Rajasthan JET Biology Sample Paper-1

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. Which of the following characteristics is NOT typical of members of the family Solanaceae?

(A) Inferior ovary

(B) Pentamerous flowers

(C) Axile placentation

(D) Alternate leaves

Q2. The enzyme that catalyzes the fixation of CO_2 in the Calvin cycle is:

(A) Phosphofructokinase

(B) Ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO)

(C) Aldolase

(D) Pyruvate kinase

Q3. Photoperiodism in plants is primarily regulated by which pigment?

(A) Chlorophyll-a

(B) Phytochrome

(C) Xanthophyll

(D) Carotenoid

Q4. During the *S* phase of the interphase, which of the following events occurs?

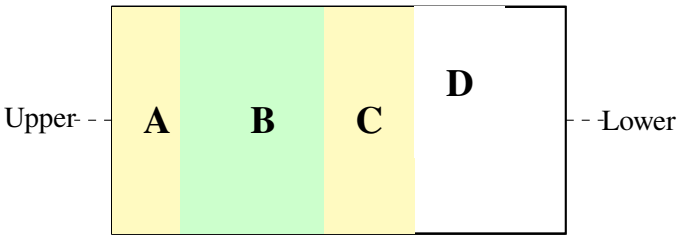
(A) DNA replication

(B) Protein synthesis

(C) Nuclear division

(D) Cytokinesis

Q5. The structure and arrangement of tissues inside a dicot leaf is shown in the diagram below. Which region is responsible for maximum photosynthesis?



Dicot Leaf Cross-Section

(A) Region A

(B) Region B

(C) Region C

(D) Region D

Q6. In a monohybrid cross between two heterozygous parents ($Aa \times Aa$), the phenotypic ratio of the F_1 generation is:

(A) 3 : 1

(B) 1 : 2 : 1

(C) 9 : 3 : 3 : 1

(D) 1 : 1 : 1 : 1

Q7. The phenomenon where a single gene controls multiple traits is called:

(A) Complementary genes

(B) Supplementary genes

(C) Pleiotropy

(D) Epistasis

Q8. Which of the following is a secondary metabolite synthesized by plants?

(A) Glucose

(B) Glycerol

(C) Quinine

(D) Alanine

Q9. The primary function of mycorrhizal fungi in plant roots is to:

(A) Fix nitrogen in the soil

(B) Absorb water and mineral nutrients

(C) Produce plant growth hormones

(D) Decompose dead organic matter

Q10. Which hormone is responsible for the inhibition of seed germination during unfavorable environmental conditions?

(A) Gibberellin

(B) Auxin

(C) Abscisic acid

(D) Cytokinin

Q11. The triploid endosperm in angiosperms is formed by the union of:

(A) One sperm nucleus and one egg nucleus

(B) One sperm nucleus and two polar nuclei

(C) Two sperm nuclei and one egg nucleus

(D) Two sperm nuclei and two polar nuclei

Q12. Guttation in plants is the process of water exudation through:

(A) Stomata

(B) Hydathodes

(C) Lenticels

(D) Trichomes

Q13. The energy-yielding stage of aerobic respiration that produces the maximum number of ATP molecules is:

(A) Glycolysis

(B) Krebs cycle

(C) Electron transport chain

(D) Decarboxylation

Q14. In the context of plant tissue culture, the hormone ratio required to induce callus formation is:

(A) Higher auxin to cytokinin ratio

(B) Higher cytokinin to auxin ratio

(C) Equal ratio of both hormones

(D) Independent of hormone ratio

Q15. Which of the following stains is specifically used to identify DNA and RNA in cells?

(A) Methylene blue

(B) Safranin

(C) Aceto-orcein

(D) Congo red

Q16. The decomposition process in which dead organic matter is broken down by microorganisms in an aerobic environment is:

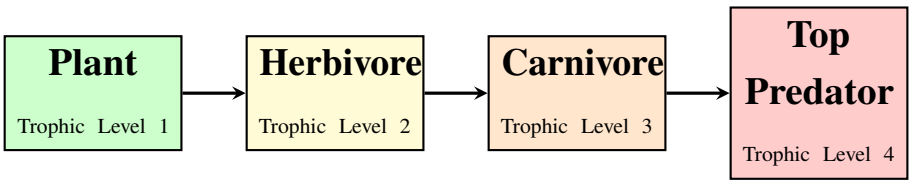
(A) Putrefaction

(B) Fermentation

(C) Composting

(D) Anaerobic respiration

Q17. The food chain pathway that begins with a primary producer is represented by the diagram below. According to ecological principles, which trophic level contains the least amount of available energy?



(A) Plant (Trophic Level 1)

(B) Herbivore (Trophic Level 2)

(C) Carnivore (Trophic Level 3)

(D) Top Predator (Trophic Level 4)

Q18. Which of the following is NOT a method of vegetative reproduction in plants?

(A) Fragmentation

(B) Micropropagation

(C) Pollination

(D) Somatic embryogenesis

Q19. Recombinant DNA technology's main application in agriculture includes:

(A) Development of genetically modified crops

(B) Traditional cross-breeding

(C) Mutation breeding

(D) Polyploidy induction

Q20. Biofortification refers to the process of:

(A) Increasing the bio-availability of nutrients in crop plants

(B) Preserving crops from pathogenic attacks

(C) Removing toxic substances from crops

(D) Increasing the yield of crops

Q21. The major kharif crop of Rajasthan that is susceptible to leaf spot disease is:

(A) Wheat

(B) Cotton

(C) Mustard

(D) Barley

Q22. Powdery mildew, a common fungal disease, primarily affects which crop in Rajasthan?

(A) Rice

(B) Chickpea

(C) Maize

(D) Sugarcane

Q23. The causal agent of late blight disease in potato is:

(A) Alternaria solani

(B) Phytophthora infestans

(C) Xanthomonas campestris

(D) Fusarium oxysporum

Q24. Which of the following insecticides is recommended for controlling the white grub pest in Rajasthan?

(A) Endosulfan

(B) Carbaryl

(C) Quinalphos

(D) Chlorpyriphos

Q25. The practice of using natural enemies to control pests is known as:

(A) Chemical control

(B) Cultural control

(C) Biological control

(D) Mechanical control

Q26. The primary body cavity of most animals is:

(A) Blastocoel

(B) Coelom

(C) Hemocoel

(D) Archenteron

Q27. The characteristic feature of members of phylum Annelida is:

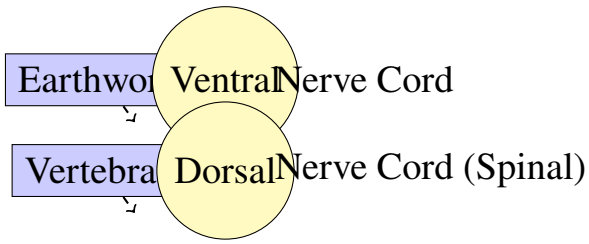
(A) Presence of segments

(B) Complete absence of segmentation

(C) Presence of jointed appendages

(D) Presence of a rigid exoskeleton

Q28. The ventral nerve cord in the earthworm is compared to which structure in vertebrates shown in the diagram below?



(A) Ventral nerve cord

(B) Dorsal nerve cord / Spinal cord

(C) Brain

(D) Autonomic nervous system

Q29. The respiratory organs of most insects are:

(A) Lungs

(B) Book gills

(C) Tracheae

(D) Skin

Q30. In a typical insect body plan, the body region that bears the wings and legs is:

(A) Head

(B) Thorax

(C) Abdomen

(D) Coxa

Q31. The control of the khapra beetle pest in stored grains can be achieved by:

(A) Exposing grains to high temperatures

(B) Using fumigants

(C) Maintaining low humidity

(D) All of the above

Q32. Which of the following nematodes is a major pest of vegetable crops in Rajasthan?

(A) Wuchereria bancrofti

(B) Ascaris lumbricoides

(C) Meloidogyne incognita

(D) Strongyloides stercoralis

Q33. The parasitic protozoan responsible for sleeping sickness in humans is:

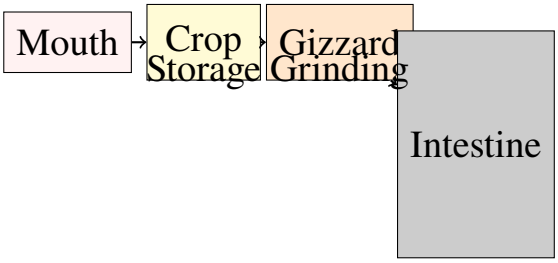
(A) Plasmodium vivax

(B) Trypanosoma brucei

(C) Leishmania donovani

(D) Entamoeba histolytica

Q34. The digestive system anatomy of the cockroach is shown in the diagram below. Which region stores food temporarily?



(A) Mouth

(B) Crop

(C) Gizzard

(D) Intestine

Q35. The primary organs of excretion in insects are:

(A) Kidneys

(B) Nephridia

(C) Malpighian tubules

(D) Contractile vacuoles

Q36. The chordate characteristic that is absent in protochordates but present in all other members is:

(A) Notochord

(B) Pharyngeal gill slits

(C) Dorsal nerve cord

(D) Vertebral column

Q37. The basal metabolic rate (BMR) of an animal is most directly influenced by:

(A) Body surface area

(B) Activity level

(C) Thyroid hormone secretion

(D) Environmental temperature

Q38. Which of the following is NOT a fat-soluble vitamin?

(A) Vitamin A

(B) Vitamin D

(C) Vitamin K

(D) Vitamin C

Q39. The enzyme that specifically initiates protein digestion in the stomach is:

(A) Amylase

(B) Pepsin

(C) Trypsin

(D) Lipase

Q40. The process by which carbohydrates are converted into glycogen and stored in the liver is called:

(A) Gluconeogenesis

(B) Glycogenesis

(C) Glycogenolysis

(D) Glycolysis

Detailed Solutions

Q1.

Solution

Concept:

The family Solanaceae (nightshade family) includes important plants such as tomato, potato, pepper, and tobacco. These plants share specific consistent morphological features that distinguish them as a unique taxonomic unit. Understanding the diagnostic characteristics is crucial for accurate plant classification.

Solution:

(a) Members of the family Solanaceae are typically characterized by pentamerous flowers, meaning all floral whorls contain five elements (sepals, petals, stamens).

(b) The flowers in Solanaceae are arranged with alternate leaves along the stems, which is a consistent feature across the family.

(c) The ovary in these flowers is typically superior (not inferior) in position, sitting above the insertion point of other floral parts. This allows for the fruit to develop freely.

(d) The placentation pattern found in Solanaceae flowers is axile placentation, where seeds are attached to a central axis within a multi-chambered ovary.

(e) An inferior ovary, where the ovary appears below other floral parts, is characteristic of families like Rosaceae and Cucurbitaceae, NOT Solanaceae.

(f) Therefore, the presence of an inferior ovary is NOT a typical feature of Solanaceae members, making it the correct answer to identify.

Final Answer: The characteristic NOT typical of Solanaceae is an inferior ovary.

Answer: (A)

Go Back to Question 1

Q2.

Solution

Concept:

The Calvin cycle, also known as the dark reaction or light-independent reaction of photosynthesis, is a cyclic biochemical pathway that fixes atmospheric carbon dioxide into organic molecules. Multiple enzymes catalyze different steps in this pathway, each with specific functions in carbon fixation and reduction.

Solution:

(a) The Calvin cycle begins with the fixation of CO_2 from the atmosphere, combining it with a five-carbon sugar molecule.

(b) Ribulose-1,5-bisphosphate (RuBP) is a five-carbon sugar that serves as the immediate CO_2 acceptor molecule.

(c) The enzyme that catalyzes the direct combination of CO_2 with RuBP is RuBisCO (ribulose-1,5-bisphosphate carboxylase/oxygenase).

(d) This enzyme is considered one of the most abundant proteins in the world due to its critical role in fixing the vast majority of carbon dioxide on Earth.

(e) RuBisCO catalyzes the initial carboxylation reaction producing an unstable 6-carbon intermediate that immediately splits into two 3-phosphoglycerate molecules.

(f) The other enzymes listed are involved in different metabolic pathways (phosphofructokinase in glycolysis, aldolase in glycolysis/gluconeogenesis, pyruvate kinase in glycolysis).

Final Answer: The enzyme that catalyzes CO_2 fixation is RuBisCO.

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept:

Photoperiodism is the physiological response of plants to the duration of light and darkness within a 24-hour period. This response is controlled by a specialized photoreceptor protein that exists in two interconvertible forms depending on light exposure, enabling plants to measure day length and regulate flowering.

Solution:

(a) Plants respond to seasonal changes in day length, which influences flowering time and dormancy patterns. This measurement of photoperiod is critical for plant survival and reproduction.

(b) The primary photoreceptor responsible for detecting light duration is the protein phytochrome, which exists in two reversible forms.

(c) The red light-absorbing form (Pr) and the far-red light-absorbing form (Pfr) interconvert based on light exposure.

(d) When exposed to red light (during the day), phytochrome converts from Pr to Pfr, the active form. During darkness or far-red light exposure, it reverts to Pr.

(e) The ratio and total amount of Pfr present at the end of the day allows plants to measure the duration of darkness and hence the length of the night.

(f) Based on this measurement, plants determine whether to flower, enter dormancy, or continue vegetative growth.

(g) Chlorophyll molecules absorb light but do not directly regulate photoperiodism; xanthophyll and carotenoid pigments are accessory pigments but not the primary photoperiodic sensor.

Final Answer: Photoperiodism is primarily regulated by phytochrome.

Answer: (B)

Go Back to Question 3

Q4.

Solution

Concept:

The cell cycle is a series of events that leads to the growth, duplication, and division of a cell. The interphase consists of G_1, S, and G_2 phases, during which the cell grows and prepares for division. The S phase is specifically dedicated to genetic material replication.

Solution:

(a) The cell cycle consists of interphase (G_1, S, and G_2) and the mitotic or meiotic phase.

(b) During G_1 phase, the cell increases in size and accumulates metabolites and nutrients necessary for replication.

(c) The S (synthesis) phase is the period during which DNA replication occurs. The cell's DNA content doubles as each chromosome is replicated.

(d) During this phase, histone proteins are also synthesized to package the newly replicated DNA into chromatin.

(e) DNA polymerase catalyzes the formation of phosphodiester bonds between nucleotides, creating exact copies of the DNA strands.

(f) After S phase, the cell enters G_2 phase, during which protein synthesis continues in preparation for mitosis.

(g) Nuclear division (mitosis) and cytokinesis occur during the mitotic phase, which is distinct from and follows the interphase.

(h) Protein synthesis occurs throughout the cell cycle but is not the primary event defining S phase.

Final Answer: During the S phase, DNA replication occurs.

Answer: (A)

Go Back to Question 4

Q5.

Solution

Concept:

The leaf is the primary photosynthetic organ of plants, with distinct tissue layers arranged to maximize light absorption and gas exchange while minimizing water loss. The anatomy of a dicot leaf differs from a monocot leaf, particularly in the arrangement and density of photosynthetic tissues. The diagram shows a typical dicot leaf structure with labeled regions.

Solution:

(a) Region A represents the upper epidermis with a layer of cuticle, providing protection and reducing water loss.

(b) Region B represents the palisade mesophyll, composed of elongated cells densely packed with chloroplasts. These cells are organized perpendicular to the leaf surface and receive maximum light exposure from the upper surface.

(c) The palisade cells are specifically adapted for photosynthesis due to their dense chloroplast content and exposure to direct light.

(d) Region C represents the spongy mesophyll, which contains loosely arranged cells with large intercellular spaces. These spaces facilitate gas exchange (CO_2 uptake and O_2 release) but contain fewer chloroplasts than palisade cells.

(e) Region D represents the lower epidermis containing stomata, which allow for gas exchange and water vapor loss.

(f) The palisade mesophyll (Region B) is the primary site of photosynthesis because it receives the most direct light and has the highest chloroplast density.

(g) In dicot leaves, palisade tissue is more developed on the upper side, reflecting the dorsiventral structure adapted to overhead light sources.

Final Answer: Region B (palisade mesophyll) is responsible for maximum photosynthesis.

Answer: (B)

Go Back to Question 5

Q6.

Solution

Concept:

Mendelian genetics describes inheritance patterns based on the segregation and assortment of alleles. A monohybrid cross examines the inheritance of a single trait controlled by one gene with two alleles. When both parents are heterozygous, the offspring show characteristic ratios.

Solution:

(a) In a monohybrid cross between two heterozygous parents ($Aa \times Aa$), each parent can contribute either the dominant allele (A) or the recessive allele (a).

(b) A Punnett square analysis of this cross yields the following genotypic ratio: 1 AA : 2 Aa : 1 aa.

(c) The AA genotype expresses the dominant phenotype, the Aa genotype also expresses the dominant phenotype (heterozygous individuals show the dominant trait), and the aa genotype expresses the recessive phenotype.

(d) Therefore, the phenotypic ratio combines the dominant phenotypes (AA and Aa together) against the recessive phenotype (aa alone).

(e) The phenotypic ratio of the F_1 generation is 3 dominant : 1 recessive, abbreviated as 3:1.

(f) This 3:1 ratio is one of the most characteristic results of Mendelian genetics and demonstrates the principle of dominance.

(g) A 1:2:1 ratio represents the genotypic, not phenotypic ratio of this cross.

Final Answer: The phenotypic ratio is 3:1.

Answer: (A)

Go Back to Question 6

Q7.

Solution

Concept:

Genetic phenomena can be classified based on the relationship between genes and their phenotypic effects. Pleiotropy refers to a situation where a single gene influences multiple, seemingly unrelated traits. This demonstrates the far-reaching effects of individual genes in biological development and physiology.

Solution:

(a) Pleiotropy is the phenomenon where a single gene has multiple, independent effects on phenotypic traits.

(b) A classic example is the gene controlling eye color in Drosophila. A mutation affecting the gene for white eye color also affects the reproductive system, making the mutant flies sterile. The same gene product influences multiple cellular processes.

(c) Another well-known example is the gene for phenylketonuria (PKU) in humans. A single gene mutation prevents the metabolism of phenylalanine, leading to intellectual disability, light pigmentation, and a characteristic "mousy" odor.

(d) In contrast, complementary genes involve the interaction of two or more genes to produce a single phenotype, not one gene producing multiple traits.

(e) Supplementary genes also involve multiple genes working together, with one gene suppressing or modifying the expression of another.

(f) Epistasis is a phenomenon where one gene masks or modifies the effect of another gene, but it does not describe a single gene controlling multiple traits.

(g) Pleiotropy demonstrates that genes do not work in isolation but have widespread effects throughout the organism.

Final Answer: The phenomenon is called pleiotropy.

Answer: (C)

Go Back to Question 7

Q8.

Solution

Concept:

Plant secondary metabolites are organic compounds synthesized by plants that are not directly involved in the fundamental life processes (growth, reproduction, development) but serve specialized functions such as defense against predators, stress tolerance, and attracting pollinators. Understanding the difference between primary and secondary metabolites is crucial in plant biochemistry.

Solution:

(a) Primary metabolites are compounds essential for normal plant growth and development, including glucose (a primary carbohydrate), glycerol (a component of fats), and amino acids like alanine (components of proteins).

(b) These compounds are involved in central pathways such as photosynthesis, respiration, protein synthesis, and lipid metabolism.

(c) Secondary metabolites, in contrast, are compounds produced by plants that are not essential for basic life functions but provide ecological advantages.

(d) Quinine is a secondary metabolite alkaloid produced by the bark of the Cinchona tree and has been historically used as an antimalarial drug.

(e) Other examples of secondary metabolites include morphine from poppies, caffeine from coffee and tea plants, and various flavonoids and terpenes used in plant defense.

(f) Secondary metabolites often accumulate in specific plant tissues (bark, roots, flowers) and may serve roles in chemical defense against herbivores and pathogens.

(g) Glucose is fundamental to photosynthesis and cellular respiration, making it a primary metabolite.

(h) Glycerol and alanine are critical components of fats and proteins, respectively, making them primary metabolites.

Final Answer: Quinine is a secondary metabolite.

Answer: (C)

Go Back to Question 8

Q9.

Solution

Concept:

Mycorrhizal associations represent a mutualistic symbiotic relationship between fungi and plant roots. The fungal hyphae extend into the soil far beyond the root system, creating a network that facilitates nutrient uptake. This partnership is particularly beneficial in nutrient-poor soils.

Solution:

(a) Mycorrhizal fungi form associations with plant roots, with the fungal hyphae penetrating either the root cortex cells (endomycorrhizae) or the root surface and apoplast (ectomycorrhizae).

(b) The primary benefit for the plant is enhanced absorption of water and mineral nutrients, particularly phosphorus and nitrogen, from the soil.

(c) The fungal hyphae extend throughout the soil, effectively increasing the absorptive surface area available to the plant root system.

(d) The fungus receives organic compounds (sugars) produced by photosynthesis and translocated to the roots by the plant.

(e) Nitrogen-fixing bacteria (such as Rhizobium), not mycorrhizal fungi, are responsible for fixing atmospheric nitrogen into bioavailable forms.

(f) While mycorrhizal fungi may synthesize some growth-promoting compounds, their primary function is nutrient absorption, not hormone production.

(g) Mycorrhizal fungi do not directly decompose dead organic matter; this function is carried out by saprotrophs and other decomposing microorganisms.

(h) The association is particularly important in natural ecosystems and in agriculture, where it increases crop productivity without requiring additional fertilizer inputs.

Final Answer: The primary function is to absorb water and mineral nutrients.

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept:

Plant hormones are organic compounds that regulate growth, development, and responses to environmental stresses. Different hormones have distinct roles: growth-promoting (gibberellins, auxins, cytokinins) and growth-inhibiting (abscisic acid). Understanding these distinctions is essential for predicting plant responses to environmental conditions.

Solution:

(a) Abscisic acid (ABA) is a plant hormone primarily responsible for stress responses, particularly in conditions of drought, cold, or salt stress.

(b) ABA inhibits seed germination by maintaining seed dormancy until environmental conditions become favorable for growth.

(c) ABA also promotes stomatal closure to reduce water loss during drought and stimulates the accumulation of osmolytic substances.

(d) In unfavorable environmental conditions (low temperature, drought, waterlogging), ABA accumulation keeps seeds dormant, preventing germination that would lead to death.

(e) When environmental conditions improve (proper temperature, moisture, light), ABA levels decrease, allowing gibberellins to promote germination.

(f) Gibberellin hormones promote seed germination and elongation of stems; they do not inhibit germination.

(g) Auxins are primarily involved in cell elongation and apical dominance, not seed dormancy regulation.

(h) Cytokinins promote cell division and shoot growth but do not inhibit germination.

(i) The balance between ABA (inhibitor) and gibberellins (promoter) determines whether seeds germinate or remain dormant.

Final Answer: The hormone is abscisic acid (ABA).

Answer: (C)

Go Back to Question 10

Q11.

Solution

Concept:

Double fertilization is a characteristic feature of flowering plants (angiosperms) that distinguishes them from all other plant groups. This process involves two fusion events: one between a sperm nucleus and the egg nucleus to form the zygote, and another between a sperm nucleus and the polar nuclei to form the endosperm. Understanding this process is crucial to angiosperm reproduction.

Solution:

(a) During double fertilization, two sperm nuclei are released from the pollen tube into the embryo sac.

(b) One sperm nucleus fuses with the egg cell (female gamete) to form the diploid zygote (2n), which develops into the embryo.

(c) The second sperm nucleus fuses with the two polar nuclei (or central cell nucleus) present in the center of the embryo sac.

(d) This fusion creates a triploid endosperm nucleus (3n), which contains three sets of chromosomes: one from the sperm and two from the polar nuclei.

(e) The triploid endosperm develops into endosperm tissue that stores nutrients for the developing embryo.

(f) The ploidy level of the endosperm (3n) is significant because it ensures that the nutrient reserves are genetically similar to the embryo, optimizing resource allocation.

(g) Other fusion combinations (such as two sperm nuclei and one egg nucleus) would not be viable or would produce incorrect ploidy levels.

(h) This double fertilization mechanism is unique to angiosperms and provides a selective advantage in plant evolution.

Final Answer: The triploid endosperm is formed by one sperm nucleus and two polar nuclei.

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept:

Guttation is the process by which plants lose water in the form of liquid droplets, distinct from transpiration which involves water vapor loss through stomata. This phenomenon occurs particularly in the early morning and is driven by root pressure developed during nighttime water absorption.

Solution:

(a) Guttation is the exudation of water in liquid form from plants, typically observed as droplets on leaf margins in early morning.

(b) This process is driven by root pressure, which develops when roots actively absorb water and minerals from the soil during the night.

(c) The absorbed water moves upward through the xylem, creating a positive hydrostatic pressure within the plant.

(d) When this root pressure exceeds atmospheric pressure, water is forced out of the plant through specialized pores called hydathodes.

(e) Hydathodes are modified stomata located at the leaf margins (particularly on dicots) or leaf tips (particularly on monocots) that permit water exudation.

(f) Unlike transpiration through stomata, which produces water vapor, guttation produces liquid water droplets because it occurs at night when transpiration is minimal.

(g) Guttation is particularly prominent in species with large leaves and high transpiration rates, such as grasses and herbaceous plants.

(h) The liquid exuded through guttation often contains dissolved minerals that can accumulate and form crusty deposits on the leaf surface.

(i) Lenticels are pores for gas exchange, not water loss; trichomes are hair-like extensions with various functions but not for guttation.

Final Answer: Guttation occurs through hydathodes.

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept:

Aerobic respiration is the process by which glucose is completely oxidized to CO_2 and H_2O in the presence of oxygen. This process is divided into four main stages: glycolysis, pyruvate decarboxylation, Krebs cycle, and electron transport chain. Each stage produces ATP (or equivalent) but in different amounts, making the electron transport chain the most energy-yielding stage.

Solution:

(a) Glycolysis occurs in the cytoplasm and produces a net yield of 2 ATP and 2 NADH molecules per glucose molecule.

(b) The Krebs cycle (citric acid cycle) occurs in the mitochondrial matrix and produces 2 GTP (equivalent to 2 ATP), 6 NADH, and 2 $FADH_2$ per glucose molecule.

(c) The electron transport chain (ETC) occurs on the inner mitochondrial membrane and is where NADH and $FADH_2$ donate their electrons.

(d) During the ETC, electrons move through a series of protein complexes, releasing energy that is used to pump protons across the mitochondrial membrane.

(e) This creates a proton gradient that powers ATP synthase, generating approximately 28-30 ATP molecules from the complete oxidation of one glucose molecule.

(f) The majority of ATP (approximately 75-80% of total) is produced in the electron transport chain due to the large number of electrons oxidized and the efficient chemiosmotic mechanism.

(g) Decarboxylation reactions produce no direct ATP but generate NADH, which subsequently produces ATP through the ETC.

(h) Therefore, the electron transport chain is the energy-yielding stage that produces the maximum number of ATP molecules during aerobic respiration.

Final Answer: The electron transport chain is the energy-yielding stage producing maximum ATP.

Answer: (C)

Go Back to Question 13

Q14.

Solution

Concept:

Plant tissue culture is a technique in which plant cells, tissues, or organs are cultured in vitro on nutrient media. The balance of plant growth regulators, particularly auxins and cytokinins, determines the developmental fate of the cultured tissue. Different hormone ratios induce different organogenetic or morphogenetic responses.

Solution:

(a) Plant tissue culture exploits the totipotency of plant cells (their ability to regenerate a whole plant from a single cell).

(b) Two key plant growth regulators control the developmental pathways in tissue culture: auxins and cytokinins.

(c) When auxin and cytokinin concentrations are approximately equal, undifferentiated cell proliferation occurs, leading to callus formation.

(d) Callus is a mass of undifferentiated parenchymatous cells that serves as the starting material for further regeneration.

(e) A higher ratio of cytokinin to auxin promotes shoot (aerial) development, allowing the formation of adventitious shoots and plantlets.

(f) A higher ratio of auxin to cytokinin promotes root development, allowing the formation of adventitious roots.

(g) The equal or roughly equal hormone ratio is specifically required for callus induction, making this the correct principle for tissue culture initiation.

(h) This relationship between hormone ratio and organogenesis is fundamental to most plant tissue culture protocols and has been validated experimentally across numerous plant species.

(i) The specific concentrations must be adjusted for different plant species based on their endogenous hormone levels and sensitivity.

Final Answer: Callus formation requires an equal ratio of both hormones.

Answer: (C)

Go Back to Question 14

Q15.

Solution

Concept:

Biological staining is a fundamental technique in cytology and microscopy used to visualize different cellular and tissue structures. Different stains have affinity for specific molecules or cellular components, allowing researchers to identify and differentiate between nucleic acids and other structures.

Solution:

(a) DNA and RNA are nucleic acids that possess distinctive chemical properties due to their phosphate groups, sugar components, and nitrogenous bases.

(b) Aceto-orcein is a stain specifically used to visualize nucleic acids in cells. It binds preferentially to DNA and RNA, staining them intensely.

(c) Aceto-orcein staining is particularly useful in preparing cells for cytological observations, such as during meiotic or mitotic studies.

(d) The stain produces characteristic colors: DNA typically appears purple or dark red, making chromosomes visible during division stages.

(e) Methylene blue is a basic dye that stains various cellular structures but is not specifically selective for nucleic acids.

(f) Safranin is an acidic dye commonly used in Gram staining of bacteria and also for plant tissue staining, but it is not the primary nucleic acid stain.

(g) Congo red is used primarily for visualizing specific structures like fungal cell walls and certain pathological deposits.

(h) For research requiring specific visualization of nucleic acids, aceto-orcein remains one of the most reliable and commonly used stains in cytological studies.

Final Answer: Aceto-orcein is used to identify DNA and RNA.

Answer: (C)

Go Back to Question 15

Q16.

Solution

Concept:

Decomposition is the process by which dead organic matter is broken down into simpler inorganic compounds. Depending on oxygen availability, decomposition can follow different pathways, with aerobic decomposition being more efficient and complete. Composting is a controlled form of aerobic decomposition with specific environmental management.

Solution:

(a) Decomposition is the biochemical breakdown of dead organisms and organic waste into basic elements and compounds.

(b) Putrefaction is anaerobic decomposition that produces foul-smelling compounds (amines, sulfides) due to incomplete oxidation in the absence of oxygen.

(c) Fermentation is an anaerobic biochemical process that produces ethanol or lactic acid and is used in food production, not for natural decomposition.

(d) Anaerobic respiration is a metabolic process but does not encompass the complete decomposition of organic matter.

(e) Composting is a controlled, aerobic decomposition process where dead organic materials are actively managed to optimize decomposition.

(f) In composting, organic matter is arranged in piles or bins and kept at optimal moisture levels with periodic turning to maintain aerobic conditions.

(g) Decomposers (bacteria, fungi) actively break down organic matter under aerobic conditions, producing carbon dioxide, water, and humus.

(h) Composting is more efficient than natural decomposition because it creates optimal conditions (temperature, moisture, aeration) that accelerate microbial activity.

(i) The product of composting is a nutrient-rich humus that can be used as soil amendment, demonstrating its value in sustainable agriculture.

Final Answer: The process is composting.

Answer: (C)

Go Back to Question 16

Q17.

Solution

Concept:

Energy transfer through food chains follows the law of conservation of energy. Energy enters the ecosystem through producers (plants) and flows through successive trophic levels via consumers. With each transfer, energy is lost as heat through respiration and maintenance, resulting in progressively less energy available at higher trophic levels.

Solution:

(a) A food chain represents the linear transfer of energy and nutrients from one organism to the next through feeding relationships.

(b) Primary producers (plants) capture solar energy through photosynthesis and convert it into chemical energy stored in organic molecules.

(c) Primary consumers (herbivores) obtain energy by feeding on plants, but not all plant energy is ingested or assimilated.

(d) Secondary consumers (carnivores) feed on primary consumers, and tertiary or higher-level consumers feed on secondary consumers.

(e) Energy transfer efficiency between trophic levels is approximately 10% (sometimes cited as 5-20%), meaning only about 10% of energy is converted to biomass at each level.

(f) The remaining 90% is lost through respiration (heat production), excretion, feces, and other metabolic processes.

(g) As a result, the primary producer (plant) level contains the most total energy, while each successive consumer level contains progressively less energy.

(h) The top predator level, being at the end of the food chain, has the least total energy available in the ecosystem.

(i) This energy pyramid structure explains why predator populations are always much smaller than prey populations in balanced ecosystems.

Final Answer: The top predator level contains the least energy.

Answer: (D)

Go Back to Question 17

Q18.

Solution

Concept:

Vegetative reproduction is any method of plant reproduction that does not involve the production and fusion of gametes. Instead, new individuals develop from vegetative parts (roots, stems, leaves) or from specialized structures. This allows plants to produce clones of themselves without genetic recombination.

Solution:

(a) Vegetative or asexual reproduction produces offspring that are genetically identical to the parent plant.

(b) Fragmentation is a form of vegetative reproduction where a plant breaks into fragments that develop into new plants. Examples include the fragmentation of Lemna (duckweed) in water bodies.

(c) Micropropagation is an in vitro technique that uses tissue culture to produce many identical plants from a single plant explant rapidly and efficiently.

(d) Somatic embryogenesis is the development of embryos from somatic (body) cells without meiosis or fusion of gametes, producing genetically identical plants.

(e) Pollination, in contrast, is the transfer of pollen from the male reproductive organ (anther) to the female reproductive organ (stigma).

(f) Pollination is a prerequisite for sexual reproduction, which involves the fusion of gametes and the generation of genetic variation through recombination.

(g) Sexual reproduction through pollination is fundamentally different from asexual vegetative reproduction because it involves gamete fusion and generates genetic diversity.

(h) Therefore, pollination is NOT a method of vegetative reproduction; it is a sexual reproductive process.

(i) All other options (fragmentation, micropropagation, somatic embryogenesis) are valid methods of vegetative reproduction.

Final Answer: Pollination is NOT a method of vegetative reproduction.

Answer: (C)

Go Back to Question 18

Q19.

Solution

Concept:

Recombinant DNA technology involves the manipulation of DNA molecules to create new genetic combinations. This technology has revolutionized agriculture by enabling the creation of genetically modified organisms (GMOs) with improved traits such as pest resistance, herbicide tolerance, and nutritional enhancement.

Solution:

(a) Recombinant DNA technology uses restriction enzymes to cut DNA and DNA ligase to join DNA fragments from different sources.

(b) The resulting recombinant DNA is introduced into organisms, typically crops, to create genetically modified organisms (GMOs).

(c) Key applications in agriculture include developing crops resistant to specific pests or herbicides, increasing crop yield, and improving nutritional content.

(d) Examples of genetically modified crops include Bt cotton (resistant to Lepidoptera), glyphosate-resistant soybeans, and golden rice (enriched with beta-carotene).

(e) Traditional cross-breeding relies on sexual reproduction between plant varieties and involves mixing entire genomes without specific control over which genes are transferred.

(f) Mutation breeding involves exposing seeds or plants to mutagenic agents to induce random mutations, which is less precise than genetic modification.

(g) Polyploidy induction involves changing chromosome numbers but does not involve the direct manipulation of genes from recombinant sources.

(h) Recombinant DNA technology offers precise control over genetic modification, allowing the insertion of specific genes from any source, not limited to sexually compatible species.

(i) This technology has made possible agricultural advances that traditional breeding alone could not achieve.

Final Answer: The main application is development of genetically modified crops.

Answer: (A)

Go Back to Question 19

Q20.

Solution

Concept:

Biofortification is a biotechnological approach aimed at improving the nutritional quality of food crops. It involves increasing the concentration or bio-availability of essential nutrients such as vitamins, minerals, and proteins in staple crops through conventional breeding or genetic engineering.

Solution:

(a) Biofortification addresses micronutrient malnutrition, which affects billions of people worldwide, particularly in developing countries.

(b) The term "biofortification" combines "biological" with "fortification," indicating the use of biological methods to increase nutrient density.

(c) Bio-availability refers to the fraction of nutrients that the body can actually absorb and utilize from food, which is as important as total nutrient content.

(d) Increasing bio-availability may involve reducing anti-nutritional factors (phytates, oxalates) that inhibit nutrient absorption or enhancing nutrient forms that are more readily absorbed.

(e) Golden rice is a famous example of biofortification, where genes for beta-carotene synthesis were inserted into rice, increasing vitamin A content.

(f) Orange maize has been developed with increased beta-carotene content to combat vitamin A deficiency in African populations.

(g) Biofortification differs from traditional food fortification (adding nutrients to processed foods) because it occurs at the crop production level.

(h) While pathogenic protection and yield improvement are benefits of agricultural biotechnology, they are not the defining purpose of biofortification.

(i) The primary goal of biofortification is to make nutritious food more accessible to vulnerable populations at the point of production.

Final Answer: Biofortification increases nutrient bio-availability in crops.

Answer: (A)

Go Back to Question 20

Q21.

Solution

Concept:

Cotton is a major kharif (monsoon season) crop in Rajasthan, valued for its fiber production. This crop is susceptible to various diseases, including leaf spot diseases caused by fungal pathogens. Understanding disease susceptibility is crucial for developing management strategies.

Solution:

(a) Wheat is primarily a rabi (winter season) crop in Rajasthan, not a kharif crop, and is susceptible to different diseases like rust and Karnal bunt.

(b) Cotton is planted during the kharif season when monsoon rains provide adequate moisture, and is particularly susceptible to leaf spot diseases.

(c) Cotton leaf spot disease is caused by fungal pathogens such as Alternaria and Colletotrichum species, which thrive in humid conditions.

(d) These fungal diseases produce characteristic brown or dark spots on cotton leaves, reducing photosynthetic efficiency and ultimately decreasing fiber yield.

(e) Management strategies include crop rotation, use of disease-resistant varieties, and timely fungicide application during high humidity periods.

(f) Mustard is primarily a rabi crop in Rajasthan and is susceptible to white rust and other different diseases than cotton.

(g) Barley is also a rabi crop in Rajasthan, grown in winter and susceptible to different disease pressures than kharif crops.

(h) Cotton's susceptibility to leaf spot disease during the kharif season makes it a notable example of disease management challenges in Rajasthan's agriculture.

Final Answer: Cotton is the major kharif crop susceptible to leaf spot disease.

Answer: (B)

Go Back to Question 21

Q22.

Solution

Concept:

Powdery mildew is a fungal disease caused by various Erysiphales species that affects a wide range of crops under specific environmental conditions. This disease is characterized by a white powdery coating on affected plant parts and is particularly problematic in certain crops grown in Rajasthan.

Solution:

(a) Powdery mildew is caused by obligate parasitic fungi that form a white or gray powdery coating on leaves and other plant parts.

(b) The disease thrives in warm temperatures (20-27°C) with low humidity, making it less dependent on high moisture than many other fungal diseases.

(c) Rice is primarily affected by blast and sheath blight diseases, not powdery mildew, as rice cultivation involves waterlogged conditions unfavorable for powdery mildew.

(d) Chickpea (gram) is a rabi crop susceptible to multiple diseases including powdery mildew, particularly when grown under irrigated conditions with warm days and cool nights.

(e) Powdery mildew on chickpea reduces photosynthetic efficiency and seed quality, significantly impacting yield in Rajasthan's grain legume production.

(f) Maize can be affected by powdery mildew, but it is not as consistently problematic as in chickpea under Rajasthan's climate conditions.

(g) Sugarcane is susceptible to various foliar diseases but powdery mildew is not the primary constraint in sugarcane production.

(h) Management of chickpea powdery mildew includes variety selection, sulfur application, and proper irrigation scheduling to minimize disease development.

Final Answer: Powdery mildew primarily affects chickpea crops.

Answer: (B)

Go Back to Question 22

Q23.

Solution

Concept:

Late blight is one of the most economically important diseases of potato, caused by a water mold (oomycete) pathogen. This disease was historically responsible for the Great Irish Famine and remains a major threat to potato production worldwide. Understanding the causal agent is essential for disease management.

Solution:

(a) Late blight of potato is caused by Phytophthora infestans, a haploid oomycete (water mold) belonging to the class Oomycetes.

(b) This pathogen is not a true fungus but is often treated similarly due to its disease-causing behavior and appearance.

(c) The disease is characterized by dark brown or water-soaked spots on leaves and stems, which become covered with white sporangiophore structures on the leaf underside.

(d) Affected tubers develop brown, sunken lesions that are often invaded by secondary bacterial pathogens, causing rot.

(e) Alternaria solani is the causal agent of early blight of potato, a different disease characterized by concentric rings on leaves and affecting potatoes earlier in the season.

(f) Xanthomonas campestris causes bacterial diseases in various crops but not late blight in potato.

(g) Fusarium oxysporum causes wilt diseases in many crops but is not the causal agent of potato late blight.

(h) Late blight management requires preventive measures including resistant varieties, proper spacing, fungicide application, and removal of infected plant material.

(i) The disease thrives in cool, wet conditions typical of the monsoon season, making it a significant concern in potato growing regions.

Final Answer: Late blight is caused by Phytophthora infestans.

Answer: (B)

Go Back to Question 23

Q24.

Solution

Concept:

The white grub is a major soil-inhabiting pest of crops in Rajasthan, particularly affecting sugarcane, maize, and other field crops. Management of this pest requires targeted insecticide recommendations that effectively control the larval stages in the soil.

Solution:

(a) The white grub (Melolontha melolontha and related species) is the larval stage of various beetle species that feed on crop roots in the soil.

(b) White grub larvae can cause severe damage by severing roots, leading to wilting and death of young plants.

(c) Management strategies include soil incorporation of insecticides that can reach the pest in the soil environment.

(d) Chlorpyriphos is an organophosphate insecticide commonly recommended for soil application to control white grub larvae in Rajasthan.

(e) This insecticide can be mixed with soil or applied in irrigation water to reach the soil-dwelling larvae effectively.

(f) Endosulfan is an organochlorine insecticide that has been banned or restricted in many countries due to environmental and health concerns, though it was historically used.

(g) Carbaryl is a carbamate insecticide used more commonly for foliage applications rather than soil incorporation for white grub control.

(h) Quinalphos is an organophosphate insecticide used for foliage pest control but is not the primary recommended product for white grub soil management.

(i) Regular monitoring and timely application of recommended insecticides are essential for white grub management in Rajasthan's agriculture.

Final Answer: Chlorpyriphos is recommended for white grub control.

Answer: (D)

Go Back to Question 24

Q25.

Solution

Concept:

Integrated Pest Management (IPM) is a systematic approach to pest management that combines multiple strategies. Biological control is one key component, involving the use of natural enemies to suppress pest populations. This environmentally sustainable method reduces reliance on chemical pesticides.

Solution:

(a) Biological control is the deliberate use of natural enemies (parasitoids, predators, pathogens) to suppress pest populations and reduce crop damage.

(b) Examples of biological control agents include parasitic wasps that parasitize pest eggs, ladybugs that feed on aphids, and entomopathogenic fungi that infect pest insects.

(c) This approach offers sustainable pest management with minimal environmental impact and no chemical residues on crops.

(d) Chemical control involves the application of synthetic or natural pesticides to kill or repel pests; this is effective but can lead to resistance development and environmental damage.

(e) Cultural control includes practices such as crop rotation, removal of crop residues, and adjustment of planting dates to disrupt pest lifecycle.

(f) Mechanical control involves physical removal of pests through hand-picking, trapping, or other manual methods.

(g) Biological control is particularly valued in organic agriculture and sustainable farming systems.

(h) The most effective pest management programs combine biological, cultural, and chemical approaches based on economic thresholds and ecological considerations.

(i) Farmer education about biological control options is essential for successful implementation of this sustainable strategy.

Final Answer: This is known as biological control.

Answer: (C)

Go Back to Question 25

Q26.

Solution

Concept:

Body cavities in animals are essential spaces that house and protect internal organs, facilitate nutrient distribution, and allow organ movement during physiological functions. The classification of body cavities (acoelomate, pseudocoelomate, coelomate) is a fundamental principle of animal taxonomy.

Solution:

(a) The blastocoel is a temporary cavity that exists during early embryonic development (blastula stage) and is gradually filled with mesodermal tissue.

(b) The coelom (celom) is the true body cavity found in most invertebrate and all vertebrate animals, bounded by mesodermal tissue (peritoneum).

(c) The hemocoel is a body cavity found in arthropods and some mollusks where body fluids (hemolymph) bathe the organs directly, without a peritoneal lining.

(d) The archenteron is the primordial gut cavity formed during gastrulation, not a permanent body cavity.

(e) Coelomate animals (animals with true coeloms) include annelids, mollusks, echinoderms, arthropods, and all chordates.

(f) The coelom provides space for organ development, allows for greater body size, permits organ movement during contraction, and facilitates the development of complex body systems.

(g) The presence of a coelom is considered a major evolutionary advancement that enabled the development of larger, more complex animals.

(h) Most major animal phyla are coelomate, making this the primary body cavity type in the animal kingdom.

Final Answer: The primary body cavity is the coelom.

Answer: (B)

Go Back to Question 26

Q27.

Solution

Concept:

Annelida is a major animal phylum characterized by segmentation, where the body is divided into repeating units (segments or metameres). This characteristic feature is the basis of the phylum name and distinguishes annelids from other invertebrate groups.

Solution:

(a) The phylum Annelida includes earthworms, marine polychaetes, and leeches, all characterized by a highly segmented body plan.

(b) Segmentation means that the body is divided into multiple similar units (segments or metameres) arranged linearly along the body axis.

(c) Each segment is separated from adjacent segments by septa (internal partitions) and contains its own set of organs, including nerve ganglia and blood vessels.

(d) Segmentation allows for more specialized functions because different segments can develop different structures and functions while maintaining the basic body plan.

(e) Jointed appendages are characteristic of arthropods (insects, spiders, crustaceans), not annelids.

(f) A rigid exoskeleton is also characteristic of arthropods, which have a chitinous or calcified outer covering.

(g) The absence of complete segmentation characterizes other invertebrate phyla like platyhelminthes and nematodes.

(h) Annelids have a complete digestive system (mouth to anus), a closed circulatory system, and a centralized nervous system with a ventral nerve cord.

(i) The segmentation in annelids represents a major evolutionary advancement that permitted greater complexity and specialization.

Final Answer: The characteristic feature is the presence of segments.

Answer: (A)

Go Back to Question 27

Q28.

Solution

Concept:

The comparative anatomy of invertebrates and vertebrates reveals fascinating examples of functional similarity despite different evolutionary origins. The nervous system organization provides one of the most striking comparisons, with earthworms possessing a ventral nerve cord performing functions similar to the dorsal nerve cord (spinal cord) of vertebrates.

Solution:

(a) In earthworms, the ventral nerve cord runs along the ventral (belly) side of the body, extending the entire length and connecting ganglia in each segment.

(b) This ventral nerve cord functions as the main information superhighway, coordinating movement, sensation, and visceral functions throughout the body.

(c) In vertebrates, the nervous system's main longitudinal tract is the dorsal nerve cord, which develops during embryogenesis from the neural tube.

(d) In vertebrates, this dorsal structure becomes the brain and spinal cord, running along the dorsal (back) side of the body.

(e) The spinal cord performs comparable functions to the earthworm's ventral nerve cord: integrating sensory information, coordinating motor response, and controlling vital functions.

(f) The anatomical inversion (ventral in invertebrates versus dorsal in vertebrates) is thought to have occurred during early animal evolution.

(g) The ventral nerve cord in invertebrates such as arthropods also serves similar coordinating functions.

(h) Despite the positional difference, the functional homology between these structures demonstrates evolutionary conservation of nervous system organization principles.

(i) This comparison is a classic example used in comparative anatomy to illustrate evolutionary relationships between major animal groups.

Final Answer: The ventral nerve cord is compared to the dorsal nerve cord (spinal cord).

Answer: (B)

Go Back to Question 28

Q29.

Solution

Concept:

Insects have evolved diverse respiratory systems to meet their physiological needs. The tracheal system is the characteristic respiratory mechanism of insects, consisting of a network of tubes that deliver oxygen directly to tissues. This system is one of the most efficient gas exchange mechanisms in the animal kingdom.

Solution:

(a) Insects do not possess lungs; lungs are characteristic of vertebrate animals such as amphibians, reptiles, mammals, and birds.

(b) Book gills are a respiratory structure found in some arachnids (spiders, scorpions), consisting of thin plates resembling book pages.

(c) Skin respiration occurs in some amphibians and other aquatic animals, but not in insects with thick chitinous exoskeletons.

(d) Tracheae (singular: trachea) are the defining respiratory structures of insects, consisting of a network of tubes that branch throughout the body.

(e) The tracheal system begins with spiracles, external openings on the sides of the abdomen and thorax that allow air to enter.

(f) From spiracles, air enters trachea that branch into progressively smaller tubes (tracheoles) that penetrate between cells and tissues.

(g) This arrangement allows oxygen to be delivered directly to cells without requiring a blood-based oxygen transport system.

(h) Tracheolar fluid at the terminal ends of tracheoles provides the final gas exchange interface with cells.

(i) The tracheal system is a highly efficient adaptation that contributes to insect success and allows them to colonize diverse ecological niches.

(j) Some insects possess air sacs that expand and contract to ventilate the tracheal system, enhancing oxygen delivery during activity.

Final Answer: The respiratory organs are tracheae.

Answer: (C)

Go Back to Question 29

Q30.

Solution

Concept:

The insect body is divided into three distinct regions, each with specialized structures and functions. This tripartite division (head, thorax, abdomen) represents the basic body organization of all insects and reflects their evolutionary adaptations.

Solution:

(a) The head is the anterior body region containing sensory organs (eyes, antennae) and mouthparts adapted for feeding.

(b) The thorax is the middle body region consisting of three segments (prothorax, mesothorax, metathorax) that bear the legs and wings.

(c) Each leg arises from one of the three thoracic segments, and in most insects, wings (when present) attach to the meso- and metathoracic segments.

(d) The abdomen is the posterior body region containing abdominal segments, with reproductive organs and various sensory appendages.

(e) The coxa is the basal segment of each leg that attaches to the thorax; it is not a body region but rather a leg segment.

(f) The arrangement of wings and legs exclusively on the thorax is a defining characteristic of the class Insecta.

(g) This body organization provides structural support for locomotion, with the thorax housing powerful muscles for leg and wing movement.

(h) The segmented abdomen contains digestive and reproductive organs while maintaining the overall aerodynamic body shape.

(i) Understanding insect body regions is essential for insect identification, taxonomy, and understanding insect evolution and development.

Final Answer: The thorax bears wings and legs.

Answer: (B)

Go Back to Question 30

Q31.

Solution

Concept:

The khapra beetle (Trogoderma granarium) is a major pest of stored grains in countries with warm climates, including India and Rajasthan. This pest can cause substantial economic losses if not properly managed. Effective control requires an integrated approach combining multiple strategies.

Solution:

(a) The khapra beetle's larval stage causes the most damage by feeding on grain kernels and contaminating grain with feces and body fragments.

(b) High temperatures can kill khapra beetle at all life stages. Exposure to temperatures above 52°C for extended periods is lethal to the pest.

(c) Fumigation using phosphine or methyl bromide fumigants effectively kills all life stages of the khapra beetle within stored grains.

(d) Low humidity levels (below 12-15% relative humidity) inhibit larval development and reproduction of the khapra beetle.

(e) Maintaining proper storage conditions with reduced humidity makes the environment unsuitable for khapra beetle development.

(f) Integrated control involves combining physical methods (temperature, humidity control) with chemical methods (fumigation, insecticides) for maximum effectiveness.

(g) Proper grain cleaning and sanitation of storage facilities before grain storage prevents initial beetle infestation.

(h) All three methods mentioned (high temperature, fumigants, and low humidity) are effective and recommended as part of an integrated pest management approach.

(i) The answer "All of the above" correctly identifies the comprehensive nature of khapra beetle control strategies.

Final Answer: All three methods (temperature, fumigants, humidity) are effective.

Answer: (D)

Go Back to Question 31

Q32.

Solution

Concept:

Nematodes (roundworms) include both free-living and parasitic species. Some parasitic nematodes are significant agricultural pests, causing damage to plant roots and reducing crop productivity. Root-knot nematodes are particularly destructive in vegetable cultivation.

Solution:

(a) Wuchereria bancrofti is a parasitic nematode of humans, causing lymphatic filariasis (elephantiasis), not a plant pest.

(b) Ascaris lumbricoides is a parasitic nematode that infects the human intestine, causing disease in humans but not directly affecting vegetable crops.

(c) Meloidogyne incognita is the root-knot nematode, a major pest of vegetables and other crops in Rajasthan and other tropical regions.

(d) Root-knot nematodes parasitize plant roots, inducing the formation of galls (knots) on roots, disrupting water and nutrient uptake.

(e) Affected plants show stunting, wilting, yellowing, and reduced yield, with symptoms more severe under water stress.

(f) Vegetable crops particularly susceptible include tomato, pepper, cucumber, okra, and many others commonly grown in Rajasthan.

(g) Management includes use of resistant varieties, crop rotation, soil solarization, and chemical nematicides.

(h) Strongyloides stercoralis is a parasitic nematode of humans, not a plant pest.

(i) Root-knot nematodes represent one of the most significant agricultural problems in India, causing substantial crop losses annually.

Final Answer: Meloidogyne incognita (root-knot nematode) is the major vegetable pest.

Answer: (C)

Go Back to Question 32

Q33.

Solution

Concept:

Parasitic protozoans cause significant diseases in humans and animals. These unicellular eukaryotic parasites have complex life cycles involving vectors and various hosts. Understanding the etiological agents of parasitic diseases is crucial for diagnosis and control.

Solution:

(a) Plasmodium vivax is the causal agent of tertian malaria in humans, transmitted by Anopheles mosquitoes, not sleeping sickness.

(b) Trypanosoma brucei is the parasitic protozoan responsible for African trypanosomiasis, commonly known as sleeping sickness or nagana.

(c) This parasite exists in two subspecies: Trypanosoma brucei brucei (causes nagana in cattle and other animals) and Trypanosoma brucei gambiense/rhodesiense (cause sleeping sickness in humans).

(d) Sleeping sickness is characterized by fever, lymphadenopathy, and later neurological symptoms including disturbance of sleep-wake cycle, giving the disease its common name.

(e) The disease is transmitted by the tsetse fly (Glossina species) found in sub-Saharan Africa.

(f) Leishmania donovani is a parasitic protozoan causing visceral leishmaniasis (kala-azar) in humans.

(g) Entamoeba histolytica is a parasitic protozoan causing dysentery in humans.

(h) The neurological effects of Trypanosoma brucei infection, particularly the sleep disturbance, are distinctive characteristics that distinguish sleeping sickness from other parasitic diseases.

(i) Trypanosomiasis remains an important public health concern in tropical Africa and requires vector control and treatment programs.

Final Answer: The parasitic protozoan is Trypanosoma brucei.

Answer: (B)

Go Back to Question 33

Q34.

Solution

Concept:

The digestive system of the cockroach (and other insects) is a complete tube extending from mouth to anus, with specialized regions performing different digestive functions. The crop is an important organ for food storage, while the gizzard acts as a grinding chamber. Understanding digestive anatomy is fundamental to insect physiology.

Solution:

(a) The mouth in insects is the opening through which food enters, containing mouthparts adapted to the insect's feeding mode.

(b) The mouth does not store food but begins the immediate processing of ingested materials.

(c) The crop is a dilated region of the anterior midgut that serves as a temporary storage chamber for food.

(d) In the cockroach, the crop (extending from the foregut) can hold large quantities of food before passage into the midgut.

(e) The crop allows the insect to feed rapidly when food is available and then digest it slowly over time as energy needs dictate.

(f) The gizzard (or proventriculus) is a muscular structure lined with cuticular ridges that acts as a grinding and filtering chamber.

(g) Muscular contractions of the gizzard walls break down food particles mechanically, particularly plant fibers and other tough materials.

(h) The gizzard also prevents large food particles from entering the midgut, allowing only appropriately sized particles to pass through.

(i) The intestine is the primary site of nutrient absorption, not food storage.

(j) The crop's role as the storage organ is specifically adapted for the feeding ecology of cockroaches, which are scavengers consuming diverse and often sporadic food sources.

Final Answer: The crop stores food temporarily.

Answer: (B)

Go Back to Question 34

Q35.

Solution

Concept:

Excretion in insects involves the removal of nitrogen waste and excess water, maintaining osmotic balance and preventing the accumulation of toxic nitrogenous compounds. Insects have evolved diverse excretory mechanisms adapted to their environments and lifestyles.

Solution:

(a) Kidneys are the primary excretory organs in vertebrates, not insects, and have no functional equivalent in invertebrates.

(b) Nephridia are excretory structures found in annelids and mollusks, consisting of funnel-like organs that remove waste through nephridiopores.

(c) Insects lack nephridia and instead possess specialized structures called Malpighian tubules for excretion.

(d) Malpighian tubules are slender tubes that arise from the junction between the midgut and hindgut (posteriorly in the insect body).

(e) These tubules are bathed in the hemocoel (body cavity) where they absorb nitrogenous waste, excess water, and other metabolic waste from the hemolymph.

(f) The tubules secrete these wastes into the lumen, and the fluid (now called urine) flows into the rectum and hindgut.

(g) In the rectum, water is reabsorbed, producing a highly concentrated, semi-solid waste (frass) that is voided through the anus.

(h) This water-conserving excretory mechanism is particularly adaptive for insects living in arid environments.

(i) Contractile vacuoles are organelles found in protozoans for water expulsion, not an insect excretory organ.

(j) Malpighian tubules represent one of the most characteristic features of insects and are found in virtually all insect orders.

Final Answer: The primary organs of excretion are Malpighian tubules.

Answer: (C)

Go Back to Question 35

Q36.

Solution

Concept:

The phylum Chordata is characterized by four defining anatomical features that appear at some point in the organism's life cycle, either in development or in adults. Protochordates represent the most ancient chordates and provide insights into the evolution of vertebrate characteristics.

Solution:

(a) The four defining chordate characteristics are: (1) a notochord, (2) a dorsal hollow nerve cord, (3) pharyngeal gill slits, and (4) a post-anal tail.

(b) Protochordates include animals such as amphioxus (lancelet) and tunicates (sea squirts), representing the earliest-diverging chordate groups.

(c) All protochordates possess a notochord (a flexible rod providing body support), a dorsal nerve cord, pharyngeal gill slits, and a post-anal tail.

(d) The notochord is an embryonic structure present in the embryos of all chordates, including vertebrates.

(e) In vertebrate development, the notochord is mostly replaced by the vertebral column, though portions persist in the nucleus pulposus of intervertebral discs.

(f) Pharyngeal gill slits develop in all chordate embryos, though in terrestrial vertebrates, they are modified into other structures like the Eustachian tube.

(g) The dorsal nerve cord is present in all chordates and develops into the brain and spinal cord in vertebrates.

(h) The vertebral column (backbone) is a characteristic of vertebrates (subphylum Vertebrata) but is absent in protochordates.

(i) Therefore, the vertebral column is the chordate characteristic absent in protochordates but present in all other members.

(j) This represents a key synapomorphy (shared derived characteristic) that defines the vertebrate subphylum.

Final Answer: The vertebral column is absent in protochordates.

Answer: (D)

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Q37.

Solution

Concept:

Basal metabolic rate (BMR) is the minimum energy expenditure required to maintain life processes at rest. This energy expenditure is directly related to the production of heat through metabolic reactions, particularly those driven by thyroid hormones. Understanding BMR is crucial in nutrition and metabolic physiology.

Solution:

(a) Basal metabolic rate is measured under standardized conditions: after a fasting period, in a resting state, at thermoneutral temperature.

(b) Activity level affects total metabolic rate but not specifically the basal rate, which is measured during rest.

(c) Environmental temperature can influence overall metabolism, but BMR is measured at a neutral temperature to eliminate this variable.

(d) Body surface area has historically been used to normalize BMR for inter-individual comparisons, but it is not the factor most directly controlling BMR.

(e) Thyroid hormones (T3 and T4) are the primary regulators of the basal metabolic rate.

(f) These hormones increase the activity of cellular mitochondria and enhance oxidative metabolism in virtually all cells.

(g) Higher thyroid hormone levels increase BMR, while lower levels (as in hypothyroidism) decrease BMR.

(h) Thyroid hormone secretion is regulated by the hypothalamic-pituitary-thyroid (HPT) axis, which responds to metabolic needs and environmental factors.

(i) BMR is one of the major components of total daily energy expenditure and is particularly important in nutritional assessment and treatment of metabolic disorders.

Final Answer: BMR is most directly influenced by thyroid hormone secretion.

Answer: (C)

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Q38.

Solution

Concept:

Vitamins are essential organic compounds required for normal growth, development, and metabolic function. While most vitamins must be obtained from diet, they can be classified into fat-soluble and water-soluble categories based on their chemical properties. This classification has implications for absorption, storage, and toxicity.

Solution:

(a) Vitamin A is a fat-soluble vitamin essential for vision, immune function, and gene regulation. It is stored in the liver and fat tissues.

(b) Vitamin D is a fat-soluble vitamin (technically a steroid hormone) essential for calcium absorption and bone health. It is stored in fat tissues.

(c) Vitamin K is a fat-soluble vitamin essential for blood clotting and bone metabolism. It is stored in fat tissues.

(d) Fat-soluble vitamins (A, D, E, K) are absorbed with dietary fat and can accumulate to toxic levels with excessive intake.

(e) Vitamin C (ascorbic acid) is a water-soluble vitamin essential for collagen synthesis, immune function, and antioxidant activity.

(f) Water-soluble vitamins (B-complex vitamins and vitamin C) are not stored in significant amounts and must be consumed regularly.

(g) Excess water-soluble vitamins are excreted in urine; thus, toxicity is rare with these vitamins.

(h) The classification into fat-soluble versus water-soluble has important implications for absorption mechanisms, storage, and dietary requirements.

(i) Vitamin C deficiency causes scurvy, a disease characterized by connective tissue breakdown due to impaired collagen synthesis.

Final Answer: Vitamin C is NOT a fat-soluble vitamin (it is water-soluble).

Answer: (D)

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Q39.

Solution

Concept:

Protein digestion begins in the stomach and continues through the small intestine. Different proteases act on proteins at various stages, each adapted to specific conditions and specificities. Understanding the sequence of proteolytic enzymes is essential to digestive physiology.

Solution:

(a) Pepsin is an endopeptidase (protease) produced in the stomach by chief cells as an inactive precursor (pepsinogen).

(b) Pepsinogen is activated to pepsin in the acidic environment of the stomach (pH 2-3) by the cleavage of an activation peptide.

(c) Pepsin specifically initiates protein digestion by cleaving peptide bonds at positions adjacent to aromatic amino acids (phenylalanine, tryptophan, tyrosine).

(d) This enzyme is the only significant proteolytic activity in the stomach and works optimally at the stomach's acidic pH.

(e) Pepsin breaks proteins into smaller polypeptides, which then enter the small intestine where further digestion occurs.

(f) Amylase is an enzyme that digests carbohydrates (starch), not proteins, produced by the salivary glands and pancreas.

(g) Trypsin is a serine protease produced by the pancreas that acts in the small intestine on proteins and peptides, but it does not initiate protein digestion.

(h) Lipase is a pancreatic enzyme that digests lipids (fats), not proteins.

(i) The sequential action of pepsin (stomach) and trypsin/chymotrypsin (small intestine) ensures complete protein digestion.

Final Answer: The enzyme is pepsin.

Answer: (B)

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Q40.

Solution

Concept:

Carbohydrate metabolism involves the interconversion of glucose into storage and structural forms. Glycogenesis is the synthetic pathway that converts glucose into glycogen, a branched polymer serving as the primary carbohydrate energy reserve in animals. Understanding these metabolic processes is crucial for energy homeostasis.

Solution:

(a) Gluconeogenesis is the synthesis of glucose from non-carbohydrate precursors (amino acids, glycerol, lactate), occurring primarily in the liver and kidney.

(b) Gluconeogenesis is particularly active during fasting and provides glucose to maintain blood glucose levels when dietary carbohydrate is unavailable.

(c) Glycogenesis is the synthesis of glycogen from glucose, storing excess glucose as a branched polymer.

(d) This process is catalyzed by the enzyme glycogen synthase and is upregulated by insulin following carbohydrate meals.

(e) The liver is the primary site of glycogenesis, storing up to 100-120 grams of glycogen, and muscle also stores significant glycogen for local use.

(f) Glycogenolysis is the breakdown of glycogen back to glucose (in liver) or glucose-6-phosphate (in muscle), providing rapid energy mobilization during fasting or activity.

(g) Glycogenolysis is promoted by glucagon and epinephrine hormones during fasting or stress.

(h) Glycolysis is the metabolic pathway that breaks down glucose (or glucose-6-phosphate from glycogenolysis) to pyruvate, producing ATP.

(i) Glycogenesis is specifically the storage process, matching the question's description of carbohydrate storage in the liver.

Final Answer: The process is glycogenesis.

Answer: (B)

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Answer Key

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