin head cocking.

16. A patient's systemic arterial pressure suddenly rises while preload and contractility are unchanged. What is the immediate effect of increased left ventricular afterload?

- A.** End-systolic volume decreases and stroke volume increases because the ventricle ejects against a higher pressure.
- B.** Ejection fraction increases because afterload and contractility are physiologically identical.
- C.** End-systolic volume increases and stroke volume decreases.
- D.** End-diastolic volume instantly falls to zero before the next beat.
- E.** Stroke volume remains fixed because arterial pressure cannot alter ventricular ejection.

17. A patient's fever abruptly resolves after the hypothalamic set point returns toward normal. Why can profuse sweating occur during defervescence?

- A.** The posterior pituitary releases aldosterone, which directly activates eccrine glands.
- B.** Cutaneous vasoconstriction increases because the body must conserve heat after the set point falls.
- C.** Core temperature is now above the lowered set point, activating heat-loss responses.
- D.** Sweating raises core temperature to match the old febrile set point.
- E.** Core temperature is below the lowered set point, activating further shivering.

18. Thyroid follicular cells take up iodide from blood against an electrochemical gradient. Which transporter mediates this basolateral uptake?

- A.** The sodium-iodide symporter, powered indirectly by the sodium gradient created by Na/K ATPase.
- B.** The H/K ATPase, which exchanges hydrogen for iodide across the follicular-cell membrane.
- C.** CFTR, which is the major iodide pump responsible for concentrating iodide from plasma.
- D.** Thyroglobulin, which functions as a membrane transporter for iodide entry into follicular cells.
- E.** Pendrin, which is the basolateral transporter carrying iodide from blood into follicular cells.

19. A meal enters the stomach and raises luminal pH transiently. Which response helps increase acid secretion during the gastric phase?

- A.** Vagal activity ceases once the stomach is distended, preventing further acid secretion.
- B.** Somatostatin release from D cells rises when luminal pH increases and strongly stimulates gastrin.
- C.** Secretin from the duodenum directly activates parietal H/K ATPase as the main gastric-phase signal.
- D.** A lower gastric pH immediately stimulates unlimited gastrin secretion from G cells.
- E.** Peptides and distention stimulate gastrin release and vagovagal reflexes, increasing parietal-cell acid secretion.

20. Pulmonary function testing in a long-term smoker shows loss of alveolar elastic recoil. Which change in lung mechanics best follows from this structural loss?

- A.** Compliance and elastic recoil both increase because they represent the same property.
- B.** Compliance is unchanged while only chest-wall recoil is lost.
- C.** Elastic recoil increases enough to produce rapid passive emptying despite alveolar wall destruction.
- D.** Lung compliance decreases while elastic recoil increases, reducing residual volume.
- E.** Lung compliance increases while elastic recoil decreases, promoting expiratory airway collapse and air trapping.

21. A myelinated peripheral nerve conducts impulses much faster than an unmyelinated axon of similar diameter. Which property of myelin is most important for saltatory conduction?

- A.** It increases membrane resistance and decreases membrane capacitance between nodes of Ranvier.
- B.** It decreases membrane resistance and increases capacitance so local current dissipates more rapidly.
- C.** It abolishes voltage-gated sodium channels at nodes of Ranvier and spreads action potentials continuously.
- D.** It forces sodium ions to diffuse through the myelin sheath before reaching the next node.
- E.** It increases intracellular resistance by narrowing the axoplasm between nodes.

22. A patient asks what a newly diagnosed illness means for the future and appears frightened. Which opening response best supports patient-centered communication?

- A.** Ask the family to explain the diagnosis later so the clinician can avoid discussing uncertainty.
- B.** Immediately deliver every technical detail in a long monologue so emotion does not influence understanding.
- C.** Tell the patient not to worry before determining what the patient understands or fears.
- D.** Acknowledge the emotion and ask what concerns the patient most before giving a detailed explanation.
- E.** Change the subject to laboratory values because addressing emotion can undermine professionalism.

23. A family is found unconscious in a house with a malfunctioning furnace. One member has carbon monoxide poisoning. Which change most impairs oxygen delivery to tissues?

- A.** An isolated fall in plasma bicarbonate without any change in hemoglobin oxygen binding.
- B.** A right shift of the oxygen dissociation curve that causes excessive oxygen unloading in the lungs.
- C.** An increase in methemoglobin that converts all ferrous iron to ferric iron after carbon monoxide exposure.

D. Reduced oxygen-carrying capacity together with a left shift of the remaining hemoglobin oxygen-binding sites.

E. A large fall in PaO₂ caused by carbon monoxide displacing dissolved oxygen from plasma.

24. A term newborn takes the first several breaths after delivery. Pulmonary vascular resistance falls and pulmonary blood flow rises. Which pressure change most directly promotes functional closure of the foramen ovale?

A. Left atrial pressure rises above right atrial pressure as pulmonary venous return increases.

B. Inferior vena caval pressure rises abruptly because placental flow continues after the cord is clamped.

C. Pulmonary artery pressure rises above aortic pressure as the lungs expand with air.

D. Left ventricular end-diastolic pressure falls below right ventricular pressure because systemic resistance decreases.

E. Right atrial pressure rises above left atrial pressure because umbilical venous return increases after cord clamping.

25. During skeletal muscle contraction, ATP binds to the myosin head. What is the immediate consequence of ATP binding?

A. Myosin detaches from actin, allowing the cross-bridge cycle to continue.

B. The power stroke occurs before myosin can detach from actin.

C. Actin is hydrolyzed to provide energy for myosin head rotation.

D. Myosin binds more tightly to actin and enters the rigor state.

E. Troponin releases calcium directly because ATP binds troponin C.

26. Thyroid peroxidase acts at the apical surface of thyroid follicular cells. Which reaction does it catalyze?

A. Conversion of T₄ to T₃ in peripheral tissues by removing an iodine atom.

B. Basolateral sodium-dependent uptake of iodide from blood into follicular cells.

C. Oxidation and organification of iodide plus coupling of iodotyrosines on thyroglobulin.

D. Proteolysis of thyroglobulin inside lysosomes to release only TSH.

E. Synthesis of thyroglobulin on free ribosomes in the cytosol without endoplasmic reticulum involvement.

27. A premature infant has inadequate pulmonary surfactant. Which consequence follows most directly?

A. Airway smooth-muscle tone falls to zero, making lung inflation easier despite absent surfactant.

B. Pulmonary capillary oncotic pressure rises and substitutes for surfactant at the air-liquid interface.

C. Alveolar surface tension decreases, causing small alveoli to overexpand and compliance to become infinite.

D. Pleural pressure becomes positive at rest because surfactant normally generates negative pleural pressure.

E. Alveolar surface tension increases, especially threatening collapse of small alveoli and lowering lung compliance.

28. A beta-1 agonist increases ventricular contractility in a patient with unchanged preload and afterload. How does the pressure-volume loop change?

A. End-diastolic volume must increase before any change in stroke volume can occur.

B. End-systolic volume rises and stroke volume falls because stronger contraction impairs ejection.

C. Isovolumetric contraction disappears because increased contractility keeps the aortic valve open during diastole.

D. End-systolic volume falls and stroke volume rises because the end-systolic pressure-volume relation becomes steeper.

E. The end-systolic pressure-volume relation becomes flatter, indicating lower contractility.

29. A healthy adult loses 2 liters of isotonic fluid from the extracellular compartment during severe diarrhea. Before compensation, what happens to extracellular osmolality and cell volume?

A. Extracellular osmolality falls markedly, causing cells to swell.

B. Cell volume doubles because sodium rapidly enters cells after isotonic volume loss.

- C. Extracellular osmolality stays near normal, so cell volume changes little initially.
- D. Extracellular osmolality rises markedly, causing cells to shrink.
- E. All lost volume comes exclusively from the intracellular compartment because isotonic fluid cannot leave plasma.

30. A local anesthetic blocks voltage-gated sodium channels in a sensory axon. Which process is most directly prevented?

- A. Binding of neurotransmitter to postsynaptic ligand-gated receptors in the spinal cord.
- B. Diffusion of neurotransmitter across a synaptic cleft after vesicle fusion has already occurred.
- C. Regenerative propagation of action potentials along the axonal membrane.
- D. Synthesis of neurotransmitter in the neuronal cell body while resting membrane potential remains intact.
- E. Axonal transport of mitochondria along microtubules from the soma to the nerve terminal.

31. A diagnostic test is negative in 475 of 500 people who do not have a disease. What is the specificity?

- A. 95%, because specificity is the proportion of unaffected people who test negative.
- B. It cannot be calculated unless disease prevalence is known.
- C. 5%, because 25 unaffected people had positive results.
- D. 90%, because specificity is calculated from affected rather than unaffected people.
- E. 50%, because specificity is independent of the observed outcomes.

32. A patient develops fever and lactic acidosis during intense exercise. In actively metabolizing skeletal muscle, which local change favors oxygen unloading from hemoglobin?

- A. Increased fetal hemoglobin production shifts the curve to the right in active muscle.
- B. Decreased hydrogen ion and carbon dioxide shift the oxygen dissociation curve to the right.
- C. Lower erythrocyte 2,3-BPG shifts the curve to the right within seconds.
- D. Lower tissue temperature shifts the oxygen dissociation curve to the right and reduces affinity.

E. Increased hydrogen ion and carbon dioxide shift the oxygen dissociation curve to the right.

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

A. All protein-bound and free hormone equally, because binding proteins enter cells with hormone.

B. Only thyroxine bound tightly to thyroxine-binding globulin.

C. Only reverse T3, which has the highest affinity for nuclear thyroid receptors.

D. The free, unbound fraction of T4 and T3 that can enter target cells and signal.

E. Only albumin-bound T3, because albumin activates thyroid hormone receptors.

34. Histamine released from enterochromaffin-like cells binds H₂ receptors on gastric parietal cells. Which intracellular signal increases?

A. cGMP exclusively, which closes the apical proton pump and suppresses acid secretion.

B. G_i signaling lowers cAMP and is the principal mechanism by which histamine stimulates acid secretion.

C. cAMP, which activates protein kinase A and promotes acid secretion.

D. Intracellular chloride falls to zero because H₂ receptors are ligand-gated chloride channels.

E. Nuclear calcium receptors are activated directly without any second-messenger pathway.

35. A patient dies and develops rigor mortis several hours later. Which cellular event best explains the sustained muscle stiffness?

A. Excess ATP locks myosin heads onto actin and prevents calcium release from troponin.

B. Accelerated calcium reuptake into the sarcoplasmic reticulum maintains maximal cross-bridge detachment.

C. ATP depletion prevents myosin heads from detaching from actin after cross-bridge formation.

D. Persistent acetylcholine release from motor neurons continuously stimulates muscle action potentials.

E. Complete absence of cytosolic calcium prevents any cross-bridge formation after death.

36. Two alveoli have different radii but the same surface tension. According to the law of Laplace, which alveolus has the greater collapsing pressure?

- A.** The alveolus with lower gas volume always has zero collapsing pressure.
- B.** Collapsing pressure depends only on airway resistance and not on surface tension or radius.
- C.** The larger alveolus, because pressure is directly proportional to radius at fixed surface tension.
- D.** Both alveoli have identical collapsing pressure regardless of radius.
- E.** The smaller alveolus, because pressure is inversely proportional to radius when surface tension is equal.

37. A patient with limited English proficiency needs to discuss a complex treatment decision. What is the best communication approach?

- A.** Use the patient's young child as the interpreter because family members know the patient's preferences best.
- B.** Speak only to the interpreter and avoid eye contact with the patient to prevent confusion.
- C.** Rely on gestures and written English because professional interpretation can alter medical meaning.
- D.** Ask another patient who speaks the language to translate the discussion informally.
- E.** Use a qualified medical interpreter and speak directly to the patient in short, clear segments.

38. At a chemical synapse, an action potential arrives at the presynaptic terminal. Which event most directly triggers synaptic vesicle fusion?

- A.** Potassium entry through presynaptic voltage-gated channels during repolarization.
- B.** Sodium entry through postsynaptic ligand-gated channels before transmitter release occurs.
- C.** Chloride efflux from the synaptic cleft through vesicular chloride pumps.
- D.** Calcium entry through voltage-gated calcium channels in the presynaptic membrane.
- E.** ATP-dependent reuptake of neurotransmitter from the cleft into the presynaptic terminal.

39. During the isovolumetric contraction phase of the left ventricular pressure-volume loop, which valves are closed?

- A.** Both the mitral and aortic valves are closed while ventricular pressure rises at constant volume.
- B.** The aortic valve is open while the mitral valve opens intermittently to maintain constant pressure.
- C.** The mitral valve is open and the aortic valve is closed while ventricular volume increases.
- D.** The aortic valve is open and the mitral valve is closed while ventricular volume decreases.
- E.** Both valves are open, allowing simultaneous ventricular filling and ejection.

40. Cortisol enters a target cell and alters gene transcription. Which receptor type mediates this effect?

- A.** A receptor tyrosine kinase that autophosphorylates after cortisol binding.
- B.** A ligand-gated sodium channel on the plasma membrane.
- C.** An intracellular glucocorticoid receptor that translocates to the nucleus and regulates DNA transcription.
- D.** A Gs-coupled seven-transmembrane receptor that exclusively raises cAMP.
- E.** A membrane guanylyl cyclase receptor that generates cGMP as the only cortisol signal.

41. A patient loses large amounts of hypotonic sweat during prolonged exercise without drinking. What is the expected initial effect on extracellular fluid?

- A.** Extracellular volume decreases and osmolality increases, pulling water out of cells.
- B.** Extracellular volume decreases while osmolality stays exactly constant because sweat is isotonic to plasma.
- C.** Only intracellular volume changes because sweat loss does not affect extracellular fluid.
- D.** Extracellular volume increases and osmolality decreases, pushing water into cells.
- E.** Extracellular osmolality falls and cells shrink because water moves into plasma.

42. A healthy person spends three weeks at high altitude. Which erythrocyte adaptation directly promotes unloading of oxygen to peripheral tissues?

- A.** Decreased intracellular chloride concentration, which permanently prevents oxygen binding in the lungs.
- B.** Increased fetal hemoglobin synthesis, which decreases hemoglobin oxygen affinity.
- C.** Increased 2,3-bisphosphoglycerate concentration, which decreases hemoglobin oxygen affinity.
- D.** Decreased 2,3-bisphosphoglycerate concentration, which decreases hemoglobin oxygen affinity.
- E.** Increased carbon monoxide binding to hemoglobin, which improves peripheral unloading.

43. A patient has an acute asthma exacerbation. Which spirometric change is most characteristic of airflow obstruction?

- A.** The FEV1 decreases disproportionately, reducing the FEV1/FVC ratio.
- B.** The FEV1/FVC ratio rises because FEV1 increases more than FVC.
- C.** Total lung capacity is always reduced to the same degree as in pulmonary fibrosis.
- D.** Residual volume must fall because obstructed airways empty more completely during forced expiration.
- E.** Forced expiratory flow becomes independent of airway resistance during obstruction.

44. Acetylcholine stimulates gastric parietal cells through muscarinic receptors. Which second-messenger pathway is used?

- A.** Gs signaling lowers intracellular calcium and cAMP simultaneously.
- B.** Gq signaling increases IP3 and intracellular calcium.
- C.** A ligand-gated sodium channel depolarizes the apical membrane without any G protein.
- D.** Gi signaling is the only pathway and completely suppresses acid secretion.
- E.** A receptor tyrosine kinase phosphorylates insulin receptor substrate proteins in parietal cells.

45. A skeletal muscle is stretched from a very short resting length toward its optimal length before stimulation. Why does active tension initially increase?

- A.** Actin-myosin filament overlap becomes more favorable for cross-bridge formation.

- B.** Myosin filaments become longer, increasing the number of myosin heads per thick filament.
- C.** Passive connective tissue tension disappears, directly creating additional ATP for contraction.
- D.** Calcium affinity of troponin falls to zero at short lengths and becomes maximal only after overstretching.
- E.** The number of sarcomeres in series immediately doubles with each stretch.

46. A postsynaptic neuron receives an inhibitory synaptic input that opens chloride channels. What is the usual immediate effect on membrane excitability?

- A.** The membrane becomes electrically isolated because chloride channels prevent all other ions from moving.
- B.** The sodium-potassium ATPase reverses direction and produces an excitatory postsynaptic potential.
- C.** The membrane is stabilized near the chloride equilibrium potential, making threshold harder to reach.
- D.** Intracellular chloride always falls to zero, producing a prolonged regenerative action potential.
- E.** The membrane depolarizes rapidly toward the sodium equilibrium potential and reaches threshold more easily.

47. A patient develops severe physiologic stress. Which hypothalamic-pituitary-adrenal sequence increases cortisol secretion?

- A.** Cortisol stimulates ACTH through positive feedback during all forms of stress.
- B.** CRH stimulates ACTH release, and ACTH stimulates cortisol production by the adrenal cortex.
- C.** Aldosterone stimulates ACTH, which then suppresses adrenal cortisol synthesis.
- D.** ACTH stimulates hypothalamic CRH release, and CRH directly stimulates adrenal cortisol synthesis.
- E.** Renin directly stimulates cortisol secretion without pituitary involvement.

48. A physician has just made a medication error that caused temporary harm. Which approach to disclosure is most appropriate?

- A.** Promptly explain what happened, acknowledge the harm, apologize appropriately, and describe corrective and preventive steps.
- B.** Ask a nurse to disclose the event without physician participation because the prescription was entered electronically.
- C.** Wait until discharge so the patient cannot change clinicians before hearing about the error.
- D.** Describe the event only as an unpredictable complication and avoid mentioning the medication error.
- E.** Withhold the error unless the patient discovers it independently because disclosure may increase anxiety.

49. A disease becomes much more prevalent in a population while a test's sensitivity and specificity remain unchanged. What happens to the positive predictive value?

- A.** Positive predictive value becomes equal to specificity whenever prevalence increases.
- B.** Positive predictive value falls to zero because more true cases create more false positives.
- C.** Positive predictive value generally increases because a positive result is more likely to represent true disease.
- D.** Positive predictive value decreases because prevalence has no relationship to post-test probability.
- E.** Positive predictive value remains exactly fixed because it depends only on sensitivity.

50. A healthy adult receives recombinant erythropoietin for an appropriate medical indication. Which marrow cell is directly stimulated to increase red-cell production?

- A.** Erythroid progenitor cells, especially colony-forming units committed to the erythrocyte lineage.
- B.** Mature circulating erythrocytes, which reenter the marrow and divide after erythropoietin binding.
- C.** Mature neutrophils, which transdifferentiate into reticulocytes in response to hypoxia.
- D.** Splenic macrophages, which synthesize new heme-containing erythrocytes from recycled iron.
- E.** Megakaryocytes, which convert platelets into erythrocytes when oxygen delivery falls.

51. A patient with interstitial lung disease has a restrictive ventilatory defect. Which spirometric pattern is expected?

- A.** Total lung capacity increases because stiff lungs require greater resting inflation.
- B.** Residual volume must be increased because restriction always causes severe air trapping.
- C.** FVC is reduced with a normal or increased FEV1/FVC ratio.
- D.** FEV1 is normal while FVC is infinitely large because elastic recoil is increased.
- E.** FVC is increased while FEV1 falls, producing a markedly low FEV1/FVC ratio.

52. During isovolumetric relaxation of the left ventricle, which event terminates the phase?

- A.** Aortic pressure falls below ventricular pressure, causing both semilunar valves to close simultaneously.
- B.** Left ventricular pressure falls below left atrial pressure, causing the mitral valve to open.
- C.** Left atrial pressure falls below ventricular pressure, causing the mitral valve to close.
- D.** Ventricular volume reaches its maximum and forces the aortic valve open during diastole.
- E.** Left ventricular pressure rises above aortic pressure, causing the aortic valve to open.

53. A patient rapidly drinks several liters of pure water. Before renal excretion restores balance, what happens to body-fluid compartments?

- A.** Only plasma volume expands because water cannot cross cell membranes.
- B.** Extracellular osmolality falls and water shifts into cells, expanding both extracellular and intracellular volumes.
- C.** Extracellular osmolality rises and water leaves cells, shrinking the intracellular compartment.
- D.** Intracellular volume falls while extracellular volume rises with unchanged osmolality.
- E.** Both compartments shrink because ingested water suppresses vasopressin.

54. A skeletal muscle fiber is stimulated at the neuromuscular junction. Which receptor mediates the end-plate depolarization?

- A.** GABA-A receptors that open chloride channels on the skeletal muscle membrane.
- B.** Alpha-1 adrenergic receptors that activate Gq signaling at the neuromuscular junction.
- C.** Muscarinic M2 receptors that open potassium channels and hyperpolarize the motor end plate.
- D.** Nicotinic acetylcholine receptors that function as ligand-gated cation channels.
- E.** NMDA glutamate receptors that are the principal postsynaptic receptors at the adult motor end plate.

55. A patient takes high-dose glucocorticoids for several months. Abrupt discontinuation can cause adrenal insufficiency because of which adaptation?

- A.** Exogenous glucocorticoids permanently activate the renin-angiotensin system and destroy the adrenal medulla.
- B.** High-dose glucocorticoids increase CRH secretion until the hypothalamus becomes exhausted.
- C.** Cortisol receptors disappear from adrenal cortical cells, causing excess endogenous cortisol production.
- D.** Glucocorticoids chronically stimulate ACTH and cause pituitary hypertrophy.
- E.** Chronic negative feedback suppresses CRH and ACTH, leading to adrenal cortical atrophy.

56. A skeletal muscle is stretched far beyond its optimal sarcomere length before stimulation. Why does active tension fall?

- A.** Tropomyosin is mechanically removed from the thin filament at long sarcomere lengths.
- B.** Actin and myosin overlap decreases, reducing the number of cross-bridges that can form.
- C.** Calcium is unable to leave the sarcoplasmic reticulum in a stretched muscle fiber.
- D.** Actin and myosin overlap increases excessively, creating more cross-bridges than the muscle can support.
- E.** Myosin ATPase becomes permanently inactive whenever passive tension rises.

57. Soon after acidic gastric contents reach the first part of the small intestine, duodenal endocrine cells signal the pancreas. Which hormonal response is most important for neutralization?

- A.** Motilin stimulates a large alkaline pancreatic secretion immediately after every acidic meal.
- B.** Ghrelin stimulates gallbladder bicarbonate secretion while closing the pancreatic duct.
- C.** Gastrin stimulates pancreatic bicarbonate secretion and suppresses gastric acid secretion as its main duodenal action.
- D.** Somatostatin stimulates pancreatic enzyme secretion and accelerates gastric emptying of acid.
- E.** Secretin stimulates pancreatic and biliary bicarbonate secretion to neutralize acid.

58. A patient with emphysema exhales forcefully. At high effort, flow becomes limited despite greater expiratory muscle contraction. What explains this effort-independent flow limitation?

- A.** Surfactant loss causes large bronchi to collapse by increasing alveolar surface tension during every forced expiration.
- B.** Dynamic airway compression occurs when pleural pressure exceeds intraluminal pressure beyond the equal-pressure point.
- C.** The equal-pressure point moves toward larger cartilaginous airways because elastic recoil is increased in emphysema.
- D.** Alveolar pressure falls below pleural pressure only during inspiration and therefore cannot affect expiration.
- E.** Increasing effort always increases airway radius enough to prevent any compression.

59. A patient with chronic kidney disease develops normocytic anemia. The kidney normally increases erythropoietin secretion in response to which local signal?

- A.** Increased oxygen delivery to renal interstitial cells, signaling excess tissue oxygenation.
- B.** A rise in plasma iron concentration independent of renal oxygenation.
- C.** Reduced oxygen delivery to renal interstitial cells, signaling tissue hypoxia.
- D.** An increase in arterial carbon dioxide that directly stimulates erythropoietin release regardless of oxygen delivery.
- E.** A fall in platelet count detected by renal glomerular endothelial cells.

60. A patient with severe aortic stenosis has a large systolic pressure gradient between the left ventricle and aorta. What causes this gradient?

- A.** Reduced blood viscosity across the valve creates the pressure gradient independently of flow.
- B.** The stenotic valve lowers ventricular pressure below aortic pressure throughout systole.
- C.** Aortic pressure always exceeds ventricular pressure during ejection in a normal heart.
- D.** The narrowed valve requires a much higher ventricular pressure to drive blood through the restricted orifice.
- E.** The mitral valve remains open during systole and dissipates all ventricular pressure into the left atrium.

61. A patient is volume depleted. Angiotensin II and hyperkalemia stimulate aldosterone release from which adrenal layer?

- A.** Zona glomerulosa of the adrenal cortex, the mineralocorticoid-producing outer layer.
- B.** Zona fasciculata, which is the principal site of aldosterone synthesis.
- C.** Adrenal medulla, where chromaffin cells synthesize mineralocorticoids.
- D.** Posterior pituitary, which stores aldosterone made in the hypothalamus.
- E.** Zona reticularis, which secretes aldosterone in response to ACTH alone.

62. A patient receives hypertonic saline. Which immediate fluid shift is expected?

- A.** Intracellular volume expands because sodium enters cells more rapidly than water can move.
- B.** Extracellular osmolality falls, moving water into cells and shrinking extracellular volume.
- C.** Extracellular osmolality rises, drawing water out of cells and expanding extracellular volume while intracellular volume contracts.
- D.** Water remains confined to plasma because hypertonic sodium freely crosses all cell membranes.
- E.** Both intracellular and extracellular volumes contract because hypertonic fluid pulls water into the kidney.

63. A patient receives a drug that inhibits acetylcholinesterase at the neuromuscular junction. What happens initially to acetylcholine signaling?

- A.** Presynaptic acetylcholine synthesis stops because choline can no longer enter the neuron.
- B.** Nicotinic receptors are removed from the muscle membrane before acetylcholine can bind.
- C.** Acetylcholine is destroyed more rapidly, shortening the end-plate potential.
- D.** Acetylcholine remains in the synaptic cleft longer, prolonging nicotinic receptor activation.
- E.** Voltage-gated sodium channels in the motor axon are directly and irreversibly blocked.

64. After a prolonged emergency-department delay, a patient raises his voice and says the staff have ignored him. Which clinician response is most likely to de-escalate the interaction?

- A.** Tell the patient the anger is inappropriate and end the conversation until the patient apologizes.
- B.** Explain that other patients are sicker before acknowledging the patient's experience.
- C.** Promise that no delay will ever happen again even though that cannot be guaranteed.
- D.** Acknowledge the frustration, invite the patient to explain the concern, and address what can be done now.
- E.** Ignore the statement and continue asking closed-ended medical questions.

65. A motor unit begins firing more rapidly during a voluntary contraction. Individual twitches merge into a sustained contraction. What phenomenon explains the rise in force?

- A.** The muscle enters rigor because ATP is depleted between each action potential.
- B.** Spatial summation occurs because each motor neuron begins innervating new muscle fibers during the same contraction.
- C.** Temporal summation occurs because cytosolic calcium remains elevated between closely spaced stimuli.
- D.** Recruitment stops completely, causing individual fibers to produce greater force through denervation.
- E.** Muscle spindles stop firing, directly increasing calcium release from the sarcoplasmic reticulum.

66. 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.** 6.0 L/min, calculated as total tidal volume multiplied by respiratory rate.
- B.** 4.2 L/min, calculated as (500 - 150) mL multiplied by 12 breaths/min.
- C.** 0.35 L/min, calculated as tidal volume minus dead space without accounting for respiratory rate.
- D.** 7.8 L/min, calculated by adding dead space to tidal volume before multiplying.
- E.** 1.8 L/min, calculated as dead-space volume multiplied by respiratory rate.

67. A healthy 30-week fetus is sampled during a maternal-fetal physiology study. Compared with adult hemoglobin, fetal hemoglobin facilitates oxygen transfer across the placenta primarily because it has which property?

- A.** A greater sensitivity to temperature that shifts its dissociation curve markedly to the right at placental temperature.
- B.** A lower oxygen-carrying capacity because fetal erythrocytes contain less hemoglobin per cell.
- C.** A lower affinity for oxygen caused by stronger binding of 2,3-bisphosphoglycerate.
- D.** A higher affinity for oxygen due to reduced binding of 2,3-bisphosphoglycerate.
- E.** A greater capacity to carry carbon dioxide because its heme groups bind bicarbonate directly.

68. A patient with chronic inflammation develops anemia despite adequate iron stores. Increased hepatic hepcidin contributes by producing which effect?

- A.** Inhibition of ferritin synthesis, forcing stored iron into plasma for erythropoiesis.
- B.** Direct destruction of erythropoietin receptors on mature circulating erythrocytes.
- C.** Degradation of ferroportin, reducing intestinal iron export and iron release from macrophages.
- D.** Activation of ferroportin, increasing intestinal iron absorption and macrophage iron release.
- E.** Stimulation of transferrin production so strongly that plasma iron concentration rises.

69. A patient has hyperkalemia but normal renal perfusion. Which direct endocrine response helps restore potassium balance?

- A.** Hyperkalemia directly stimulates zona glomerulosa cells to release aldosterone.
- B.** Hyperkalemia increases vasopressin as the only hormonal route for urinary potassium excretion.
- C.** Hyperkalemia suppresses distal sodium reabsorption to promote potassium retention.
- D.** Hyperkalemia stimulates cortisol release, which is the main hormone increasing renal potassium secretion.
- E.** Hyperkalemia directly suppresses aldosterone release until renin rises.

70. A neurologic examination tests the patellar tendon reflex. Stretch of the quadriceps muscle spindle produces which afferent response?

- A.** Decreased firing of group Ia afferents that directly inhibits alpha motor neurons to the stretched muscle.
- B.** Increased group Ib firing from Golgi tendon organs that provides the monosynaptic excitatory limb of the stretch reflex.
- C.** Decreased gamma motor neuron activity that is the only sensory input required for the reflex.
- D.** Increased nociceptor firing that bypasses the spinal cord and directly contracts the quadriceps.
- E.** Increased firing of group Ia afferents that monosynaptically excite alpha motor neurons to the same muscle.

71. A meal rich in fat and protein reaches the proximal small intestine. Which intestinal hormone coordinates gallbladder emptying with enzyme-rich pancreatic secretion?

- A.** Secretin, whose main effect is gallbladder contraction and enzyme-rich acinar secretion.
- B.** Motilin, released continuously during meals to drive pancreatic enzyme secretion.
- C.** Gastrin, released from pancreatic beta cells to contract the gallbladder.
- D.** GIP, whose dominant action is contraction of the sphincter of Oddi and inhibition of insulin.
- E.** Cholecystokinin released from duodenal and jejunal I cells.

72. A rare disease becomes even less prevalent while test sensitivity and specificity are unchanged. What happens to the negative predictive value?

- A.** Negative predictive value falls to zero because there are too few true-positive results.
- B.** Negative predictive value remains fixed because prevalence never affects predictive values.
- C.** Negative predictive value becomes equal to sensitivity whenever prevalence falls.
- D.** Negative predictive value generally increases because a negative result is more likely to come from an unaffected person.
- E.** Negative predictive value decreases because rare diseases cause more false-negative results by definition.

73. A patient has chronic mitral regurgitation. During left ventricular systole, what happens to left atrial pressure?

- A.** It becomes lower than ventricular pressure only during diastole and cannot change during systole.
- B.** It falls because regurgitant flow empties the atrium into the ventricle during ventricular ejection.
- C.** It falls to near zero because the mitral valve prevents any systolic communication between chambers.
- D.** It remains identical to right atrial pressure because atrial pressures equalize during systole.
- E.** It rises because blood is ejected backward from the ventricle into the atrium.

74. A patient with severe burns develops generalized edema despite intravascular volume depletion. Which microvascular change contributes?

- A.** Increased capillary permeability allows protein to enter the interstitium, raising interstitial oncotic pressure and fluid filtration.
- B.** Reduced interstitial protein concentration is the main force pulling water out of capillaries after burns.
- C.** Lymphatic drainage becomes infinite and is the primary cause of interstitial fluid accumulation.
- D.** Burn injury lowers capillary hydrostatic pressure and therefore increases filtration.
- E.** Decreased capillary permeability traps additional albumin in plasma and increases edema by raising plasma oncotic pressure.

75. A postoperative patient doubles respiratory rate but takes much shallower breaths, increasing the fraction of each breath occupied by anatomic dead space. What can happen to alveolar ventilation despite an unchanged minute ventilation?

- A.** Alveolar ventilation rises only because carbon dioxide production falls with shallow breathing.
- B.** Alveolar ventilation is identical to minute ventilation because conducting airways do not contain gas.
- C.** Alveolar ventilation becomes independent of dead-space volume at high respiratory rates.
- D.** Alveolar ventilation can fall because a larger fraction of total ventilation is wasted in dead space.
- E.** Alveolar ventilation must rise whenever respiratory rate rises, regardless of tidal volume.

76. During a gradually increasing voluntary contraction, additional motor units are recruited. Which motor units are generally activated first?

- A.** Large motor units are always activated before small units to minimize energy expenditure.
- B.** Small, fatigue-resistant motor units with low-threshold alpha motor neurons.
- C.** Large, rapidly fatigable motor units with the highest activation thresholds.
- D.** Motor units are recruited randomly without relation to motor-neuron size.
- E.** Only fast glycolytic units, because slow units cannot participate in voluntary contraction.

77. A healthy person eats a carbohydrate-rich meal. Which event occurs in pancreatic beta cells as glucose rises?

- A.** Insulin granules fuse before any change in membrane potential or intracellular calcium occurs.
- B.** ATP-sensitive potassium channels close, depolarizing the membrane and opening voltage-gated calcium channels.
- C.** ATP-sensitive potassium channels open, hyperpolarizing the cell and increasing insulin exocytosis.
- D.** Glucose leaves the beta cell through sodium-glucose cotransport, lowering ATP production.
- E.** Voltage-gated calcium channels close because calcium inhibits insulin release.

78. After several days of oral iron therapy, absorbed iron exits duodenal enterocytes across the basolateral membrane through which transporter?

- A.** Ferritin, which is secreted across the basolateral membrane as the principal plasma iron carrier.
- B.** Hepcidin, which functions as a membrane channel for iron across enterocyte membranes.
- C.** Transferrin receptor, which exports iron directly from the enterocyte into the intestinal lumen.
- D.** Ferroportin, which transfers iron from the enterocyte into the circulation.
- E.** Divalent metal transporter 1, which moves iron from plasma into the basolateral side of the enterocyte.

79. A patient says, 'I'm not sure I want this procedure.' What is the best next step before seeking consent?

- A.** Ask for a signature immediately because uncertainty does not affect informed consent.
- B.** Repeat the recommendation more forcefully without asking why the patient is uncertain.
- C.** Have a family member sign in the patient's place even though the patient has capacity.
- D.** Explore the patient's understanding, values, and specific concerns about the procedure.
- E.** Cancel all future care because hesitation means the patient has refused every treatment.

80. During a heavy isometric contraction, tension in a tendon rises markedly. Which receptor detects this tension and contributes to autogenic inhibition?

- A.** Ruffini endings in the dermis that provide the primary tendon-force signal.
- B.** Pacinian corpuscles in the skin with rapidly adapting A-beta fibers.
- C.** Golgi tendon organs with group Ib afferent fibers.
- D.** Muscle spindle nuclear bag fibers with group Ia afferents only.
- E.** Free nerve endings in the joint capsule with unmyelinated C fibers only.

81. A pulmonary embolus blocks perfusion to a ventilated lung region. How does the local ventilation-perfusion ratio change?

- A.** It rises toward infinity because ventilation persists while perfusion approaches zero.
- B.** It remains exactly one because emboli affect ventilation and perfusion equally.
- C.** It becomes negative because carbon dioxide enters alveoli from inspired air.
- D.** It cannot change because ventilation-perfusion ratio is fixed by atmospheric pressure.
- E.** It falls toward zero because perfusion persists while ventilation approaches zero.

82. A carbohydrate-containing meal reaches the small intestine. Which incretin effect helps limit the postprandial rise in glucose?

- A.** GLP-1 and GIP enhance glucose-dependent insulin secretion from pancreatic beta cells.
- B.** Incretins act only on gastric parietal cells and have no pancreatic effect.
- C.** GLP-1 stimulates glucagon release strongly during hyperglycemia as its principal effect.
- D.** GIP directly converts glucose to glycogen inside enterocytes before absorption.
- E.** GLP-1 and GIP suppress insulin secretion whenever oral glucose is present.

83. After a carbohydrate-rich meal, circulating insulin engages receptors on a skeletal-muscle cell. What type of receptor initiates the intracellular signal?

- A.** A ligand-gated calcium channel that opens directly when insulin binds.
- B.** A receptor tyrosine kinase that autophosphorylates and recruits intracellular signaling proteins.
- C.** A Gs-coupled receptor that produces cAMP as the sole metabolic signal.
- D.** An intracellular nuclear receptor identical to the glucocorticoid receptor.
- E.** A membrane guanylyl cyclase receptor that acts only through cGMP.

84. A patient has complete heart block. Which cardiac tissue has the fastest intrinsic pacemaker rate after sinoatrial impulses can no longer reach the ventricles?

- A.** The coronary sinus endothelium, which initiates the fastest ventricular pacemaker rhythm.
- B.** The atrial contractile myocardium, which has no pacemaker activity but becomes the ventricular escape focus.

- C. The atrioventricular junction or His region, typically faster than distal Purkinje escape pacemakers.
- D. Papillary muscle fibers, which normally set the sinus rhythm at 90 to 100 beats per minute.
- E. Ventricular working myocytes, which normally depolarize spontaneously faster than all nodal tissue.

85. A patient with severe sepsis has elevated lactate despite adequate arterial oxygen tension. Which mechanism can contribute?

- A. Impaired tissue oxygen utilization and maldistributed perfusion increase anaerobic glycolysis and lactate production.
- B. Peripheral vasodilation guarantees uniform capillary perfusion and prevents cellular hypoxia.
- C. High arterial oxygen tension prevents any tissue from producing lactate.
- D. Lactate is produced only by the liver during sepsis and is unrelated to tissue metabolism.
- E. Sepsis eliminates glycolysis, so lactate must result exclusively from dietary intake.

86. A sprinter relies heavily on fast glycolytic muscle fibers during a short maximal effort. Which feature is characteristic of these fibers?

- A. Low glycogen content and dependence almost entirely on fatty-acid oxidation.
- B. High glycolytic enzyme activity, large fiber diameter, and rapid fatigue.
- C. High mitochondrial density, abundant myoglobin, and very slow shortening velocity.
- D. Minimal myosin ATPase activity and prolonged contraction times.
- E. Small motor units with low force production and exceptional fatigue resistance.

87. A healthy volunteer has a transient increase in plasma volume after receiving isotonic saline. Before erythropoiesis changes, what happens to hematocrit?

- A. It remains exactly unchanged because isotonic fluid cannot alter the plasma compartment.
- B. It decreases because red-cell volume is diluted by an increase in plasma volume.
- C. It increases because plasma proteins immediately pull water from plasma into red cells.

D. It increases because isotonic saline rapidly enters erythrocytes and expands their volume selectively.

E. It falls only if the infused solution is hypotonic, because isotonic saline does not expand extracellular fluid.

88. A patient has a lesion of the right dorsal columns at T10. Which sensory deficit is expected below the lesion?

A. Loss of vibration and proprioception on the left side because dorsal-column fibers cross in the spinal cord.

B. Loss of pain and temperature on the right side because spinothalamic fibers do not cross until the medulla.

C. Bilateral loss of all sensory modalities because dorsal columns carry every ascending sensory pathway.

D. Loss of vibration and proprioception on the right side until fibers cross in the medulla.

E. Isolated loss of motor function without any sensory deficit because dorsal columns contain only descending fibers.

89. A study reports a positive likelihood ratio of 10 for a diagnostic test. What does this indicate?

A. A positive result is ten times as likely in a person with the disease as in a person without it.

B. Ten percent of all positive results are false positives regardless of prevalence.

C. The test has 10% sensitivity and 100% specificity.

D. Disease prevalence must be 10% in the population studied.

E. A negative result reduces disease odds by a factor of ten.

90. A mucus plug completely obstructs a small bronchus while perfusion to the distal alveoli continues. What happens to the local ventilation-perfusion ratio?

A. It becomes negative because pulmonary venous blood reverses direction through the capillary.

B. It remains unchanged because mucus affects only airway resistance, not alveolar gas composition.

- C. It increases above normal because hypoxic vasoconstriction fully eliminates perfusion instantly.
- D. It falls toward zero, creating a shunt-like unit with perfusion but no ventilation.
- E. It rises toward infinity because ventilation continues despite absent perfusion.

91. Insulin increases glucose uptake into skeletal muscle and adipose tissue by which immediate mechanism?

- A. Inhibition of all glucose transporters so intracellular glucose concentration falls.
- B. Opening of voltage-gated glucose channels that are constitutively absent from muscle.
- C. Translocation of GLUT4-containing vesicles to the plasma membrane.
- D. Conversion of GLUT2 into GLUT4 through phosphorylation at the cell surface.
- E. Synthesis of SGLT1 in the intestinal lumen and transport of glucose into muscle.

92. A patient with capacity asks that a serious diagnosis not be shared with adult children who are present in the hospital. What should the physician do?

- A. Tell the family everything because relatives automatically have access to medical information.
- B. Share the diagnosis only with the oldest child because family hierarchy overrides patient confidentiality.
- C. Ask the family to persuade the patient to waive confidentiality before continuing treatment.
- D. Maintain confidentiality and ask the patient what information, if any, may be shared with the family.
- E. Refuse to speak with the family at all, even about information the patient explicitly authorizes.

93. Between meals, a healthy adult develops periodic waves of gastrointestinal motility that sweep residual contents distally. Which hormone is associated with this migrating motor complex?

- A. Cholecystokinin, whose cyclic fasting release is the main initiator of migrating motor complexes.
- B. Motilin, whose cyclic release promotes fasting interdigestive contractions.
- C. Secretin, which causes vigorous fasting gastric contractions every few minutes.

- D.** Insulin, which is the exclusive mediator of fasting intestinal peristalsis.
- E.** Somatostatin, which directly triggers the migrating motor complex while accelerating gastric emptying.

94. A patient has a focal lesion of the left anterolateral spinal cord. Which sensory pathway is most affected?

- A.** Vestibulospinal fibers that carry facial pain and temperature sensation to the thalamus.
- B.** Dorsal-column fibers that cross immediately in the anterior white commissure at entry.
- C.** Corticospinal motor fibers that carry only sensory information from the opposite limb.
- D.** Vibration fibers that remain contralateral from the moment they enter the spinal cord.
- E.** Pain and temperature fibers that crossed within a few spinal segments and ascend contralaterally.

95. A blood sample is passed through a narrow tube. If all other variables remain constant, doubling the tube radius changes laminar flow by approximately what factor?

- A.** Flow increases sixteenfold because it is proportional to the fourth power of radius.
- B.** Flow remains unchanged because viscosity, not radius, determines laminar flow.
- C.** Flow increases twofold because it is directly proportional to radius.
- D.** Flow decreases fourfold because increasing radius lowers the pressure gradient.
- E.** Flow increases fourfold because it is proportional to the square of radius.

96. A marathon runner has a high proportion of slow oxidative skeletal muscle fibers. Which property supports prolonged endurance activity?

- A.** High mitochondrial density, rich capillary supply, and abundant myoglobin.
- B.** Low oxidative capacity with reliance on anaerobic glycolysis for nearly all ATP production.
- C.** Large diameter and sparse capillary supply that maximize diffusion distance for oxygen.
- D.** Very high glycogen use with minimal fatty-acid oxidation and rapid fatigue.
- E.** Absence of myoglobin, which allows oxygen to diffuse more rapidly through the cytosol.

97. Norepinephrine stimulates beta-1 receptors in sinoatrial nodal cells. Which change increases heart rate?

- A.** Decreased cAMP reduces funny current and flattens phase 4 depolarization.
- B.** Increased cAMP enhances funny current and calcium currents, steepening phase 4 depolarization.
- C.** Inhibition of calcium channels steepens phase 4 depolarization and shortens nodal action potentials.
- D.** Opening of fast voltage-gated sodium channels becomes the only determinant of phase 0 in nodal cells.
- E.** Increased potassium efflux during phase 4 hyperpolarizes the membrane so strongly that threshold is reached later.

98. A patient has hemorrhagic shock. Which variable most directly falls because of reduced circulating blood volume?

- A.** Mean systemic filling pressure rises because blood volume is the major determinant and has decreased.
- B.** Venous return increases because low blood volume decreases venous capacitance automatically without neural input.
- C.** Stroke volume increases because the Frank-Starling curve is inverted during hemorrhage.
- D.** Cardiac preload rises because less blood in the circulation increases filling pressure.
- E.** Venous return and cardiac preload decrease, tending to reduce stroke volume and cardiac output.

99. A healthy person fasts overnight. Which hepatic effect of glucagon helps maintain blood glucose?

- A.** Activation of an intracellular steroid receptor that increases glucose storage.
- B.** Increased glycogen synthesis and suppression of gluconeogenesis through receptor tyrosine kinase signaling.
- C.** Increased GLUT4 translocation in hepatocytes as the main mechanism of glucagon action.
- D.** Direct inhibition of hepatic glucose output during fasting.
- E.** Increased glycogenolysis and gluconeogenesis through Gs-cAMP signaling.

100. A patient has hypoxemia from a right-to-left intracardiac shunt. Which feature helps distinguish shunt from simple ventilation-perfusion mismatch?

- A.** PaCO₂ is necessarily extremely high because shunt prevents all carbon dioxide excretion.
- B.** The alveolar-arterial oxygen gradient must be normal in a right-to-left shunt.
- C.** The hypoxemia improves relatively little with administration of high-concentration oxygen.
- D.** Arterial oxygen content is preserved because shunted blood bypasses the lungs without mixing.
- E.** The hypoxemia always corrects completely with a small increase in inspired oxygen.

101. A bright light is shone into the right eye of a healthy person. Which neural pathway mediates constriction of both pupils?

- A.** The trigeminal nerve carries the afferent signal to both facial motor nuclei.
- B.** Visual cortex sends a unilateral corticospinal projection to the right iris sphincter.
- C.** The optic nerve directly activates sympathetic neurons in the superior cervical ganglion.
- D.** Retinal input reaches the lateral geniculate body only, which projects unilaterally to the right oculomotor nucleus.
- E.** Retinal input reaches the pretectal area, which projects bilaterally to Edinger-Westphal nuclei.

102. A patient develops marked polycythemia. If vessel radius and pressure gradient are unchanged, how does the increase in blood viscosity affect laminar blood flow?

- A.** Flow increases because hematocrit lowers friction between plasma and the vessel wall.
- B.** Flow increases because erythrocytes create a stronger axial pressure gradient.
- C.** Flow decreases because vascular resistance rises as viscosity increases.
- D.** Flow becomes independent of vessel radius once hematocrit rises above normal.
- E.** Flow is unchanged because viscosity affects turbulence but not laminar resistance.

103. A patient's adult daughter asks the physician to hide a new cancer diagnosis from her father because 'he will lose hope.' The patient has capacity and has asked to know all results. What should the physician do?

- A.** Delay disclosure indefinitely because serious diagnoses should be shared only if family members agree.
- B.** Document that the patient lacks capacity because the family anticipates emotional distress.
- C.** Honor the daughter's request because family preferences supersede those of an adult patient.
- D.** Explain to the daughter that the patient's expressed preference for information will be honored and disclose the diagnosis sensitively to the patient.
- E.** Tell the daughter the diagnosis but never discuss it with the patient unless he guesses it.

104. A patient becomes hypoglycemic after fasting. Which hormone is an important rapid counterregulatory signal?

- A.** Insulin rises and suppresses hepatic glucose production.
- B.** Aldosterone rises and directly converts fatty acids to glucose in hepatocytes.
- C.** Leptin rises within seconds and is the principal emergency counterregulatory hormone.
- D.** Glucagon rises and stimulates hepatic glucose production.
- E.** Somatostatin rises and directly releases glucose from skeletal muscle into blood.

105. A patient begins an isometric contraction of the quadriceps while holding the knee at a fixed angle. Which change occurs in the muscle?

- A.** Both muscle length and tension remain unchanged despite active cross-bridge cycling.
- B.** Muscle tension rises while overall muscle length remains approximately constant.
- C.** Muscle length shortens substantially while tension remains exactly zero.
- D.** Sarcomeres cannot generate force because isometric contractions prevent actin-myosin interaction.
- E.** Muscle length increases because every isometric contraction is eccentric.

106. A patient has diffusion limitation across a thickened alveolar-capillary membrane. Which gas property favors more rapid diffusion?

- A.** High solubility and low molecular weight increase diffusion across the membrane.

- B.** Low solubility and high molecular weight increase diffusion across the membrane.
- C.** Low partial-pressure gradient increases diffusion by reducing back-diffusion.
- D.** Diffusion is determined only by airway resistance and is independent of gas properties.
- E.** High molecular weight increases diffusion because heavier molecules carry more momentum through tissue.

107. Vagal stimulation slows the sinoatrial node. Which electrophysiologic change contributes?

- A.** Blockade of muscarinic receptors increases vagal acetylcholine action on the node.
- B.** Decreased potassium conductance depolarizes pacemaker cells and increases the slope of phase 4 depolarization.
- C.** Increased cAMP strongly activates L-type calcium channels and shortens the interval to threshold.
- D.** Activation of fast sodium channels converts the nodal action potential into a ventricular-type action potential.
- E.** Increased potassium conductance hyperpolarizes pacemaker cells and decreases the slope of phase 4 depolarization.

108. A patient with cardiogenic shock has low cardiac output and high systemic vascular resistance. Why does vascular resistance increase?

- A.** Systemic vascular resistance is unrelated to autonomic or hormonal responses.
- B.** Low output suppresses catecholamines and angiotensin II, lowering vascular tone.
- C.** Baroreflex and neurohormonal activation produce sympathetic arteriolar vasoconstriction in response to low arterial pressure.
- D.** High venous oxygen saturation directly dilates every systemic arteriole in cardiogenic shock.
- E.** Cardiac failure directly paralyzes sympathetic nerves, causing universal arteriolar dilation.

109. A patient eats a fatty meal. Gastric emptying slows. Which signal contributes to this response?

- A.** Motilin rises sharply during a meal and stops all gastric contractions.

- B.** Duodenal CCK and neural feedback reduce gastric motility when fat enters the small intestine.
- C.** Gastrin from the antrum is the dominant inhibitor of gastric emptying after fat enters the duodenum.
- D.** Vagal activity is completely abolished by intestinal fat and therefore gastric tone becomes zero.
- E.** Duodenal acid directly increases gastric emptying to clear the stomach faster.

110. A randomized trial finds that an event occurs in 20% of the control group and 10% of the treatment group. What is the absolute risk reduction?

- A.** 50 percentage points, calculated from the relative reduction in risk.
- B.** 30 percentage points, calculated by adding the treatment and control risks.
- C.** 100 percentage points, because the treatment cut the relative risk in half.
- D.** 10 percentage points, calculated as 20% minus 10%.
- E.** 2 percentage points, calculated by multiplying the two event rates.

111. A healthy person shifts gaze from a distant object to a nearby page. Which ocular change improves near vision?

- A.** Sympathetic activation of the ciliary muscle is required to make the lens more convex.
- B.** Ciliary muscle relaxation reduces zonular tension, flattening the lens for near focus.
- C.** Ciliary muscle contraction reduces zonular tension, allowing the lens to become more convex.
- D.** Radial iris muscle contraction constricts the pupil and increases lens flattening.
- E.** Superior oblique contraction increases lens curvature through the zonular fibers.

112. Growth hormone is secreted in pulses, especially during sleep. Which mediator accounts for many of its growth-promoting effects?

- A.** Erythropoietin produced by the kidney as the principal mediator of bone elongation.
- B.** Insulin-like growth factor 1 produced largely by the liver and other tissues.
- C.** Aldosterone produced by the adrenal cortex in response to growth hormone.

- D.** Calcitonin released from thyroid C cells as the exclusive mediator of linear growth.
- E.** Somatostatin produced by the pancreas as the main growth-promoting hormone.

113. A patient with pulmonary fibrosis has impaired oxygen transfer during exercise. Why can exercise reveal diffusion limitation more clearly?

- A.** Exercise lengthens capillary transit time so oxygen remains trapped in capillaries longer.
- B.** Pulmonary capillary blood becomes venous only after exercise and therefore cannot bind oxygen at rest.
- C.** Shorter capillary transit time leaves less time for oxygen to equilibrate across a thickened membrane.
- D.** Hemoglobin loses all oxygen affinity during exercise, independent of membrane thickness.
- E.** Exercise abolishes the alveolar oxygen gradient by reducing ventilation to zero.

114. A small arterial injury exposes subendothelial collagen. Which interaction is most important for the initial adhesion of platelets to the damaged vessel wall?

- A.** Platelet glycoprotein IIb/IIIa binding directly to collagen without an intermediary protein.
- B.** Platelet glycoprotein Ib binding to von Willebrand factor attached to exposed collagen.
- C.** Antithrombin binding to exposed collagen and recruiting platelets through thrombin inhibition.
- D.** Protein C binding to platelet ADP receptors and activating platelet adhesion.
- E.** Fibrin binding to platelet glycoprotein Ib before thrombin has been generated.

115. A person slowly lowers a heavy weight while the elbow flexors remain active. What type of contraction is occurring in the biceps?

- A.** Passive stretch without cross-bridge activity, because active muscle cannot lengthen under load.
- B.** Tetanus without force production, because lowering a load suppresses motor-unit firing.
- C.** Isometric contraction, in which active muscle length cannot change at all.
- D.** Concentric contraction, in which active muscle shortens while generating force.

E. Eccentric contraction, in which active muscle generates force while lengthening.

116. A healthy 12-year-old begins puberty. Pulsatile hypothalamic signaling increases during sleep before becoming prominent throughout the day. Which endocrine event initiates this change?

A. A fall in pituitary sensitivity to gonadotropin-releasing hormone that increases luteinizing hormone release.

B. Increased pulsatile secretion of gonadotropin-releasing hormone from the hypothalamus.

C. Abrupt suppression of adrenal androgen synthesis that removes inhibition of gonadal steroid production.

D. A sustained rise in prolactin that directly stimulates gonadal steroidogenesis without gonadotropins.

E. Continuous secretion of gonadotropin-releasing hormone that prevents receptor desensitization at the pituitary.

117. In a ventricular myocyte, which ion current is most important for maintaining the plateau phase of the action potential?

A. A massive sustained inward sodium current through fast sodium channels with no potassium efflux.

B. Inward calcium current through L-type calcium channels balanced by outward potassium current.

C. Complete closure of every ion channel so membrane voltage remains fixed passively.

D. An inward chloride current that is the sole current during the plateau.

E. Outward calcium current through ryanodine receptors into the extracellular space.

118. A patient has anaphylactic shock. Which combined physiologic changes can rapidly lower effective circulating volume?

A. Systemic vasoconstriction and decreased permeability trap excess fluid in the vasculature and reduce preload.

B. Anaphylaxis increases venous return by constricting capacitance vessels without any permeability change.

- C. Systemic vasodilation and increased vascular permeability reduce venous return and arterial pressure.
- D. Bronchoconstriction alone explains the full fall in systemic blood pressure without vascular effects.
- E. A sudden rise in plasma oncotic pressure draws all interstitial water into blood and causes shock.

119. A patient has high circulating IGF-1. Which feedback effect is expected on growth hormone secretion?

- A. IGF-1 suppresses all hypothalamic hormones except GHRH, which rises markedly.
- B. IGF-1 stimulates pituitary growth hormone release through strong positive feedback.
- C. IGF-1 directly converts somatostatin into growth hormone in the hypothalamus.
- D. IGF-1 suppresses pituitary growth hormone release and increases hypothalamic inhibitory signaling.
- E. IGF-1 has no feedback role because only cortisol regulates growth hormone.

120. A patient has conductive hearing loss from cerumen impaction in the external auditory canal. Which tuning-fork finding is expected in the affected ear?

- A. The vestibulo-ocular reflex is absent because the external canal is blocked.
- B. Sound lateralizes to the unaffected ear because conductive loss decreases perceived bone-conducted sound.
- C. Bone conduction exceeds air conduction on the affected side because external sound transmission is reduced.
- D. Air conduction exceeds bone conduction by an exaggerated amount on the affected side.
- E. Both air and bone conduction are absent because cochlear hair cells cannot be stimulated by bone vibration.

121. A patient with mild cognitive impairment is considering a procedure. Which approach best evaluates decision-making capacity?

- A. Ask whether the patient agrees with the physician; disagreement proves incapacity.

- B.** Assess whether the patient can understand relevant information, appreciate consequences, reason about options, and communicate a choice.
- C.** Require perfect recall of every technical detail before recognizing any capacity.
- D.** Delegate capacity determination automatically to the nearest family member.
- E.** Use the diagnosis of cognitive impairment alone to declare the patient incapable of all medical decisions.

122. A patient receives supplemental oxygen. Which component of arterial oxygen content increases directly with PaO₂ even after hemoglobin is nearly fully saturated?

- A.** Hemoglobin concentration, which rises immediately when inspired oxygen increases.
- B.** Dissolved oxygen in plasma, which is proportional to arterial oxygen tension.
- C.** Erythrocyte count, which doubles within minutes of oxygen administration.
- D.** Plasma bicarbonate, which is the main carrier of oxygen at high PaO₂.
- E.** The number of heme groups per hemoglobin molecule, which increases with PaO₂.

123. A patient has pancreatic exocrine insufficiency and develops steatorrhea. Which digestive process is most impaired?

- A.** Active transport of intact triglycerides across the apical membrane through sodium-glucose cotransporters.
- B.** Brush-border cleavage of all triglycerides into amino acids by intestinal peptidases.
- C.** Hydrolysis of fat by gastric intrinsic factor as the main lipid-digesting enzyme.
- D.** Hydrolysis of dietary triglycerides by pancreatic lipase before micellar absorption of fatty acids and monoglycerides.
- E.** Absorption of long-chain fat directly into portal blood without chylomicron formation.

124. Platelets at a site of vascular injury release ADP and thromboxane A₂. Which change most directly promotes platelet aggregation?

- A.** Suppression of intracellular calcium signaling, which maintains platelets in a resting configuration.

- B.** Cleavage of von Willebrand factor from collagen, preventing any further platelet recruitment.
- C.** Conversion of fibrin directly into fibrinogen, dissolving the developing platelet plug.
- D.** Activation of glycoprotein IIb/IIIa receptors that bind fibrinogen between adjacent platelets.
- E.** Inactivation of glycoprotein IIb/IIIa receptors so platelets cannot bind fibrinogen.

125. A patient has impaired smooth-muscle contraction due to inhibition of myosin light-chain kinase. Which normal signal activates this kinase?

- A.** Calcium-calmodulin binding, which activates myosin light-chain kinase.
- B.** Calcium binding directly to troponin C, which is the main regulatory protein in smooth muscle.
- C.** Opening of nicotinic receptors on every smooth-muscle cell as the obligatory first step.
- D.** ATP binding to tropomyosin, which activates myosin light-chain kinase independently of calcium.
- E.** cAMP-dependent phosphorylation that always activates myosin light-chain kinase.

126. A patient has hypocalcemia. Which immediate parathyroid response is expected?

- A.** Increased activation of calcium-sensing receptors increases PTH secretion.
- B.** Reduced activation of calcium-sensing receptors increases PTH secretion.
- C.** Parathyroid cells release calcitonin rather than PTH during hypocalcemia.
- D.** Hypocalcemia directly suppresses PTH and increases urinary calcium excretion.
- E.** PTH secretion is controlled only by plasma phosphate and is independent of calcium.

127. A patient has sensorineural hearing loss from cochlear hair-cell damage in the left ear. On Weber testing, where is sound most likely perceived?

- A.** The left ear, because sensorineural loss amplifies bone-conducted sound in the damaged cochlea.
- B.** The right ear, because sensorineural loss causes lateralization away from the affected side.
- C.** Only through the mastoid on the left, because air conduction is selectively preserved.

- D.** Equally in both ears, because Weber testing cannot distinguish conductive from sensorineural loss.
- E.** Nowhere, because unilateral cochlear damage abolishes all skull vibration.

128. A patient hypoventilates after receiving a sedative. What happens to arterial carbon dioxide tension if metabolic CO₂ production is unchanged?

- A.** PaCO₂ rises because it is inversely related to alveolar ventilation.
- B.** PaCO₂ becomes equal to inspired carbon dioxide, which is normally higher than arterial levels.
- C.** PaCO₂ remains fixed because carbon dioxide elimination is independent of ventilation.
- D.** PaCO₂ falls because reduced ventilation retains less carbon dioxide in blood.
- E.** PaCO₂ falls only because bicarbonate production stops during hypoventilation.

129. A ventricular myocyte is in phase 0 of its action potential. Which current produces the rapid depolarization?

- A.** Rapid sodium influx through fast voltage-gated sodium channels.
- B.** Sodium extrusion by the sodium-potassium ATPase faster than passive sodium entry.
- C.** Chloride efflux through ligand-gated channels activated by acetylcholine.
- D.** Slow calcium influx through T-type calcium channels as the only inward current.
- E.** Rapid potassium influx through delayed rectifier potassium channels.

130. A healthy person starts vigorous exercise. Which change helps maintain arterial oxygen delivery to working muscle?

- A.** Cardiac output falls while muscle arterioles constrict to preserve oxygen for resting tissues.
- B.** Hemoglobin concentration falls immediately by half because plasma enters red cells.
- C.** Pulmonary ventilation stops briefly so blood can remain longer in alveolar capillaries.
- D.** Muscle blood flow becomes independent of local metabolic demand during exercise.
- E.** Cardiac output rises and local arterioles in active muscle dilate, increasing regional blood flow.

131. In the same trial, the control event rate is 20% and the treatment event rate is 10%. What is the number needed to treat?

- A.** 100 patients, because percentage values are used without converting to proportions.
- B.** 10 patients, because NNT is the reciprocal of the absolute risk reduction of 0.10.
- C.** 20 patients, because NNT equals the reciprocal of the treatment event rate only.
- D.** 2 patients, because the relative risk is one half.
- E.** 5 patients, because the control risk is 20%.

132. A patient has a deficiency of factor VIII. Which laboratory test is most likely prolonged before treatment?

- A.** Both prothrombin time and bleeding time with a normal partial thromboplastin time.
- B.** Bleeding time alone, because factor VIII is required for platelet adhesion to collagen.
- C.** Activated partial thromboplastin time, reflecting impairment of the intrinsic coagulation pathway.
- D.** Prothrombin time alone, reflecting isolated impairment of the extrinsic pathway.
- E.** Thrombin time alone, because factor VIII directly converts fibrinogen to fibrin.

133. Parathyroid hormone acts on the kidney during hypocalcemia. Which combination is expected?

- A.** Decreased calcium reabsorption, increased phosphate reabsorption, and inhibition of vitamin D activation.
- B.** Increased distal calcium reabsorption, decreased proximal phosphate reabsorption, and increased 1-alpha-hydroxylase activity.
- C.** Decreased vitamin D activation together with increased urinary calcium excretion.
- D.** No renal effects because PTH acts only on bone and intestine.
- E.** Increased proximal phosphate reabsorption with complete suppression of calcium transport.

134. An incapacitated patient has a written advance directive that clearly addresses the current clinical situation. What should guide treatment?

- A.** Ignore the directive whenever family members request a different treatment.
- B.** Treat the directive as advisory only and automatically defer to the most senior physician.
- C.** Follow the patient's documented preferences unless there is a compelling reason the directive is invalid or inapplicable.
- D.** Ask the hospital to choose treatment based only on resource cost rather than patient preferences.
- E.** Provide every available life-sustaining treatment because incapacity eliminates prior autonomous choices.

135. Bile salts enter the intestinal lumen after a meal. What is their most important role in lipid absorption?

- A.** They hydrolyze triglycerides enzymatically into glycerol and fatty acids without pancreatic lipase.
- B.** They form micelles that keep lipid digestion products soluble and deliver them to the enterocyte surface.
- C.** They bind vitamin B12 and carry it to receptors in the terminal ileum.
- D.** They convert long-chain fatty acids into glucose before absorption.
- E.** They transport chylomicrons from lymph directly into the intestinal lumen for reabsorption.

136. A vasodilator raises cAMP in vascular smooth muscle. How does increased cAMP usually promote relaxation?

- A.** Protein kinase A inhibits myosin light-chain phosphatase, prolonging phosphorylated myosin.
- B.** cAMP binds troponin C and blocks calcium release from skeletal-muscle sarcoplasmic reticulum.
- C.** Protein kinase A activates myosin light-chain kinase, increasing myosin phosphorylation and contraction.
- D.** cAMP directly opens nicotinic acetylcholine receptors and causes sustained depolarization.
- E.** Protein kinase A reduces myosin light-chain kinase activity, decreasing myosin phosphorylation.

137. During head rotation to the left, the vestibulo-ocular reflex helps maintain visual fixation. Which initial eye movement occurs?

- A.** The eyes move to the left at the same velocity as the head.
- B.** Both eyes converge maximally without any horizontal movement.
- C.** The eyes remain fixed in the orbits because vestibular input suppresses extraocular motor neurons.
- D.** The eyes move upward because horizontal semicircular canals signal only vertical motion.
- E.** The eyes move to the right, opposite the direction of head rotation.

138. A patient hyperventilates because of acute anxiety. Which primary acid-base change occurs first?

- A.** No acid-base change because PaCO_2 does not influence hydrogen ion concentration.
- B.** Respiratory acidosis caused by a fall in PaCO_2 .
- C.** Respiratory alkalosis caused by a fall in PaCO_2 and carbonic acid.
- D.** Metabolic alkalosis caused by immediate renal generation of new bicarbonate.
- E.** Metabolic acidosis caused by loss of bicarbonate in the lungs.

139. The PR interval on an electrocardiogram reflects conduction from the atria through the atrioventricular node to the ventricular conduction system. Why is AV nodal conduction relatively slow?

- A.** Ventricular repolarization feeds backward into the AV node and creates the normal PR interval.
- B.** Small cells with calcium-dependent depolarization and fewer gap junctions delay impulse transmission.
- C.** Purkinje fibers slow conduction before reaching the AV node because they have the smallest diameter in the heart.
- D.** The AV node is electrically isolated from atrial tissue and conducts only by diffusion of acetylcholine.
- E.** Large cells with abundant fast sodium channels and many gap junctions maximize delay.

140. A patient has severe vitamin K deficiency. Which coagulation proteins require gamma-carboxylation for normal calcium-dependent membrane binding?

- A.** Only fibrinogen and antithrombin, which bind calcium through heme groups.
- B.** Platelet glycoproteins Ib and IIb/IIIa, which are synthesized exclusively in the liver.
- C.** Factors I, V, VIII, and XIII together with von Willebrand factor.
- D.** Factors II, VII, IX, and X as well as proteins C and S.
- E.** Only factor XII and prekallikrein, which initiate the contact pathway.

141. Calcitonin is released from thyroid parafollicular cells when calcium is high. Which effect can it produce?

- A.** Direct increase in intestinal calcium absorption exceeding the effect of calcitriol.
- B.** Reduced osteoclast activity, tending to decrease bone resorption.
- C.** Strong stimulation of osteoclasts through RANKL as its dominant action.
- D.** Increased PTH secretion from chief cells despite hypercalcemia.
- E.** Activation of renal 1-alpha-hydroxylase as the primary regulator of vitamin D.

142. During prolonged exercise in a hot environment, dehydration reduces plasma volume. Which cardiovascular consequence can limit performance?

- A.** Reduced venous return lowers stroke volume, requiring a higher heart rate to sustain cardiac output.
- B.** Reduced plasma volume increases venous return and stroke volume through higher preload.
- C.** Dehydration lowers skin blood flow requirements because sweating becomes more efficient as plasma volume falls.
- D.** Cardiac output becomes independent of venous return during dynamic exercise.
- E.** Stroke volume rises because blood viscosity falls as hematocrit increases.

143. A patient with opioid overdose hypoventilates. Which primary acid-base disorder develops before renal compensation?

- A.** No acid-base disorder because dissolved carbon dioxide does not participate in buffering.
- B.** Acute respiratory acidosis from carbon dioxide retention.
- C.** Primary metabolic acidosis from immediate bicarbonate loss in urine.
- D.** Primary metabolic alkalosis from suppression of ventilation.
- E.** Acute respiratory alkalosis from carbon dioxide retention.

144. A healthy person stands upright and then closes the eyes. Which sensory systems can still provide the central nervous system with information about body position?

- A.** Retinal input and spinothalamic pain input exclusively.
- B.** Vestibular input and proprioceptive input from muscles and joints.
- C.** Sympathetic efferent activity and corticospinal motor output only.
- D.** Auditory input and gustatory input only, because vestibular signaling stops when the eyes close.
- E.** Visual input and olfactory input only, because proprioception requires vision.

145. A bone-remodeling unit is activated after microdamage. Which cell resorbs mineralized bone by acidifying the resorption lacuna?

- A.** Osteoclasts, multinucleated cells derived from the monocyte-macrophage lineage.
- B.** Chondrocytes, which are the primary resorptive cells in adult cortical bone.
- C.** Osteoblasts, multinucleated cells derived from neutrophils that dissolve hydroxyapatite.
- D.** Osteocytes, which circulate in blood and secrete hydrochloric acid onto bone surfaces.
- E.** Fibroblasts, which form a sealed resorption lacuna and dissolve mineral with carbonic acid.

146. A patient undergoes resection of the terminal ileum. Which normal process is most directly reduced?

- A.** Absorption of nearly all monosaccharides, which occurs only in the terminal ileum.
- B.** Production of gastric intrinsic factor, which is synthesized by ileal crypt cells.
- C.** Absorption of most dietary iron, which occurs mainly in the terminal ileum.

D. Active reabsorption of bile salts, which normally recycles them through the enterohepatic circulation.

E. Secretion of pancreatic lipase, which is produced by ileal enterocytes.

147. An incapacitated patient has no advance directive. A legally appropriate surrogate is available and knows the patient's values well. Which decision standard should be used first?

A. Substituted judgment based on what the patient would have chosen if able to decide.

B. The physician's personal preference because medical expertise replaces patient values during incapacity.

C. The surrogate's own preferred treatment regardless of the patient's prior beliefs.

D. The most expensive available treatment because it maximizes the appearance of care.

E. A random choice among medically acceptable options because patient values cannot be inferred.

148. A patient has central diabetes insipidus. Which physiologic defect is present?

A. Renal resistance to aldosterone selectively prevents water reabsorption while vasopressin remains effective.

B. Insufficient renin secretion prevents glomerular filtration of water into the nephron.

C. Excess vasopressin release causes maximal aquaporin insertion and dilute polyuria.

D. Insufficient vasopressin release reduces collecting-duct water permeability despite intact renal responsiveness.

E. Excess atrial natriuretic peptide directly destroys collecting-duct aquaporin channels.

149. Thrombin generation is tightly limited to the site of vascular injury. Which endogenous anticoagulant is activated when thrombin binds thrombomodulin on intact endothelium?

A. Factor XIII, which inactivates factors V and VIII after binding thrombomodulin.

B. Plasminogen activator inhibitor, which directly cleaves thrombin and fibrinogen.

C. Tissue factor, which binds thrombomodulin and inhibits the extrinsic pathway.

D. Von Willebrand factor, which degrades activated factors IX and X on intact endothelium.

E. Protein C, which inactivates factors Va and VIIIa with protein S as a cofactor.

150. In a cohort study, disease develops in 30 of 300 exposed people and 10 of 400 unexposed people. Which expression gives the relative risk?

A. 30 divided by 10 without considering the number of people in each exposure group.

B. $(30+10)$ divided by $(300+400)$, which is the overall incidence rather than relative risk.

C. $(300/30)$ divided by $(400/10)$, which is the reciprocal of each incidence and has no relative-risk interpretation.

D. $(30/300)$ divided by $(10/400)$, comparing incidence in exposed with incidence in unexposed.

E. $(30/400)$ divided by $(10/300)$, because denominators should be exchanged between exposure groups.

151. A patient exercises vigorously. Coronary blood flow to the left ventricular myocardium increases primarily in response to which signal?

A. Reduced myocardial carbon dioxide production that causes coronary vasodilation.

B. A fall in myocardial adenosine concentration as ATP breakdown accelerates.

C. Local metabolic vasodilation caused by increased oxygen consumption and metabolites such as adenosine.

D. Direct sympathetic alpha-1 vasoconstriction that overrides all local metabolic signals during exercise.

E. Decreased endothelial shear stress that increases nitric oxide release.

152. A person fasts for 24 hours. Which metabolic adaptation helps maintain blood glucose?

A. The brain immediately switches entirely to ketone bodies within the first hour of fasting.

B. Skeletal muscle releases free glucose by dephosphorylating glucose-6-phosphate with high glucose-6-phosphatase activity.

C. Adipose tissue converts fatty acids directly into net glucose through beta-oxidation.

D. Hepatic glycogenolysis early and increasing gluconeogenesis as glycogen stores decline.

E. Insulin secretion rises and completely suppresses hepatic glucose production.

153. A freely filtered substance is neither reabsorbed nor secreted by the renal tubules. Its clearance is therefore a measure of which variable?

A. Renal plasma flow, because all filtered substance must represent total plasma entering the kidney.

B. Filtration fraction only, independent of glomerular filtration rate.

C. Tubular reabsorptive capacity, because the substance is completely reabsorbed.

D. Glomerular filtration rate, because excretion equals filtered load when no tubular transport occurs.

E. Renal blood flow including erythrocyte volume, because clearance measures whole-blood delivery.

154. A patient rapidly ascends to a high altitude and hyperventilates. Cerebral blood flow initially decreases. Which local effect of the respiratory change causes this decrease?

A. Reduced arterial carbon dioxide causes cerebral arteriolar vasodilation.

B. Reduced arterial carbon dioxide causes cerebral arteriolar vasoconstriction.

C. Increased arterial oxygen tension causes maximal cerebral vasoconstriction despite unchanged carbon dioxide.

D. Increased cerebrospinal fluid bicarbonate acutely causes cerebral vasodilation within seconds.

E. Reduced arterial pH directly relaxes cerebral arterioles during hyperventilation.

155. A patient produces large volumes of dilute urine despite a high endogenous vasopressin concentration. How should urine concentration respond to an administered V2-selective vasopressin analog?

A. Plasma osmolality falls immediately before any water intake because desmopressin blocks filtration.

B. Desmopressin directly replaces aquaporin-2 protein in the urine and normalizes concentration.

C. Urine output falls to zero because nephrogenic resistance increases V2 receptor signaling.

- D.** Urine osmolality rises dramatically because the pituitary is the only abnormal site.
- E.** Urine concentrating ability improves little because the collecting duct is resistant to vasopressin signaling.

156. Parathyroid hormone is released in response to hypocalcemia. How can it increase osteoclast-mediated bone resorption despite osteoclasts lacking the classic PTH receptor?

- A.** PTH suppresses RANKL and increases osteoprotegerin, thereby increasing osteoclast formation.
- B.** PTH stimulates osteoblast-lineage cells to increase RANKL, which promotes osteoclast differentiation and activity.
- C.** PTH converts mature osteoblasts directly into multinucleated osteoclasts.
- D.** PTH inhibits all osteoblast signaling so osteoclasts become autonomous and independent of RANKL.
- E.** PTH binds directly to osteoclast troponin receptors and activates proton secretion.

157. Several days after a clot forms, endothelial cells promote fibrinolysis. Tissue plasminogen activator has which principal action?

- A.** It converts plasminogen to plasmin, which cleaves fibrin within the clot.
- B.** It converts prothrombin to thrombin independently of factor Xa.
- C.** It inhibits antithrombin and thereby prolongs coagulation at the site of injury.
- D.** It activates factor XIII, strengthening covalent cross-links in the fibrin mesh.
- E.** It converts fibrin to fibrinogen, which directly increases platelet aggregation.

158. A patient lacks intrinsic factor after autoimmune destruction of gastric parietal cells. Absorption of which nutrient is impaired?

- A.** Calcium in the jejunum through a vitamin D-independent intrinsic factor channel.
- B.** Vitamin B12 in the terminal ileum through the intrinsic factor-cobalamin receptor pathway.
- C.** Vitamin C in the terminal ileum through the cobalamin receptor.
- D.** Folate in the colon through a gastric intrinsic factor receptor.

E. Iron in the duodenum through a transferrin-intrinsic factor complex.

159. A substance is almost completely removed from renal plasma in one pass because it is filtered and avidly secreted at low plasma concentrations. Its clearance approximates which variable?

- A. Glomerular filtration rate only, because secretion cannot contribute to clearance.
- B. Urine flow rate, because complete extraction makes plasma concentration irrelevant.
- C. Filtration fraction, because excretion equals the fraction of plasma filtered.
- D. Effective renal plasma flow, because nearly all delivered substance is cleared from plasma in one pass.
- E. Renal blood flow without any correction for hematocrit.

160. A 2-day-old healthy newborn has a lower glomerular filtration rate than a healthy young adult. Which developmental feature contributes most directly to this physiologic difference?

- A. Markedly increased filtration coefficient caused by a larger mature glomerular surface area at birth.
- B. Relatively high renal vascular resistance and low renal blood flow in the neonatal kidney.
- C. Higher systemic arterial pressure in the newborn that is fully transmitted to the glomerular capillaries.
- D. Complete absence of glomerular capillary hydrostatic pressure during the first week of life.
- E. Relatively low renal vascular resistance and excessive cortical blood flow in the neonatal kidney.

161. A patient develops a rapidly expanding intracranial hematoma. Once compensatory displacement of cerebrospinal fluid and venous blood is exhausted, what happens to intracranial pressure with further volume expansion?

- A. It rises steeply because the cranial vault has very low remaining compliance.
- B. It remains constant because skull volume expands freely in adults.
- C. It oscillates around zero because cerebrospinal fluid production stops completely.
- D. It falls because cerebral arteries constrict enough to create unlimited compensatory space.

E. It becomes equal to atmospheric pressure because the dura transmits pressure outside the skull.

162. A patient asks for antibiotics for a clearly viral upper respiratory infection. Which response best preserves the therapeutic relationship while practicing appropriately?

- A. Order multiple unnecessary tests to make the patient accept that antibiotics are not indicated.
- B. Explain why antibiotics are unlikely to help, discuss potential harms, and offer symptomatic care with return precautions.
- C. Prescribe antibiotics solely to meet the patient's request and avoid dissatisfaction.
- D. Refuse without explanation and end the visit because the request is medically inappropriate.
- E. Tell the patient that asking for antibiotics proves poor judgment and should not be discussed further.

163. A patient has inappropriate vasopressin secretion. Which renal effect contributes to hyponatremia?

- A. Increased collecting-duct water reabsorption retains water in excess of solute.
- B. Suppression of aquaporin-2 insertion causes maximal urine dilution despite high vasopressin.
- C. Direct renal sodium secretion by vasopressin is so large that water balance is unchanged.
- D. Increased proximal glucose secretion drives an obligatory sodium gain.
- E. Decreased collecting-duct water permeability causes free-water loss and hypernatremia.

164. Most left ventricular coronary perfusion occurs during diastole. Why is systolic perfusion limited?

- A. Left ventricular relaxation compresses coronary vessels more strongly than contraction does.
- B. Coronary ostia are covered by the aortic valve leaflets throughout systole in every healthy person.
- C. Coronary vascular resistance is maximal in diastole because adenosine disappears between beats.
- D. Contracting myocardium compresses intramural coronary vessels during systole.
- E. The aortic pressure falls to zero during systole, eliminating coronary perfusion pressure.

165. After several days of fasting, the liver produces large amounts of ketone bodies. What physiologic benefit results?

- A.** The brain can use more ketone bodies, reducing its glucose requirement and limiting muscle protein breakdown for gluconeogenesis.
- B.** Ketone production eliminates the need for fatty-acid oxidation in the liver.
- C.** Ketone bodies prevent adipose lipolysis by acting as a stronger anabolic signal than insulin.
- D.** Ketones are converted into glucose with net carbon gain and completely replace gluconeogenesis.
- E.** The liver uses ketone bodies as its major fuel because it has the highest thiophorase activity.

166. A patient has increased osteoprotegerin expression in bone. What is the expected effect on osteoclast development?

- A.** Osteoclast formation increases because osteoprotegerin is the principal ligand for RANK on precursors.
- B.** Osteoclast formation decreases because osteoprotegerin acts as a decoy receptor for RANKL.
- C.** Osteoclast development is unchanged because RANKL affects only mature osteoblasts.
- D.** Osteoblast formation stops because osteoprotegerin directly degrades type I collagen.
- E.** Bone resorption increases because osteoprotegerin activates proton pumps in osteoclasts.

167. A child has recurrent infections with catalase-positive organisms because neutrophils cannot generate superoxide normally. Which enzyme complex is defective?

- A.** NADPH oxidase, which initiates the respiratory burst in phagocytes.
- B.** Catalase, which is required in neutrophils to convert chloride into hypochlorous acid.
- C.** Glucose-6-phosphatase, which forms hypochlorous acid inside neutrophil granules.
- D.** Myeloperoxidase, which generates superoxide directly from molecular oxygen and NADPH.
- E.** Superoxide dismutase, which is the membrane enzyme that transfers electrons from NADPH to oxygen.

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

- A.** 120%, because filtration fraction equals GFR expressed as a percent.
- B.** 72%, calculated by subtracting GFR from renal plasma flow and converting to a percentage.
- C.** 50%, because half of renal plasma is normally filtered in one pass.
- D.** 5%, calculated as renal plasma flow divided by GFR.
- E.** 20%, calculated as GFR divided by renal plasma flow.

169. A pituitary stalk lesion interrupts dopamine delivery from the hypothalamus. Which anterior pituitary hormone is most likely to increase?

- A.** TSH, because thyroid-releasing hormone reaches the pituitary through systemic rather than portal blood.
- B.** Growth hormone, because dopamine is the only tonic inhibitor of somatotrophs.
- C.** Prolactin, because dopamine normally provides tonic inhibitory control of lactotrophs.
- D.** FSH, because gonadotropins are normally under continuous dopaminergic inhibition.
- E.** ACTH, because dopamine tonically suppresses corticotrophs more strongly than CRH stimulates them.

170. Cerebrospinal fluid is produced mainly by the choroid plexus. Which process contributes directly to its secretion?

- A.** Direct secretion of erythrocytes by ependymal cells to maintain ventricular osmolality.
- B.** Active transport of plasma proteins into ventricles, followed by water entry to match the protein gradient.
- C.** Passive filtration of whole blood through large endothelial gaps with unchanged protein concentration.
- D.** Active ion transport across choroid epithelial cells creates an osmotic gradient that draws water into the ventricles.
- E.** Movement of water from ventricles into choroid epithelium as sodium is pumped into blood.

171. A case-control study compares prior exposure among patients with disease and controls without disease. Which association measure is ordinarily calculated?

- A.** Absolute risk reduction, because case-control sampling directly measures incidence in exposed and unexposed people.
- B.** Number needed to treat, because every case-control study is an intervention trial.
- C.** The odds ratio, because subjects are selected by outcome and incidence cannot be measured directly.
- D.** Population attributable risk only, because case-control studies never compare exposure odds.
- E.** Hazard ratio only, because odds cannot be calculated when controls are included.

172. Oral glucose is absorbed across the apical membrane of small-intestinal enterocytes. Which transporter is most important?

- A.** SGLT1 cotransports glucose with sodium using the sodium gradient created by the basolateral Na/K ATPase.
- B.** The H/K ATPase actively pumps glucose into enterocytes in exchange for hydrogen ions.
- C.** GLUT2 is the principal sodium-coupled apical transporter under normal conditions.
- D.** CFTR cotransports glucose and chloride across the apical membrane.
- E.** SGLT1 transports glucose out of the basolateral membrane directly into portal blood.

173. A healthy person stands suddenly. Venous pooling decreases arterial pressure for several seconds. Which baroreflex response helps restore pressure?

- A.** Increased carotid sinus firing increases vagal tone and decreases sympathetic vasoconstriction.
- B.** Reduced baroreceptor firing suppresses heart rate and contractility to conserve energy.
- C.** Increased aortic arch firing causes venodilation and lowers venous return further.
- D.** Baroreceptors release renin directly into the bloodstream before neural responses occur.
- E.** Reduced carotid sinus firing increases sympathetic outflow and decreases parasympathetic outflow.

174. A patient with uncontrolled type 1 diabetes develops ketoacidosis. Which hormonal pattern promotes ketogenesis?

- A.** High insulin activates hormone-sensitive lipase in adipose tissue.
- B.** Low catecholamines and high insulin are required for maximal hepatic ketone production.
- C.** High insulin with low glucagon increases adipose lipolysis and ketone formation.
- D.** Low glucagon prevents hepatic entry of fatty acids into mitochondria and therefore increases ketogenesis.
- E.** Low insulin with high glucagon increases adipose lipolysis and hepatic fatty-acid oxidation.

175. A patient with vitamin D deficiency has reduced intestinal calcium absorption. Which vitamin D metabolite normally acts through a nuclear receptor to increase calcium-binding proteins in enterocytes?

- A.** 1,25-dihydroxyvitamin D, the hormonally active form produced mainly in the kidney.
- B.** Cholecalciferol, which is secreted by parathyroid cells and directly activates the calcium-sensing receptor.
- C.** Calcitonin, which is converted in the kidney to 1,25-dihydroxyvitamin D before acting on intestine.
- D.** 7-dehydrocholesterol, which acts directly as a nuclear hormone before ultraviolet exposure.
- E.** 25-hydroxyvitamin D, which is the only active form and is produced exclusively in skin.

176. Afferent arteriolar constriction occurs in an isolated kidney while systemic pressure is stable. What happens to GFR and renal blood flow?

- A.** Neither changes because afferent resistance is upstream from the glomerulus and cannot affect flow.
- B.** Both GFR and renal blood flow decrease because less blood reaches the glomerular capillaries.
- C.** GFR increases while renal blood flow decreases because glomerular pressure always rises with afferent constriction.
- D.** GFR decreases while renal blood flow increases because resistance has fallen.
- E.** Both GFR and renal blood flow increase because afferent constriction raises filtration pressure.

177. A nursing infant stimulates mechanoreceptors in the nipple. Which hormonal response promotes milk ejection?

- A.** Oxytocin release from the posterior pituitary contracts myoepithelial cells around mammary alveoli.
- B.** Prolactin release from the posterior pituitary contracts myoepithelial cells to eject milk.
- C.** Oxytocin release from the anterior pituitary stimulates synthesis of milk proteins but not ejection.
- D.** Estrogen release from the adrenal medulla produces the immediate let-down reflex.
- E.** Dopamine release from the pituitary contracts mammary smooth muscle and increases milk flow.

178. A clinician suspects intimate partner violence after noticing repeated injuries with inconsistent explanations. The patient is alone and medically stable. What is the best next step?

- A.** Ask family members to confirm the abuse before discussing it with the patient.
- B.** Confront the suspected partner immediately without first speaking privately with the patient.
- C.** Ask privately and nonjudgmentally about safety and abuse, then offer resources and assess immediate danger.
- D.** Avoid asking because direct questions about safety usually cause abuse.
- E.** Tell the patient to leave the relationship immediately as a condition of receiving medical care.

179. A neutrophil engulfs bacteria and uses myeloperoxidase in the phagolysosome. Which microbicidal product is formed from hydrogen peroxide and chloride?

- A.** Hypochlorous acid, a potent oxidant generated by the myeloperoxidase system.
- B.** Catalase, which is synthesized from hydrogen peroxide and functions as the principal neutrophil oxidant.
- C.** Nitric oxide, which is generated from chloride by myeloperoxidase and arginine oxidase.
- D.** Peroxynitrite, which is formed directly from hydrogen peroxide and chloride without nitric oxide.
- E.** Superoxide, which is produced from hydrogen peroxide by myeloperoxidase in a chloride-independent step.

180. Polysomnography records a sleep period with vivid dreaming and marked suppression of postural muscle activity. Which accompanying pattern best identifies this stage?

- A.** A fully awake alpha rhythm accompanied by generalized skeletal muscle contraction.
- B.** Continuous slow-wave activity with regular respiration and no autonomic variability.
- C.** High-amplitude delta waves with increased skeletal muscle tone and no eye movements.
- D.** Rapid eye movements, skeletal muscle atonia, and a desynchronized low-amplitude EEG.
- E.** Sleep spindles with maximal postural muscle activity and absence of dreaming.

181. Moderate efferent arteriolar constriction occurs while afferent tone is unchanged. What is the typical initial effect on glomerular filtration?

- A.** GFR always falls because efferent constriction lowers glomerular capillary pressure.
- B.** GFR tends to rise because glomerular capillary hydrostatic pressure increases, although renal plasma flow falls.
- C.** Filtration fraction falls because GFR decreases more than renal plasma flow.
- D.** GFR is unchanged because efferent resistance lies downstream and cannot influence capillary pressure.
- E.** GFR and renal plasma flow both rise because total renal resistance falls.

182. During lactation, suckling increases milk production by altering prolactin regulation. What change occurs?

- A.** Prolactin is released from the posterior pituitary without hypothalamic regulation.
- B.** Oxytocin inhibits lactotrophs so milk synthesis stops during each feeding.
- C.** Hypothalamic dopamine output falls, permitting increased prolactin secretion from the anterior pituitary.
- D.** Hypothalamic dopamine rises sharply and directly stimulates lactotroph prolactin release.
- E.** Suckling suppresses prolactin while increasing only growth hormone secretion.

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

- A.** Sodium is absorbed only through the gastric H/K ATPase, which is activated by oral glucose.
- B.** Sodium-glucose cotransport remains functional and creates osmotic absorption of sodium and water.
- C.** Secretory diarrhea abolishes sodium-glucose cotransport, so oral glucose is useful only as a calorie source.
- D.** Glucose blocks all intestinal chloride channels and therefore stops secretion immediately.
- E.** Water is actively transported uphill by SGLT1 independently of solute movement.

184. A healthy person's mean arterial pressure rises abruptly. Which immediate baroreceptor response occurs?

- A.** Carotid sinus firing decreases, increasing sympathetic outflow to the heart and vessels.
- B.** Increased arterial stretch directly inhibits vagal output and produces tachycardia.
- C.** Carotid sinus and aortic arch afferent firing increases, reducing sympathetic outflow.
- D.** Baroreceptor firing remains constant because these receptors respond only to venous pressure.
- E.** Aortic baroreceptors activate the renin-angiotensin system before changing autonomic tone.

185. A patient with severe diarrhea has bicarbonate loss. Which primary acid-base disorder develops?

- A.** A normal-anion-gap metabolic acidosis due to gastrointestinal bicarbonate loss.
- B.** A respiratory alkalosis without any metabolic component because bicarbonate is not lost in stool.
- C.** A primary respiratory acidosis because diarrhea directly suppresses medullary ventilation.
- D.** A metabolic alkalosis because all gastrointestinal fluid loss raises plasma bicarbonate.
- E.** A high-anion-gap metabolic acidosis caused exclusively by retained chloride.

186. A healthy person moves from a cool room into a hot environment. Which cutaneous response increases heat loss?

- A.** Parasympathetic activation of piloerector muscles to trap a thicker layer of air.
- B.** Somatic motor activation of sweat glands through nicotinic receptors on gland cells.
- C.** Increased thyroid hormone secretion within seconds as the primary mechanism for dissipating heat.
- D.** Sympathetic cholinergic activation of eccrine sweat glands with cutaneous vasodilation.
- E.** Sympathetic adrenergic vasoconstriction with complete inhibition of eccrine sweating.

187. A sleeping adult has prominent sleep spindles and K complexes on EEG. Which sleep stage is most likely?

- A.** REM sleep characterized by muscle atonia and a wake-like EEG without spindles.
- B.** Stage N3 non-REM sleep dominated by high-amplitude delta activity.
- C.** Stage N2 non-REM sleep, the stage defined by sleep spindles and K complexes.
- D.** Quiet wakefulness with eyes closed characterized by a posterior alpha rhythm.
- E.** Stage N1 sleep characterized exclusively by continuous high-frequency beta waves.

188. A naive CD4-positive T lymphocyte recognizes peptide presented by an antigen-presenting cell. Which molecule presents exogenous peptide to this T cell?

- A.** Major histocompatibility complex class I on all nucleated cells presenting only exogenous peptide.
- B.** CD1 on erythrocytes presenting peptide antigens to helper T cells.
- C.** Major histocompatibility complex class II on professional antigen-presenting cells.
- D.** Immunoglobulin M on neutrophils presenting peptide directly to CD4-positive cells.
- E.** Major histocompatibility complex class III on hepatocytes presenting peptide to helper T cells.

189. A patient with a new chronic illness says, 'I know I should change my diet, but I'm not ready.' Which response is most consistent with motivational interviewing?

- A.** Lecture the patient about complications until the patient agrees to change immediately.

- B.** Ask what the patient likes and dislikes about the current diet and what changes might feel achievable.
- C.** Use fear-based statements and avoid exploring ambivalence.
- D.** Set a strict diet plan without asking about goals because expert advice should replace patient choice.
- E.** Tell the patient that reluctance means the clinician should stop discussing behavior change.

190. A researcher repeatedly measures a physiologic variable with an instrument that gives values tightly clustered around a number that is consistently 10 units too high. How should the instrument be described?

- A.** Accuracy and precision cannot be distinguished unless the sample size exceeds 100.
- B.** It is both accurate and precise because reproducibility guarantees truth.
- C.** It is accurate but imprecise because the measurements are tightly clustered away from the true value.
- D.** It is neither accurate nor precise because any systematic error creates random scatter.
- E.** It is precise but inaccurate because measurements are reproducible yet systematically biased from the true value.

191. A healthy woman is in the early follicular phase of the menstrual cycle. Which hormone stimulates granulosa-cell aromatase activity?

- A.** Prolactin, which directly converts cholesterol to estradiol within granulosa cells.
- B.** FSH, promoting conversion of theca-derived androgens to estrogens.
- C.** Oxytocin, which stimulates aromatase through a posterior pituitary feedback loop.
- D.** LH, acting only on granulosa cells to provide all aromatase activity throughout the cycle.
- E.** Progesterone, which is the primary pituitary hormone controlling granulosa aromatase.

192. A patient has severe constriction of the efferent arteriole. Why can GFR eventually decrease despite elevated glomerular hydrostatic pressure?

- A.** Afferent pressure becomes unrelated to systemic arterial pressure and forces filtrate back into plasma.
- B.** Efferent constriction directly decreases Bowman's space hydrostatic pressure below atmospheric pressure.
- C.** Severe efferent constriction lowers plasma protein concentration within glomerular capillaries to zero.
- D.** Markedly reduced renal plasma flow raises glomerular capillary oncotic pressure and lowers net filtration along the capillary.
- E.** The filtration coefficient necessarily doubles during severe vasoconstriction.

193. A patient with Parkinson disease has reduced dopamine input from the substantia nigra pars compacta to the striatum. What is the net effect on movement through basal ganglia circuits?

- A.** No change in movement because dopamine acts only on sensory thalamic nuclei.
- B.** Pure cerebellar ataxia because the basal ganglia do not influence thalamocortical motor activity.
- C.** Reduced facilitation of movement because the direct pathway is less stimulated and the indirect pathway is less inhibited.
- D.** Loss of lower motor neurons because nigrostriatal dopamine directly innervates skeletal muscle.
- E.** Excessive facilitation of movement because dopamine normally suppresses the direct pathway and activates the indirect pathway.

194. A virally infected nucleated cell displays intracellular viral peptides to cytotoxic T lymphocytes. Which antigen-presenting molecule is used?

- A.** Secreted immunoglobulin G, which displays viral peptides on the surface of infected cells.
- B.** Major histocompatibility complex class II, which is constitutively expressed by all nucleated cells for endogenous antigen presentation.
- C.** Complement C3b, which presents intracellular peptides to cytotoxic T cells after opsonization.
- D.** Major histocompatibility complex class III, which binds the CD8 coreceptor and displays viral peptides.
- E.** Major histocompatibility complex class I, which presents endogenous peptides to CD8-positive T cells.

- 195.** A person is exposed to cold wind. Which skin response limits heat loss?
- A.** Maximal eccrine sweating creates an insulating water layer over the skin.
 - B.** Cutaneous arteriolar vasodilation increases the temperature gradient between skin and environment.
 - C.** Increased skin blood flow shifts heat from the environment into the body regardless of ambient temperature.
 - D.** Cutaneous arteriolar vasoconstriction reduces warm blood flow near the body surface.
 - E.** Loss of sympathetic tone opens arteriovenous anastomoses and conserves core heat.
- 196.** A drug selectively constricts systemic arterioles without changing cardiac function initially. Which hemodynamic variable rises most directly?
- A.** Pulmonary capillary wedge pressure, which must fall to zero after systemic constriction.
 - B.** Cardiac output, which must rise immediately in exact proportion to resistance.
 - C.** Venous compliance, because arteriolar constriction directly expands the venous reservoir.
 - D.** Blood volume, because arteriolar smooth muscle creates new intravascular fluid.
 - E.** Total peripheral resistance, increasing the pressure drop across systemic arterioles.
- 197.** A patient has repeated vomiting of gastric contents. Which primary acid-base disturbance is expected?
- A.** Respiratory acidosis because vomiting directly retains carbon dioxide.
 - B.** High-anion-gap acidosis because gastric hydrogen loss increases lactate production.
 - C.** No acid-base disturbance because gastric acid loss is exactly balanced by pancreatic bicarbonate loss in every patient.
 - D.** Metabolic alkalosis from loss of hydrogen chloride, often maintained by volume and chloride depletion.
 - E.** Normal-anion-gap metabolic acidosis from loss of gastric bicarbonate.

198. In the late follicular phase, estradiol concentrations remain high for a sustained period. What endocrine event follows?

- A.** Positive feedback produces an LH surge that triggers ovulation.
- B.** Progesterone from the corpus luteum rises before ovulation and suppresses all pituitary signaling.
- C.** Prolactin surges and directly ruptures the follicle without gonadotropin involvement.
- D.** FSH remains the only gonadotropin to surge because estradiol cannot affect LH secretion.
- E.** Negative feedback completely suppresses LH and prevents ovulation.

199. A patient has lactase deficiency. Ingested lactose remains in the intestinal lumen. Which mechanism contributes to diarrhea?

- A.** Lactase deficiency increases bile acid synthesis enough to cause secretory diarrhea independent of lactose intake.
- B.** Unabsorbed lactose lowers luminal osmolality and drives water into the bloodstream.
- C.** Lactose is absorbed intact and causes systemic osmotic diuresis rather than intestinal water retention.
- D.** Unabsorbed lactose raises luminal osmolality and retains water, producing osmotic diarrhea.
- E.** Lactose directly activates cholera toxin and causes cAMP-mediated chloride secretion.

200. The macula densa senses increased sodium chloride delivery in the distal tubule. Which tubuloglomerular feedback response helps normalize GFR?

- A.** Efferent arteriolar dilation with maximal renin secretion regardless of sodium delivery.
- B.** Direct secretion of aldosterone from macula densa cells into the glomerulus.
- C.** Increased vasopressin release from juxtaglomerular cells as the primary local response.
- D.** Afferent arteriolar constriction and reduced renin release.
- E.** Afferent arteriolar dilation and increased renin release.

201. A patient has an acute lesion of the cerebellar hemisphere. Which finding is most likely on the same side as the lesion?

- A.** Flaccid paralysis caused by denervation of the neuromuscular junction.
- B.** Spastic paralysis with a Babinski sign caused by loss of lower motor neurons.
- C.** Complete loss of pain and temperature from the contralateral body.
- D.** Resting tremor that improves with movement and results from dopaminergic neuron loss.
- E.** Limb dysmetria and intention tremor during goal-directed movement.

202. A patient asks the physician, 'What would you do if you were me?' regarding two medically reasonable treatments. What is the best response?

- A.** Clarify the patient's goals and values, explain how each option fits those priorities, and offer a recommendation if the patient wants one.
- B.** Present only the treatment the physician prefers and omit alternatives to simplify the decision.
- C.** Refuse to provide any guidance because clinicians must never make recommendations.
- D.** Ask the family to choose because the patient is uncertain despite retaining capacity.
- E.** Choose an option based on the physician's personal values without discussing the patient's preferences.

203. A B lymphocyte receives T-cell help in a germinal center. Which process allows it to produce antibodies with the same antigen specificity but a different heavy-chain constant region?

- A.** Class-switch recombination, which changes the immunoglobulin heavy-chain constant region.
- B.** Somatic hypermutation, which replaces the heavy-chain constant region while preserving all variable-region sequences.
- C.** V(D)J recombination in the mature plasma cell, which changes only the antibody isotype after antigen exposure.
- D.** Allelic exclusion, which permits simultaneous expression of several heavy-chain constant regions from both chromosomes.
- E.** Receptor editing, which changes the heavy-chain constant region to improve effector function without altering specificity.

204. Midcycle ovulation has occurred and the endometrium enters its secretory phase. Which ovarian structure now supplies the progesterone that supports this phase?

- A.** Primary oocytes arrested in prophase I.
- B.** The corpus luteum formed from luteinized follicular cells.
- C.** The ovarian surface epithelium, which becomes the sole steroid-producing tissue after ovulation.
- D.** The dominant preovulatory follicle before it has ruptured.
- E.** The fimbriae of the fallopian tube, which secrete progesterone in response to FSH.

205. A patient has a full-thickness skin wound. Which cell is the major producer of collagen during the proliferative phase of wound healing?

- A.** Neutrophils, which become the long-term source of type I collagen after phagocytosis.
- B.** Fibroblasts in granulation tissue, which synthesize collagen and other extracellular matrix.
- C.** Keratinocytes, which synthesize most deep dermal collagen while remaining confined to the epidermis.
- D.** Platelets, which directly assemble mature collagen fibrils for months after injury.
- E.** Mast cells, which replace fibroblasts as the principal extracellular-matrix producing cell.

206. Renal perfusion pressure falls after hemorrhage. Which juxtaglomerular response is expected?

- A.** Renin secretion increases, promoting angiotensin II formation and sodium retention.
- B.** Aldosterone secretion stops because angiotensin II is generated only during hypertension.
- C.** Macula densa sodium chloride delivery rises and directly suppresses the renin response.
- D.** Renin secretion decreases because low renal pressure suppresses juxtaglomerular beta-1 signaling.
- E.** Atrial natriuretic peptide secretion from juxtaglomerular cells becomes the dominant response.

207. A local metabolite causes arteriolar dilation in a tissue while systemic arterial pressure is unchanged. What happens to blood flow through that vascular bed?

- A.** Flow is unchanged because local resistance does not influence regional blood flow.
- B.** Flow becomes turbulent and therefore must stop until the vessel reconstricts.
- C.** Flow increases because resistance falls while the perfusion pressure gradient is maintained.
- D.** Flow decreases because arteriolar dilation always lowers perfusion pressure to zero.
- E.** Flow reverses direction because venous pressure exceeds arterial pressure after dilation.

208. A patient has metabolic acidosis with bicarbonate of 12 mEq/L. Which respiratory response is expected if compensation is intact?

- A.** Respiratory compensation raises bicarbonate directly by secreting carbon dioxide through the kidney.
- B.** PaCO₂ remains fixed because the respiratory system cannot compensate for metabolic disorders.
- C.** Ventilation increases only after the kidneys have fully restored bicarbonate over several days.
- D.** Alveolar ventilation decreases, raising PaCO₂ and worsening acidemia as normal compensation.
- E.** Alveolar ventilation increases, lowering PaCO₂ and partially restoring pH.

209. A healthy 78-year-old has a larger pulse pressure than he had at age 30 despite a similar mean arterial pressure. Which age-related vascular change best explains this finding?

- A.** Increased venous compliance that directly increases systolic aortic pressure during ventricular ejection.
- B.** Decreased systemic vascular resistance caused by loss of arteriolar smooth muscle tone in normal aging.
- C.** Decreased compliance of large elastic arteries, causing a greater pressure rise for a given stroke volume.
- D.** Decreased blood viscosity that raises pulse pressure by increasing resistance to systolic outflow.
- E.** Increased compliance of the aorta, causing systolic pressure to rise while diastolic pressure remains unchanged.

210. A healthy person becomes dehydrated after prolonged exercise. Which hypothalamic response is triggered by increased plasma osmolality?

- A.** Thirst decreases because intracellular water shifts into hypothalamic osmoreceptor cells.
- B.** Osmoreceptor activation increases thirst and vasopressin release.
- C.** Baroreceptor activation in the hypothalamus suppresses vasopressin despite hyperosmolality.
- D.** Increased plasma osmolality directly inhibits supraoptic and paraventricular neurons.
- E.** Osmoreceptor inhibition suppresses thirst while increasing renal free-water excretion.

211. A healthy colon absorbs sodium while secreting potassium. Which hormone can enhance this distal colonic sodium absorption?

- A.** Aldosterone, which increases epithelial sodium channels and Na/K ATPase activity.
- B.** Secretin, which closes epithelial sodium channels in the colon as its primary effect.
- C.** Motilin, which directly activates colonic Na/K ATPase during fasting.
- D.** Insulin, which replaces aldosterone as the dominant regulator of colonic sodium transport.
- E.** Gastrin, which acts as the principal mineralocorticoid in distal colon.

212. A normally distributed physiologic measurement has mean 100 and standard deviation 10. Approximately what proportion of observations lie between 80 and 120?

- A.** About 25%, because each standard deviation contains one quarter of a normal distribution.
- B.** About 50%, because any symmetric interval around the mean contains half the observations.
- C.** About 99.7%, because two standard deviations include nearly every observation.
- D.** About 68%, because that proportion lies within two standard deviations.
- E.** About 95%, because the interval spans approximately two standard deviations on each side of the mean.

213. If pregnancy does not occur, what causes menstruation near the end of the luteal phase?

- A.** Increasing hCG causes corpus luteum regression and loss of endometrial support.
- B.** Corpus luteum regression lowers progesterone and estrogen, leading to spiral-artery instability and endometrial shedding.

- C. A sustained rise in progesterone causes immediate endometrial ischemia and shedding.
- D. FSH becomes undetectable and directly constricts uterine arteries independently of ovarian steroids.
- E. The LH surge persists for two weeks and directly destroys the functional endometrium.

214. A germinal-center B cell population produces antibodies with progressively higher affinity for an antigen during an immune response. Which mechanism generates the sequence diversity selected during this process?

- A. Recombination of T-cell receptor genes within mature B cells after antigen exposure.
- B. Class-switch recombination of constant-region genes without mutation of the antigen-binding site.
- C. Deletion of all low-affinity B cells before any variable-region mutation occurs.
- D. Replacement of light chains by complement proteins that increase antigen-binding strength.
- E. Somatic hypermutation of immunoglobulin variable-region genes followed by affinity-based selection.

215. A filtered glucose molecule enters the proximal tubule. Under normal plasma glucose concentrations, what usually happens to it?

- A. It remains in tubular fluid because the nephron normally has no glucose transporters.
- B. It is converted to bicarbonate in the lumen before entering proximal tubular cells.
- C. It is reabsorbed only in the collecting duct through vasopressin-regulated channels.
- D. It is actively secreted from peritubular capillaries into the proximal tubule for energy disposal.
- E. It is reabsorbed almost completely through sodium-glucose cotransport followed by basolateral facilitated diffusion.

216. Several weeks after a surgical incision, wound tensile strength is increasing. Which process is most responsible?

- A. Progressive accumulation of fibrin without any collagen deposition.
- B. Collagen remodeling and increased cross-linking of collagen fibers.

- C. Conversion of collagen into elastin so the scar becomes identical to normal skin.
- D. Permanent maintenance of a neutrophil-rich inflammatory infiltrate in the wound.
- E. Complete replacement of extracellular matrix by epithelial cells alone.

217. A patient begins crying after hearing a difficult diagnosis. What is the most appropriate immediate response?

- A. Allow a brief pause, acknowledge the emotion, and offer to continue when the patient is ready.
- B. Leave the room without explanation because emotional reactions are private.
- C. Tell the patient to stop crying so important medical information can be delivered efficiently.
- D. Continue speaking rapidly so there is no uncomfortable silence.
- E. Change the topic to billing or scheduling until the patient regains composure.

218. A patient touches a hot surface and withdraws the hand before consciously localizing the pain. Which spinal process permits this rapid response?

- A. A dorsal-column reflex bypasses spinal interneurons and contracts only contralateral muscles.
- B. A vestibular reflex directly activates hand flexors through the vestibulocochlear nerve.
- C. A polysynaptic withdrawal reflex activates ipsilateral flexors while inhibiting ipsilateral extensors.
- D. A corticospinal reflex requires conscious visual recognition before motor neurons can fire.
- E. A monosynaptic stretch reflex activates ipsilateral extensors and inhibits all flexors.

219. A patient with severe hypoalbuminemia develops peripheral edema. Which Starling-force change favors movement of fluid out of systemic capillaries?

- A. Reduced plasma colloid oncotic pressure decreases the force drawing water back into capillaries.
- B. Increased plasma colloid oncotic pressure strongly favors filtration into the interstitium.
- C. Increased lymphatic drainage is the primary force causing edema in hypoalbuminemia.
- D. Reduced capillary hydrostatic pressure increases filtration despite lower outward pressure.

E. Reduced interstitial hydrostatic pressure always forces water into capillaries and causes edema.

220. A woman is four weeks pregnant and the corpus luteum must continue progesterone secretion before the placenta can assume steroid production. Which embryonic signal provides this support?

A. Oxytocin released continuously from the posterior pituitary to sustain luteal progesterone.

B. Inhibin B produced by the fetal adrenal cortex.

C. FSH secreted at high levels throughout the first trimester.

D. Human chorionic gonadotropin produced by syncytiotrophoblast.

E. Human placental lactogen produced by maternal pituitary lactotrophs.

221. A patient with chronic obstructive pulmonary disease has chronic hypercapnia. Which renal compensation helps stabilize pH?

A. Renal ammonium production falls because hypercapnia suppresses acid excretion.

B. The kidneys excrete carbon dioxide gas directly into urine as the main compensatory mechanism.

C. The kidney cannot compensate for respiratory disorders, so bicarbonate remains unchanged.

D. Increased hydrogen secretion and bicarbonate retention raise plasma bicarbonate over days.

E. Increased bicarbonate excretion lowers plasma bicarbonate in proportion to PaCO_2 .

222. A newborn has passive systemic immunity against several pathogens because maternal antibody crossed the placenta before delivery. Which immunoglobulin class is responsible?

A. Immunoglobulin G, transported across the placenta by neonatal Fc receptors.

B. Immunoglobulin E, which crosses the placenta and supplies the major neonatal antibacterial defense.

C. Immunoglobulin A, transported across the placenta by the polymeric immunoglobulin receptor.

D. Immunoglobulin M, which readily crosses the placenta because of its large pentameric structure.

E. Immunoglobulin D, which is actively transported to the fetus as the dominant serum antibody.

- 223.** A patient's plasma glucose rises above the renal threshold. Why does glucose appear in the urine?
- A.** Glomerular filtration of glucose suddenly stops, forcing glucose to be secreted into urine.
 - B.** The filtered glucose load exceeds the reabsorptive capacity of proximal tubular sodium-glucose transporters.
 - C.** Aldosterone inhibits proximal glucose reabsorption whenever plasma glucose is elevated.
 - D.** Glucose becomes protein-bound in plasma and is actively transported into the urine by albumin receptors.
 - E.** Vasopressin closes collecting-duct glucose channels and prevents all glucose reabsorption.
- 224.** A bolus of food distends the esophagus. Which reflex coordinates movement toward the stomach?
- A.** Primary peristalsis consists of sequential contraction behind the bolus with relaxation ahead of it.
 - B.** Peristalsis requires sympathetic inhibition of all enteric neural activity.
 - C.** Food moves mainly by gravity because smooth muscle cannot generate coordinated contractions.
 - D.** The esophagus contracts simultaneously along its entire length, trapping the bolus centrally.
 - E.** The lower esophageal sphincter contracts before the peristaltic wave reaches it to prevent entry into the stomach.
- 225.** A patient with scurvy has poor wound healing. Defective hydroxylation of which amino acids weakens collagen triple helices?
- A.** Phenylalanine and tyrosine residues through a folate-dependent reaction.
 - B.** Proline and lysine residues in newly synthesized collagen chains.
 - C.** Glutamate and aspartate residues through a biotin-dependent carboxylation.
 - D.** Alanine and glycine residues through a vitamin K-dependent reaction.
 - E.** Tryptophan and methionine residues through a copper-independent reaction.
- 226.** During pregnancy, progesterone helps maintain uterine quiescence. Which physiologic effect contributes?

- A.** Suppression of all uterine blood flow to prevent premature placental separation.
- B.** Markedly increased myometrial gap-junction formation early in pregnancy to promote synchronized contractions.
- C.** Continuous stimulation of oxytocin release at levels that initiate labor in the first trimester.
- D.** Direct activation of cervical collagen breakdown throughout pregnancy.
- E.** Reduced myometrial excitability and decreased responsiveness to contractile stimuli.

227. A noxious stimulus activates thinly myelinated A-delta fibers. What type of pain is typically carried by these fibers?

- A.** Deep proprioceptive sensation from muscle spindles without any nociceptive component.
- B.** Visceral stretch sensation carried only by heavily myelinated motor axons.
- C.** Fast, sharp, well-localized pain that begins soon after the stimulus.
- D.** Vibration sense transmitted in dorsal columns by unmyelinated C fibers.
- E.** Slow, burning, poorly localized pain carried exclusively by large A-beta fibers.

228. Two studies estimate the same population mean. Study A has a much larger sample size but similar standard deviation. What happens to the standard error of the mean?

- A.** It falls in direct proportion to sample size rather than to the square root of sample size.
- B.** It decreases because standard error equals the standard deviation divided by the square root of sample size.
- C.** It becomes equal to the standard deviation whenever sample size exceeds 30.
- D.** It increases because larger samples create more uncertainty about the population mean.
- E.** It remains identical because standard error depends only on the population mean.

229. A patient has acute arteriolar dilation upstream of a capillary bed. Which capillary Starling force is likely to increase?

- A.** Lymphatic hydrostatic pressure becomes the only determinant of transcapillary fluid movement.

- B.** Plasma oncotic pressure, because arteriolar dilation immediately increases plasma albumin concentration.
- C.** Interstitial oncotic pressure falls to zero because capillary pressure rises.
- D.** Capillary hydrostatic pressure falls because resistance upstream has decreased.
- E.** Capillary hydrostatic pressure, promoting greater filtration into the interstitium.

230. Micropuncture measurements show that most of the filtered sodium and water have already been reclaimed before tubular fluid reaches the loop of Henle. Which segment performed most of this reabsorption?

- A.** The thin ascending limb, which is highly permeable to water and reabsorbs most filtered sodium.
- B.** Bowman's space, where active sodium transport precedes glomerular filtration.
- C.** The collecting duct, which reabsorbs nearly all sodium independently of hormones.
- D.** The distal convoluted tubule, which normally reabsorbs more than half of filtered sodium.
- E.** The proximal tubule, where sodium and water are reabsorbed approximately iso-osmotically.

231. A patient ascends to high altitude and develops hypoxemia. Which immediate respiratory response occurs?

- A.** Ventilation cannot change until erythropoietin raises hematocrit several days later.
- B.** Hypoxemia immediately causes renal bicarbonate retention that suppresses ventilation.
- C.** Peripheral chemoreceptor activation increases ventilation, lowering PaCO_2 .
- D.** Central chemoreceptors sense low arterial oxygen directly and suppress respiratory drive.
- E.** Peripheral chemoreceptor inhibition decreases ventilation and raises PaCO_2 .

232. A breastfed infant receives passive mucosal protection in the gastrointestinal tract. Which antibody is most important in this setting?

- A.** Immunoglobulin E, which prevents gastrointestinal colonization by coating all ingested bacteria.
- B.** Immunoglobulin G, which is secreted into milk as the dominant polymeric mucosal antibody.

- C.** Immunoglobulin D, which is secreted in large amounts into colostrum and activates complement in the lumen.
- D.** Secretory immunoglobulin A, which resists proteolysis and neutralizes pathogens at mucosal surfaces.
- E.** Immunoglobulin M, which is the only antibody capable of binding epithelial polymeric immunoglobulin receptors.

233. A physician must deliver bad news about a progressive disease. Which communication sequence is most appropriate?

- A.** Assess understanding and information preferences, explain clearly, respond to emotion, and agree on next steps.
- B.** Provide all possible statistics at once and avoid discussing emotions until a later visit.
- C.** Use euphemisms exclusively so the patient never hears the name of the disease.
- D.** Ask the family to decide how much the patient may know even when the patient has capacity.
- E.** Give the prognosis immediately without assessing prior understanding or information preferences.

234. Near term, uterine contractions stimulate cervical stretch, which increases oxytocin release and further contractions. This is an example of what control mechanism?

- A.** Long-loop negative feedback from the placenta to the hypothalamus that terminates every contraction.
- B.** Positive feedback that amplifies the initiating stimulus until delivery interrupts the loop.
- C.** Negative feedback that suppresses oxytocin as cervical stretch increases.
- D.** A tonic endocrine set point in which oxytocin remains constant regardless of cervical input.
- E.** Feed-forward inhibition that prevents further uterine contractions once they begin.

235. A patient receives morphine for severe pain. Activation of mu-opioid receptors in the central nervous system has which cellular effect?

- A.** Gi-mediated reduction of cAMP with potassium efflux and reduced presynaptic calcium entry.

B. Gs-mediated increase in cAMP with opening of presynaptic calcium channels and increased transmitter release.

C. Inhibition of potassium channels with prolonged depolarization of dorsal horn neurons.

D. Gq-mediated phospholipase C activation with increased neuronal excitability as the principal analgesic mechanism.

E. Direct activation of voltage-gated sodium channels causing repetitive firing of nociceptive neurons.

236. A patient has impaired lysyl oxidase activity due to severe copper deficiency. Which collagen maturation step is reduced?

A. Translation of procollagen on free cytosolic ribosomes.

B. Cleavage of the signal peptide before collagen enters the endoplasmic reticulum.

C. Covalent cross-linking between collagen molecules in the extracellular matrix.

D. Assembly of procollagen triple helices exclusively within lysosomes.

E. Hydroxylation of proline residues within the rough endoplasmic reticulum.

237. A patient has impaired relaxation of the lower esophageal sphincter because inhibitory enteric neurons are lost. Which neurotransmitters normally mediate sphincter relaxation?

A. Acetylcholine and substance P, which are the dominant relaxant transmitters at the lower esophageal sphincter.

B. Nitric oxide and vasoactive intestinal peptide from inhibitory myenteric neurons.

C. Glutamate and GABA released from somatic motor neurons in the esophageal wall.

D. Gastrin and secretin released directly from the vagus nerve at the sphincter.

E. Norepinephrine and endothelin, which are the primary inhibitory transmitters in the myenteric plexus.

238. The thick ascending limb of the loop of Henle reabsorbs sodium, potassium, and chloride. Which feature is essential to its role in diluting tubular fluid?

A. It secretes large amounts of water into the lumen while retaining all sodium.

- B.** It is the only nephron segment that is freely permeable to plasma proteins.
- C.** It is highly permeable to water, so water follows every reabsorbed sodium ion.
- D.** It is relatively impermeable to water while actively reabsorbing solute.
- E.** It lacks active solute transport and depends only on passive urea diffusion.

239. A patient lacks complement component C3. Which immune function is most directly impaired?

- A.** Opsonization of microbes by C3b, reducing efficient phagocytosis.
- B.** Formation of histamine within mast cells, because C3 is the enzyme that synthesizes histamine.
- C.** Generation of immunoglobulin variable regions, because C3 mediates V(D)J recombination.
- D.** Presentation of peptide antigen on MHC class I, because C3 is required for intracellular peptide loading.
- E.** T-cell receptor signaling through CD3, because complement is the principal intracellular kinase pathway.

240. A patient has right-sided heart failure with elevated systemic venous pressure. Why does peripheral edema develop?

- A.** Elevated venous pressure raises capillary hydrostatic pressure, increasing filtration into tissues.
- B.** Venous hypertension reduces interstitial fluid volume by increasing lymphatic clearance without limit.
- C.** Right-sided failure directly raises plasma albumin concentration and therefore pushes fluid outward.
- D.** Elevated venous pressure lowers capillary hydrostatic pressure and increases reabsorption.
- E.** Increased right atrial pressure lowers systemic capillary pressure because veins are upstream from capillaries.

241. A healthy man has normal spermatogenesis. Which pituitary hormone acts primarily on Sertoli cells?

- A.** TSH, which regulates inhibin B production in seminiferous tubules.

- B.** ACTH, which stimulates Sertoli testosterone synthesis directly.
- C.** LH, whose only testicular target is the Sertoli cell.
- D.** Prolactin, which replaces FSH as the principal regulator of spermatogenesis.
- E.** FSH, supporting spermatogenesis and stimulating inhibin B production.

242. After several days at high altitude, ventilation increases further despite persistent respiratory alkalosis. Which renal adaptation facilitates this acclimatization?

- A.** Renal acid excretion stops completely so arterial pH becomes progressively more alkaline.
- B.** Increased bicarbonate retention raises cerebrospinal-fluid pH and stimulates further ventilation.
- C.** Aldosterone causes intracellular bicarbonate accumulation in carotid bodies and suppresses ventilation.
- D.** Increased bicarbonate excretion lowers plasma and cerebrospinal-fluid buffering, reducing alkalotic inhibition of ventilation.
- E.** The kidneys retain carbon dioxide in urine, directly raising alveolar oxygen tension.

243. A patient has damage to the hippocampus after prolonged hypoxia. Which function is most impaired?

- A.** Primary visual processing in the occipital cortex.
- B.** Generation of lower motor neuron action potentials in the spinal anterior horn.
- C.** Execution of learned motor skills mediated primarily by cerebellar and basal ganglia circuits.
- D.** Detection of sound frequency by hair cells in the cochlea.
- E.** Formation of new declarative memories from recent experiences.

244. A patient nods during a complex explanation but has a low health-literacy level. Which technique best checks understanding?

- A.** Give the patient a long consent form and assume that signing it demonstrates understanding.
- B.** Repeat the same technical explanation more loudly without changing wording.

- C. Ask only, 'Do you understand?' because a yes response confirms comprehension.
- D. Ask a family member whether the patient probably understood instead of speaking with the patient.
- E. Use teach-back by asking the patient to explain the plan in their own words.

245. A healthy adult begins resistance training. Early strength gains occur before substantial muscle hypertrophy. Which adaptation contributes most?

- A. Loss of inhibitory spinal circuits followed by permanent maximal motor-unit firing at rest.
- B. Immediate doubling of the number of muscle fibers through mitosis of mature myocytes.
- C. Rapid synthesis of new tendons that shortens muscle lever arms and reduces force requirements.
- D. Improved neural recruitment and synchronization of existing motor units.
- E. Conversion of all slow oxidative fibers into identical fast glycolytic fibers within days.

246. The descending thin limb of the loop of Henle enters the hypertonic renal medulla. What happens to tubular fluid?

- A. Protein secretion raises tubular oncotic pressure enough to pull water into the lumen.
- B. Water is actively secreted into the lumen, reducing tubular osmolality below plasma.
- C. Water leaves the tubule because this segment is water permeable, concentrating the tubular fluid.
- D. Sodium chloride is actively pumped out while the segment remains impermeable to water, diluting tubular fluid.
- E. Tubular fluid remains unchanged because the descending limb is impermeable to both water and solute.

247. A patient has a vagotomy. Which gastrointestinal function can still occur because it is generated largely by the enteric nervous system?

- A. All gastrointestinal motility ceases because the enteric nervous system cannot operate without vagal input.
- B. Parietal cells lose every mechanism for acid secretion because histamine and gastrin require an intact vagus.

- C. Pancreatic bicarbonate secretion becomes impossible because secretin acts only through the vagus.
- D. The colon becomes electrically silent because slow waves are generated exclusively by vagal motor neurons.
- E. Local peristaltic and secretory reflexes initiated by luminal distention or chemical stimuli.

248. Which pituitary hormone stimulates testosterone synthesis by Leydig cells?

- A. FSH acting on Leydig cells as the exclusive regulator of testosterone synthesis.
- B. Oxytocin acting on nuclear receptors in Leydig cells.
- C. LH acting on Gs-coupled receptors to promote steroidogenesis.
- D. TSH acting on LH receptors because the two hormones are physiologically interchangeable.
- E. Prolactin acting through a receptor tyrosine kinase as the main acute stimulus.

249. A patient has recurrent *Neisseria* infections due to a terminal complement deficiency. Which complement function is most impaired?

- A. Formation of the C5b-9 membrane attack complex that creates pores in target membranes.
- B. C3b-mediated opsonization of all bacteria, which requires only terminal complement proteins.
- C. Immunoglobulin class switching, which requires assembly of C5b-9 on B lymphocytes.
- D. Mast-cell histamine synthesis, which depends specifically on the C8 and C9 proteins.
- E. C1 inhibitor activity, which is generated by the terminal complement components.

250. A clinical study has low statistical power. Which change would most directly increase power while all other design features are preserved?

- A. Increase the sample size, reducing the chance of a type II error for a true effect.
- B. Use a more stringent alpha level while keeping the same sample size and effect size.
- C. Decrease the sample size so only the largest effects remain detectable.
- D. Remove outcome events after randomization to reduce the number of observations.

E. Increase measurement variability, which makes true group differences easier to detect.

251. A right-handed patient has a dominant-hemisphere lesion involving Broca area. Which language deficit is most likely?

- A. Fluent speech with severely impaired comprehension and poor content.
- B. Complete deafness with normal written and spoken language production.
- C. Normal spontaneous speech with isolated inability to recognize faces.
- D. Nonfluent, effortful speech with relatively preserved comprehension.
- E. Isolated loss of recent memory with fully fluent and comprehensible speech.

252. A patient loses 1.5 liters of blood after trauma. Before fluid replacement, which compensatory change supports venous return?

- A. Parasympathetic venodilation increases venous capacitance and central blood volume.
- B. Decreased catecholamine release increases ventricular contractility after blood loss.
- C. Suppression of the renin-angiotensin system increases sodium retention during hemorrhage.
- D. Arteriolar dilation in all organs reduces systemic resistance and restores pressure without changing venous return.
- E. Sympathetic venoconstriction reduces venous capacitance and mobilizes blood toward the heart.

253. A patient has severe hypoalbuminemia from liver disease. Which body-fluid change is most directly expected?

- A. Interstitial oncotic pressure falls below zero and forces water into capillaries.
- B. Extracellular volume cannot change because albumin affects only intracellular osmolality.
- C. Capillary filtration ceases because albumin is required for hydrostatic pressure.
- D. Increased plasma oncotic pressure draws fluid out of vessels and causes edema.
- E. Reduced plasma oncotic pressure favors movement of fluid from capillaries into the interstitium.

254. A patient is dehydrated and has high vasopressin levels. Which collecting-duct change increases water reabsorption?

- A.** Activation of Na-K-2Cl cotransporters in the collecting duct as the only vasopressin response.
- B.** Insertion of aquaporin-2 channels into the apical membrane of principal cells.
- C.** Closure of basolateral aquaporin channels so water cannot leave principal cells.
- D.** Insertion of epithelial sodium channels into intercalated cells as the direct water pathway.
- E.** Removal of aquaporin-2 channels from the apical membrane of principal cells.

255. A healthy man receives exogenous testosterone for several months. Which effect on endogenous gonadotropins is expected?

- A.** LH rises while FSH must remain unchanged because FSH is not subject to gonadal feedback.
- B.** LH and FSH fall because androgen and estrogen metabolites exert negative feedback on the hypothalamus and pituitary.
- C.** Both gonadotropins become independent of GnRH once circulating testosterone increases.
- D.** FSH rises because testosterone directly inhibits Sertoli cells and removes inhibin feedback.
- E.** LH and FSH rise because testosterone stimulates GnRH through positive feedback in adult men.

256. A previously sedentary person begins endurance training. Which chronic skeletal-muscle adaptation improves oxidative capacity?

- A.** Decreased ability to oxidize fatty acids because endurance training relies exclusively on glycogen.
- B.** Loss of myoglobin from slow-twitch fibers, improving oxygen release from blood.
- C.** Complete replacement of oxidative metabolism by anaerobic glycolysis during submaximal exercise.
- D.** Increased mitochondrial density and capillary supply within trained muscle.
- E.** Decreased mitochondrial enzymes and reduced capillary density to conserve oxygen.

257. A healthy 82-year-old stands quickly after lying supine. Compared with a healthy 25-year-old, the older adult has a larger transient fall in arterial pressure. Which normal age-related change most contributes to this response?

- A.** Enhanced beta-adrenergic responsiveness that produces excessive vasodilation during orthostasis.
- B.** A chronically increased circulating blood volume that causes greater venous pooling in the legs.
- C.** Increased carotid sinus sensitivity that produces excessive reflex tachycardia after standing.
- D.** Increased skeletal-muscle pump activity that lowers venous return during the first seconds of standing.
- E.** Reduced baroreflex sensitivity with a smaller reflex increase in heart rate and vascular tone.

258. A patient has an acute bacterial infection with marked neutrophilia. Which chemokine is a potent recruiter and activator of neutrophils?

- A.** Interleukin-4, which primarily drives neutrophil migration and oxidative burst in acute bacterial infection.
- B.** Interferon-alpha, which specifically attracts neutrophils through the C5a receptor.
- C.** Interleukin-8, which promotes neutrophil chemotaxis toward sites of inflammation.
- D.** Interleukin-10, which is the principal neutrophil chemoattractant released by endothelial cells.
- E.** Transforming growth factor-beta, which acutely recruits neutrophils as its dominant physiologic action.

259. A patient requests a nonindicated imaging study because a friend had a serious disease found incidentally. What is the best response?

- A.** Refuse all future screening because the patient asked about an unnecessary test.
- B.** Order the study because any patient-requested test is ethically required if it is technically available.
- C.** Dismiss the request without discussing the fear that prompted it.
- D.** Explore the concern, explain the expected benefits and harms of testing, and recommend against the study if the balance is unfavorable.

E. Tell the patient that incidental findings are always harmless and therefore no explanation is needed.

260. A patient has a dominant temporal-lobe lesion involving Wernicke area. Which finding is most likely?

- A.** Slow, nonfluent speech with good comprehension and intact repetition.
- B.** Isolated contralateral leg weakness with normal language function.
- C.** Loss of pupillary light reflexes with preserved speech and comprehension.
- D.** Complete inability to move the tongue due to bilateral hypoglossal injury.
- E.** Fluent speech with impaired comprehension and frequent paraphasic or meaningless content.

261. A patient drinks a large volume of water and suppresses vasopressin secretion. What happens in the collecting duct?

- A.** The medullary osmotic gradient reverses so urine becomes hypertonic despite low vasopressin.
- B.** Aquaporin-2 channels remain permanently inserted regardless of vasopressin concentration.
- C.** Sodium reabsorption in the proximal tubule stops completely because vasopressin is absent.
- D.** Apical water permeability falls, allowing excretion of a larger volume of dilute urine.
- E.** Apical water permeability rises, causing maximal water reabsorption and concentrated urine.

262. Interstitial cells of Cajal contribute to gastrointestinal motility by performing which function?

- A.** They produce gastric intrinsic factor and hydrochloric acid in response to vagal stimulation.
- B.** They form the epithelial barrier that actively absorbs glucose and amino acids.
- C.** They generate and propagate slow-wave electrical activity that sets the timing of smooth-muscle excitability.
- D.** They are the principal endocrine cells that secrete insulin after a meal.
- E.** They are the major phagocytic cells responsible for clearing luminal bacteria.

- 263.** Inhibin B produced by Sertoli cells provides feedback primarily on which pituitary hormone?
- A.** ACTH secretion is strongly suppressed while FSH is unchanged.
 - B.** LH secretion is the only gonadotropin suppressed by inhibin.
 - C.** Prolactin secretion is selectively suppressed during spermatogenesis.
 - D.** FSH secretion is selectively suppressed by inhibin.
 - E.** TSH secretion falls in proportion to inhibin B concentration.
- 264.** During dynamic exercise in a healthy adult, cardiac output rises substantially. Which combination of changes usually contributes?
- A.** Heart rate and stroke volume increase through sympathetic activation and enhanced venous return.
 - B.** Total peripheral resistance rises in every vascular bed because active skeletal muscle constricts.
 - C.** Heart rate falls while stroke volume falls because parasympathetic tone dominates exercise.
 - D.** Stroke volume becomes zero during peak exercise while tissue flow is maintained by diffusion alone.
 - E.** Venous return decreases because the skeletal-muscle pump traps blood in exercising limbs.
- 265.** A patient develops acute inflammation in a limb. Which local vascular sequence is typical?
- A.** Arteriolar constriction permanently stops blood flow and prevents leukocyte delivery.
 - B.** Capillary permeability decreases, trapping protein-rich fluid in plasma and causing tissue dehydration.
 - C.** Lymphatic flow ceases before any change in vascular tone, causing immediate ischemia.
 - D.** Arteriolar dilation increases blood flow, followed by increased microvascular permeability and protein-rich fluid extravasation.
 - E.** Venous pressure falls below atmospheric pressure and is the only cause of inflammatory swelling.

266. A person performs a maximal 6-second sprint. Which energy source provides ATP most rapidly at the start of the effort?

- A.** Beta-oxidation of long-chain fatty acids, which provides nearly all ATP in the first second.
- B.** Stored ATP and phosphocreatine, which buffer ATP during the first seconds of intense activity.
- C.** Hepatic gluconeogenesis, which is the fastest source of ATP within contracting muscle.
- D.** De novo mitochondrial biogenesis, which supplies ATP before glycolysis begins.
- E.** Ketone-body oxidation, which immediately replaces phosphocreatine in maximal sprinting.

267. A macrophage is activated by interferon-gamma during a cell-mediated immune response. Which lymphocyte population is an important source of this cytokine?

- A.** Plasma cells, which secrete interferon-gamma together with large amounts of antibody.
- B.** Neutrophils, which are the exclusive physiologic source of interferon-gamma.
- C.** T helper 2 cells only, which use interferon-gamma to promote IgE class switching.
- D.** T helper 1 cells and natural killer cells, which enhance macrophage microbicidal activity.
- E.** Regulatory T cells only, which use interferon-gamma as their main suppressive cytokine.

268. A patient with an upper motor neuron lesion develops increased deep-tendon reflexes weeks later. Which change contributes to the hyperreflexia?

- A.** Complete blockade of Ia afferent conduction reduces spinal motor-neuron firing.
- B.** Increased presynaptic inhibition of sensory afferents suppresses the stretch reflex.
- C.** Destruction of muscle spindles prevents detection of muscle stretch.
- D.** Loss of descending inhibitory influence increases excitability of spinal reflex circuits.
- E.** Loss of alpha motor neurons eliminates the efferent limb of the stretch reflex.

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

- A.** Closure of all apical potassium channels, producing obligatory potassium reabsorption.

- B.** Direct inhibition of the basolateral sodium-potassium ATPase, preventing sodium uptake.
- C.** Decreased epithelial sodium channel activity and reduced sodium reabsorption.
- D.** Increased bicarbonate secretion by principal cells as the major mechanism of potassium retention.
- E.** Increased epithelial sodium channel activity and increased potassium secretion into tubular fluid.

270. A man has an erection after parasympathetic stimulation. Which local mediator relaxes cavernosal smooth muscle?

- A.** Norepinephrine raises intracellular calcium and is the principal mediator of erection.
- B.** Acetylcholine acts only on nicotinic receptors of penile skeletal muscle and has no vascular role.
- C.** Thromboxane A₂ raises cGMP and increases cavernosal blood inflow.
- D.** Endothelin raises cAMP and relaxes cavernosal smooth muscle during parasympathetic stimulation.
- E.** Nitric oxide raises cGMP, decreasing intracellular calcium and promoting arterial dilation and venous trapping.

271. Investigators compare a new intervention with standard care but selectively enroll healthier patients into the intervention group. What type of problem threatens the study?

- A.** Recall bias because participants misremember past exposures after the outcome occurs.
- B.** Lead-time bias because earlier diagnosis appears to prolong survival without changing disease course.
- C.** Selection bias because group membership is related to baseline prognosis rather than determined comparably.
- D.** Length-time bias because screening preferentially detects slower diseases.
- E.** Observer bias only, because unequal baseline risk cannot be a selection problem.

272. A trainee notices that a colleague may be impaired while caring for patients. What principle should guide the trainee's response?

- A.** Confront the colleague publicly in front of patients before collecting any information.

- B.** Assume impairment is impossible unless a patient has already been seriously harmed.
- C.** Post the suspicion on social media so other clinicians can decide what to do.
- D.** Keep the concern secret because professional loyalty always overrides patient safety.
- E.** Protect patient safety by raising the concern through appropriate supervisory or institutional channels rather than ignoring it.

273. A patient receives a meal rich in protein. Gastrin release increases. Which cell secretes gastrin and where is it located predominantly?

- A.** Enterochromaffin-like cells in the fundus, which release gastrin directly onto parietal H₂ receptors.
- B.** D cells in the gastric body, which release gastrin in response to low pH.
- C.** S cells in the duodenum, which secrete gastrin in response to acid.
- D.** G cells in the gastric antrum and proximal duodenum.
- E.** I cells in the jejunum, which secrete gastrin in response to fatty acids.

274. A patient with septic shock has warm extremities early in the course. Which hemodynamic change is typical of this distributive state?

- A.** Plasma oncotic pressure rises abruptly and is the main cause of warm skin.
- B.** Venous return is always increased because sepsis raises effective circulating volume.
- C.** Cardiac output must be zero because peripheral vasodilation prevents any blood flow.
- D.** Systemic vascular resistance is markedly increased because all arterioles constrict uniformly.
- E.** Systemic vascular resistance is reduced because of widespread vasodilation.

275. A patient has generalized sympathetic activation during acute stress. Which metabolic effect supports rapid fuel availability?

- A.** Sympathetic activation drives glucose exclusively into adipose cells through GLUT4 without insulin.
- B.** Norepinephrine converts fatty acids directly into glycogen in skeletal muscle.

- C. Catecholamines promote glycogen breakdown and lipolysis, increasing circulating glucose and fatty acids.
- D. Epinephrine prevents hepatic glucose output by inhibiting glucagon release completely.
- E. Catecholamines suppress glycogenolysis and lipolysis to conserve all stored fuel.

276. During prolonged moderate exercise, muscle blood flow rises. Which local metabolite contributes to arteriolar dilation in active skeletal muscle?

- A. Increased endothelin release as the dominant local vasodilator during exercise.
- B. Reduced adenosine concentration caused by accelerated ATP synthesis in working fibers.
- C. Decreased nitric oxide production from endothelium exposed to increased shear stress.
- D. Decreased carbon dioxide and decreased hydrogen ion concentration in active muscle.
- E. Adenosine and increased extracellular potassium generated by metabolically active fibers.

277. A patient receives an ABO-incompatible red-cell transfusion and rapidly develops intravascular hemolysis. The preexisting antibodies responsible are usually of which class?

- A. Immunoglobulin D, which circulates at high concentration and fixes complement strongly.
- B. Immunoglobulin G4, which is the only antibody capable of binding ABO carbohydrate antigens.
- C. Immunoglobulin E, which directly lyses erythrocytes through Fc-epsilon receptors.
- D. Immunoglobulin M, which efficiently activates complement against incompatible erythrocytes.
- E. Immunoglobulin A, which is the dominant intravascular antibody against ABO antigens.

278. A patient has a lesion of a peripheral motor nerve causing denervation of a skeletal muscle. Which electrophysiologic change is expected in the affected muscle after denervation?

- A. Increased myelin thickness around the muscle fibers that restores neuromuscular transmission.
- B. Complete elimination of acetylcholine receptors from the muscle membrane.
- C. A sustained increase in normal motor-unit recruitment caused by intact alpha motor neurons.

D. Loss of all membrane excitability because skeletal muscle cannot generate action potentials without innervation.

E. Increased expression of extrajunctional acetylcholine receptors and spontaneous fibrillation activity.

279. A patient with hyperkalemia increases aldosterone secretion. How does this hormone help lower extracellular potassium?

A. It directly moves potassium from plasma into erythrocytes without any renal effect.

B. It blocks the sodium-potassium ATPase so intracellular potassium falls in principal cells.

C. It increases potassium reabsorption in the proximal tubule and prevents urinary potassium loss.

D. It increases potassium secretion by principal cells in the distal nephron.

E. It suppresses distal sodium delivery, eliminating the electrical gradient for potassium secretion.

280. Ejaculation is mediated primarily by which autonomic division?

A. Enteric autonomic neurons coordinate ejaculation independently of spinal sympathetic pathways.

B. Vagal efferents directly contract the prostate and seminal vesicles during ejaculation.

C. Parasympathetic outflow is solely responsible for emission and ejaculation.

D. Sympathetic outflow promotes emission and contraction of reproductive ducts and internal sphincters.

E. Somatic sensory fibers alone transport semen through the vas deferens.

Answers

1. A. Thyroid hormone exerts negative feedback at both hypothalamus and pituitary. Primary thyroid failure lowers T₄/T₃, so TRH and TSH tend to rise unless another process alters the axis.

2. B. Inspiratory muscle contraction enlarges the thorax and makes intrapleural pressure more negative. The lungs expand, alveolar pressure transiently falls below atmospheric pressure, and air flows inward down that pressure gradient.

- 3. E.** The rapid depolarizing phase of a neuronal action potential is caused by opening of voltage-gated sodium channels and inward sodium current. Delayed opening of voltage-gated potassium channels then repolarizes the membrane.
- 4. A.** Most oxygen in blood is carried bound to hemoglobin, not dissolved in plasma. Arterial oxygen content is therefore dominated by hemoglobin concentration and hemoglobin oxygen saturation, with only a small contribution from dissolved oxygen proportional to PaO₂.
- 5. B.** In skeletal muscle, T-tubule depolarization changes the conformation of dihydropyridine receptors, which are mechanically coupled to ryanodine receptors on the sarcoplasmic reticulum. Ryanodine receptor opening releases stored calcium into the cytosol for contraction.
- 6. D.** The Frank-Starling relationship links greater ventricular filling to stronger contraction at a given inotropic state. Increased end-diastolic fiber length improves myofilament interaction and calcium sensitivity, increasing stroke volume.
- 7. D.** Pyrogens raise the hypothalamic set point through prostaglandin E₂. The current body temperature is then perceived as too low, triggering vasoconstriction and shivering until core temperature approaches the higher set point.
- 8. B.** Cephalic-phase secretion is largely vagally mediated. Acetylcholine stimulates parietal and enterochromaffin-like cells, and vagal GRP stimulates gastrin release, together increasing gastric acid before food reaches the stomach.
- 9. E.** A capable adult has the right to accept or refuse recommended treatment after receiving relevant information and demonstrating understanding. The clinician should respect the decision, document informed refusal, and continue appropriate care within the patient's preferences.
- 10. D.** Sensitivity equals true positives divided by all people who actually have the disease. Here, $270/(270+30)=0.90$, or 90%.
- 11. E.** Autonomous TSH secretion drives thyroid hormone production despite negative feedback. The combination of high or inappropriately normal TSH with elevated thyroid hormone indicates central hyperthyroidism rather than normal feedback suppression.
- 12. A.** Fibrosis increases elastic recoil and reduces lung compliance. More distending pressure is therefore needed to achieve a given lung volume, increasing the work of breathing.
- 13. B.** During the absolute refractory period, most voltage-gated sodium channels are in the inactivated state. They cannot return to a closed, activatable state until repolarization occurs, so no second action potential can be generated regardless of stimulus strength.
- 14. B.** PaO₂ reflects dissolved oxygen tension and can be normal in anemia. Saturation can also be normal because the remaining hemoglobin is appropriately oxygenated. Total arterial oxygen content falls because the concentration of hemoglobin available to carry oxygen is reduced.

- 15. D.** Calcium binds troponin C on the thin filament. This alters the troponin-tropomyosin complex, exposing myosin-binding sites on actin and allowing ATP-dependent cross-bridge cycling.
- 16. C.** Greater afterload makes ejection more difficult, so the ventricle empties less completely on that beat. End-systolic volume rises and stroke volume and ejection fraction fall unless compensatory mechanisms increase contractility or preload.
- 17. C.** When the set point falls back toward normal, the elevated body temperature is sensed as too high. Cutaneous vasodilation and sweating increase heat loss until body temperature returns toward the new set point.
- 18. A.** The sodium-iodide symporter on the basolateral membrane uses the inward sodium gradient to concentrate iodide in thyroid follicular cells. Iodide then moves apically into colloid, including through pendrin.
- 19. E.** Gastric distention and protein digestion products stimulate vagal pathways and gastrin release. Gastrin and histamine increase parietal-cell acid secretion, whereas very low gastric pH eventually stimulates somatostatin and restrains gastrin.
- 20. E.** Loss of elastic tissue makes emphysematous lungs easier to inflate but less able to recoil during expiration. Reduced radial traction on small airways promotes dynamic collapse and air trapping.
- 21. A.** Myelin limits current leak by increasing membrane resistance and reduces the charge needed to change membrane voltage by decreasing capacitance. Depolarizing current therefore spreads farther and faster to the next node, where a new action potential is generated.
- 22. D.** Effective communication includes recognizing emotion, eliciting the patient's concerns and understanding, and then tailoring information. Acknowledgment and an open question create space for the patient's priorities and improve comprehension.
- 23. D.** Carbon monoxide binds hemoglobin with high affinity, reducing the number of sites available for oxygen. It also increases the oxygen affinity of the remaining sites, shifting the dissociation curve left and making tissue unloading more difficult. PaO₂ can remain normal because it measures dissolved oxygen.
- 24. A.** Lung expansion sharply lowers pulmonary vascular resistance, increasing pulmonary blood flow and pulmonary venous return to the left atrium. At the same time, loss of placental venous return lowers right-sided filling. The resulting left-to-right atrial pressure gradient presses the septum primum against the septum secundum and functionally closes the foramen ovale.
- 25. A.** ATP binding decreases myosin affinity for actin and causes cross-bridge detachment. ATP hydrolysis then cocks the myosin head, and subsequent phosphate release is associated with the power stroke.

- 26. C.** Thyroid peroxidase oxidizes iodide and attaches iodine to tyrosyl residues on thyroglobulin, then catalyzes coupling reactions that form T3 and T4 precursors. Later, thyroglobulin is endocytosed and proteolyzed to release hormone.
- 27. E.** Surfactant lowers surface tension at the alveolar air-liquid interface, with particularly important stabilization of small alveoli. Deficiency increases collapsing pressure, decreases compliance, and raises the work required to inflate the lungs.
- 28. D.** Positive inotropy increases the slope of the end-systolic pressure-volume relationship. At the same loading conditions, the ventricle ejects more completely, lowering end-systolic volume and increasing stroke volume and ejection fraction.
- 29. C.** Loss of isotonic extracellular fluid reduces extracellular volume without substantially changing its osmolality. Because there is little osmotic gradient across cell membranes, intracellular volume changes little initially.
- 30. C.** Voltage-gated sodium channels provide the inward current required for the regenerative upstroke of action potentials. Blocking these channels prevents propagation of impulses along the axon and thereby interrupts sensory transmission.
- 31. A.** Specificity equals true negatives divided by all people without disease. Here, $475/(475+25)=0.95$, or 95%.
- 32. E.** The Bohr effect describes reduced hemoglobin oxygen affinity in tissues with increased H⁺, CO₂, and temperature. This right shift promotes oxygen unloading where metabolic demand is high.
- 33. D.** Binding proteins provide a circulating reservoir and prolong hormone half-life, but only free hormone is readily available to enter tissues and exert biologic effects. Changes in binding proteins can alter total hormone concentrations while free hormone remains normal.
- 34. C.** Parietal-cell H₂ receptors are G_s coupled. Increased cAMP and protein kinase A signaling work synergistically with acetylcholine and gastrin pathways to activate the apical H/K ATPase and acid secretion.
- 35. C.** Detachment of myosin from actin requires ATP. After death, ATP becomes depleted while calcium leaks into the cytosol, so cross-bridges form but cannot detach, producing rigor mortis.
- 36. E.** For a spherical alveolus, collapsing pressure is proportional to twice the surface tension divided by radius. Without surfactant effects, smaller alveoli would therefore have higher collapsing pressures and tend to empty into larger alveoli.
- 37. E.** Qualified medical interpreters improve accuracy, confidentiality, and informed decision-making. The clinician should address the patient directly, pause for interpretation, and confirm understanding rather than delegating the clinical conversation to family members.

- 38. D.** Depolarization opens presynaptic voltage-gated calcium channels. The rise in intracellular calcium interacts with the vesicle fusion machinery and triggers exocytosis of neurotransmitter into the synaptic cleft.
- 39. A.** Isovolumetric contraction begins after the mitral valve closes and ends when ventricular pressure exceeds aortic pressure and the aortic valve opens. Because both valves are closed during this interval, volume remains constant while pressure rises.
- 40. C.** Steroid hormones are lipophilic and cross cell membranes. Cortisol binds an intracellular receptor, and the hormone-receptor complex regulates transcription through glucocorticoid response elements and protein interactions.
- 41. A.** Sweat is generally hypotonic relative to plasma, so losing sweat removes proportionally more water than solute from extracellular fluid. ECF volume falls and osmolality rises, causing water to shift from intracellular to extracellular space.
- 42. C.** Chronic hypoxemia increases erythrocyte 2,3-BPG. Binding of 2,3-BPG stabilizes deoxygenated adult hemoglobin, shifts the oxygen dissociation curve to the right, and facilitates tissue oxygen unloading.
- 43. A.** Obstructive disease limits expiratory flow, so FEV1 falls substantially while FVC may fall less. The FEV1/FVC ratio is therefore reduced, and air trapping can raise residual volume.
- 44. B.** Parietal-cell M3 receptors are Gq coupled. Phospholipase C activation raises IP3 and intracellular calcium, stimulating acid secretion and acting synergistically with histamine-driven cAMP signaling.
- 45. A.** Active force depends on the number of cross-bridges that can form. At very short sarcomere lengths, excessive thin-filament overlap and compression reduce effective cross-bridges; stretching toward optimal length improves overlap and increases active tension.
- 46. C.** Opening chloride channels generally drives or clamps membrane potential near the chloride equilibrium potential, which is near or below resting potential in mature neurons. This opposes depolarization and produces inhibitory postsynaptic effects.
- 47. B.** Stress increases hypothalamic CRH and pituitary ACTH, which stimulates cortisol synthesis in the zona fasciculata. Cortisol then exerts negative feedback on both CRH and ACTH.
- 48. A.** Ethical error disclosure is timely and transparent. Patients should be told the known facts, the consequences, what is being done to address the harm, and how recurrence will be reduced, with an appropriate expression of regret or apology.
- 49. C.** Positive predictive value depends on disease prevalence as well as test characteristics. When prevalence rises, a larger proportion of positive tests are true positives, so PPV typically increases while negative predictive value tends to decrease.

- 50. A.** Erythropoietin is produced mainly by renal interstitial cells in response to hypoxia and acts on erythroid progenitors in bone marrow. Mature erythrocytes lack nuclei and cannot divide, so the hormone must act earlier in the lineage.
- 51. C.** Restriction reduces lung volumes, including FVC and total lung capacity. FEV1 also falls but usually in proportion to or less than FVC, so the FEV1/FVC ratio is preserved or increased.
- 52. B.** Isovolumetric relaxation follows aortic valve closure. Ventricular pressure falls at constant end-systolic volume until it becomes lower than left atrial pressure, at which point the mitral valve opens and ventricular filling begins.
- 53. B.** Pure water lowers extracellular osmolality. Water distributes throughout total body water and moves into cells until osmolalities equilibrate, so both ECF and ICF expand while overall osmolality falls.
- 54. D.** Acetylcholine released from motor neurons binds nicotinic Nm receptors on skeletal muscle. These ligand-gated cation channels permit net inward positive current, generating an end-plate potential that triggers a muscle action potential.
- 55. E.** Exogenous glucocorticoids suppress hypothalamic CRH and pituitary ACTH. Prolonged low ACTH reduces trophic stimulation of the adrenal cortex, so endogenous cortisol production may not recover immediately when therapy is stopped.
- 56. B.** When a sarcomere is stretched beyond its optimal length, overlap between thick and thin filaments progressively decreases. Fewer cross-bridges can form, so active tension falls even as passive connective-tissue tension may increase.
- 57. E.** Duodenal S cells release secretin in response to acid. Secretin promotes bicarbonate-rich secretion from pancreatic ducts and biliary epithelium and helps reduce further gastric acid delivery.
- 58. B.** During forced expiration, positive pleural pressure can exceed pressure inside intrathoracic airways beyond the equal-pressure point and compress them. Emphysema reduces elastic recoil, moving the equal-pressure point toward smaller collapsible airways and worsening flow limitation.
- 59. C.** Renal peritubular interstitial cells sense reduced tissue oxygen availability through hypoxia-inducible pathways. Hypoxia increases erythropoietin production, which then stimulates marrow erythropoiesis.
- 60. D.** Flow through a narrowed aortic valve requires a larger pressure gradient. The left ventricle therefore generates high systolic pressure while the downstream aortic pressure is lower, increasing wall stress and promoting concentric hypertrophy.
- 61. A.** The zona glomerulosa produces aldosterone, regulated mainly by angiotensin II and extracellular potassium. ACTH has a smaller permissive or transient effect.

- 62. C.** Hypertonic sodium remains largely extracellular and increases ECF osmolality. Water shifts from cells into extracellular fluid until osmotic equilibrium is restored, expanding ECF and shrinking ICF.
- 63. D.** Acetylcholinesterase terminates signaling by hydrolyzing acetylcholine in the synaptic cleft. Inhibition increases the duration and amount of acetylcholine available to stimulate nicotinic receptors, although excessive exposure can later produce depolarization block.
- 64. D.** De-escalation begins with calm acknowledgment and empathic listening. Exploring the patient's specific concern and offering realistic next steps is more effective than defensiveness, dismissal, or promises that cannot be kept.
- 65. C.** With higher stimulation frequency, calcium is not fully resequestered between twitches. Successive mechanical responses summate, and at sufficiently high frequency the muscle reaches fused tetanus with greater sustained force.
- 66. B.** Alveolar ventilation equals respiratory rate multiplied by the portion of each tidal breath that reaches gas-exchanging alveoli. Here, $(500-150) \times 12 = 4200 \text{ mL/min}$, or 4.2 L/min.
- 67. D.** Fetal hemoglobin contains gamma rather than beta chains and binds 2,3-BPG less avidly. Its oxygen dissociation curve is therefore left-shifted relative to adult hemoglobin, allowing fetal blood to load oxygen from maternal blood across the placenta.
- 68. C.** Hepcidin binds ferroportin and promotes its internalization and degradation. Iron therefore becomes trapped in enterocytes and macrophages, lowering plasma iron availability for erythropoiesis despite preserved or increased iron stores.
- 69. A.** Elevated extracellular potassium directly depolarizes zona glomerulosa cells and stimulates aldosterone secretion. Aldosterone then enhances distal nephron potassium secretion and sodium reabsorption.
- 70. E.** Muscle spindles detect muscle length and rate of stretch. Their Ia afferents enter the spinal cord and make a direct excitatory connection with alpha motor neurons supplying the stretched muscle, producing the classic monosynaptic stretch reflex.
- 71. E.** CCK is released from I cells in response to fatty acids and amino acids. It stimulates pancreatic acinar enzyme secretion, contracts the gallbladder, relaxes the sphincter of Oddi, and slows gastric emptying.
- 72. D.** When prevalence is low, most tested individuals are disease-free, so negative results are more likely to be true negatives. Thus NPV increases as prevalence decreases, all else equal.
- 73. E.** An incompetent mitral valve allows systolic regurgitant flow from the high-pressure left ventricle into the left atrium. This produces a prominent systolic rise in left atrial pressure and a large v wave.

- 74. A.** Inflammatory injury increases endothelial permeability, allowing plasma proteins to escape into the interstitium. Plasma oncotic pressure falls locally, interstitial oncotic pressure rises, and fluid leaves the vasculature, producing edema and relative intravascular depletion.
- 75. D.** Minute ventilation is respiratory rate times tidal volume, but alveolar ventilation subtracts dead-space volume from each breath. Rapid shallow breathing can therefore maintain minute ventilation while reducing effective ventilation of gas-exchanging alveoli.
- 76. B.** The size principle describes orderly recruitment from small, low-threshold motor neurons to progressively larger motor units as force demand rises. This permits fine control at low force and reserves powerful fast units for higher loads.
- 77. B.** Glucose metabolism raises the ATP/ADP ratio in beta cells, closing ATP-sensitive potassium channels. Depolarization opens voltage-gated calcium channels, and the calcium rise triggers insulin granule exocytosis.
- 78. D.** Divalent metal transporter 1 participates in apical uptake of ferrous iron, whereas ferroportin exports iron across the basolateral membrane. In plasma, oxidized iron binds transferrin for transport.
- 79. D.** Valid informed consent requires voluntary agreement based on adequate information and understanding. When a patient expresses uncertainty, the clinician should clarify the patient's concerns, correct misunderstandings, discuss alternatives, and allow a voluntary decision.
- 80. C.** Golgi tendon organs lie in series with muscle fibers and detect tension. Group Ib afferents activate inhibitory spinal interneurons that reduce alpha motor neuron activity to the contracting muscle, providing autogenic inhibition.
- 81. A.** A ventilated but unperfused alveolus behaves like physiologic dead space. As regional perfusion approaches zero while ventilation remains, the V/Q ratio approaches infinity.
- 82. A.** The incretin hormones GIP and GLP-1 are released after nutrient ingestion and augment glucose-dependent insulin secretion. This explains why an oral glucose load produces a larger insulin response than an equivalent intravenous load.
- 83. B.** The insulin receptor is a receptor tyrosine kinase. Ligand binding activates intrinsic kinase activity and phosphorylation cascades involving insulin receptor substrates, PI3K, Akt, and other pathways.
- 84. C.** When higher pacemakers fail to drive the ventricles, subsidiary pacemakers can emerge. Junctional tissue generally has an intrinsic rate around 40-60 beats/min, faster than distal Purkinje or ventricular escape rhythms around 20-40 beats/min.
- 85. A.** Sepsis can cause heterogeneous microcirculatory flow, mitochondrial dysfunction, adrenergic stimulation, and regional oxygen-delivery mismatch. Lactate can therefore rise even when global arterial oxygen tension is normal.

- 86. B.** Fast glycolytic fibers generate high force and shorten rapidly because of high myosin ATPase and glycolytic capacity. They have fewer mitochondria and less myoglobin than oxidative fibers and fatigue relatively quickly.
- 87. B.** Isotonic saline expands the extracellular compartment, including plasma, without directly increasing red-cell mass. The ratio of red-cell volume to total blood volume therefore falls transiently, producing hemodilution and a lower hematocrit.
- 88. D.** Dorsal-column fibers ascend ipsilaterally in the spinal cord and cross in the caudal medulla after synapsing in gracile or cuneate nuclei. A right T10 dorsal-column lesion therefore impairs ipsilateral vibration, fine touch, and proprioception below the lesion.
- 89. A.** The positive likelihood ratio equals sensitivity divided by one minus specificity. It compares the probability of a positive result in diseased versus nondiseased individuals and is useful for converting pretest odds to post-test odds.
- 90. D.** Complete airway obstruction eliminates ventilation while perfusion may initially persist. The regional V/Q ratio therefore approaches zero, resembling a right-to-left shunt and producing poorly oxygenated blood leaving that unit.
- 91. C.** Insulin signaling promotes translocation of GLUT4 vesicles to the cell surface in skeletal muscle and adipose tissue, increasing facilitated diffusion of glucose into these cells.
- 92. D.** A competent patient controls disclosure of private medical information. The physician should clarify the patient's preferences and may share information only within the scope authorized, subject to limited legal or safety exceptions.
- 93. B.** Motilin rises cyclically during fasting and is associated with the migrating motor complex, which clears residual material from the stomach and small intestine between meals. Eating interrupts the cycle.
- 94. E.** Second-order spinothalamic neurons cross through the anterior white commissure within a few segments of entry. An anterolateral cord lesion therefore impairs pain and temperature predominantly on the contralateral side below the lesion.
- 95. A.** Poiseuille law states that flow is proportional to the fourth power of vessel radius when the pressure gradient, length, and viscosity are fixed. Doubling radius therefore increases flow by 2^4 , or sixteenfold.
- 96. A.** Slow oxidative fibers are specialized for endurance. Dense mitochondria, capillary supply, oxidative enzymes, and myoglobin support sustained aerobic ATP production and resistance to fatigue.
- 97. B.** Beta-1 receptors are G_s coupled and raise cAMP. In pacemaker cells, cAMP increases funny current and calcium-channel activity, making spontaneous diastolic depolarization steeper and threshold occur sooner.

- 98. E.** Hemorrhage lowers stressed vascular volume and mean systemic filling pressure, reducing the pressure gradient for venous return. Lower preload reduces stroke volume through the Frank-Starling relationship unless compensatory mechanisms restore filling.
- 99. E.** Glucagon acts mainly on liver through a Gs-coupled receptor that raises cAMP and protein kinase A activity. The response favors glycogen breakdown, gluconeogenesis, and ketogenesis while inhibiting glycolysis and glycogen synthesis.
- 100. C.** In a true right-to-left shunt, some blood reaches the systemic circulation without contacting ventilated alveoli. Raising inspired oxygen can oxygenate ventilated units but cannot directly oxygenate shunted blood, so the response is limited compared with many forms of V/Q mismatch.
- 101. E.** The pupillary light reflex uses retinal and optic nerve afferents that synapse in the pretectal area. Bilateral projections to the Edinger-Westphal nuclei explain simultaneous direct and consensual parasympathetic pupillary constriction.
- 102. C.** Poiseuille resistance is directly proportional to fluid viscosity. Higher hematocrit increases blood viscosity, increasing resistance and reducing flow for a given pressure gradient and vessel geometry.
- 103. D.** Respect for autonomy includes honoring a capable patient's stated preference to receive medical information. Family concerns can be explored compassionately, but they do not override the patient's choice to know his diagnosis.
- 104. D.** Falling glucose suppresses insulin and increases glucagon, with epinephrine also contributing importantly. Glucagon stimulates hepatic glycogenolysis and gluconeogenesis to restore plasma glucose.
- 105. B.** In an isometric contraction, muscle develops tension without appreciable change in overall length because the external load prevents shortening. Cross-bridge cycling and internal shortening can still occur within elastic components.
- 106. A.** Fick's law states that diffusion increases with surface area, partial-pressure gradient, and a diffusion coefficient related to solubility divided by the square root of molecular weight. Thickening the membrane or reducing surface area impairs transfer.
- 107. E.** Acetylcholine acting at M2 receptors increases potassium conductance and lowers cAMP. Pacemaker cells become more negative and spontaneous phase 4 depolarization slows, reducing heart rate.
- 108. C.** Low effective arterial pressure activates sympathetic outflow and the renin-angiotensin system. Arteriolar vasoconstriction helps preserve pressure and redistribute flow, although it also increases afterload.
- 109. B.** Fat in the duodenum releases CCK and activates enterogastric neural reflexes. These signals slow gastric emptying so the small intestine receives nutrients at a rate appropriate for digestion and absorption.

- 110. D.** Absolute risk reduction is control event rate minus treatment event rate. Here, $0.20 - 0.10 = 0.10$, or 10 percentage points.
- 111. C.** Accommodation for near vision is parasympathetically mediated. Ciliary muscle contraction decreases tension on the zonular fibers, allowing the elastic lens to round up and increase its refractive power.
- 112. B.** Growth hormone directly alters metabolism but many effects on linear growth and tissue growth are mediated by IGF-1, produced in liver and locally in tissues. IGF-1 also feeds back on the growth hormone axis.
- 113. C.** Exercise raises cardiac output and shortens the time red cells spend in pulmonary capillaries. In healthy lungs equilibration is rapid, but a thickened diffusion barrier may prevent complete oxygen equilibration during the shorter transit interval.
- 114. B.** Von Willebrand factor binds exposed subendothelial collagen and platelet glycoprotein Ib, providing the key bridge for platelet adhesion. Glycoprotein IIb/IIIa is more important for platelet aggregation through fibrinogen bridging.
- 115. E.** During eccentric contraction, the external load exceeds the shortening tendency of the activated muscle, so the muscle lengthens while producing force. Eccentric contractions can generate high forces with relatively low energy cost.
- 116. B.** Pubertal activation of the hypothalamic-pituitary-gonadal axis begins with increased pulsatile GnRH secretion. Pulsatility is essential because continuous GnRH exposure downregulates pituitary GnRH receptors, whereas physiologic pulses stimulate LH and FSH release.
- 117. B.** The ventricular plateau reflects prolonged calcium entry through L-type channels opposed by outward potassium currents. This long action potential and refractory period help prevent tetanic contraction of cardiac muscle.
- 118. C.** Anaphylaxis releases mediators that cause widespread vasodilation and capillary leak. Reduced systemic vascular resistance and movement of plasma into the interstitium decrease effective circulating volume and venous return.
- 119. D.** IGF-1 participates in negative feedback by suppressing somatotroph secretion and influencing hypothalamic GHRH and somatostatin signaling. Growth hormone itself also exerts short-loop feedback.
- 120. C.** In conductive hearing loss, air conduction is impaired while bone conduction bypasses the external and middle ear. Rinne testing may therefore show bone conduction greater than air conduction on the affected side, and Weber testing tends to lateralize to that ear.

- 121. B.** Capacity is decision-specific and based on functional abilities: understanding, appreciation, reasoning, and communication of a stable choice. A diagnosis or unusual decision alone does not establish incapacity.
- 122. B.** Dissolved oxygen content follows Henry's law and rises linearly with PaO₂. Hemoglobin-bound oxygen dominates total content, but once hemoglobin is near fully saturated, additional PaO₂ mainly increases the small dissolved fraction.
- 123. D.** Pancreatic lipase is the major enzyme digesting dietary triglycerides into absorbable fatty acids and monoglycerides. Bile salts then facilitate micelle formation and delivery to the enterocyte surface.
- 124. D.** Platelet activation increases surface expression and affinity of glycoprotein IIb/IIIa. Fibrinogen binds these receptors on neighboring platelets and forms bridges that mediate platelet aggregation.
- 125. A.** Smooth muscle lacks troponin-based regulation. Cytosolic calcium binds calmodulin, and the calcium-calmodulin complex activates myosin light-chain kinase, which phosphorylates myosin and permits cross-bridge cycling.
- 126. B.** Parathyroid chief cells express calcium-sensing receptors. Low extracellular calcium reduces receptor signaling and increases PTH secretion, which raises serum calcium through renal, skeletal, and vitamin D-dependent intestinal effects.
- 127. B.** With unilateral sensorineural loss, both air- and bone-conducted perception are reduced on the affected side. The Weber test therefore lateralizes to the better-hearing, unaffected ear.
- 128. A.** At steady state, PaCO₂ is inversely proportional to alveolar ventilation for a given rate of CO₂ production. Hypoventilation therefore causes hypercapnia, whereas hyperventilation lowers PaCO₂.
- 129. A.** In atrial and ventricular working myocytes and Purkinje fibers, phase 0 is generated by rapid opening of fast voltage-gated sodium channels. Nodal cells differ because their phase 0 depends mainly on calcium entry.
- 130. E.** Exercise increases cardiac output through higher heart rate and stroke volume. Local metabolic vasodilation markedly increases perfusion of active muscle, while ventilation and oxygen extraction also rise to support oxygen delivery and use.
- 131. B.** NNT equals 1/absolute risk reduction when ARR is expressed as a proportion. An ARR of 0.10 gives an NNT of 10.
- 132. C.** Factor VIII functions in the intrinsic pathway with factor IX to activate factor X. Deficiency therefore prolongs the aPTT, whereas PT is usually normal and platelet number and primary hemostatic function are not directly affected.

133. B. PTH conserves calcium, promotes phosphate excretion, and stimulates renal 1-alpha-hydroxylase to increase calcitriol. These effects raise extracellular calcium while preventing excessive calcium-phosphate precipitation.

134. C. Advance directives extend patient autonomy into periods of incapacity. When valid and applicable, documented preferences should guide care, with surrogates helping interpret the patient's goals when needed.

135. B. Bile salts are amphipathic molecules that emulsify fat and form mixed micelles containing fatty acids, monoglycerides, cholesterol, and fat-soluble vitamins. Micelles deliver these hydrophobic products across the unstirred layer to the enterocyte membrane.

136. E. In vascular smooth muscle, increased cAMP activates protein kinase A, which inhibits myosin light-chain kinase and can lower intracellular calcium. Reduced myosin light-chain phosphorylation favors relaxation.

137. E. The vestibulo-ocular reflex generates compensatory eye movement equal and opposite to head movement, stabilizing images on the retina. Leftward head rotation therefore drives an initial slow-phase eye movement to the right.

138. C. Hyperventilation lowers PaCO₂, shifting the carbonic acid equilibrium and reducing hydrogen ion concentration. This produces acute respiratory alkalosis before renal compensation develops.

139. B. AV nodal tissue conducts slowly because cells are small, have fewer gap junctions, and rely on slower calcium-dependent phase 0 depolarization. The delay permits additional ventricular filling before ventricular systole.

140. D. Vitamin K is required for gamma-carboxylation of glutamate residues on factors II, VII, IX, X and proteins C and S. This modification permits calcium-dependent binding to phospholipid surfaces during coagulation.

141. B. Calcitonin can inhibit osteoclast-mediated bone resorption and lower serum calcium modestly. In adults, it is less important for day-to-day calcium homeostasis than PTH and vitamin D.

142. A. Sweating lowers plasma volume and can reduce central venous pressure and ventricular filling. Stroke volume falls, and heart rate may drift upward to maintain cardiac output while skin and muscle compete for blood flow.

143. B. Hypoventilation raises PaCO₂, increasing carbonic acid and hydrogen ion concentration and lowering pH. Acute respiratory acidosis precedes the slower renal increase in bicarbonate reabsorption and generation.

144. B. Postural control integrates visual, vestibular, and somatosensory proprioceptive information. Closing the eyes removes visual input, but vestibular organs and proprioceptors continue to signal head movement and body position.

- 145. A.** Osteoclasts attach to bone surfaces and create an acidic sealed compartment that dissolves hydroxyapatite while proteases degrade organic matrix. Osteoblast-lineage cells regulate osteoclast formation through RANKL and also synthesize new bone matrix.
- 146. D.** Most bile salts are actively reabsorbed in the terminal ileum and returned to the liver through portal blood. Extensive ileal loss can deplete the bile salt pool and impair micelle formation and fat absorption.
- 147. A.** When an incapacitated patient's preferences are known or can reasonably be inferred, the surrogate should use substituted judgment. If preferences are unknown, decisions should generally use the patient's best interests.
- 148. D.** Central diabetes insipidus results from deficient synthesis or release of vasopressin. The kidney can respond to administered vasopressin or desmopressin by inserting aquaporin-2 channels and concentrating urine.
- 149. E.** Endothelial thrombomodulin changes thrombin substrate specificity so that thrombin activates protein C. Activated protein C, aided by protein S, proteolytically inactivates factors Va and VIIIa and limits further thrombin generation.
- 150. D.** Relative risk compares the incidence proportion among exposed people with the incidence proportion among unexposed people. It is directly estimable in cohort studies where the denominators at risk are known.
- 151. C.** Coronary flow is closely coupled to myocardial metabolic demand. Increased ATP breakdown and oxygen consumption generate vasodilator signals, including adenosine, that overcome sympathetic vasoconstrictor effects and increase perfusion.
- 152. D.** Early fasting uses hepatic glycogen to support glucose. As glycogen is depleted, gluconeogenesis from lactate, glycerol, and glucogenic amino acids becomes increasingly important while insulin falls and glucagon rises.
- 153. D.** If a substance is freely filtered and then neither reabsorbed nor secreted, the amount excreted equals the filtered load. Its clearance therefore equals GFR, as approximated clinically by creatinine and measured more ideally by inulin.
- 154. B.** Cerebral blood flow is highly sensitive to PaCO_2 . Acute hypocapnia raises perivascular pH and causes cerebral vasoconstriction, reducing cerebral blood flow; hypercapnia has the opposite effect.
- 155. E.** In nephrogenic diabetes insipidus, vasopressin production may be normal or high but the kidney cannot respond appropriately. Desmopressin therefore produces little increase in urine osmolality compared with central diabetes insipidus.

- 156. B.** PTH receptors are expressed on osteoblast-lineage cells. Sustained PTH signaling increases RANKL relative to osteoprotegerin, promoting differentiation and activation of osteoclasts and increasing bone resorption.
- 157. A.** Tissue plasminogen activator converts plasminogen to plasmin. Plasmin degrades fibrin and produces fibrin degradation products, providing the major enzymatic mechanism for physiologic clot dissolution.
- 158. B.** Intrinsic factor binds vitamin B12 after it is released from dietary proteins and pancreatic enzymes remove R proteins. The complex is absorbed by specific receptors in the terminal ileum.
- 159. D.** A substance such as para-aminohippurate is filtered and secreted so efficiently at low concentrations that nearly all arriving plasma is cleared of it. Its clearance therefore approximates effective renal plasma flow.
- 160. B.** Neonates have relatively low renal blood flow and high renal vascular resistance, so GFR is lower than in older children and adults. GFR rises over the first months of life as renal perfusion increases and nephron function matures.
- 161. A.** The adult skull is a fixed-volume compartment containing brain, blood, and CSF. Early volume increases can be buffered, but after compensatory mechanisms are exhausted, intracranial compliance falls and small additional volume increases cause large rises in intracranial pressure.
- 162. B.** Good communication combines evidence-based care with respect for the patient's concern. Explaining the reasoning, potential harms, expected course, and a concrete symptom-management plan supports trust without providing unnecessary treatment.
- 163. A.** Excess vasopressin raises collecting-duct water permeability and retains relatively solute-free water. This lowers plasma osmolality and sodium concentration; secondary natriuresis may limit volume expansion.
- 164. D.** During left ventricular systole, high intramyocardial pressure compresses coronary vessels, especially in the subendocardium. Flow therefore occurs predominantly during diastole when myocardial compression is relieved while aortic pressure remains sufficient to drive perfusion.
- 165. A.** Prolonged fasting increases hepatic beta-oxidation and ketogenesis. As the brain adapts to ketones, its glucose demand falls, reducing the need to catabolize muscle protein for gluconeogenic substrates.
- 166. B.** Osteoprotegerin is a soluble decoy receptor produced by osteoblast-lineage cells. It binds RANKL and prevents RANK activation on osteoclast precursors, thereby suppressing osteoclast differentiation and bone resorption.

- 167. A.** The phagocyte respiratory burst begins when NADPH oxidase transfers electrons to oxygen, producing superoxide. Downstream reactions form hydrogen peroxide and, through myeloperoxidase, hypochlorous acid used for microbial killing.
- 168. E.** Filtration fraction is GFR/RPF . Here, $120/600 = 0.20$, or 20%.
- 169. C.** Unlike most anterior pituitary hormones, prolactin is tonically inhibited by hypothalamic dopamine. Interruption of the pituitary stalk reduces dopamine delivery and therefore tends to raise prolactin while reducing many other hypothalamic stimulatory signals.
- 170. D.** CSF formation depends on active secretion of ions, especially sodium, chloride, and bicarbonate, by choroid plexus epithelial cells. Water follows osmotically, producing a low-protein fluid distinct from plasma.
- 171. C.** Case-control studies begin with cases and controls rather than a defined at-risk cohort, so incidence and risk cannot usually be measured directly. The odds ratio compares exposure odds and approximates relative risk when disease is uncommon.
- 172. A.** Apical SGLT1 uses the inward sodium electrochemical gradient to cotransport glucose and galactose into enterocytes. Basolateral GLUT2 then allows facilitated diffusion into the portal circulation.
- 173. E.** A fall in arterial stretch decreases carotid and aortic baroreceptor firing to the medulla. The reflex response is increased sympathetic and decreased parasympathetic activity, raising heart rate, contractility, arteriolar resistance, and venous tone.
- 174. E.** Insulin deficiency and relative glucagon excess activate adipose lipolysis and deliver fatty acids to the liver. Low malonyl-CoA permits mitochondrial fatty-acid entry, producing acetyl-CoA that is diverted toward ketone-body synthesis.
- 175. A.** Renal 1- α -hydroxylase converts 25-hydroxyvitamin D to 1,25-dihydroxyvitamin D. Calcitriol binds an intracellular nuclear receptor and increases transcription of proteins that support intestinal calcium and phosphate absorption.
- 176. B.** Afferent constriction reduces blood flow into the glomerulus and lowers glomerular capillary hydrostatic pressure. Both renal blood flow and GFR therefore fall.
- 177. A.** Suckling triggers a neuroendocrine reflex that increases oxytocin release from posterior pituitary nerve terminals. Oxytocin contracts myoepithelial cells and causes milk let-down; prolactin mainly supports milk production.
- 178. C.** Screening for intimate partner violence should occur privately and with a nonjudgmental, trauma-informed approach. The clinician should assess immediate safety, provide support and resources, and follow applicable mandatory-reporting laws without coercing a capable adult.

- 179. A.** Myeloperoxidase uses hydrogen peroxide and chloride to generate hypochlorous acid. This highly reactive oxidant contributes to killing of ingested microorganisms within the phagolysosome.
- 180. D.** REM sleep resembles wakefulness on EEG, with low-amplitude mixed-frequency activity, but is accompanied by rapid eye movements and profound skeletal muscle atonia. Autonomic activity is variable, and vivid dreaming is common.
- 181. B.** Moderate efferent constriction raises pressure within glomerular capillaries while reducing renal plasma flow, often increasing GFR and filtration fraction. Severe constriction can ultimately reduce GFR as plasma oncotic pressure rises markedly and renal flow falls.
- 182. C.** Suckling reduces tonic dopaminergic inhibition of lactotrophs and promotes prolactin secretion, supporting milk synthesis. The same stimulus also promotes oxytocin release for milk ejection.
- 183. B.** Many secretory diarrheas leave SGLT1-mediated sodium-glucose absorption intact. Coupled sodium and glucose uptake promotes net solute absorption, and water follows osmotically, which is the physiologic basis of oral rehydration therapy.
- 184. C.** Arterial baroreceptors are stretch receptors. Increased pressure raises afferent firing, which increases parasympathetic and decreases sympathetic activity, tending to lower heart rate, contractility, and vascular resistance.
- 185. A.** Lower gastrointestinal secretions contain bicarbonate. Loss of bicarbonate lowers plasma bicarbonate, and chloride is retained to maintain electroneutrality, producing a hyperchloremic normal-anion-gap metabolic acidosis.
- 186. D.** Heat stress activates thermoregulatory pathways that increase eccrine sweating and skin blood flow. Human eccrine glands are unusual because they are innervated by sympathetic postganglionic fibers that release acetylcholine.
- 187. C.** Stage N2 is defined by sleep spindles and K complexes. N3 is slow-wave sleep with delta activity, while REM has low-amplitude mixed-frequency activity and muscle atonia.
- 188. C.** CD4-positive T cells recognize peptide bound to MHC class II, which is expressed on professional antigen-presenting cells such as dendritic cells, macrophages, and B cells. MHC class I primarily presents endogenous peptides to CD8-positive T cells.
- 189. B.** Motivational interviewing uses open questions, reflective listening, and exploration of ambivalence to elicit the patient's own reasons for change. It avoids confrontation and supports autonomy and achievable goals.
- 190. E.** Precision refers to reproducibility or low random variation, whereas accuracy refers to closeness to the true value. A consistent offset produces high precision but poor accuracy due to systematic error.

- 191. B.** The two-cell, two-gonadotropin model assigns LH-driven androgen synthesis mainly to theca cells and FSH-driven aromatase activity to granulosa cells. Granulosa cells convert theca androgens to estradiol.
- 192. D.** With severe efferent constriction, renal plasma flow can fall substantially. Protein becomes concentrated rapidly along the glomerular capillary, increasing opposing oncotic pressure and reducing net filtration enough that GFR can decline.
- 193. C.** Dopamine promotes movement by stimulating D1 receptors in the direct pathway and inhibiting D2 receptors in the indirect pathway. Dopamine loss therefore shifts basal ganglia output toward greater thalamic inhibition and reduced movement.
- 194. E.** MHC class I is expressed by nearly all nucleated cells and presents peptides generated from intracellular proteins. CD8-positive cytotoxic T cells recognize these peptide-MHC I complexes and can kill infected target cells.
- 195. D.** Cold exposure increases sympathetic vasoconstrictor tone to skin, reducing cutaneous blood flow and conductive-convective heat transfer from the core to the surface. This conserves core temperature.
- 196. E.** Arterioles are the major resistance vessels in the systemic circulation. Constriction decreases their radius and increases total peripheral resistance, increasing the pressure gradient required to maintain flow.
- 197. D.** Loss of hydrochloric acid removes hydrogen from the body and raises plasma bicarbonate relative to chloride. Volume and chloride depletion then enhance renal bicarbonate retention and distal hydrogen secretion, sustaining the alkalosis.
- 198. A.** Most of the cycle is governed by negative feedback, but sustained high estradiol late in the follicular phase switches to positive feedback at the hypothalamus and pituitary. The resulting LH surge initiates ovulation and luteinization.
- 199. D.** When lactose is not hydrolyzed, it remains osmotically active in the lumen and is also fermented by colonic bacteria. Water retention causes osmotic diarrhea, often with gas and bloating.
- 200. D.** High NaCl delivery to the macula densa signals excessive filtration or insufficient proximal reabsorption. Adenosine-related signaling constricts the afferent arteriole and suppresses renin, reducing glomerular pressure and GFR.
- 201. E.** Cerebellar hemispheres coordinate ipsilateral limb movements. Lesions cause ipsilateral dysmetria, intention tremor, decomposition of movement, and other signs of incoordination rather than primary weakness.

- 202. A.** Shared decision-making combines medical expertise with patient values. A physician may make a recommendation, but it should be grounded in the patient's goals and accompanied by transparent discussion of reasonable alternatives and tradeoffs.
- 203. A.** Class-switch recombination changes the heavy-chain constant region, such as switching from IgM to IgG, while retaining the same variable-region antigen specificity. Somatic hypermutation instead introduces point mutations in variable regions to permit affinity maturation.
- 204. B.** LH transforms the ruptured follicle into the corpus luteum. Luteal cells secrete progesterone, estrogen, and inhibin, preparing and stabilizing the endometrium for possible implantation.
- 205. B.** Fibroblasts proliferate and migrate into the wound under the influence of growth factors, producing collagen and other extracellular matrix. Early collagen is remodeled over time, increasing tensile strength but never restoring it fully to uninjured skin.
- 206. A.** Juxtaglomerular cells increase renin in response to reduced afferent arteriolar stretch, beta-1 sympathetic stimulation, and low macula densa NaCl delivery. The renin-angiotensin-aldosterone system supports pressure and extracellular volume.
- 207. C.** Regional flow is approximately the pressure gradient divided by vascular resistance. At a given arterial and venous pressure, arteriolar dilation lowers resistance and therefore increases flow.
- 208. E.** Metabolic acidosis stimulates peripheral and central respiratory control to increase ventilation. Lower PaCO₂ reduces carbonic acid and limits the fall in pH, although respiratory compensation cannot fully normalize pH while the primary metabolic process persists.
- 209. C.** Large arteries stiffen with age because of structural changes in elastin and collagen. A less compliant aorta expands less for a given stroke volume, producing a larger systolic pressure rise and a wider pulse pressure.
- 210. B.** Increased extracellular osmolality causes hypothalamic osmoreceptor cells to shrink and increases their firing. This stimulates thirst and vasopressin release, promoting water intake and renal water conservation.
- 211. A.** Aldosterone increases sodium reabsorption in the distal colon, similar to its effects in principal cells of the kidney. Enhanced sodium absorption can increase the electrical and chemical driving forces for potassium secretion.
- 212. E.** For a normal distribution, roughly 68% of observations lie within one standard deviation, 95% within two, and 99.7% within three. The interval 80-120 is mean $\pm$ 2 SD.
- 213. B.** Without embryonic hCG, the corpus luteum involutes and progesterone and estrogen fall. Withdrawal of steroid support promotes prostaglandin-mediated vascular changes and breakdown of the functional endometrial layer, producing menstruation.

- 214. E.** Activation-induced cytidine deaminase promotes point mutations in immunoglobulin variable regions in germinal-center B cells. Clones with higher-affinity receptors receive preferential survival signals, producing affinity maturation.
- 215. E.** Glucose is freely filtered and normally almost completely reabsorbed in the proximal tubule by apical sodium-glucose cotransporters and basolateral GLUT transporters. Glucosuria appears when filtered load exceeds transport capacity.
- 216. B.** During remodeling, collagen is reorganized, degraded, resynthesized, and increasingly cross-linked. These changes raise tensile strength over months, although a mature scar remains mechanically weaker than uninjured skin.
- 217. A.** Silence and explicit acknowledgment can communicate empathy and allow patients to process difficult news. The clinician can then assess understanding and preferences for how much information to receive at that time.
- 218. C.** Nociceptive afferents activate spinal interneuronal circuits that excite ipsilateral flexor motor neurons and inhibit extensors, producing withdrawal before cortical pain perception is complete. The reflex is polysynaptic and can be accompanied by a crossed-extensor response in the opposite limb.
- 219. A.** Plasma proteins, especially albumin, generate capillary oncotic pressure that favors fluid reabsorption. Hypoalbuminemia reduces this inward force, increasing net filtration and predisposing to edema when lymphatic return is exceeded.
- 220. D.** Syncytiotrophoblast secretes hCG, which acts on LH receptors and maintains corpus luteum progesterone production during early pregnancy. Later, the placenta becomes the major source of progesterone and estrogen.
- 221. D.** Chronic respiratory acidosis increases renal acid excretion, ammoniagenesis, and bicarbonate reabsorption/generation. The resulting rise in plasma bicarbonate partially offsets the effect of sustained high PaCO₂ on pH.
- 222. A.** IgG is the major immunoglobulin class actively transported across the placenta, providing passive systemic immunity to the fetus and newborn. Secretory IgA is instead supplied after birth mainly through breast milk and protects mucosal surfaces.
- 223. B.** The filtered load equals GFR times plasma glucose concentration. Once this load exceeds the transport maximum of proximal tubular glucose carriers, not all filtered glucose can be reabsorbed and glucosuria results.
- 224. A.** Swallowing initiates an organized peristaltic wave that propagates distally, while inhibitory enteric signaling relaxes downstream smooth muscle and the lower esophageal sphincter. This pattern propels the bolus toward the stomach.

- 225. B.** Vitamin C is required for hydroxylation of proline and lysine residues in procollagen. Hydroxyproline stabilizes the triple helix, and hydroxylysine participates in glycosylation and cross-linking; deficiency weakens connective tissue.
- 226. E.** Progesterone supports pregnancy by maintaining the endometrium and limiting myometrial excitability. Near term, changes in estrogen/progesterone signaling, prostaglandins, gap junctions, and oxytocin responsiveness favor labor.
- 227. C.** A-delta fibers are thinly myelinated and conduct relatively rapidly, producing the first, sharp component of pain. Unmyelinated C fibers conduct more slowly and contribute to delayed, dull, burning pain.
- 228. B.** The standard error quantifies uncertainty in the estimated mean and equals $SD/\sqrt{n}$. Increasing sample size narrows the sampling distribution and usually narrows confidence intervals.
- 229. E.** Arteriolar dilation transmits more arterial pressure to downstream capillaries, increasing capillary hydrostatic pressure. This favors filtration, especially if venous pressure or permeability is also increased.
- 230. E.** The proximal tubule reabsorbs roughly two thirds of filtered sodium and water along with most bicarbonate, glucose, and amino acids. Water follows solute readily, so tubular fluid remains approximately iso-osmotic.
- 231. C.** Low arterial oxygen stimulates carotid bodies and increases ventilation. Acute hyperventilation raises alveolar oxygen but lowers $PaCO_2$ and produces respiratory alkalosis, which initially limits further ventilatory drive.
- 232. D.** Secretory IgA is abundant in breast milk and mucosal secretions. Its secretory component protects it from proteolysis, allowing it to bind microbes and toxins at mucosal surfaces without provoking strong inflammation.
- 233. A.** Structured bad-news communication begins by assessing understanding and preferences, then sharing information clearly, checking comprehension, responding empathically, and creating a plan. This approach supports both autonomy and emotional processing.
- 234. B.** The Ferguson reflex is a classic positive-feedback loop. Cervical stretch increases oxytocin release, oxytocin strengthens uterine contractions, and stronger contractions increase cervical stretch until delivery ends the stimulus.
- 235. A.** Mu-opioid receptors are G_i -coupled. Their activation reduces adenylyl cyclase activity, opens potassium channels postsynaptically, and inhibits voltage-gated calcium channels presynaptically, decreasing neuronal excitability and neurotransmitter release.

- 236. C.** Lysyl oxidase is a copper-dependent extracellular enzyme that oxidatively deaminates lysine and hydroxylysine residues, enabling covalent cross-links between collagen molecules. Cross-linking increases tensile strength.
- 237. B.** Inhibitory myenteric neurons release nitric oxide and VIP to relax gastrointestinal smooth muscle, including the lower esophageal sphincter during swallowing. Loss of these neurons causes impaired relaxation and functional obstruction.
- 238. D.** The thick ascending limb actively reabsorbs NaCl through NKCC2 but is relatively impermeable to water. Solute leaves without water, diluting tubular fluid and contributing to the hypertonic medullary interstitium.
- 239. A.** C3 is central to all major complement pathways. Cleavage produces C3b, an important opsonin that coats microbial surfaces and promotes phagocytosis through complement receptors; C3 cleavage products also contribute to inflammation and downstream membrane attack complex formation.
- 240. A.** Systemic venous hypertension raises pressure at the venous end of capillaries and reduces the normal decline in capillary hydrostatic pressure. Net filtration increases, contributing to dependent peripheral edema.
- 241. E.** FSH acts on Sertoli cells to support germ-cell development and produce proteins such as androgen-binding protein and inhibin B. LH mainly stimulates Leydig cells to synthesize testosterone.
- 242. D.** Renal bicarbonate excretion compensates for altitude-induced respiratory alkalosis. As pH moves back toward normal, inhibitory effects of alkalosis on respiratory drive lessen, permitting a sustained higher ventilation.
- 243. E.** The hippocampal formation is critical for consolidation of new declarative memories. Damage can produce anterograde amnesia while many procedural memories and previously consolidated remote memories are relatively preserved.
- 244. E.** Teach-back directly assesses comprehension by asking the patient to restate key information in their own words. It identifies misunderstandings and allows the clinician to re-explain without framing the exercise as a test of the patient.
- 245. D.** Early strength gains with resistance training are largely neural, including improved motor-unit recruitment, firing patterns, and coordination. Structural hypertrophy becomes a larger contributor with continued training.
- 246. C.** The descending thin limb has high water permeability but relatively lower solute permeability. As it traverses the hypertonic medulla, water exits osmotically and tubular fluid becomes progressively concentrated.

- 247. E.** The enteric nervous system contains intrinsic sensory neurons, interneurons, and motor neurons capable of organizing local motility and secretory reflexes. Extrinsic autonomic input modulates these circuits but is not required for all basic gastrointestinal function.
- 248. C.** LH binds receptors on Leydig cells and stimulates cAMP-dependent steroidogenesis from cholesterol. Testosterone then supports spermatogenesis locally and exerts systemic androgenic effects and negative feedback.
- 249. A.** C5b through C9 assemble the membrane attack complex, which forms transmembrane pores. Deficiency of terminal complement components particularly predisposes to *Neisseria* infections because MAC-mediated killing is important for these organisms.
- 250. A.** Power is the probability of detecting a true effect and equals $1 - \beta$. Larger sample size, larger true effect size, lower variability, or a less stringent α can increase power.
- 251. D.** Broca area in the dominant frontal lobe is important for motor language production. Lesions cause nonfluent, effortful speech with relatively preserved comprehension, whereas Wernicke lesions produce fluent but poorly comprehended and nonsensical language.
- 252. E.** Veins contain a large fraction of circulating blood and serve as capacitance vessels. Sympathetic venoconstriction decreases venous compliance and shifts blood centrally, helping sustain cardiac filling during hemorrhage.
- 253. E.** Albumin is the major contributor to plasma colloid oncotic pressure. Lower albumin reduces the inward osmotic force opposing capillary filtration, promoting edema and sometimes reducing effective circulating volume.
- 254. B.** Vasopressin binds V2 receptors on principal cells, activates cAMP signaling, and promotes insertion of aquaporin-2 water channels into the apical membrane. Water then enters cells and exits through basolateral aquaporins into the hypertonic interstitium.
- 255. B.** Exogenous androgen suppresses GnRH and pituitary gonadotropin secretion. Lower LH reduces intratesticular testosterone production, and lower FSH impairs Sertoli-cell support, so spermatogenesis can decrease despite high serum testosterone.
- 256. D.** Endurance training increases mitochondrial number and oxidative enzymes, capillary density, and the ability to oxidize fatty acids. These adaptations support sustained ATP production and reduce reliance on anaerobic metabolism at a given workload.
- 257. E.** Normal aging is associated with diminished arterial baroreflex sensitivity and reduced beta-adrenergic responsiveness. The compensatory rise in heart rate and peripheral vasoconstriction after standing is therefore slower and smaller, predisposing to orthostatic hypotension.
- 258. C.** IL-8 is a major chemokine for neutrophils and promotes their chemotaxis and activation. Other potent neutrophil chemoattractants include C5a and bacterial products.

- 259. D.** Clinicians should understand the motivation behind a request, explain evidence and tradeoffs, and make a professional recommendation. Shared decision-making does not require providing interventions whose expected harms outweigh benefits.
- 260. E.** Wernicke area is important for language comprehension. Damage produces fluent but poorly comprehended speech, often with paraphasias and impaired repetition, and patients may be unaware of the deficit.
- 261. D.** When vasopressin is low, fewer aquaporin-2 channels are present in the apical collecting-duct membrane. The collecting duct becomes relatively water impermeable and dilute tubular fluid can be excreted as dilute urine.
- 262. C.** Interstitial cells of Cajal act as pacemaker cells within the gastrointestinal tract and generate slow waves. Slow waves do not necessarily cause contraction by themselves, but when threshold is reached, spike potentials and calcium entry produce smooth-muscle contraction.
- 263. D.** Inhibin from Sertoli cells feeds back predominantly at the anterior pituitary to reduce FSH secretion. Testosterone and estradiol provide broader negative feedback on GnRH and LH/FSH secretion.
- 264. A.** Exercise increases sympathetic tone and reduces vagal tone, raising heart rate and contractility. The skeletal-muscle and respiratory pumps increase venous return, supporting a higher stroke volume, while local vasodilation directs flow to active muscle.
- 265. D.** Inflammatory mediators cause arteriolar vasodilation and increased endothelial permeability. Hyperemia produces warmth and redness, while protein and fluid extravasation increase interstitial volume and contribute to edema.
- 266. B.** Muscle contains a small store of ATP and a larger phosphocreatine reserve that rapidly regenerates ATP through creatine kinase. This phosphagen system dominates the first seconds of maximal effort before glycolysis and oxidative phosphorylation contribute more.
- 267. D.** Interferon-gamma is produced prominently by Th1 cells and NK cells. It activates macrophages, enhances antigen presentation, and supports cell-mediated immunity against intracellular pathogens.
- 268. D.** Descending pathways normally modulate and often inhibit spinal reflex excitability. Upper motor neuron lesions remove part of this control, leading over time to increased tone, hyperreflexia, and pathologic reflexes such as Babinski responses.
- 269. E.** Aldosterone increases ENaC and Na⁺/K⁺-ATPase expression and activity in principal cells. Sodium reabsorption creates a lumen-negative potential and increases intracellular potassium availability, both favoring potassium secretion.

- 270. E.** Parasympathetic and endothelial nitric oxide activates guanylyl cyclase in cavernosal smooth muscle, raising cGMP and causing relaxation. Increased arterial inflow and compression of venous outflow produce erection.
- 271. C.** Selection bias occurs when the way participants enter or are assigned to groups creates systematic baseline differences related to the outcome. Randomization and proper allocation concealment help reduce this threat in trials.
- 272. E.** Clinicians have a duty to protect patients from unsafe care while treating colleagues fairly. Concerns about impairment should be addressed promptly through appropriate confidential supervisory, occupational health, or institutional processes.
- 273. D.** G cells in the antrum and proximal duodenum release gastrin in response to peptides, distention, and vagal GRP. Gastrin stimulates acid secretion directly and indirectly through histamine release from enterochromaffin-like cells.
- 274. E.** Early distributive septic shock is characterized by systemic vasodilation and low systemic vascular resistance, often with preserved or increased cardiac output. Maldistribution of flow and capillary leak can still produce tissue hypoperfusion.
- 275. C.** Catecholamines mobilize stored fuels during stress by promoting glycogenolysis and lipolysis and by supporting glucagon action. This increases substrate availability for tissues with increased energy demand.
- 276. E.** Active muscle accumulates vasodilator metabolites including adenosine, K⁺, CO₂, H⁺, and others. Increased endothelial shear also promotes nitric oxide release, producing functional hyperemia that matches flow to metabolic demand.
- 277. D.** Naturally occurring anti-A and anti-B antibodies are predominantly IgM. Pentameric IgM efficiently activates complement, explaining the rapid intravascular hemolysis that can follow an incompatible transfusion.
- 278. E.** Denervated muscle becomes supersensitive to acetylcholine because receptors spread beyond the motor end plate. Individual muscle fibers may also depolarize spontaneously, producing fibrillation potentials on electromyography.
- 279. D.** Hyperkalemia directly stimulates adrenal aldosterone release. Aldosterone enhances distal sodium reabsorption and potassium secretion by principal cells, increasing urinary potassium excretion.
- 280. D.** Sexual function has distinct autonomic components: parasympathetic activity is central to erection, whereas sympathetic activity drives emission. Somatic pudendal motor activity contributes to rhythmic contraction during ejaculation.