

NEET PG Physiology Sample Paper-2

Duration: 15 Minutes

Maximum Marks: 68

Instructions

- This paper contains 17 Multiple Choice Questions.
- Each correct answer carries +4 mark. Incorrect answer: -1 marks. Only one correct option.
- Unattempted questions carry 0 marks.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. A 24-year-old medical student is participating in an undergraduate research project measuring cell membrane potentials. While recording from a skeletal muscle fiber, they accidentally double the extracellular potassium concentration from 4 mEq/L to 8 mEq/L. According to the Nernst equation at normal body temperature (37°C), which of the following changes will most accurately describe the immediate effect on the equilibrium potential for potassium (E_K)?

- (A) It will become more negative by approximately 61 mV
- (B) It will become less negative by approximately 18 mV
- (C) It will become less negative by approximately 61 mV
- (D) It will remain unchanged because the sodium-potassium pump will instantly compensate

Q2. A 62-year-old male with a history of chronic hypertension presents to the cardiology clinic. An echocardiogram reveals concentric left ventricular hypertrophy. The cardiologist explains that the increased wall thickness is a compensatory mechanism to normalize ventricular wall stress during ejection. Which of the following parameters, when increased, directly leads to the higher afterload initiating this pathology?



- (A) Total peripheral resistance
- (B) End-diastolic volume
- (C) Pulmonary capillary wedge pressure
- (D) Mean circulatory filling pressure

Q3. A 35-year-old male climber is ascending Mount Everest and reaches an altitude where the barometric pressure is significantly reduced. As a compensatory response to the hypobaric hypoxia, his alveolar ventilation increases dramatically. Which of the following combinations of arterial blood gas parameters is most characteristic of this acute adaptation before renal compensation begins?

- (A) Decreased pH, Increased PaCO₂, Decreased HCO₃⁻
- (B) Increased pH, Decreased PaCO₂, Normal HCO₃⁻
- (C) Increased pH, Increased PaCO₂, Increased HCO₃⁻
- (D) Decreased pH, Decreased PaCO₂, Decreased HCO₃⁻

Q4. An experimental drug is being tested for its effects on renal hemodynamics. In a laboratory model, the drug selectively constricts the efferent arteriole of the glomerulus without altering the afferent arteriole tone or systemic arterial pressure. How will this drug affect the glomerular filtration rate (GFR) and the filtration fraction (FF)?

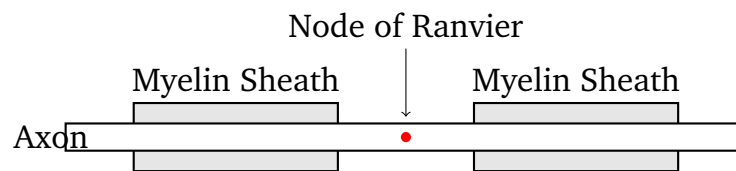
- (A) GFR decreases, FF decreases
- (B) GFR increases, FF decreases
- (C) GFR increases, FF increases
- (D) GFR decreases, FF increases

Q5. A 41-year-old female presents with progressive weight gain, cold intolerance, fatigue, and generalized sluggishness. On physical examination, she has a diffuse, non-tender enlargement of the thyroid gland (goiter) and coarse, dry skin. Laboratory evaluation confirms primary hypothyroidism due to Hashimoto's thyroiditis. Which of the following sets of plasma hormone levels is expected in this patient?



- (A) High TSH, High Free T4, High Free T3
- (B) Low TSH, Low Free T4, Low Free T3
- (C) High TSH, Low Free T4, Low Free T3
- (D) Low TSH, High Free T4, Low Free T3

Q6. A researcher is analyzing the conduction velocity of various nerve fibers within the human peripheral nervous system. They isolate a bundle containing both myelinated and unmyelinated fibers. To visually map the structural differences influencing these velocities, the researcher creates a schematic diagram of a myelinated nerve fiber cross-section. Which of the following options correctly describes the physiological property of the specific zone labeled "Node of Ranvier" in the diagram below?

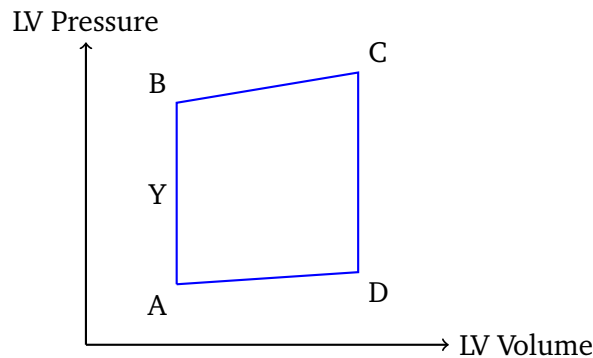


- (A) High membrane resistance and low membrane capacitance, preventing ion flow
 - (B) Low density of voltage-gated sodium channels, requiring electrotonic propagation
 - (C) High density of voltage-gated sodium channels and low membrane resistance, facilitating saltatory conduction
 - (D) Absence of potassium channels, ensuring unidirectional action potential propagation
- Q7.** A 58-year-old female with chronic kidney disease secondary to long-standing diabetes mellitus is evaluated during a routine follow-up. Her laboratory profile shows a significantly reduced glomerular filtration rate and a low plasma calcium level. The physician notes that her underlying condition impairs the final step in the synthesis of the active form of Vitamin D. In which specific segment of the nephron does this hydroxylation process normally occur?



- (A) Cortical collecting duct
- (B) Thick ascending limb of the loop of Henle
- (C) Proximal convoluted tubule
- (D) Distal convoluted tubule

Q8. During an experimental study on cardiac cycle dynamics, a pressure-volume loop of the left ventricle is generated using a conductance catheter. The investigator isolates a specific phase where the mitral valve has just closed, the aortic valve remains closed, and left ventricular pressure is rising sharply. Which phase of the cardiac cycle is being observed, and how is it represented on the schematic pressure-volume loop below?

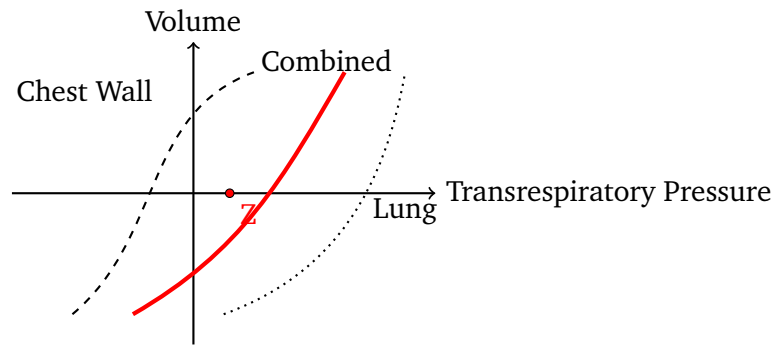


- (A) Isovolumetric relaxation; represented by segment C to D
 - (B) Isovolumetric contraction; represented by segment A to B
 - (C) Rapid ventricular ejection; represented by segment B to C
 - (D) Isovolumetric contraction; represented by segment D to A
- Q9.** A 29-year-old male is admitted to the emergency department after sustaining a traumatic head injury in a motor vehicle accident. Head CT demonstrates a fracture localized to the cribriform plate of the ethmoid bone. On neurological examination, he is found to have lost his sense of smell. Which of the following secondary messengers is primarily involved in transducing signals within the normal olfactory receptor neurons that pass through this fractured bone?
- (A) Inositol 1,4,5-trisphosphate (IP3)



- (B) Cyclic adenosine monophosphate (cAMP)
- (C) Cyclic guanosine monophosphate (cGMP)
- (D) Diacylglycerol (DAG)

Q10. A medical student utilizes a standard model of the respiratory system to study the mechanical properties of the lungs and chest wall. The graph illustrates the static pressure-volume curves of the lung alone, the chest wall alone, and the combined respiratory system. At which specific point on the combined curve does the inward elastic recoil of the lungs exactly balance the outward elastic recoil of the chest wall?



- (A) At Total Lung Capacity (TLC)
 - (B) At Residual Volume (RV)
 - (C) At Functional Residual Capacity (FRC), corresponding to point Z
 - (D) At Vital Capacity (VC)
- Q11.** A 48-year-old executive is undergoing a detailed metabolic assessment. To understand his energy homeostatic pathways, the clinician reviews the mechanism of action of leptin. Which region of the central nervous system serves as the primary site of action for leptin to suppress appetite and stimulate energy expenditure?
- (A) Supraoptic nucleus of the hypothalamus
 - (B) Arcuate nucleus of the hypothalamus
 - (C) Ventromedial nucleus of the thalamus
 - (D) Nucleus tractus solitarius in the medulla

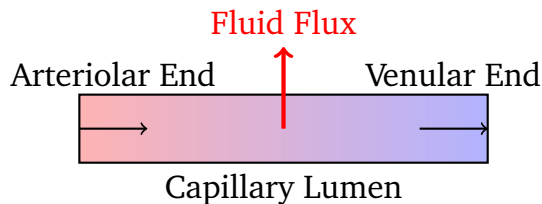


- Q12.** A clinical trial evaluates the vascular effects of an intravenous infusion of epinephrine in healthy volunteers. At low therapeutic doses, epinephrine causes a decrease in total peripheral resistance and a reduction in diastolic blood pressure. Which of the following adrenergic receptor subtypes is primarily responsible for mediating this vasodilation in skeletal muscle vascular beds?
- (A) Alpha-1 adrenergic receptors
 - (B) Alpha-2 adrenergic receptors
 - (C) Beta-1 adrenergic receptors
 - (D) Beta-2 adrenergic receptors
- Q13.** A 19-year-old female presents with severe polyuria and polydipsia. A water deprivation test is performed to differentiate between central diabetes insipidus, nephrogenic diabetes insipidus, and primary polydipsia. Following the administration of exogenous desmopressin (dAVP), her urine osmolality increases by more than 50 percent. This diagnostic finding confirms a deficiency in the secretion of antidiuretic hormone (ADH). From which cellular site is this hormone physiologically released into the systemic circulation?
- (A) Secretory granules within cells of the anterior pituitary gland
 - (B) Nerve terminals of hypothalamic neurons located in the posterior pituitary gland
 - (C) Interstitial endocrine cells of the intermediate pituitary lobe
 - (D) Chief cells of the parathyroid gland acting as a neuroendocrine loop
- Q14.** A 26-year-old male subject undergoes an experimental evaluation of gastrointestinal motility. Following the ingestion of a meal rich in long-chain fatty acids and peptides, a rapid increase in gallbladder contraction and a concomitant relaxation of the sphincter of Oddi are recorded. Which of the following endocrine cells, located predominantly in the duodenum and jejunum, are responsible for secreting the hormone that coordinates this response?
- (A) I cells



- (B) S cells
- (C) G cells
- (D) K cells

Q15. An investigator is studying the regulatory mechanisms of the human microcirculation. They construct a simplified schematic diagram of a microvascular unit to demonstrate the dynamic changes in hydrostatic and oncotic pressures that govern fluid movement across the capillary wall. According to Starling's forces, which of the following alterations will significantly increase the net filtration of fluid out of the capillary into the interstitium?



- (A) A reduction in the precapillary arteriolar resistance
 - (B) An increase in the plasma colloid oncotic pressure
 - (C) A decrease in the systemic venous pressure
 - (D) A reduction in the inter-endothelial cleft pore size
- Q16.** During a laboratory demonstration of respiratory physiology, the oxygen-hemoglobin dissociation curve is plotted under varying chemical conditions. The instructor shows that certain physiological states reduce the affinity of hemoglobin for oxygen, thereby shifting the curve to the right to facilitate tissue oxygen delivery. Which of the following sets of modifications shifts the curve in this manner?
- (A) Decreased H^+ concentration, decreased temperature, decreased 2,3-BPG
 - (B) Increased H^+ concentration, increased temperature, increased 2,3-BPG
 - (C) Decreased PCO_2 , increased pH, decreased temperature
 - (D) Increased pH, decreased 2,3-BPG, decreased PCO_2



- Q17.** A 74-year-old male patient with advanced emphysema exhibits a marked increase in dead space ventilation. His physiological dead space is calculated using the Bohr equation. Which of the following gas measurements is an absolute prerequisite to quantify the volume of the physiological dead space using this classical method?
- (A) Mixed venous oxygen tension (PvO_2)
 - (B) Fractional concentration of nitrogen in inspired air (FiN_2)
 - (C) Partial pressure of carbon dioxide in expired air ($PECO_2$) and arterial blood ($PaCO_2$)
 - (D) Maximum voluntary ventilation volume (MVV)



Detailed Solutions

Q1.

Solution

Concept:

The equilibrium potential for an ion (E_{ion}) is the membrane potential at which the electrical driving force balances the chemical concentration gradient. It is calculated using the Nernst equation: $E_K = \frac{R \cdot T}{z \cdot F} \cdot \ln\left(\frac{[K^+]_{out}}{[K^+]_{in}}\right)$. At a normal body temperature of 37°C, the formula simplifies using base-10 logarithms to: $E_K = 61.5 \cdot \log_{10}\left(\frac{[K^+]_{out}}{[K^+]_{in}}\right)$ mV. Altering extracellular ion concentrations changes this potential immediately.

Solution:

- The baseline extracellular potassium concentration $[K^+]_{out}$ is normally 4 mEq/L, and the typical intracellular concentration $[K^+]_{in}$ is approximately 140 mEq/L. This creates a highly negative baseline potassium equilibrium potential (E_K) of around -95 mV.
- When the extracellular potassium concentration doubles from 4 mEq/L to 8 mEq/L, the ratio of concentration across the cell membrane changes. The mathematical shift can be isolated by analyzing the properties of logarithms: $\Delta E_K = 61.5 \cdot \log_{10}\left(\frac{8}{4}\right)$.
- Simplifying the logarithmic term yields: $\Delta E_K = 61.5 \cdot \log_{10}(2) \approx 61.5 \cdot 0.301 = +18.5$ mV.
- Because the concentration gradient driving potassium outward is reduced, the electrical force needed to balance it decreases. Consequently, the equilibrium potential becomes less negative by approximately 18 mV (shifting from roughly -95 mV to -77 mV).
- The sodium-potassium pump regulates long-term homeostatic gradients but cannot instantly prevent this immediate change in electrical equilibrium caused by experimental changes in extracellular fluid.

Final Answer: It will become less negative by approximately 18 mV.

Answer: (B)

[Go Back to Question 1](#)



Q2.

Solution**Concept:**

Ventricular afterload is the resistance or force that the heart must overcome to pump blood into the systemic circulation during systole. According to the Law of Laplace, ventricular wall stress is directly proportional to transmural pressure and internal radius, and inversely proportional to wall thickness. Left ventricular hypertrophy develops chronically as a structural adaptation to high afterload to normalize wall stress.

Solution:

- (a) Total peripheral resistance (TPR) represents the cumulative resistance of the systemic vasculature, primarily determined by the constriction of arterioles. Sustained elevations in TPR increase mean arterial pressure.
- (b) When a patient suffers from chronic systemic hypertension, the left ventricle must generate a much higher intraventricular pressure to open the aortic valve and eject blood into the high-resistance arterial tree.
- (c) This chronic elevation in arterial resistance and pressure constitutes an increased afterload. The continuous mechanical strain triggers parallel replication of sarcomeres, leading to concentric left ventricular hypertrophy.
- (d) End-diastolic volume reflects preload rather than afterload. Increased preload causes eccentric hypertrophy (dilation) rather than concentric thickening.
- (e) Pulmonary capillary wedge pressure assesses left atrial and pulmonary venous pressures, while mean circulatory filling pressure is an indicator of total vascular filling status. Neither initiates systemic concentric left ventricular hypertrophy.

Final Answer: Total peripheral resistance.

Answer: (A)

[Go Back to Question 2](#)



Q3.

Solution**Concept:**

At high altitudes, low barometric pressure decreases the ambient partial pressure of oxygen (P_{iO_2}), causing hypobaric hypoxia. This low oxygen level stimulates peripheral chemoreceptors in the carotid and aortic bodies, triggering an immediate increase in alveolar ventilation. Hyperventilation increases the elimination of carbon dioxide, disrupting the baseline acid-base balance of the extracellular fluid.

Solution:

- (a) Acute hyperventilation causes excessive exhalation of carbon dioxide from the alveoli, which rapidly decreases the partial pressure of carbon dioxide in arterial blood (P_{aCO_2}).
- (b) According to the Henderson-Hasselbalch principle and the chemical equilibrium equation $CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$, a reduction in P_{aCO_2} drives the reaction to the left.
- (c) This leftward shift reduces the concentration of hydrogen ions (H^+) in plasma, directly raising the arterial blood pH above the normal range of 7.45. This physiological state is known as respiratory alkalosis.
- (d) In the acute phase (within minutes to hours), the kidneys have not had sufficient time to excrete bicarbonate ions. Therefore, plasma bicarbonate (HCO_3^-) levels remain within normal limits.
- (e) Over subsequent days, renal compensation occurs as the proximal tubules decrease bicarbonate reabsorption to normalize the blood pH. However, the acute profile features an elevated pH with low P_{aCO_2} and normal HCO_3^- .

Final Answer: Increased pH, Decreased P_{aCO_2} , Normal HCO_3^- .

Answer: (B)

[Go Back to Question 3](#)



Q4.

Solution**Concept:**

Glomerular filtration rate (GFR) and renal plasma flow (RPF) are regulated by modifying the vascular resistance of the afferent and efferent arterioles. The filtration fraction (FF) represents the proportion of renal plasma flow that is filtered across the glomerular capillaries into Bowman's space, defined mathematically by the formula: $FF = \frac{GFR}{RPF}$.

Solution:

- (a) Selective constriction of the efferent arteriole creates a downstream bottleneck for blood exiting the glomerular capillaries. This resistance increases the hydrostatic pressure within the glomerulus (P_{GC}).
- (b) The elevated glomerular hydrostatic pressure acts as the primary driving force for ultrafiltration, which leads directly to an increase in the glomerular filtration rate (GFR).
- (c) Concurrently, the increased overall resistance within the renal microvasculature reduces the total renal plasma flow (RPF) entering the kidney.
- (d) Because GFR increases while RPF decreases, the mathematical ratio $\frac{GFR}{RPF}$ shifts upward. Therefore, the filtration fraction (FF) increases significantly.
- (e) If efferent constriction becomes extreme, GFR may eventually decrease due to a profound drop in RPF and a rapid rise in oncotic pressure, but moderate selective constriction increases both GFR and FF.

Final Answer: GFR increases, FF increases.

Answer: (C)

[Go Back to Question 4](#)



Q5.

Solution**Concept:**

The hypothalamic-pituitary-thyroid axis operates via a negative feedback loop. The hypothalamus releases thyrotropin-releasing hormone (TRH), which stimulates the anterior pituitary gland to secrete thyroid-stimulating hormone (TSH). TSH binds to receptors on the thyroid gland to promote the synthesis and release of thyroxine (T_4) and triiodothyronine (T_3).

Solution:

- (a) Hashimoto's thyroiditis is an autoimmune disorder characterized by antibody-mediated destruction of thyroid follicular cells. This process severely impairs the gland's capacity to synthesize thyroid hormones.
- (b) Due to structural damage to the gland, the circulating levels of metabolic thyroid hormones (Free T_4 and Free T_3) fall below normal physiological levels, causing primary hypothyroidism.
- (c) The reduction in circulating Free T_4 and Free T_3 removes the normal negative feedback inhibition exerted on the anterior pituitary gland and the hypothalamus.
- (d) Lacking feedback inhibition, thyrotrophs in the anterior pituitary gland increase the synthesis and secretion of TSH into the systemic circulation.
- (e) Consequently, laboratory analysis of a patient with primary hypothyroidism reveals a significantly elevated plasma TSH concentration paired with abnormally low concentrations of free thyroid hormones.

Final Answer: High TSH, Low Free T_4 , Low Free T_3 .

Answer: (C)

[Go Back to Question 5](#)



Q6.

Solution**Concept:**

Nerve conduction velocity depends on axonal diameter and the presence of myelin. Myelin sheaths are formed by Schwann cells in the peripheral nervous system and oligodendrocytes in the central nervous system. They wrap around axons in segments, separated by uninsulated regions called Nodes of Ranvier. This architectural organization allows action potentials to propagate via saltatory conduction.

Solution:

- (a) The myelin sheath acts as an electrical insulator, giving the myelinated segments high membrane resistance and low membrane capacitance. This prevents the loss of electrical current across the axonal membrane.
- (b) At the uninsulated Nodes of Ranvier, the structural properties are reversed: membrane resistance is low, allowing current to pass across the lipid bilayer.
- (c) The nodal axolemma contains an extremely high concentration of voltage-gated sodium (Na^+) channels, which are essential for generating action potentials.
- (d) When an action potential occurs at one node, the local current flows electrotonically through the insulated internodal segment to the next node with minimal signal decay.
- (e) Upon reaching the next Node of Ranvier, the dense clusters of voltage-gated sodium channels are rapidly depolarized to threshold, regenerating the action potential. This rapid jumping of the impulse from node to node increases conduction speed.

Final Answer: High density of voltage-gated sodium channels and low membrane resistance, facilitating saltatory conduction.

Answer: (C)

[Go Back to Question 6](#)



Q7.

Solution**Concept:**

Vitamin D metabolism requires structural modifications across multiple organ systems. Cholecalciferol (Vitamin D₃) is synthesized in the skin or absorbed from dietary sources. It undergoes its first metabolic alteration in the liver, where it is converted into 25-hydroxycholecalciferol by the enzyme 25-hydroxylase. Final activation must occur in the kidneys to produce the fully functional hormone.

Solution:

- (a) The circulating metabolite 25-hydroxycholecalciferol is transported to the kidneys, where it undergoes a final regulatory hydroxylation step to become 1,25-dihydroxycholecalciferol (calcitriol), the active form of Vitamin D.
- (b) This activation step is catalyzed by the enzyme 1-alpha-hydroxylase. The expression and enzymatic activity of this molecule are highly regulated by parathyroid hormone (PTH) and plasma phosphate levels.
- (c) Anatomically, 1-alpha-hydroxylase is localized within the epithelial cells of the proximal convoluted tubule (PCT) of the nephron.
- (d) In patients suffering from advanced chronic kidney disease, severe parenchymal destruction destroys these PCT epithelial cells, causing a deficiency of 1-alpha-hydroxylase.
- (e) Without functioning renal tissue in the proximal tubule, calcitriol production drops, leading to impaired intestinal calcium absorption and secondary hypocalcemia.

Final Answer: Proximal convoluted tubule.

Answer: (C)

[Go Back to Question 7](#)



Q8.

Solution**Concept:**

The cardiac cycle consists of alternating phases of systole (contraction and ejection) and diastole (relaxation and filling). A ventricular pressure-volume loop plots these mechanical relationships. The four corners of the loop reflect the precise instances when the cardiac valves open or close, while the segments represent distinct phases of ventricular activity.

Solution:

- (a) Point A on the diagram marks the closure of the mitral valve, which occurs when intraventricular pressure exceeds atrial pressure at the end of diastole.
- (b) Following mitral valve closure, the ventricle enters a phase where it contracts vigorously against a closed aortic valve. Because both the inflow and outflow valves are shut, the blood volume inside the chamber cannot change.
- (c) This specific interval is termed the isovolumetric contraction phase. It is characterized by a rapid vertical increase in left ventricular pressure with no change in ventricular volume.
- (d) On the pressure-volume loop, this process is represented by the vertical line segment moving from point A to point B.
- (e) Once the pressure exceeds the diastolic pressure of the aorta at point B, the aortic valve opens, initiating the ventricular ejection phase (segment B to C). Segment C to D represents isovolumetric relaxation.

Final Answer: Isovolumetric contraction; represented by segment A to B.

Answer: (B)

[Go Back to Question 8](#)



Q9.

Solution**Concept:**

Sensory transduction converts external environmental stimuli into electrochemical signals within the nervous system. Olfactory receptor neurons are specialized bipolar cells located in the nasal epithelium. Their unmyelinated axons project superiorly through the perforations of the cribriform plate of the ethmoid bone to synapse inside the olfactory bulb.

Solution:

- (a) When an odorant molecule binds to specific G-protein-coupled olfactory receptors on the cilia of receptor neurons, it activates a specialized heterotrimeric G-protein termed G_{olf} .
- (b) The alpha subunit of G_{olf} dissociates and stimulates the membrane-bound effector enzyme adenylyl cyclase (specifically type III).
- (c) Activated adenylyl cyclase catalyzes the conversion of intracellular adenosine triphosphate (ATP) into cyclic adenosine monophosphate (cAMP).
- (d) The resulting rise in intracellular cAMP acts as the primary second messenger, binding directly to cyclic nucleotide-gated (CNG) ion channels in the plasma membrane.
- (e) Opening these channels allows an influx of sodium (Na^+) and calcium (Ca^{2+}) ions, causing depolarization of the olfactory receptor neuron. This generates an action potential that travels through the cribriform plate.

Final Answer: Cyclic adenosine monophosphate (cAMP).

Answer: (B)

[Go Back to Question 9](#)



Q10.

Solution**Concept:**

The structural components of the respiratory system possess individual elastic properties. The lungs exhibit an inward elastic recoil that favors collapsing to a volume below residual volume. Conversely, the chest wall exhibits an outward elastic recoil that tends to expand the thoracic cavity. The combined respiratory system curve represents the interaction between these forces.

Solution:

- (a) When a person relaxes their respiratory muscles at the end of a normal, unforced expiration, the respiratory system reaches a state of mechanical equilibrium.
- (b) At this specific resting volume, the inward collapsing force of the lung tissue is equal in magnitude and opposite in direction to the outward expanding force of the chest wall.
- (c) This equilibrium point is defined as the Functional Residual Capacity (FRC). On the combined respiratory system curve, it corresponds to the volume where transrespiratory pressure is zero (Point Z).
- (d) At volumes above FRC, the inward recoil of the lungs dominates, making the total system recoil inward. At volumes below FRC, the outward recoil of the chest wall dominates.
- (e) Therefore, point Z represents the resting equilibrium volume of the respiratory system, which is clinically measured as the functional residual capacity.

Final Answer: At Functional Residual Capacity (FRC), corresponding to point Z.

Answer: (C)

[Go Back to Question 10](#)



Q11.

Solution**Concept:**

Leptin is an adipokine peptide hormone synthesized and released primarily by adipose tissue in proportion to total body fat stores. It plays a foundational role in long-term energy homeostasis by monitoring systemic energy status and signaling metabolic fullness to the brain. This pathway heavily involves reciprocal interactions with neurochemical circuits in specialized areas of the hypothalamus.

Solution:

- (a) Circulating leptin crosses the blood-brain barrier to bind to high-affinity leptin receptors expressed heavily on neuronal populations situated directly within the arcuate nucleus of the ventral hypothalamus.
- (b) Within the arcuate nucleus, leptin coordinates two opposing neural systems: it suppresses orexigenic (appetite-stimulating) pathways and concurrently stimulates anorexigenic (appetite-suppressing) neuroendocrine pathways.
- (c) Specifically, the hormone inhibits neuropeptide Y (NPY) and agouti-related peptide (AgRP) co-expressing neurons, which actively decreases downstream signals that would normally drive food consumption.
- (d) Concurrently, leptin activates pro-opiomelanocortin (POMC) neurons in the arcuate nucleus. POMC is cleaved to release alpha-melanocyte-stimulating hormone (α -MSH), which activates downstream melanocortin-4 receptors (MC4R) to diminish appetite and boost sympathetic tone.
- (e) The supraoptic nucleus handles water balance via vasopressin production, while the medullary solitary tract processes visceral sensory inputs, making the arcuate nucleus the absolute focal regulatory site for leptin-mediated energetic homeostasis.

Final Answer: Arcuate nucleus of the hypothalamus.

Answer: (B)

[Go Back to Question 11](#)



Q12.

Solution**Concept:**

Epinephrine is a primary catecholamine released into systemic circulation by the adrenal medulla during sympathetic activation. It exhibits variable affinities for alpha and beta-adrenergic receptor subtypes. The physiological response of a given vascular bed depends directly on the localized concentration of the hormone and the distribution density of these specific adrenergic receptor variations.

Solution:

- (a) Epinephrine binds to alpha-1, alpha-2, beta-1, and beta-2 adrenergic receptors. However, it possesses a significantly higher functional affinity for beta-2 adrenergic receptors than it does for alpha-1 adrenergic receptors at low concentrations.
- (b) Under low therapeutic doses or initial physiological infusions, epinephrine selectively binds and activates beta-2 adrenergic receptors. These are heavily concentrated on the vascular smooth muscle cells supplying skeletal muscle beds.
- (c) Activation of the beta-2 receptor stimulates the heterotrimeric Gs protein, activating adenylyl cyclase to raise intracellular cyclic adenosine monophosphate (cAMP). This inhibits myosin light chain kinase, inducing marked smooth muscle relaxation.
- (d) This localized vasodilation in large skeletal muscle vascular networks reduces overall total peripheral resistance (TPR), which manifests clinically as a distinctive drop in systemic diastolic blood pressure.
- (e) At much higher doses, epinephrine overcomes this selectivity and saturates alpha-1 adrenergic receptors, triggering overriding Gq-mediated vasoconstriction that increases TPR and blood pressure instead.

Final Answer: Beta-2 adrenergic receptors.

Answer: (D)

[Go Back to Question 12](#)



Q13.

Solution**Concept:**

Antidiuretic hormone (ADH), also termed arginine vasopressin (AVP), is a nonapeptide hormone central to fluid volume regulation and plasma osmolality maintenance. While the hormone acts downstream on the V2 receptors of renal collecting ducts to insert aquaporin channels, its physiological life cycle begins entirely within specialized neurosecretory centers of the central nervous system.

Solution:

- (a) ADH is synthesized within the cell bodies of magnocellular neurons located primarily in the supraoptic and paraventricular nuclei of the hypothalamus. It is packaged into secretory vesicles alongside its carrier protein, neurophysin II.
- (b) Following synthesis, these secretory granules travel down long unmyelinated axons through the hypothalamic-hypophyseal tract via axoplasmic transport, traversing the pituitary stalk to cross into the neurohypophysis.
- (c) The posterior pituitary gland (neurohypophysis) does not possess endocrine glandular epithelium and does not synthesize hormones itself; it functions strictly as a storage and release reservoir for these hypothalamic tracts.
- (d) The terminal endings of these magnocellular neurons terminate in close anatomical proximity to a dense fenestrated capillary network within the posterior pituitary gland.
- (e) When systemic osmoreceptors detect elevated plasma osmolality, action potentials travel down these axons, triggering calcium-dependent exocytosis of ADH directly from these nerve terminals into the systemic capillary circulation.

Final Answer: Nerve terminals of hypothalamic neurons located in the posterior pituitary gland.

Answer: (B)

[Go Back to Question 13](#)



Q14.

Solution**Concept:**

Gastrointestinal motility and digestion are highly regulated by a specialized network of enteroendocrine cells distributed along the mucosal lining of the alimentary canal. These cells sense the chemical composition of chyme entering the small intestine and release specific regulatory hormones into local circulation to coordinate hepatobiliary and pancreatic secretions.

Solution:

- (a) The ingestion of a meal concentrated with long-chain fatty acids, monoglycerides, and small peptides stimulates enteroendocrine I cells, which are located predominantly in the mucosal epithelium of the duodenum and upper jejunum.
- (b) In response to these luminal digestive breakdown products, I cells secrete the peptide hormone cholecystokinin (CCK) into the portal and systemic blood streams.
- (c) CCK acts via endocrine pathways to stimulate powerful contractions of the smooth muscle wall of the gallbladder, while simultaneously activating vago-vagal reflexes that induce relaxation of the sphincter of Oddi.
- (d) This coordinated mechanical response ensures the prompt delivery of concentrated bile into the duodenal lumen, which is essential for emulsifying dietary lipids to facilitate subsequent enzymatic breakdown.
- (e) S cells secrete secretin to regulate bicarbonate release, G cells release gastrin to stimulate gastric acid, and K cells secrete glucose-dependent insulinotropic peptide (GIP). This isolates I cells as the correct coordinators of gallbladder emptying.

Final Answer: I cells.

Answer: (A)

[Go Back to Question 14](#)



Q15.

Solution**Concept:**

Fluid movement across the endothelial wall of microvascular networks is governed by Starling's forces. This relationship is quantified by the Starling equation: $J_v = K_f \cdot [(P_c - P_i) - \sigma \cdot (\pi_c - \pi_i)]$, where fluid flux (J_v) is dictated by the fine balance between hydrostatic and oncotic pressures inside and outside the capillary lumen.

Solution:

- (a) Precapillary arterioles possess significant smooth muscle tone that regulates the entry of blood into downstream capillary beds. Reducing precapillary arteriolar resistance induces marked vasodilation.
- (b) This reduction in upstream resistance allows a higher systemic arterial pressure to be transmitted directly into the fragile capillary lumen, sharply increasing the baseline capillary hydrostatic pressure (P_c).
- (c) Because P_c represents the primary filtration force driving fluid outward across the endothelial barrier, a significant elevation in this parameter dramatically enhances net fluid filtration into the interstitium.
- (d) An increase in plasma colloid oncotic pressure (π_c) acts as an inward reabsorptive force, which would decrease fluid filtration rather than increase it.
- (e) A decrease in systemic venous pressure reduces downstream resistance, thereby lowering P_c and reducing outward filtration. A reduction in inter-endothelial cleft size reduces the filtration coefficient (K_f), which dampens overall fluid movement.

Final Answer: A reduction in the precapillary arteriolar resistance.

Answer: (A)

[Go Back to Question 15](#)



Q16.

Solution**Concept:**

The oxygen-hemoglobin dissociation curve illustrates the relationship between the partial pressure of oxygen (PO_2) and the percentage saturation of hemoglobin. Changes in the local biochemical environment modify the quaternary structure of the hemoglobin tetramer, shifting the curve to alter oxygen loading in the lungs or unloading in peripheral tissues.

Solution:

- (a) A rightward shift of the oxygen-hemoglobin dissociation curve signifies a localized reduction in hemoglobin's affinity for oxygen, meaning a higher PO_2 is required to achieve any given saturation level, which helps unload oxygen to working tissues.
- (b) During periods of elevated metabolic activity (such as exercising muscle), tissues produce large volumes of carbon dioxide (PCO_2) and metabolic acids, which significantly increases the local hydrogen ion concentration (H^+) and drops the pH.
- (c) This high concentration of H^+ binds to specific amino acid residues on hemoglobin, stabilizing the deoxygenated T (tense) state over the oxygenated R (relaxed) state. This phenomenon is known as the Bohr effect.
- (d) Elevated metabolic rates concurrently generate excess thermal energy, raising local temperature, and stimulate erythrocyte glycolysis, which increases production of the allosteric effector 2,3-bisphosphoglycerate (2,3-BPG).
- (e) Together, elevations in H^+ concentration (low pH), temperature, PCO_2 , and 2,3-BPG decrease hemoglobin affinity, effectively shifting the dissociation curve to the right to optimize tissue oxygenation.

Final Answer: Increased H^+ concentration, increased temperature, increased 2,3-BPG.

Answer: (B)

[Go Back to Question 16](#)



Q17.

Solution**Concept:**

Physiological dead space represents the total volume of inspired air that does not participate in respiratory gas exchange. It encompasses both anatomical dead space (the volume of the conducting airways) and alveolar dead space (ventilated alveoli that are under-perfused or non-perfused). It is quantified clinically using the Bohr equation.

Solution:

- (a) The Bohr equation utilizes carbon dioxide (CO_2) as an intrinsic metabolic tracer because nearly all CO_2 present in expired air must originate from gas exchange occurring in functional pulmonary capillaries.
- (b) The mathematical formula is expressed as: $V_D/V_T = \frac{\text{PaCO}_2 - \text{PECO}_2}{\text{PaCO}_2}$, where V_D is physiological dead space, V_T is tidal volume, PaCO_2 is arterial carbon dioxide tension, and PECO_2 is the partial pressure of carbon dioxide in mixed expired air.
- (c) To compute this ratio, the clinician must measure the partial pressure of carbon dioxide in the patient's arterial blood (PaCO_2) alongside the partial pressure of carbon dioxide collected within a mixed expired air sample (PECO_2).
- (d) If an area of the lung is ventilated but lacks perfusion, it cannot contribute CO_2 to the expired air, causing PECO_2 to drop relative to PaCO_2 , which proportionally increases the calculated dead space.
- (e) Oxygen tensions (PvO_2) and nitrogen fractions (FiN_2) are completely omitted from this specific material balance equation, leaving CO_2 partial pressures as the absolute prerequisite.

Final Answer: Partial pressure of carbon dioxide in expired air (PECO_2) and arterial blood (PaCO_2).

Answer: (C)

[Go Back to Question 17](#)



Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	A	3	B	4	C	5	C
6	C	7	C	8	B	9	B	10	C
11	B	12	D	13	B	14	A	15	A
16	B	17	C						

