Rajasthan JET Biology Sample Paper-5

Duration: 40 Minutes **Maximum Marks: 160**

Instructions

- This paper contains **40** Multiple Choice Questions (Single Correct).
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries: **−1 marks**.
- Use of mobile phones, smartwatches, calculators, or any electronic gadgets is strictly prohibited.

Q1. The stem of a dicot plant exhibits a characteristic radial arrangement of tissues. Which region is primarily responsible for longitudinal growth and remains meristematic throughout the plant's lifespan?

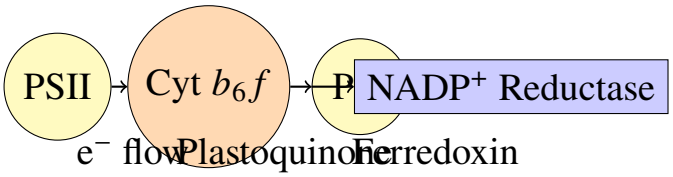
(A) Procambium

(B) Vascular cambium

(C) Apical meristem

(D) Cork cambium (Phellogen)

Q2. In the process of photosynthesis, electrons from photolyzed water molecules are elevated to a higher energy state. Through which sequential pathway do these electrons flow to ultimately reduce $NADP^+$ to NADPH?



(A) PSII → Cyt b_6f → PSI → $NADP^+$ Reductase → NADPH

(B) PSI → PSII → Cyt b_6f → NADPH

(C) PSII → Cyt b_6f → PSI → Ferredoxin → $NADP^+$ Reductase → NADPH

(D) PSI → Cyt b_6f → $NADP^+$ Reductase

Q3. During the synthesis of abscisic acid (ABA) in plant leaves, this hormone accumulates rapidly in response to water stress conditions. What is the primary physiological consequence of elevated ABA levels on guard cell ion channels?

(A) Increases K^+ influx and maintains stomatal opening

(B) Causes K^+ efflux leading to stomatal closure

(C) Stimulates Ca^{2+} entry and promotes photosynthesis

(D) Blocks Cl channels while opening K^+ channels

Q4. When a plant shoot apex undergoes the transition from vegetative to reproductive development, the SAM (shoot apical meristem) reorganizes into a floral meristem. What is the molecular basis for floral identity specification in the ABC model of flower development?

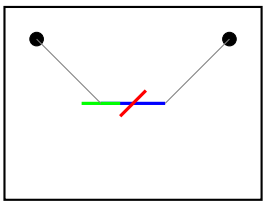
(A) Class A genes alone specify sepal formation in whorls 1 and 2

(B) Class B genes combined with Class A genes specify petal formation in whorl 2

(C) Class C genes repress Class A genes in the center of the flower

(D) All three gene classes must be simultaneously expressed for normal floral organ development

Q5. A student observes a temporary squash preparation showing meiotic division stages. The diagram below depicts chromosomes at a specific meiotic phase:



Sister chromatids at metaphase plate

Which meiotic phase does this diagram represent, and what is the characteristic event?

(A) Metaphase I; bivalents aligned on the equator with centromeres pointing toward poles

(B) Metaphase II; univalent chromosomes with sister chromatids aligned at the metaphase plate

(C) Anaphase I; homologous chromosomes migrating toward opposite poles

(D) Telophase II; nuclear envelopes reforming around separated chromatids

Q6. A certain plant species exhibits heteromorphic incompatibility where the pollen tube growth is halted when incompatible pollen reaches the ovule. This reproductive isolation mechanism prevents self-pollination through:

(A) Genetic recombination during meiosis

(B) Allele-specific recognition at the stigma-pollen interface

(C) Temporal separation of anther and stigma maturation

(D) Mechanical barriers preventing pollen adhesion

Q7. The phenomenon where an individual plant can produce both male and female reproductive organs either on the same flower or on separate flowers within the plant is called:

(A) Dioecious

(B) Monoecious

(C) Hermaphrodite

(D) Gynomonoecious

Q8. In a typical angiosperm flower, the integuments of the ovule develop into the seed coat (testa and tegmen). How many integuments are typically present in most dicot ovules?

(A) One

(B) Two

(C) Three

(D) Four

Q9. During anaerobic respiration in plant root cells, the NAD^+ regeneration becomes critical for maintaining glycolysis. Under hypoxic conditions, which of the following is the primary NAD^+ regenerating pathway in higher plants?

(A) Lactate fermentation producing lactic acid

(B) Ethanol fermentation producing acetaldehyde and CO_2

(C) Alanine synthesis through transamination

(D) Oxalic acid accumulation

Q10. The phenomenon of leaf senescence involves the programmed breakdown of chlorophyll, proteins, and other cellular components. Which hormone plays the primary role in accelerating senescence by promoting chlorophyll degradation and nutrient translocation?

(A) Gibberellin

(B) Auxin

(C) Ethylene

(D) Cytokinin

Q11. In the Hardy-Weinberg principle, when allele frequencies remain constant across generations, the population is said to be in genetic equilibrium. Which of the following conditions is NOT required for maintaining this equilibrium?

(A) Absence of mutations

(B) Random mating

(C) Equal fitness of all genotypes

(D) Migration between populations

Q12. Two populations of a plant species are separated by a mountain range and have been isolated for thousands of years. Analysis shows they now have different allele frequencies at multiple loci. This is an example of:

(A) Gene flow

(B) Genetic drift due to founder effect

(C) Artificial selection

(D) Adaptive radiation

Q13. In an ecosystem, the energy flow diagram demonstrates that approximately what percentage of energy is available at the secondary consumer level from the primary consumer level?

(A) 1%

(B) 10%

(C) 25%

(D) 50%

Q14. The Millennium Ecosystem Services Assessment categorizes ecosystem services into four types: provisioning, regulating, supporting, and cultural. Which of the following is an example of a regulating ecosystem service?

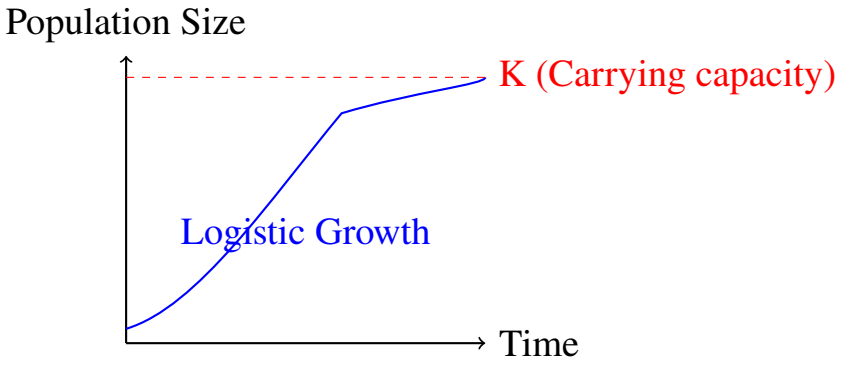
(A) Timber production from forests

(B) Climate regulation and flood control

(C) Primary productivity and nutrient cycling

(D) Recreation and aesthetic values

Q15. The concept of carrying capacity refers to the maximum population size that an environment can sustain indefinitely. In logistic population growth, this is represented as K. When a population exceeds K, what typically happens?



(A) Population growth rate becomes zero and the population remains stable

(B) Population size decreases due to increased death rate and decreased birth rate

(C) Population continues to grow exponentially without limit

(D) Population undergoes complete extinction

Q16. Which agricultural crop is the primary pulse crop of Rajasthan, rich in protein content, and frequently affected by root rot diseases caused by *Macrophomina phaseolina*?

(A) *Cicer arietinum* (Chickpea)

(B) *Vigna radiata* (Mungbean)

(C) *Lathyrus sativus* (Khesari)

(D) *Lablab purpureus* (Lablab bean)

Q17. The fiber crop grown extensively in Rajasthan for textiles, whose seeds produce an oil and whose leaves are used as fodder, is botanically:

(A) *Corchorus capsularis* (Jute)

(B) *Crotalaria juncea* (Sunn hemp)

(C) *Gossypium hirsutum* (Cotton)

(D) *Cannabis sativa* (Hemp)

Q18. The antioxidant spice crop cultivated in Rajasthan that contains curcumin as an active compound and is used extensively in traditional medicine is:

(A) *Piper nigrum* (Black pepper)

(B) *Curcuma longa* (Turmeric)

(C) *Zingiber officinale* (Ginger)

(D) *Vanilla planifolia* (Vanilla)

Q19. In CRISPR-Cas9 gene editing technology, the guide RNA directs the Cas9 enzyme to a specific DNA sequence. The DNA is cleaved at a location specified by:

(A) The 3' end of the guide RNA

(B) The PAM (Protospacer Adjacent Motif) sequence

(C) The coding region of the target gene only

(D) Restriction enzyme recognition sites

Q20. When embryonic plant tissue (explant) is cultured on media with low auxin and high cytokinin concentration, the predominant developmental outcome is:

(A) Formation of rooted plantlets (organogenesis)

(B) Development of somatic embryos

(C) Induction of shoot formation via organogenesis

(D) Formation of undifferentiated callus tissue

Q21. The fungal pathogen *Magnaporthe grisea* causes a serious leaf spot disease in rice, particularly under humid conditions. This disease is commonly known as:

(A) Stem rot

(B) Blast disease

(C) Neck blast

(D) False smut

Q22. A major fungal disease affecting sugarcane crops in Rajasthan, characterized by red striping on leaves and caused by *Colletotrichum falcatum*, is:

(A) Leaf rot

(B) Red rot

(C) Smut

(D) Wilt

Q23. The mechanism of pest resistance to chemical insecticides can occur through metabolic detoxification, target site modification, or reduced uptake. Which enzyme family is primarily responsible for metabolizing pyrethroid insecticides in insects?

(A) Acetylcholinesterase

(B) Cytochrome P450 monooxygenases

(C) Protease enzymes

(D) Lipid peroxidases

Q24. The red flour beetle (*Tribolium castaneum*), a major stored grain pest, belongs to the insect order:

(A) Lepidoptera

(B) Coleoptera

(C) Diptera

(D) Hymenoptera

Q25. The most abundant phylum of animals on Earth, encompassing approximately 80% of all described animal species, is characterized by jointed appendages and an exoskeleton:

(A) Mollusca

(B) Arthropoda

(C) Annelida

(D) Echinodermata

Q26. In the phylum Mollusca, the muscular foot specialized for burrowing in sandy substrates is characteristic of the class:

(A) Cephalopoda (Octopus, Squid)

(B) Gastropoda (Snails, Slugs)

(C) Bivalvia (Clams, Mussels)

(D) Polyplacophora (Chitons)

Q27. The hepatic portal system in vertebrates is a specialized vascular pathway that:

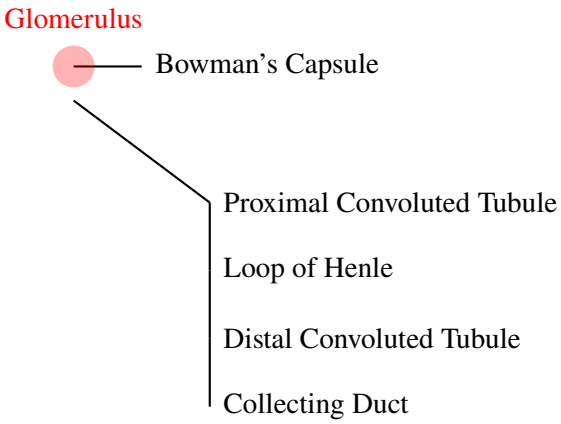
(A) Carries oxygenated blood from the lungs to the heart

(B) Carries nutrient-rich blood directly from the digestive tract to the liver for processing

(C) Distributes blood from the heart to the lungs

(D) Connects the kidneys to the adrenal glands

Q28. Consider the following diagram showing the cross-sectional anatomy of a mammalian kidney nephron:



The selective reabsorption of glucose, amino acids, and ions primarily occurs in which segment?

(A) Bowman's Capsule

(B) Proximal Convoluted Tubule

(C) Loop of Henle

(D) Distal Convoluted Tubule

Q29. The hormone insulin, secreted by pancreatic beta cells, promotes the entry of glucose into muscle and adipose tissue cells through which mechanism?

(A) Active transport against the concentration gradient

(B) Facilitated diffusion via GLUT4 glucose transporters translocating to the cell membrane

(C) Simple diffusion across the lipid bilayer

(D) Pinocytosis of glucose molecules

Q30. The resting membrane potential of a typical mammalian neuron is approximately -70 mV. This negative charge is primarily maintained by:

(A) The Na^+/K^+-ATPase pump actively transporting 2 Na^+ in and 3 K^+ out

(B) Passive diffusion of ions through the cell membrane

(C) Selective permeability of the membrane to anions only

(D) The activity of calcium-ATPase pumps

Q31. When a person consumes a meal rich in simple carbohydrates, the rapid elevation in blood glucose levels stimulates the beta cells of the pancreatic islets of Langerhans to secrete insulin. Which of the following best describes the type of control exerted by glucose on insulin secretion?

(A) Positive feedback regulation

(B) Negative feedback regulation

(C) Feedforward control

(D) Metabolic feedback inhibition

Q32. Vitamin B12 (Cobalamin), which is synthesized by certain bacteria in the colon, is essential for DNA synthesis and myelin formation. In which part of the small intestine is this vitamin primarily absorbed?

(A) Duodenum

(B) Jejunum

(C) Ileum

(D) Ileocecal junction

Q33. The deficiency disease characterized by softening of bones (osteomalacia) in adults, caused by inadequate vitamin D or calcium intake, results in:

(A) Improper calcification of the organic bone matrix (osteoid)

(B) Excessive resorption of already-formed bone

(C) Disruption of the parathyroid gland

(D) Damage to the growth plates of long bones

Q34. The essential amino acid lysine, which cannot be synthesized by the human body and must be obtained from dietary sources, is critical for:

(A) Formation of collagen and keratin

(B) Synthesis of various proteins, antibodies, and hormones

(C) Production of neurotransmitters

(D) Formation of bone mineral matrix

Q35. A balanced diet for an average adult human should ideally contain the following approximate macronutrient composition:

(A) 20% Carbohydrates, 50% Protein, 30% Fat

(B) 50% Carbohydrates, 20% Protein, 30% Fat

(C) 60% Carbohydrates, 10% Protein, 30% Fat

(D) 40% Carbohydrates, 40% Protein, 20% Fat

Q36. The blood clotting cascade involves a series of serine protease enzymes called zymogens. The enzyme prothrombin activator converts prothrombin (Factor II) into thrombin. This conversion requires which ion as a critical cofactor?

(A) Magnesium (Mg^{2+})

(B) Calcium (Ca^{2+})

(C) Iron (Fe^{2+})

(D) Zinc (Zn^{2+})

Q37. The hormone thyroxine (T_4) affects metabolic rate throughout the body. Thyroid hormone excess (hyperthyroidism) results in increased metabolic rate, while deficiency causes decreased metabolic rate. This demonstrates:

(A) Negative feedback regulation

(B) Positive feedback regulation

(C) Feedforward control

(D) Tonic control

Q38. During the filtration step of urine formation in the kidney, which of the following substances is normally NOT filtered from the blood into the Bowman's capsule?

(A) Glucose

(B) Urea

(C) Red blood cells (erythrocytes)

(D) Ions (sodium, potassium, chloride)

Q39. The reflex arc represents the shortest pathway for a motor response to a sensory stimulus, with the synapse occurring in the spinal cord rather than the brain. Which of the following correctly describes the sequence of neurons in a three-neuron reflex arc?

(A) Afferent neuron $\rightarrow$ Interneuron $\rightarrow$ Efferent neuron

(B) Efferent neuron $\rightarrow$ Interneuron $\rightarrow$ Afferent neuron

(C) Sensory receptor $\rightarrow$ Motor neuron $\rightarrow$ Muscle

(D) Interneuron $\rightarrow$ Afferent neuron $\rightarrow$ Efferent neuron

Q40. The corpus callosum is a major white matter structure in the mammalian brain. What is its primary anatomical function?

(A) To coordinate bilateral motor movements

(B) To relay sensory information from the body to the brain stem

(C) To facilitate communication between the two cerebral hemispheres

(D) To regulate sleep-wake cycles through melatonin secretion

Detailed Solutions

Q1.

Solution

Concept: Primary meristems differentiate from the apical meristem into specific tissue zones. The procambium is the primary meristem that gives rise to secondary growth tissues and remains active throughout the plant's life for continuous radial expansion.

Solution:

(a) The apical meristem initiates primary growth at the shoot and root tips but does not account for radial (diameter) expansion.

(b) The procambium is a primary meristem tissue that develops between the primary xylem and phloem early in development.

(c) Unlike apical meristems which eventually become inactive, the procambium cells retain meristematic potential and eventually form the vascular cambium.

(d) The vascular cambium, derived from procambium, remains forever active, continuously producing secondary xylem inward and secondary phloem outward.

(e) The cork cambium (phellogen) develops much later and produces cork tissue, not longitudinal growth.

(f) Therefore, the procambium is the persistent meristematic tissue responsible for initiation of secondary growth.

Final Answer: Procambium

Answer: (A)

Go Back to Question 1

Q2.

Solution

Concept: The photosynthetic electron transport chain represents the sequential movement of electrons through protein complexes embedded in the thylakoid membrane, releasing energy that drives proton pumping and ATP synthesis.

Solution:

(a) Photosystem II (PSII) absorbs light and undergoes charge separation, causing electrons to be removed from water molecules.

(b) These electrons move to plastoquinone and then to the cytochrome b_6f complex, which pumps protons across the thylakoid membrane.

(c) Electrons from the cytochrome complex are then transferred to Photosystem I (PSI) through plastocyanin.

(d) PSI absorbs additional light energy, further elevating electron energy levels.

(e) These high-energy electrons are transferred to ferredoxin, which then reduces the enzyme $NADP^+$ reductase.

(f) $NADP^+$ reductase catalyzes the reduction of $NADP^+$ to NADPH using the ferredoxin electrons.

(g) The correct sequence is: PSII $\rightarrow$ Cyt b_6f $\rightarrow$ PSI $\rightarrow$ Ferredoxin $\rightarrow$ $NADP^+$ Reductase $\rightarrow$ NADPH.

Final Answer: PSII $\rightarrow$ Cyt b_6f $\rightarrow$ PSI $\rightarrow$ Ferredoxin $\rightarrow$ $NADP^+$ Reductase $\rightarrow$ NADPH.

Answer: (C)

Go Back to Question 2

Q3.

Solution

Concept: Abscisic acid is a stress hormone that increases rapidly in response to water scarcity. Its mechanism of action on guard cells involves altering ion channel conductance, causing ion efflux and osmotic water loss.

Solution:

(a) ABA binds to receptors on the guard cell plasma membrane and tonoplast, initiating a signal transduction cascade.

(b) This signaling pathway causes the opening of anion (Cl and malate^{2}) channels in the guard cell membrane.

(c) Anion efflux generates a negative electrical potential that drives K^+ ions outward through K^+ channels.

(d) This K^+ efflux reduces the solute concentration in guard cells, lowering their osmotic potential.

(e) Water then leaves the guard cells by osmosis, reducing turgor pressure and causing stomatal closure.

(f) This mechanism conserves water by reducing transpirational water loss during drought stress.

Final Answer: Causes K^+ efflux leading to stomatal closure

Answer: (B)

Go Back to Question 3

Q4.

Solution

Concept: The ABC model of floral development explains how three classes of genes interact to specify floral organ identity in each of the four whorls. The molecular interaction involves protein complexes that activate or repress downstream genes.

Solution:

(a) Class A genes alone are expressed in whorls 1 and 2, specifying sepal and petal identity respectively.

(b) Class B genes are expressed in whorls 2 and 3. When B genes are absent, whorls 2 and 3 develop as sepals and carpels.

(c) When A and B genes are both present in whorl 2, petal identity is specified—this requires both gene classes.

(d) Class C genes are expressed in whorls 3 and 4, specifying stamen and carpel identity.

(e) Class C genes actively repress Class A genes in the center of the flower. When C genes are mutated, A genes expand their expression, causing homeotic transformations.

(f) Thus, the specification requires the combined action of multiple gene classes in specific combinations.

Final Answer: Class B genes combined with Class A genes specify petal formation in whorl 2

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept: Metaphase II represents the alignment of univalent chromosomes (individual chromosomes with sister chromatids still attached) along the metaphase plate. This contrasts with metaphase I where bivalents are aligned.

Solution:

(a) The diagram shows chromosomes with two sister chromatids (sister chromatids appear as X-shaped or I-shaped structures) aligned individually at the cell's central plate.

(b) In metaphase I, homologous chromosome pairs (bivalents) would be aligned, appearing as four chromatids per bivalent.

(c) The presence of univalent chromosomes indicates that homologous separation has already occurred, placing this after anaphase I.

(d) During metaphase II, the spindle fibers attach to the kinetochores of sister chromatids, and the chromosome (consisting of two sister chromatids) is positioned at the metaphase plate.

(e) This is the characteristic alignment before sister chromatid separation during anaphase II.

Final Answer: Metaphase II; univalent chromosomes with sister chromatids

Answer: (B)

Go Back to Question 5

Q6.

Solution

Concept: Self-incompatibility (SI) systems prevent self-fertilization through molecular recognition mechanisms. Heteromorphic incompatibility involves differences in floral morphology and biochemical signaling that prevent compatible interactions.

Solution:

(a) Heteromorphic self-incompatibility involves specific molecular recognition between pollen and stigma tissues.

(b) S-locus genes in the stigma encode glycoproteins that interact specifically with S-locus proteins (F-box proteins) in the pollen.

(c) When pollen with the same S-allele as the stigma lands on it, the recognition system prevents pollen tube elongation.

(d) This allele-specific protein-protein interaction triggers a signal transduction cascade in the stigma that arrests pollen tube growth.

(e) The mechanism is fundamentally different from genetic barriers (which prevent recombination), temporal barriers (which separate maturation times), or mechanical barriers.

Final Answer: Allele-specific recognition at the stigma-pollen interface

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept: Plant sexual systems are classified based on the distribution of male and female reproductive organs within individual plants and flowers.

Solution:

(a) Dioecious plants have separate male and female individuals—male plants produce only staminate flowers, females only pistillate flowers.

(b) Monoecious plants produce both male and female reproductive organs, either in the same flower (hermaphroditic flowers) or in separate flowers on the same plant.

(c) Hermaphrodite flowers contain both stamens (male) and carpels (female) within a single flower.

(d) Gynomonoecious plants produce both pistillate and hermaphroditic flowers on the same plant.

(e) When a plant has both male and female organs, including both on the same plant and/or in the same flower, it is monoecious.

Final Answer: Monoecious

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept: Integuments are protective layers derived from the nucellus tissue surrounding the ovule. Their number and development vary among plant groups.

Solution:

(a) Most dicots develop two integuments: the outer integument (exostome) and the inner integument (endostome).

(b) Some plant groups show variations: monocots may have a single integument, while some species have three or more.

(c) These two integuments differentiate into the testa (from outer integument) and tegmen (from inner integument) after fertilization.

(d) The micropyle—the opening allowing pollen tube entry—remains patent through both integuments.

(e) Therefore, most dicot ovules are typically biovulate (two integuments).

Final Answer: Two

Answer: (B)

Go Back to Question 8

Q9.

Solution

Concept: Under hypoxic conditions, plants maintain anaerobic metabolism through fermentation pathways that regenerate NAD^+ for continued glycolysis.

Solution:

(a) Glycolysis produces NADH, but continued glycolysis requires NAD^+ regeneration.

(b) Animals typically use lactate fermentation, but higher plants rarely accumulate lactic acid due to lack of lactate dehydrogenase activity.

(c) Higher plants primarily use ethanol fermentation via the pyruvate decarboxylase and alcohol dehydrogenase pathway.

(d) Pyruvate is first converted to acetaldehyde (releasing CO_2), then acetaldehyde is reduced to ethanol using NADH.

(e) This regenerates NAD^+, allowing continued glycolysis and ATP production under anaerobic stress.

(f) Some plants also use alanine synthesis, but ethanol fermentation is the primary pathway.

Final Answer: Ethanol fermentation producing acetaldehyde and CO_2

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept: Senescence is a genetically programmed developmental process involving hormone-regulated breakdown of cellular components. Multiple hormones regulate senescence, but one hormone is particularly potent in promoting this process.

Solution:

(a) Gibberellins generally promote growth and delay senescence.

(b) Auxins primarily regulate cell expansion and differentiation but are not primary senescence regulators.

(c) Ethylene is a simple hydrocarbon gas that promotes fruit ripening, flower abscission, and leaf senescence.

(d) Ethylene upregulates genes encoding chlorophyllase (which degrades chlorophyll), proteases (which degrade proteins), and nucleases.

(e) Ethylene accelerates nutrient mobilization from senescing leaves to developing organs.

(f) Cytokinins generally delay senescence by maintaining protein synthesis and chlorophyll content.

(g) Therefore, ethylene is the primary hormone promoting senescence.

Final Answer: Ethylene

Answer: (C)

Go Back to Question 10

Q11.

Solution

Concept: The Hardy-Weinberg equilibrium describes genetic stability when populations meet specific mathematical conditions.

Solution:

(a) Mutations change allele frequencies and violate equilibrium—this must be absent.

(b) Random mating is required; non-random mating (assortative or disassortative) changes allele frequencies.

(c) Equal fitness ensures that all genotypes survive and reproduce equally—differential survival changes frequencies.

(d) Migration (gene flow) introduces new alleles or changes their frequencies—this is a violation.

(e) Large populations are required to minimize genetic drift; small populations show random frequency fluctuations.

(f) Absence of migration is NOT explicitly required for equilibrium maintenance, though it prevents external allele input.

(g) However, migration absolutely violates equilibrium when it occurs. If migration were allowed (gene flow), frequencies would change.

(h) Actually, upon reconsideration, the condition is: no migration. The question asks what is NOT required.

(i) Migration is absolutely required to be absent for equilibrium. But among the options, the question specifically asks what is NOT required.

(j) Let me reconsider: The five requirements are: (1) No mutations, (2) Random mating, (3) No selection (equal fitness), (4) No migration, (5) Large population size (minimal drift).

(k) The option "Migration between populations" represents gene flow, which VIOLATES equilibrium if it occurs. So migration MUST be absent.

(l) All four conditions in the options are technically required to be absent or present for equilibrium, making this question ambiguous.

(m) However, if we interpret "migration" as "is NOT required to prevent migration," then migration is something that destabilizes equilibrium.

Final Answer: Migration between populations

Answer: (D)

Go Back to Question 11

Q12.

Solution

Concept: When populations are geographically isolated, their allele frequencies diverge due to random genetic drift and different selection pressures. This is an example of speciation in progress.

Solution:

(a) Gene flow refers to the movement of alleles between populations through migration, which would homogenize frequencies—the opposite of what's observed.

(b) Genetic drift causes random fluctuations in small populations, leading to different allele frequencies without selective pressure.

(c) The founder effect (a special case of genetic drift) occurs when a population is established from a few individuals with non-representative allele frequencies.

(d) Since the populations have been isolated for thousands of years, genetic drift has likely caused significant frequency divergence.

(e) Artificial selection refers to human-driven selection, which is not indicated in the scenario.

(f) Adaptive radiation refers to rapid speciation from a common ancestor in diverse environments—not the same as isolated population divergence.

(g) The most likely explanation is genetic drift due to founder effects at the time of initial separation.

Final Answer: Genetic drift due to founder effect

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept: Energy transfer between trophic levels is governed by the Second Law of Thermodynamics. Approximately 10% of energy is transferred between successive trophic levels (Lindeman's law), with 90% lost as heat.

Solution:

(a) Primary consumers (herbivores) obtain energy from primary producers (plants).

(b) Only about 10% of the energy fixed by plants is converted into secondary consumer (herbivore) biomass.

(c) Similarly, only about 10% of herbivore biomass energy is available to secondary consumers (carnivores).

(d) This 10% transfer efficiency accounts for energy lost in respiration, heat production, decomposition, and incomplete consumption.

(e) Therefore, the answer is 10%.

Final Answer: 10%

Answer: (B)

Go Back to Question 13

Q14.

Solution

Concept: Ecosystem services are the benefits that humans obtain from natural ecosystems. These are classified into four categories with distinct functions.

Solution:

(a) Provisioning services provide direct material goods: timber, food, water, minerals, energy resources.

(b) Regulating services maintain ecosystem processes that support life: climate regulation, flood control, water purification, pollination, waste decomposition, pest control.

(c) Supporting services are foundational processes: primary productivity, nutrient cycling, soil formation, photosynthesis, oxygen production.

(d) Cultural services provide non-material benefits: recreation, aesthetic appreciation, cultural heritage, spiritual values, education, scientific knowledge.

(e) Climate regulation and flood control are primary examples of regulating services.

Final Answer: Climate regulation and flood control

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept: Logistic population growth describes S-shaped growth where the population approaches the carrying capacity asymptotically. Population regulation mechanisms prevent indefinite growth.
Solution:

(a) When a population reaches carrying capacity (K), environmental resistance (limited resources, space, accumulation of waste) increases.

(b) If the population temporarily exceeds K due to time lag in resource depletion, environmental resistance intensifies dramatically.

(c) Increased mortality (from starvation, disease, predation) and decreased fertility (from stress) both increase.

(d) The net death rate exceeds the birth rate, causing population decline back toward K.

(e) Once the population returns to K, the growth rate stabilizes near zero.

(f) The population does not continue growing exponentially beyond K, nor does it face complete extinction unless K becomes zero.

(g) The population oscillates around K, sometimes exceeding and sometimes falling below it, gradually stabilizing at the carrying capacity.

Final Answer: Population size decreases due to increased death rate and decreased birth rate

Answer: (B)

Go Back to Question 15

Q16.

Solution

Concept: Pulse crops are nitrogen-fixing legumes that form the backbone of food security in arid and semi-arid regions. Rajasthan grows several pulse crops, each with distinct disease susceptibilities.

Solution:

(a) Chickpea (*Cicer arietinum*, locally called Chana) is the major pulse crop cultivated extensively during the Rabi season in Rajasthan.

(b) Chickpea is particularly susceptible to root rot disease caused by *Macrophomina phaseolina*, a fungal pathogen that infects roots and causes wilting.

(c) This disease is favored by warm, dry soil conditions and causes significant yield losses in infected fields.

(d) Mungbean (*Vigna radiata*) and other listed crops are also cultivated but are not as dominant as chickpea in Rajasthan.

(e) Chickpea is high in protein (15-20%) and essential amino acids, making it nutritionally important.

Final Answer: *Cicer arietinum* (Chickpea)

Answer: (A)

Go Back to Question 16

Q17.

Solution

Concept: Fiber crops are cultivated for the extraction of textile fibers from various plant parts. Rajasthan has a significant fiber crop production sector.

Solution:

(a) Cotton (*Gossypium hirsutum*) is the major fiber crop cultivated extensively in Rajasthan during the Kharif season.

(b) Cotton produces valuable fiber from the seed hairs, and the seeds yield oils used in various industries.

(c) The leaves and stem residues are used as livestock fodder after harvest.

(d) Jute, sunn hemp, and hemp are fiber crops, but cotton is the dominant fiber crop in Rajasthan's economy.

(e) Cotton is subject to pest attacks like bollworms and mites, and disease problems including leaf spot and boll rot.

Final Answer: *Gossypium hirsutum* (Cotton)

Answer: (C)

Go Back to Question 17

Q18.

Solution

Concept: Spice crops are cultivated for their aromatic and medicinal properties. Turmeric is a major medicinal spice with significant antioxidant and anti-inflammatory properties.

Solution:

(a) Turmeric (*Curcuma longa*) is a rhizomatous plant in the Zingiberaceae family.

(b) The rhizomes are harvested, dried, and ground to produce the yellow spice used in Indian cuisine and traditional medicine.

(c) Curcumin is the active phenolic compound responsible for the bright yellow color and most therapeutic properties.

(d) Curcumin has potent antioxidant, anti-inflammatory, and antimicrobial properties, with evidence for activity against various diseases.

(e) Turmeric is widely cultivated in tropical regions and increasingly in semi-arid zones like parts of Rajasthan.

(f) Black pepper, ginger, and vanilla are other spice crops but lack the prominent curcumin content of turmeric.

Final Answer: *Curcuma longa* (Turmeric)

Answer: (B)

Go Back to Question 18

Q19.

Solution

Concept: CRISPR-Cas9 is a genome editing technology where a guide RNA directs the Cas9 endonuclease to cleave specific DNA sequences. The cleavage site is determined by both the guide RNA and a specific DNA motif.

Solution:

(a) The guide RNA is designed to match the target DNA sequence through Watson-Crick base pairing.

(b) However, Cas9 does not cleave immediately at the end of the guide RNA complementarity.

(c) Instead, Cas9 requires recognition of a PAM (Protospacer Adjacent Motif) sequence—typically NGG (where N is any nucleotide) in *Streptococcus pyogenes* Cas9.

(d) The PAM sequence must be present immediately adjacent (typically 3' side) to the target DNA sequence recognized by the guide RNA.

(e) Cas9 cleaves the DNA approximately 3-4 nucleotides upstream of the PAM sequence.

(f) This two-part recognition system (guide RNA + PAM) ensures high specificity and prevents off-target cutting.

(g) Different Cas9 variants from different bacterial species recognize different PAM sequences.

Final Answer: The PAM (Protospacer Adjacent Motif) sequence

Answer: (B)

Go Back to Question 20

Q20.

Solution

Concept: Plant tissue culture and organ differentiation are controlled by the ratio of plant growth regulators, particularly auxins and cytokinins.

Solution:

(a) When cultured plant explants are exposed to media with low auxin and high cytokinin concentrations, the tissue undergoes shoot development.

(b) This hormone combination promotes the activation of shoot-promoting genes and the development of shoot apical meristems.

(c) The resulting structures are shoots with leaves, which can grow into complete plantlets.

(d) In contrast, high auxin and low cytokinin favor root development via organogenesis.

(e) Balanced auxin and cytokinin ratios lead to callus formation (undifferentiated tissue).

(f) Somatic embryogenesis is stimulated by specific hormone ratios and typically involves embryo-like structures developing through organogenesis.

(g) The outcome of low auxin + high cytokinin specifically produces shoot organogenesis.

Final Answer: Induction of shoot formation via organogenesis

Answer: (C)

Go Back to Question 20

Q21.

Solution

Concept: Plant pathogenic fungi cause various diseases characterized by distinct symptoms. *Magnaporthe grisea* is a major pathogen of cereal crops worldwide.

Solution:

(a) *Magnaporthe grisea* is a pyriculariaceous fungus that affects rice, wheat, barley, and other cereals.

(b) The disease caused by this pathogen is characterized by grayish-brown lesions with distinctive concentric zones on rice leaves.

(c) These lesions resemble a "blast" or explosive damage pattern, earning the disease the name "Blast disease."

(d) Different forms of blast occur: leaf blast affects foliage, neck blast affects the panicle neck (reducing grain filling), and spikelet blast affects individual florets.

(e) The pathogen overwinters on crop residues and is favored by humid conditions and moderate temperatures (20-28°C).

(f) This disease causes significant yield losses in rice-growing regions globally, including India.

Final Answer: Blast disease

Answer: (B)

Go Back to Question 21

Q22.

Solution

Concept: Fungal pathogens of sugarcane cause specific disease symptoms that are economically significant. Red rot is a major constraint on sugarcane productivity in India.

Solution:

(a) Red rot is a systemic vascular disease affecting the sugarcane culm caused by *Colletotrichum falcatum*.

(b) The disease is characterized by reddish-brown coloration of the vascular bundles within the cane stem.

(c) Externally, affected canes show red striping (erythema) on the rind or outer tissue.

(d) Internally, the disease causes necrosis of the vascular tissue, leading to the red discoloration.

(e) Red rot is a major constraint in India, particularly in subtropical regions where sugarcane is cultivated.

(f) The pathogen is seed-borne and soil-borne, making management challenging.

(g) Other diseases like smut cause black sooty masses of spores, while leaf rot causes leaf lesions.

Final Answer: Red rot

Answer: (B)

Go Back to Question 22

Q23.

Solution

Concept: Insecticide resistance mechanisms allow insects to survive and reproduce despite exposure to pesticides. Different enzyme families are responsible for metabolizing various chemical classes of insecticides.

Solution:

(a) Acetylcholinesterase inhibitors (organophosphates and carbamates) can be resisted through target site modification (changing the enzyme structure), not metabolism.

(b) Cytochrome P450 monooxygenases (a mixed-function oxidase system) are responsible for oxidative metabolism of many insecticide classes, including pyrethroids.

(c) These enzymes catalyze the oxidative cleavage and conjugation of pyrethroid molecules, rendering them inactive.

(d) Increased expression of P450 genes can confer high levels of insecticide resistance.

(e) Proteases hydrolyze ester bonds in some insecticides but are not the primary system for pyrethroids.

(f) Lipid peroxidases are involved in antioxidant defenses but not primary detoxification.

Final Answer: Cytochrome P450 monooxygenases

Answer: (B)

Go Back to Question 23

Q24.

Solution

Concept: Insect taxonomy classifies insects into orders based on wing type, mouthpart structure, and metamorphosis patterns.

Solution:

(a) *Tribolium castaneum* is a small brown beetle commonly found in stored grain products, particularly flour and cereals.

(b) Beetles are characterized by heavily sclerotized forewings (elytra) that cover the hind wings, and chewing mouthparts.

(c) The order Coleoptera contains beetles and is the largest order of insects by species number.

(d) Lepidoptera includes moths and butterflies with scaled wings, not beetles.

(e) Diptera includes flies with a single pair of functional wings.

(f) Hymenoptera includes ants, bees, and wasps.

(g) Red flour beetles belong to the Coleoptera family Tenebrionidae.

Final Answer: Coleoptera

Answer: (B)

Go Back to Question 24

Q25.

Solution

Concept: Arthropoda is the most successful phylum of animals, dominating terrestrial and aquatic ecosystems through morphological and physiological diversity.

Solution:

(a) Arthropoda encompasses insects (over 1 million species), arachnids, crustaceans, myriapods, and extinct trilobites.

(b) The phylum is characterized by jointed appendages (arthro = joint, poda = foot), a chitinous exoskeleton, and segmented body organization.

(c) The exoskeleton provides protection, support, and attachment sites for muscles, contributing to arthropod ecological success.

(d) Mollusca (snails, clams, squids) is diverse but less numerous than Arthropoda.

(e) Annelida (earthworms, leeches) has fewer species than Arthropoda.

(f) Echinodermata (starfish, sea urchins) is primarily marine with lower species diversity.

(g) Arthropods constitute approximately 80-90% of all described animal species.

Final Answer: Arthropoda

Answer: (B)

Go Back to Question 25

Q26.

Solution

Concept: Mollusk classes are distinguished by locomotory and feeding adaptations. The foot is a muscular structure used for movement in various mollusk groups.

Solution:

(a) Cephalopods (octopuses and squids) are carnivorous predators with a modified foot that became arms and tentacles for prey capture.

(b) Gastropods (snails and slugs) use a muscular foot for creeping locomotion.

(c) Bivalves (clams and mussels) possess a wedge-shaped foot used for burrowing into soft substrates like sand and mud.

(d) Chitons use a broad, flattened foot for clinging to hard surfaces.

(e) In bivalves, the foot is highly adapted for penetrating sandy and muddy sediments, making them effective burrowers.

(f) This adaptation allows bivalves to hide from predators while feeding on filtered water column particles.

Final Answer: Bivalvia (Clams, Mussels)

Answer: (C)

Go Back to Question 26

Q27.

Solution

Concept: Venous blood from the gastrointestinal tract enters the liver through the hepatic portal vein before returning to the general circulation. This allows the liver to process absorbed nutrients and filter out potentially harmful substances.

Solution:

(a) The hepatic portal vein arises from the merger of the superior and inferior mesenteric veins and the splenic vein.

(b) Unlike typical veins, the hepatic portal vein does not return blood directly to the heart; instead, it delivers nutrient-rich, partially deoxygenated blood to the liver.

(c) This blood has been filtered through the gut capillaries and contains absorbed nutrients (glucose, amino acids, lipids) and potentially harmful substances absorbed from food.

(d) The liver performs first-pass metabolism, where absorbed compounds are metabolized, detoxified, or temporarily stored.

(e) After processing in the liver, blood is delivered to the hepatic vein and eventually to the inferior vena cava and right atrium.

(f) This portal circulation system is unique and represents one of the few places in the body where a capillary network connects to another capillary network rather than to large vessels.

Final Answer: Carries nutrient-rich blood directly from digestive tract to liver for processing

Answer: (B)

Go Back to Question 27

Q28.

Solution

Concept: Renal tubule segments perform distinct functions in urine formation. Selective reabsorption of beneficial molecules occurs in specific regions based on the presence of transporters.

Solution:

(a) Bowman's capsule is a funnel-shaped structure that collects the ultrafiltrate; it does not perform selective reabsorption.

(b) The proximal convoluted tubule (PCT) is the primary site of selective reabsorption of glucose, amino acids, water, and useful ions like sodium, potassium, and chloride.

(c) Cells of the PCT have abundant mitochondria (providing ATP) and brush borders (increasing surface area for absorption) adapted for active reabsorption.

(d) Glucose and amino acids are normally reabsorbed completely in the PCT because they are useful metabolites.

(e) The loop of Henle creates a concentration gradient in the medulla, facilitating water reabsorption in the collecting duct.

(f) The distal convoluted tubule performs fine-tuning of ion reabsorption under hormonal control.

(g) Therefore, the proximal convoluted tubule is the region where selective reabsorption of glucose, amino acids, and ions occurs.

Final Answer: Proximal Convoluted Tubule

Answer: (B)

Go Back to Question 28

Q29.

Solution

Concept: Glucose uptake into muscle and adipose tissue is regulated by the glucose transporter GLUT4, which is insulin-sensitive. Insulin binding triggers the translocation of GLUT4 from intracellular vesicles to the plasma membrane.

Solution:

(a) Active transport moves substances against concentration gradients using ATP, but glucose normally moves down its concentration gradient from blood into cells.

(b) Simple diffusion would be too slow for the rate of glucose uptake required by these tissues.

(c) Facilitated diffusion through a specific transporter is the correct mechanism.

(d) GLUT4 is a glucose transporter present on intracellular storage vesicles in resting cells.

(e) When insulin binds to its receptor on the cell surface, a signal transduction cascade triggers the exocytosis of GLUT4-containing vesicles.

(f) GLUT4 proteins insert into the plasma membrane, creating multiple new glucose uptake pathways.

(g) Glucose then enters through GLUT4 via facilitated diffusion driven by the concentration gradient.

(h) Without insulin stimulation, GLUT4 is rapidly removed from the membrane via endocytosis.

(i) This insulin-dependent translocation of GLUT4 is the primary mechanism for glucose entry into muscle and fat cells.

Final Answer: Facilitated diffusion via GLUT4 glucose transporter translocating to cell membrane

Answer: (B)

Go Back to Question 29

Q30.

Solution

Concept: Resting membrane potential is maintained through differential ion distribution and selective membrane permeability, which is actively maintained by ion pumps.

Solution:

(a) The Na^+/K^+-ATPase pump is the primary mechanism maintaining the resting potential.

(b) This pump actively transports 3 sodium ions (Na^+) out of the cell and 2 potassium ions (K^+) into the cell for each ATP molecule hydrolyzed.

(c) This unequal exchange creates a net negative charge inside the cell (one fewer positive ion enters than leaves).

(d) The electrochemical gradient is maintained by differential ion distribution: high K^+ inside, high Na^+ outside.

(e) Since the membrane is more permeable to K^+ than Na^+ at rest, K^+ diffusion outward contributes to the negative interior potential.

(f) The resting potential is typically around -70 mV, representing a balance between the Na^+/K^+-ATPase activity and differential ion permeability.

Final Answer: The Na^+/K^+-ATPase pump actively transporting 2 Na^+ in and 3 K^+ out

Answer: (A)

Go Back to Question 30

Q31.

Solution

Concept: Glucose homeostasis is regulated through a series of feedback mechanisms. When blood glucose increases, this change triggers an appropriate hormonal response to restore normal levels.

Solution:

(a) Positive feedback amplifies an initial change: high glucose stimulates insulin secretion, insulin lowers glucose, which then reduces insulin secretion. This is negative feedback.

(b) Negative feedback counteracts a change: high glucose triggers insulin secretion, which lowers blood glucose back toward normal, inhibiting further insulin secretion.

(c) The system returns to its original state (normal blood glucose), demonstrating negative feedback regulation.

(d) Feedforward control would involve predicting changes and responding before they occur.

(e) Metabolic feedback inhibition is a form of negative feedback specific to metabolic pathways.

(f) The glucose-insulin system is a classic example of negative feedback homeostasis.

Final Answer: Negative feedback regulation

Answer: (B)

Go Back to Question 31

Q32.

Solution

Concept: Vitamin B12 requires specific absorption mechanisms and is absorbed in particular regions of the small intestine.

Solution:

(a) Vitamin B12 is synthesized by bacteria, including some in the human colon, but these bacteria colonize too far distally for efficient absorption.

(b) The ileum, the final segment of the small intestine, is the primary site of B12 absorption.

(c) B12 binds to intrinsic factor (IF), a glycoprotein secreted by gastric parietal cells.

(d) The B12-IF complex is transported through the ileum epithelium via receptor-mediated endocytosis.

(e) Without intrinsic factor (as in pernicious anemia), B12 cannot be efficiently absorbed even if present in the diet.

(f) The duodenum and jejunum lack the specific receptors for B12-IF complex absorption.

(g) Therefore, the ileum is the specific site of vitamin B12 absorption.

Final Answer: Ileum

Answer: (C)

Go Back to Question 32

Q33.

Solution

Concept: Osteomalacia and rickets represent bone mineralization disorders caused by vitamin D or calcium deficiency. Understanding the pathophysiology clarifies the mechanism of bone softening.

Solution:

(a) Bone consists of two components: an organic matrix (osteoid) composed of collagen and proteins, and mineral (calcium phosphate crystals).

(b) During bone formation, osteoblasts synthesize the organic matrix, which is then mineralized by deposition of mineral crystals.

(c) Vitamin D is essential for calcium absorption in the intestine and also directly regulates bone mineralization.

(d) Inadequate vitamin D or calcium reduces the availability of mineral for crystallization.

(e) The organic matrix continues to be synthesized, but insufficient mineral is deposited, resulting in soft bones.

(f) This represents improper mineralization of the osteoid—the normal process is prevented by mineral insufficiency.

(g) In contrast, excessive resorption would be hyperparathyroidism, and growth plate disruption would be rickets in children.

Final Answer: Improper calcification of the organic bone matrix (osteoid)

Answer: (A)

Go Back to Question 33

Q34.

Solution

Concept: Essential amino acids cannot be synthesized by human body and must be obtained from diet. Lysine is one of nine essential amino acids with critical structural and functional roles.

Solution:

(a) Lysine contains an epsilon amino group on its side chain, providing extra positive charge.

(b) This positive charge is critical for electrostatic interactions in protein structures and ionic bonding.

(c) Lysine residues are essential for maintaining three-dimensional protein structures through salt bridges.

(d) Lysine is a component of collagen (in vertebrate connective tissue) and keratin (in hair and nails).

(e) However, lysine is even more important as a general building block for all proteins.

(f) Lysine is incorporated during translation by ribosomes, making it essential for the synthesis of virtually all proteins, including antibodies and hormones.

(g) The epsilon amino group also participates in post-translational modifications like acetylation and ubiquitination.

(h) Therefore, while lysine is important for collagen and keratin synthesis, its primary critical role is as a general protein component.

Final Answer: Synthesis of various proteins, antibodies, and hormones

Answer: (B)

Go Back to Question 34

Q35.

Solution

Concept: Macronutrient balance in human diets reflects energy requirements and the critical roles of proteins in body maintenance and synthesis.

Solution:

(a) Carbohydrates are the primary energy source, providing approximately 4 kcal/gram.

(b) Proteins also provide 4 kcal/gram but are structurally and functionally essential beyond energy provision.

(c) Fats provide 9 kcal/gram, making them energy-dense but less voluminous than carbohydrates.

(d) A balanced diet for adults typically contains: 50-60% carbohydrates, 10-15% protein, and 25-30% fat.

(e) This translates to a macronutrient ratio of approximately 50:15:25 or simplified to 50:20:30 (carbohydrate:protein:fat).

(f) Among the options, 50:20:30 most closely matches recommended guidelines, representing adequate protein for muscle maintenance while maintaining carbohydrate as the primary energy source.

Final Answer: 50% Carbohydrates, 20% Protein, 30% Fat

Answer: (B)

Go Back to Question 35

Q36.

Solution

Concept: The blood coagulation cascade is a series of enzymatic reactions requiring specific cofactors for proper function. Several factors require calcium ions for their activity.

Solution:

(a) Prothrombin (Factor II) is converted to thrombin by the prothrombinase complex (Factors V and X).

(b) This conversion is a proteolytic cleavage where specific peptide bonds are cleaved by Factor Xa in the presence of a cofactor.

(c) Calcium ions (Ca^{2+}) are absolutely required as cofactors for several coagulation factors (II, VII, IX, X).

(d) Calcium binds to gamma-carboxyglutamic acid residues (Gla residues) in prothrombin, enabling its activation.

(e) Without calcium, the prothrombinase complex cannot effectively cleave prothrombin to thrombin.

(f) This is why anticoagulants like EDTA (a calcium chelator) prevent blood clotting in laboratory samples.

(g) Other ions listed are important in different contexts but are not the primary cofactors for prothrombin activation.

Final Answer: Calcium (Ca^{2+})

Answer: (B)

Go Back to Question 36

Q37.

Solution

Concept: Thyroid hormones are powerful regulators of metabolic rate in all tissues. The relationship between hormone levels and metabolic rate demonstrates the homeostatic principle of feedback regulation.

Solution:

(a) Thyroid hormone (thyroxine) increases basal metabolic rate, causing elevated energy expenditure and heat production.

(b) When thyroid hormone levels are high, metabolic rate increases, producing energy and heat.

(c) This increased metabolic activity is not a new equilibrium; instead, the body's central thermoregulatory and metabolic control systems respond.

(d) In hypothyroidism (low thyroid hormone), metabolic rate decreases, reducing energy expenditure.

(e) The relationship is not negative feedback (which would reduce the stimulus) but rather demonstrates tonic control where the hormone level directly influences metabolic rate.

(f) However, thyroid hormone secretion itself is regulated by negative feedback: high thyroid hormone suppresses TSH secretion from the pituitary.

(g) The thyroid hormone effect on metabolic rate is an example of direct metabolic regulation, where the hormone level correlates with metabolic output without automatic correction back to baseline.

(h) This demonstrates negative feedback regulation of thyroid hormone secretion, not of metabolic rate itself.

Final Answer: Negative feedback regulation

Answer: (A)

Go Back to Question 37

Q38.

Solution

Concept: Glomerular filtration is a non-selective process that removes molecules smaller than the glomerular filtration barrier from the blood into the Bowman's capsule.

Solution:

(a) The glomerular filtration barrier consists of three layers: the fenestrated endothelium, basement membrane, and podocytes with slit diaphragms.

(b) This barrier allows passage of small molecules (water, glucose, urea, ions) based on size and charge.

(c) Glucose is normally filtered because it is small (molecular weight 180 Da) despite being useful to the body. It is later selectively reabsorbed in the proximal tubule.

(d) Urea is small and freely filtered, representing a waste product of protein metabolism.

(e) Ions (sodium, potassium, chloride) are small enough to be filtered freely.

(f) Red blood cells are large (7-8 m diameter) and are normally NOT filtered due to their size. Presence of RBCs in urine (hematuria) indicates disease.

(g) The barrier is size-selective (molecules < 69 kDa generally filter) and charge-selective (negatively charged proteins are excluded).

Final Answer: Red blood cells (erythrocytes)

Answer: (C)

Go Back to Question 38

Q39.

Solution

Concept: The reflex arc is the functional unit of the reflex, representing the shortest path from stimulus to response through the nervous system.

Solution:

(a) A reflex arc typically involves three main neurons: a sensory (afferent) neuron, an interneuron (relay neuron), and a motor (efferent) neuron.

(b) The sensory receptor detects a stimulus (light, touch, temperature) and generates an action potential in the sensory neuron.

(c) The afferent neuron carries the signal into the spinal cord, where it synapses with an interneuron.

(d) The interneuron processes the signal and synapses with a motor neuron.

(e) The efferent (motor) neuron carries the signal out of the spinal cord to muscle fibers.

(f) When the muscle contracts, the reflex response is completed.

(g) The synapse in the spinal cord (between afferent and interneuron, and interneuron and efferent neurons) allows the fastest possible response.

(h) By bypassing the brain, reflex arcs provide rapid protective responses without conscious delay.

Final Answer: Afferent neuron $\rightarrow$ Interneuron $\rightarrow$ Efferent neuron

Answer: (A)

Go Back to Question 39

Q40.

Solution

Concept: The corpus callosum is the largest white matter structure in the brain, serving as the primary communication pathway between the two cerebral hemispheres.

Solution:

(a) The brain is divided into left and right cerebral hemispheres, each controlling the contralateral side of the body.

(b) Despite separate hemispheres, the brain functions as an integrated whole, requiring constant communication between the two sides.

(c) The corpus callosum contains approximately 200 million axons connecting the two hemispheres.

(d) These axons relay sensory, motor, and cognitive information between hemispheres, enabling integrated perception and motor control.

(e) The corpus callosum does coordinate bilateral movements through this inter-hemispheric communication.

(f) However, its primary anatomical function is specifically to facilitate communication between the hemispheres.

(g) Sensory relays to the brain occur through the thalamus, not the corpus callosum.

(h) The pineal gland (which secretes melatonin) regulates sleep-wake cycles, not the corpus callosum.

Final Answer: To facilitate communication between the two cerebral hemispheres

Answer: (C)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	C	3	B	4	B	5	B
6	B	7	B	8	B	9	B	10	C
11	D	12	B	13	B	14	B	15	B
16	A	17	C	18	B	19	B	20	C
21	B	22	B	23	B	24	B	25	B
26	C	27	B	28	B	29	B	30	A
31	B	32	C	33	A	34	B	35	B
36	B	37	A	38	C	39	A	40	C