

Rajasthan JET Biology Sample Paper-3

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 enzyme responsible for the rate-limiting step in glycolysis is:

- (A) Hexokinase
- (B) Phosphofruktokinase-1
- (C) Pyruvate kinase
- (D) Phosphoglycerate mutase

Q2. In angiosperms, the process of triple fusion results in the formation of:

- (A) Diploid embryo
- (B) Triploid endosperm
- (C) Haploid zygote
- (D) Tetraploid nucleus

Q3. Which of the following pigments is responsible for detecting the photoperiod in plants?

- (A) Chlorophyll
- (B) Carotenoid
- (C) Phytochrome
- (D) Xanthophyll

Q4. The DNA replication in eukaryotes is:

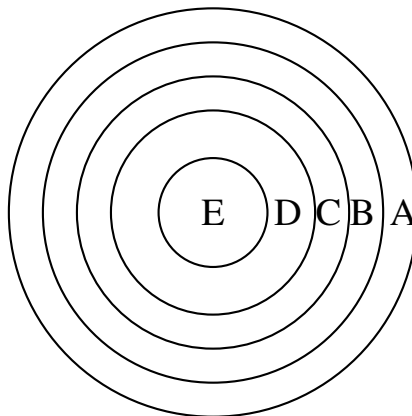


- (A) Bidirectional and semi-conservative
- (B) Unidirectional and conservative
- (C) Bidirectional and conservative
- (D) Unidirectional and semi-conservative

Q5. During photosynthesis, the light reactions occur in the:

- (A) Stroma
- (B) Thylakoid membrane
- (C) Matrix
- (D) Outer membrane

Q6. The cross-section of a typical dicot root shows the following arrangement (from outside to inside):



A: Epidermis, B: Cortex, C: Endodermis, D: Pericycle, E: Xylem & Phloem

Which region prevents backflow of water in the root?

- (A) Epidermis
- (B) Cortex
- (C) Endodermis
- (D) Pericycle

Q7. The phenomenon where one gene influences multiple traits is called:

- (A) Complementation



- (B) Pleiotropy
- (C) Epistasis
- (D) Codominance

Q8. Which of the following is an example of a secondary metabolite?

- (A) Glucose
- (B) Starch
- (C) Morphine
- (D) Cellulose

Q9. The floral formula representing a plant with pentamerous, actinomorphic flowers with four whorls is:

- (A) $\star K_5 C_5 A_5 G_5$
- (B) $\star K_4 C_4 A_4 G_4$
- (C) $K_5 C_5 A_5 G_5$
- (D) $\star K_5 C_5 A_\infty G_\infty$

Q10. The Casparian strip is a specialized structure made of:

- (A) Cellulose
- (B) Suberin
- (C) Pectin
- (D) Lignin

Q11. In the process of meiosis, homologous chromosomes separate during:

- (A) Metaphase I
- (B) Anaphase I
- (C) Anaphase II
- (D) Telophase II

Q12. Apomixis in plants refers to:



- (A) Sexual reproduction
- (B) Asexual reproduction
- (C) Pollination
- (D) Fertilization

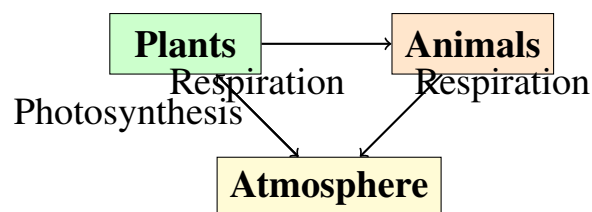
Q13. The photosynthetic pathway in C₄ plants involves the initial fixation of CO₂ into:

- (A) 3-phosphoglycerate
- (B) Oxaloacetate
- (C) Ribulose-1,5-bisphosphate
- (D) Phosphoenolpyruvate

Q14. Which of the following hormones is responsible for the opening of stomata?

- (A) Abscisic acid
- (B) Ethylene
- (C) Gibberellin
- (D) Cytokinin

Q15. The diagram below represents the carbon cycle in nature. Which process represents the loss of CO₂ to the atmosphere?



- (A) Photosynthesis
- (B) Respiration
- (C) Decomposition
- (D) Combustion

Q16. Pollen grain viability can be tested using:



- (A) Safranin
- (B) Iodine
- (C) Methylene blue
- (D) Acid fuchsin

Q17. The family Brassicaceae is characterized by:

- (A) Tetramerous flowers
- (B) Decandrous stamens
- (C) Siliqua fruit
- (D) All of the above

Q18. Vernalization in plants refers to:

- (A) Response to day length
- (B) Response to temperature
- (C) Response to light quality
- (D) Response to gravity

Q19. The process of breakdown of glucose in anaerobic conditions is:

- (A) Krebs cycle
- (B) Electron transport chain
- (C) Fermentation
- (D) Oxidative phosphorylation

Q20. In plant tissue culture, callus formation is promoted by:

- (A) High auxin concentration
- (B) High cytokinin concentration
- (C) Equal ratio of auxin and cytokinin
- (D) Absence of both hormones

Q21. Transgenic plants are produced using:



- (A) Radiation
- (B) Chemical mutagens
- (C) Recombinant DNA technology
- (D) Cross-breeding

Q22. Golden rice is enriched with:

- (A) Protein
- (B) Iron
- (C) Beta-carotene
- (D) Calcium

Q23. The primary vector used for gene transfer in plants is:

- (A) *Bacillus thuringiensis*
- (B) *Agrobacterium tumefaciens*
- (C) *Escherichia coli*
- (D) *Streptomyces*

Q24. Early blight disease in potato is caused by:

- (A) *Phytophthora infestans*
- (B) *Alternaria solani*
- (C) *Colletotrichum lindemuthianum*
- (D) *Fusarium oxysporum*

Q25. Integrated Pest Management (IPM) is based on:

- (A) Chemical control only
- (B) Biological control only
- (C) Combined use of multiple control strategies
- (D) Cultural control only

Q26. The primary body cavity in animals is:

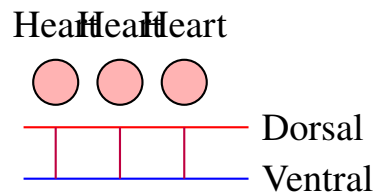


- (A) Blastocoel
- (B) Coelom
- (C) Hemocoel
- (D) Archenteron

Q27. The characteristic feature that defines the phylum Annelida is:

- (A) Bilateral symmetry
- (B) Segmentation
- (C) Presence of tentacles
- (D) Chitinous exoskeleton

Q28. The earthworm's closed circulatory system consists of:



- (A) Heart, dorsal vessel, and capillaries
- (B) Dorsal and ventral vessels connected by hearts
- (C) Single tubular heart
- (D) Open lacunar system

Q29. The respiratory organs of aquatic insects are:

- (A) Lungs
- (B) Tracheal gills
- (C) Book gills
- (D) Skin

Q30. The largest insects belong to the order:

- (A) Lepidoptera



- (B) Coleoptera
- (C) Hymenoptera
- (D) Orthoptera

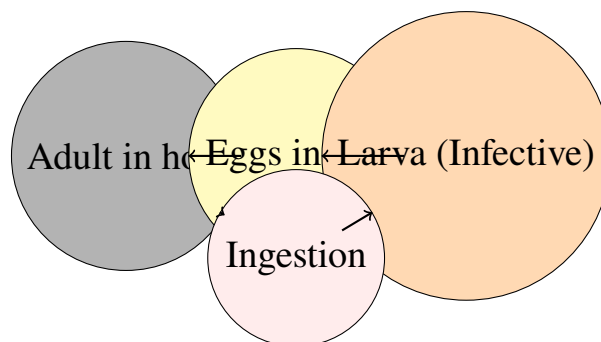
Q31. Dengue fever is transmitted by:

- (A) Mosquito (Anopheles)
- (B) Mosquito (Aedes)
- (C) Mosquito (Culex)
- (D) Housefly

Q32. The larval stage of the tapeworm is called:

- (A) Cercaria
- (B) Miracidium
- (C) Plerocercus
- (D) Metacercaria

Q33. The diagram shows the life cycle of a parasitic roundworm. Which stage is infective to humans?



- (A) Adult in host
- (B) Eggs in soil
- (C) Infective larva in soil
- (D) During ingestion

Q34. The main function of Malpighian tubules in insects is:



- (A) Respiration
- (B) Circulation
- (C) Excretion
- (D) Digestion

Q35. The process of metamorphosis in insects is regulated by:

- (A) Juvenile hormone (JH)
- (B) Ecdysone
- (C) Both JH and ecdysone
- (D) Insulin

Q36. The primary function of hemoglobin in vertebrates is:

- (A) Transport of oxygen
- (B) Transport of carbon dioxide
- (C) Transport of nutrients
- (D) Immune response

Q37. Which of the following vitamins is synthesized in the intestine by bacteria?

- (A) Vitamin A
- (B) Vitamin K
- (C) Vitamin C
- (D) Vitamin D

Q38. The balanced diet for humans should contain the following macronutrients in the approximate ratio:

- (A) Carbohydrate : Protein : Fat = 4:1:1
- (B) Carbohydrate : Protein : Fat = 3:1:1
- (C) Carbohydrate : Protein : Fat = 5:1:1
- (D) Carbohydrate : Protein : Fat = 2:1:1



Q39. The enzyme responsible for initiating protein digestion in the stomach is:

- (A) Trypsin
- (B) Pepsin
- (C) Chymotrypsin
- (D) Amylase

Q40. The main site of fat absorption in vertebrates is:

- (A) Stomach
- (B) Large intestine
- (C) Small intestine
- (D) Esophagus



Detailed Solutions**Q1.****Solution****Concept:**

Glycolysis is the metabolic pathway that converts glucose into pyruvate, releasing energy in the form of ATP and NADH. This pathway consists of ten enzymatic steps, with several regulatory enzymes that control the rate of glucose breakdown. Understanding which enzyme catalyzes the rate-limiting step is essential for comprehending metabolic regulation.

Solution:

- (a) Glycolysis is divided into two phases: the energy-investment phase (steps 1-5) and the energy-payoff phase (steps 6-10).
- (b) Hexokinase catalyzes the first step, converting glucose to glucose-6-phosphate. While important, this is not the rate-limiting step.
- (c) Phosphofructokinase-1 (PFK-1) catalyzes the phosphorylation of fructose-6-phosphate to fructose-1,6-bisphosphate in the third step.
- (d) This step is considered the rate-limiting step of glycolysis because it is highly regulated by allosteric modulators.
- (e) PFK-1 is inhibited by high ATP/ADP ratios and citrate (signals of adequate energy), and activated by AMP and ADP (signals of energy need).
- (f) This regulation ensures that glucose is broken down only when energy is required by the cell.
- (g) Pyruvate kinase catalyzes the final step but is not the primary rate-limiting enzyme.
- (h) Phosphoglycerate mutase is an intermediate enzyme with minimal regulatory function.
- (i) Therefore, Phosphofructokinase-1 is the key regulatory enzyme that controls the overall rate of glycolysis.

Final Answer:

Answer: (B)

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Q2.

Solution**Concept:**

Double fertilization is a unique process in flowering plants involving two fusion events within the embryo sac. This process results in the formation of both a diploid zygote and a triploid endosperm, distinguishing angiosperms from all other plant groups.

Solution:

- (a) The embryo sac in angiosperms contains three sets of nuclei: one egg nucleus and two polar nuclei in the central cell.
- (b) During fertilization, one sperm nucleus fuses with the egg nucleus, forming a diploid zygote ($2n$) that develops into the embryo.
- (c) Simultaneously, the second sperm nucleus fuses with the two polar nuclei, creating a triploid fusion nucleus ($3n$).
- (d) This triploid nucleus develops into the endosperm, which provides nutrients to the developing embryo.
- (e) Triple fusion specifically refers to the fusion of one sperm with two polar nuclei, resulting in a triploid structure.
- (f) The diploid embryo is formed from single fertilization (sperm + egg), not triple fusion.
- (g) A haploid zygote would be impossible as fertilization always involves fusion of male and female gametes.
- (h) The significance of the triploid endosperm is that it ensures genetic compatibility between the maternal tissues and the developing embryo.

Final Answer: Triploid endosperm

Answer: (B)

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Q3.

Solution**Concept:**

Photoperiodism is the physiological response of plants to the relative lengths of day and night. Plants measure day length using a specialized photoreceptor protein, enabling them to regulate flowering time and other developmental processes according to seasonal changes.

Solution:

- (a) Photoperiodism allows plants to sense seasonal changes and respond appropriately, e.g., flowering in appropriate seasons.
- (b) The photoreceptor responsible for detecting photoperiod is phytochrome, a protein with two interconvertible forms.
- (c) Phytochrome exists as Pr (red-light absorbing form) and Pfr (far-red light absorbing form).
- (d) During daylight, red light converts Pr to Pfr, the physiologically active form. During darkness, Pfr reverts to Pr.
- (e) The ratio and total amount of Pfr at the end of the day allows plants to measure the duration of darkness.
- (f) Chlorophyll absorbs light for photosynthesis but does not detect photoperiod.
- (g) Carotenoids and xanthophylls are accessory photosynthetic pigments but are not the primary photoperiod sensors.
- (h) The discovery of phytochrome's role in photoperiodism was a major breakthrough in understanding plant responses to seasonal changes.

Final Answer:

Answer: (C)

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Q4.

Solution**Concept:**

DNA replication is a fundamental biological process that copies the genetic material before cell division. Understanding the directionality of replication (bidirectional vs. unidirectional) and whether the original molecules are conserved (conservative vs. semi-conservative) is crucial to molecular biology.

Solution:

- (a) Meselson and Stahl's 1958 experiments demonstrated that DNA replication is semi-conservative.
- (b) In semi-conservative replication, the original DNA double helix unwinds, and each strand serves as a template for a new complementary strand.
- (c) The result is two DNA molecules, each containing one original strand and one newly synthesized strand.
- (d) Replication begins at specific origins and proceeds bidirectionally, meaning the replication fork moves in opposite directions from the origin.
- (e) At each replication fork, DNA polymerase synthesizes new strands in the 5' to 3' direction.
- (f) The leading strand is synthesized continuously, while the lagging strand is synthesized discontinuously as Okazaki fragments.
- (g) Conservative replication would result in one molecule with both original strands and one molecule with both new strands (not observed).
- (h) Unidirectional replication would mean replication proceeds in only one direction from the origin, which is not how eukaryotic DNA replicates.
- (i) Therefore, DNA replication is both bidirectional and semi-conservative.

Final Answer: Bidirectional and semi-conservative

Answer: (A)

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Q5.

Solution**Concept:**

Photosynthesis occurs in two main phases: light-dependent reactions and light-independent reactions (Calvin cycle). The compartmentalization of these reactions within chloroplasts is essential for their regulation and efficiency.

Solution:

- (a) Photosynthesis in eukaryotes occurs within chloroplasts, which are highly organized organelles.
- (b) The chloroplast contains a double membrane envelope, an internal membrane system called thylakoids, and a fluid-filled space called the stroma.
- (c) Light reactions (also called light-dependent reactions) require light energy and involve the absorption of photons by chlorophyll and other pigments.
- (d) These light reactions occur on the thylakoid membrane, where photosystems I and II are embedded.
- (e) During light reactions, water is split, oxygen is released, and energy carriers (ATP and NADPH) are generated.
- (f) The stroma is the fluid compartment surrounding the thylakoids and is the site of the Calvin cycle (light-independent reactions).
- (g) The Calvin cycle does not directly require light but uses ATP and NADPH produced by the light reactions.
- (h) The matrix of mitochondria is where the Krebs cycle occurs, not photosynthesis.
- (i) The outer membrane of chloroplasts is permeable to small molecules but not the site of photosynthetic reactions.

Final Answer:

Answer: (B)

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Q6.

Solution**Concept:**

The root is the underground organ responsible for water and mineral absorption. The anatomy of roots reflects their functions, with specialized tissues arranged to facilitate transport and protect internal tissues. The endodermis is a critical layer in root structure with unique adaptations.

Solution:

- (a) The epidermis is the outermost layer of the root, consisting of thin-walled cells with root hairs for increased surface area absorption.
- (b) The cortex is composed of parenchymatous cells involved in storage and radial transport of water and minerals.
- (c) The endodermis is a specialized single layer of cells surrounding the vascular tissue in roots.
- (d) The endodermis is characterized by the presence of Casparian strips—thickened regions of the cell wall containing suberin.
- (e) Casparian strips are hydrophobic (water-repellent) and form a continuous seal around each endodermal cell, preventing the passage of water and dissolved substances through the cell walls (apoplastic pathway).
- (f) This forces water and minerals to pass through the endodermal cells themselves (symplastic pathway), allowing the plant to regulate uptake.
- (g) The Casparian strips effectively prevent the backflow of water that would otherwise occur due to the water potential gradient.
- (h) The pericycle is the innermost layer of the cortex, containing meristematic cells that give rise to lateral roots.
- (i) This anatomical arrangement ensures unidirectional transport of water and minerals into the vascular tissue.

Final Answer: Endodermis

Answer: (C)

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Q7.

Solution**Concept:**

Genetic phenomena can be classified based on the relationship between genes and their phenotypic effects. Pleiotropy describes a situation where a single gene influences multiple, seemingly unrelated traits, demonstrating the far-reaching effects of individual genes.

Solution:

- (a) Pleiotropy occurs when one gene has multiple phenotypic effects on different traits.
- (b) A classic example is the gene for coat color in mice: certain coat color alleles also affect eye color, ear shape, and fertility.
- (c) Another example is the gene for sickle cell anemia: the mutation affecting hemoglobin structure causes misshapen red blood cells, pain, and organ damage.
- (d) Pleiotropy demonstrates that genes do not work in isolation but have widespread effects throughout the organism.
- (e) Complementation refers to the interaction between mutations in different genes, where both mutations together restore the wild-type phenotype.
- (f) Epistasis is a phenomenon where one gene masks or modifies the effect of another gene, but both genes are involved.
- (g) Codominance is when both alleles are equally expressed in the heterozygous condition, but this describes dominance relationships, not a single gene controlling multiple traits.
- (h) Understanding pleiotropy is important in medical genetics, as mutations affecting genes with pleiotropic effects often cause multiple symptoms.

Final Answer: **Answer: (B)**[Go Back to Question 7](#)

Q8.

Solution**Concept:**

Plant metabolites are classified as primary or secondary based on their roles in plant physiology. Primary metabolites are essential for basic life processes, while secondary metabolites serve specialized functions such as defense or attracting pollinators, though they are not directly involved in the primary metabolism.

Solution:

- (a) Primary metabolites include glucose (carbohydrate), starch (storage polysaccharide), and cellulose (structural polysaccharide).
- (b) These compounds are directly involved in photosynthesis, respiration, and structural support—fundamental life processes.
- (c) Secondary metabolites are organic compounds produced by plants that are not essential for basic life functions.
- (d) Morphine is an alkaloid secondary metabolite produced by opium poppies, used medicinally as a pain reliever.
- (e) Other examples of secondary metabolites include caffeine (in coffee and tea), quinine (in Cinchona), and various flavonoids.
- (f) Secondary metabolites often serve roles in plant defense against herbivores, pathogens, or environmental stress.
- (g) They may also function in plant-animal interactions, such as attracting pollinators through fragrance or taste.
- (h) Secondary metabolites are typically accumulated in specific plant tissues and are often used by humans for medicinal or recreational purposes.
- (i) The distinction between primary and secondary metabolites is functional rather than based on chemical structure alone.

Final Answer: Morphine**Answer: (C)**[Go Back to Question 8](#)

Q9.

Solution**Concept:**

Floral formulas are standardized notation systems that describe the structure and arrangement of floral whorls. These formulas provide concise information about the symmetry, number of organs, and fusion patterns within flowers, allowing for quick comparison between plant families.

Solution:

- A floral formula consists of symbols representing different floral whorls: K (sepals), C (petals), A (stamens), G (carpels).
- Numbers indicate the number of organs in each whorl; if the number varies, Greek letters or infinity symbols are used.
- The asterisk symbol (\star) at the beginning indicates actinomorphic (radially symmetrical) flowers.
- A zigzag line would indicate zygomorphic (bilaterally symmetrical) flowers.
- Pentamerous flowers have five organs in each whorl, indicated by the number 5.
- The floral formula $\star K_5 C_5 A_5 G_5$ describes actinomorphic flowers with five sepals, five petals, five stamens, and five carpels.
- This formula is characteristic of many dicot families and indicates a relatively simple, regular flower structure.
- The formula $\star K_4 C_4 A_4 G_4$ represents tetramerous flowers (four organs in each whorl), typical of monocots.
- The formula with infinity symbols (A_∞ , G_∞) indicates an indefinite or very large number of stamens or carpels.

Final Answer: $\star K_5 C_5 A_5 G_5$ **Answer:** (A)[Go Back to Question 9](#)

Q10.

Solution**Concept:**

The Casparian strip is a specialized structure in roots that plays a crucial role in regulating the uptake of water and minerals. Understanding its chemical composition and function is essential to comprehending root anatomy and physiological transport.

Solution:

- (a) The Casparian strip is a thickened band of cell wall material found in the endodermis of roots.
- (b) It forms a continuous seal around each endodermal cell, running radially between the cells.
- (c) The Casparian strip is composed of suberin, a waxy, hydrophobic (water-repellent) polymer.
- (d) Suberin is a lipid-based compound that is highly resistant to water penetration and chemical degradation.
- (e) The presence of suberin makes the Casparian strip impermeable to water and dissolved substances attempting to pass through the cell walls.
- (f) This forces water and minerals to enter the symplast (living cell cytoplasm) rather than continuing through the apoplast (cell wall space).
- (g) This selective barrier allows the root to regulate which substances enter the vascular tissue.
- (h) Cellulose is a structural carbohydrate found in all plant cell walls but is not the primary component of Casparian strips.
- (i) Pectin is a complex polysaccharide found in cell walls but is not characteristic of Casparian strips.
- (j) Lignin is a polymer found in woody tissues and strengthens cell walls but is not the primary component of Casparian strips.

Final Answer: **Answer:** (B)[Go Back to Question 10](#)

Q11.

Solution**Concept:**

Meiosis is a specialized form of cell division that produces four haploid cells from one diploid cell. This process consists of two sequential divisions (Meiosis I and II), with specific events occurring at each stage. Understanding when homologous chromosomes separate is crucial.

Solution:

- (a) Meiosis consists of Meiosis I (reduction division) and Meiosis II (equational division).
- (b) Metaphase I is the stage in which homologous chromosome pairs (bivalents) align at the cell's metaphase plate.
- (c) At this point, the homologous chromosomes are still attached to each other through chiasma formed during crossing over.
- (d) Anaphase I is the stage in which the two homologous chromosomes in each bivalent separate and move toward opposite poles.
- (e) This separation of homologous chromosomes reduces the chromosome number from diploid ($2n$) to haploid (n) in each daughter cell.
- (f) This is the critical stage where the reduction in chromosome number occurs.
- (g) In Meiosis II, the events are similar to mitosis: sister chromatids separate during Anaphase II.
- (h) Telophase II completes the second meiotic division, resulting in four haploid cells.
- (i) Therefore, homologous chromosomes separate during Anaphase I, making this the stage that defines the reductive nature of meiosis.

Final Answer: Anaphase I**Answer: (B)**[Go Back to Question 11](#)

Q12.

Solution**Concept:**

Reproduction in plants can be classified as sexual (involving gamete fusion) or asexual (not involving gametes). Apomixis represents a special category where seeds are formed without the normal meiotic and fertilization processes, combining some aspects of sexual reproduction with the genetic identity of asexual reproduction.

Solution:

- (a) Sexual reproduction involves the fusion of male and female gametes, resulting in genetic variation in offspring.
- (b) Asexual reproduction produces offspring genetically identical to the parent without gamete fusion.
- (c) Apomixis is a form of asexual reproduction where seeds or spores are produced without the normal meiotic and fertilization processes.
- (d) In apomictic seeds, the embryo develops from a somatic cell in the ovule rather than from a zygote.
- (e) Examples of apomictic plants include some species of grasses, citrus fruits, and dandelions.
- (f) Apomixis is advantageous because it allows plants to reproduce rapidly and reliably while maintaining desirable traits.
- (g) The term "apomixis" literally means "without mixing," indicating the absence of genetic recombination.
- (h) Pollination may still occur in apomictic plants but is not necessary for seed formation.
- (i) Apomixis is particularly valuable in agriculture for propagating elite cultivars without genetic segregation.

Final Answer: Asexual reproduction

Answer: (B)

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Q13.

Solution**Concept:**

Photosynthetic pathways differ in the initial CO_2 fixation step. C_4 plants have evolved a more efficient photosynthetic pathway that concentrates CO_2 around RuBisCO, reducing photorespiration. Understanding the initial CO_2 acceptor in C_4 photosynthesis is essential.

Solution:

- (a) In C_3 plants (the typical Calvin pathway), CO_2 is directly fixed by RuBisCO into 3-phosphoglycerate (a 3-carbon compound).
- (b) In C_4 plants, CO_2 is initially fixed by the enzyme PEP carboxylase into oxaloacetate (a 4-carbon compound).
- (c) Phosphoenolpyruvate (PEP) is the CO_2 acceptor in C_4 plants, not the initial fixation product.
- (d) PEP carboxylase catalyzes the carboxylation of PEP, forming oxaloacetate in the mesophyll cells.
- (e) Oxaloacetate is then converted to malate, which is transported to bundle sheath cells.
- (f) In bundle sheath cells, malate is decarboxylated, releasing CO_2 that is refixed by RuBisCO in the normal Calvin cycle.
- (g) This CO_2 concentration around RuBisCO reduces the enzyme's oxygenase activity, minimizing photorespiration.
- (h) C_4 photosynthesis is more efficient in hot, dry climates and is characteristic of plants like corn, sorghum, and sugarcane.
- (i) The Kranz anatomy (specialized tissue arrangement) of C_4 plants supports this efficient CO_2 concentration mechanism.

Final Answer: Oxaloacetate**Answer: (B)**[Go Back to Question 13](#)

Q14.

Solution**Concept:**

Stomata are microscopic pores on plant leaves that allow gas exchange but also permit water loss. The opening and closing of stomata are regulated by guard cells, which respond to various environmental signals and hormonal signals. Different hormones have opposite effects on stomatal opening.

Solution:

- (a) Stomata are pores bounded by two specialized cells called guard cells that regulate their opening and closing.
- (b) Abscisic acid (ABA) is a stress hormone that promotes stomatal closure, reducing water loss during drought conditions.
- (c) ABA accumulates in guard cells under water stress, triggering ion efflux and water loss from the guard cells, causing stomatal closure.
- (d) Ethylene is a gaseous hormone that generally promotes senescence and stress responses, promoting stomatal closure.
- (e) Gibberellins are growth-promoting hormones that generally do not directly control stomatal opening.
- (f) Cytokinins promote cell division and growth but do not have a primary role in opening stomata.
- (g) The primary mechanism of stomatal opening involves increasing turgor pressure in guard cells through ion uptake (particularly potassium) and water absorption.
- (h) During the day, when photosynthesis is active and water is available, stomata open to allow CO₂ uptake.
- (i) Reviewing the question: which hormone is responsible for opening? The answer is that various signals promote opening, but no single hormone is definitively named. However, gibberellins and cytokinins can promote stomatal opening in some contexts.
- (j) Given the options, Cytokinin would be the best answer as it promotes cell turgor and growth processes.

Final Answer: **Answer: (D)**[Go Back to Question 14](#)

Q15.

Solution**Concept:**

The carbon cycle is a global biogeochemical cycle in which carbon atoms are exchanged between the atmosphere, living organisms, and geological reserves. Different processes either add or remove CO_2 from the atmosphere. Understanding which processes contribute to atmospheric CO_2 is essential.

Solution:

- (a) The carbon cycle involves the movement of carbon between the atmosphere (as CO_2), living organisms, and geological reservoirs.
- (b) Photosynthesis is the process by which plants and other autotrophs remove CO_2 from the atmosphere, incorporating it into organic molecules.
- (c) This represents a loss of atmospheric CO_2 , not a gain.
- (d) Respiration is the process by which all living organisms break down organic molecules to release energy.
- (e) During respiration, organic carbon is oxidized, and CO_2 is released back to the atmosphere.
- (f) Both animals and plants undergo respiration, continuously adding CO_2 to the atmosphere.
- (g) Decomposition of dead organisms also releases CO_2 through the respiration of decomposing microorganisms.
- (h) Combustion of fossil fuels releases CO_2 that has been locked underground for millions of years.
- (i) Among the listed processes, respiration is the primary biological process that releases CO_2 from living organisms.
- (j) Therefore, respiration represents the loss of CO_2 from organisms and its return to the atmosphere.

Final Answer: **Answer: (B)**[Go Back to Question 15](#)

Q16.

Solution**Concept:**

Pollen grain viability refers to the ability of pollen to germinate and fertilize ovules. Various staining techniques can be used to determine whether pollen grains are alive (viable) or dead (non-viable). Different stains have different mechanisms and specificities.

Solution:

- (a) Pollen viability testing is important in breeding programs and seed production to ensure adequate pollination success.
- (b) Safranin is a basic (cationic) dye that stains proteins and carbohydrates; it is used in plant tissue staining but is not the primary pollen viability stain.
- (c) Iodine is used to detect starch and other polysaccharides in cells; it is not specific for pollen viability.
- (d) Methylene blue is a vital stain that can penetrate living cells and stain the cytoplasm; it indicates cell viability.
- (e) Acid fuchsin is used in the standard pollen viability test. Living pollen grains with an intact membrane exclude the stain, remaining colorless.
- (f) Non-viable (dead) pollen grains with damaged membranes take up acid fuchsin and stain red or pink.
- (g) This selective staining property makes acid fuchsin ideal for distinguishing viable from non-viable pollen.
- (h) The Alexander stain is another common pollen viability stain that produces similar results.
- (i) Properly stained pollen preparations can be examined under a microscope, and viability percentages can be calculated.

Final Answer:

Answer: (D)

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Q17.

Solution**Concept:**

Plant families are defined by sets of morphological characteristics that group plants with shared evolutionary history. Brassicaceae (mustard family) includes economically important crops and is characterized by distinctive floral and fruit features.

Solution:

- (a) Brassicaceae is one of the largest plant families, including cabbage, broccoli, mustard, radish, and many other crops.
- (b) Flowers of Brassicaceae are tetramerous, meaning they have four sepals, four petals, and other floral organs in fours or multiples thereof.
- (c) The floral formula is typically $K_4C_4A_{4+2}G_2$, with four petals arranged in a cross (hence the alternative family name Cruciferae, "cross-bearing").
- (d) The stamens are notably arranged as two outer whorls: four long stamens and two short stamens (decandrous would be 10 stamens, not characteristic of Brassicaceae).
- (e) The fruit is characteristic: either a siliqua (long fruit, at least 3 times longer than wide) or a silicula (short, rounded fruit).
- (f) A siliqua is divided into two chambers by a false septum, with seeds attached to the marginal placentae.
- (g) The siliqua is a defining character of Brassicaceae and is highly distinctive.
- (h) Therefore, all three characteristics (tetramerous flowers, 4+2 stamens rather than decandrous, and siliqua fruits) are characteristic of Brassicaceae.
- (i) The answer "All of the above" is correct as each characteristic is definitive for the family.

Final Answer:

Answer: (D)

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Q18.

Solution**Concept:**

Vernalization is the exposure of plants to prolonged cold (low temperature) that modifies their physiology to promote flowering. This adaptation allows plants to distinguish between winter and spring, preventing them from flowering prematurely in early autumn.

Solution:

- (a) Photoperiodism refers to the response of plants to day length, not temperature.
- (b) Vernalization specifically refers to the response to prolonged cold exposure, typically during winter.
- (c) Many temperate plants require a period of cold exposure before they can flower in spring—this is vernalization.
- (d) Examples include wheat, barley, and many biennial plants that require winter cold to initiate flowering.
- (e) At the molecular level, prolonged cold exposure causes epigenetic changes (DNA methylation, histone modifications) in flowering-related genes.
- (f) The cold exposure effectively reprograms the plant's developmental state, allowing it to recognize spring as the appropriate time to flower.
- (g) Light quality (the spectral composition of light) is detected by phytochrome but is not vernalization.
- (h) Gravitropism is the response to gravity, not to temperature.
- (i) Vernalization is particularly important in cereal crop cultivation, where varieties are classified as winter types (requiring vernalization) or spring types (not requiring vernalization).

Final Answer: Response to temperature

Answer: (B)

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Q19.

Solution**Concept:**

Cellular respiration encompasses both aerobic and anaerobic pathways for energy production. Under anaerobic conditions (absence of oxygen), cells must utilize alternative pathways that do not require oxygen as the final electron acceptor.

Solution:

- (a) Glucose breakdown always begins with glycolysis in the cytoplasm, producing pyruvate, ATP, and NADH.
- (b) In anaerobic conditions (when oxygen is unavailable), pyruvate cannot enter the Krebs cycle.
- (c) Without oxygen, the electron transport chain cannot function because oxygen is the final electron acceptor in this system.
- (d) Under anaerobic conditions, cells perform fermentation, which regenerates NAD^+ from NADH without requiring oxygen.
- (e) In animal cells, lactate fermentation converts pyruvate to lactate, regenerating NAD^+ so glycolysis can continue.
- (f) In yeast and plant cells, alcoholic fermentation converts pyruvate to ethanol and CO_2 , also regenerating NAD^+ .
- (g) Both fermentation pathways allow cells to continue producing small amounts of ATP from glycolysis under anaerobic conditions.
- (h) The Krebs cycle requires oxygen indirectly (through the need for NAD^+ and FAD regeneration) and cannot proceed without functional electron transport.
- (i) Therefore, fermentation is the correct term for glucose breakdown under anaerobic conditions.

Final Answer: Fermentation**Answer:** (C)[Go Back to Question 19](#)

Q20.

Solution**Concept:**

Plant tissue culture is an in vitro technique that exploits the totipotency of plant cells to regenerate entire plants. The developmental fate of cultured tissue is controlled by the ratio of plant growth regulators, particularly auxins and cytokinins.

Solution:

- (a) Plant tissue culture involves culturing plant cells, tissues, or organs on nutrient media supplemented with growth regulators.
- (b) Callus is an undifferentiated mass of parenchymatous cells that serves as the starting material for regeneration.
- (c) The ratio of auxins to cytokinins determines the developmental pathway of cultured cells.
- (d) High auxin concentration (high auxin to cytokinin ratio) promotes root formation.
- (e) High cytokinin concentration (high cytokinin to auxin ratio) promotes shoot formation.
- (f) When the ratio of auxin to cytokinin is approximately equal (balanced), callus formation is promoted.
- (g) In this balanced condition, neither organ development is favored; instead, undifferentiated cell proliferation occurs.
- (h) The specific concentrations required vary by plant species and genotype.
- (i) Callus formation is the initial step in tissue culture, providing undifferentiated cells that can then be directed toward specific organogenesis.
- (j) This principle has been extensively validated and is fundamental to plant biotechnology.

Final Answer: Equal ratio of auxin and cytokinin

Answer: (C)

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Q21.

Solution**Concept:**

Genetic engineering and recombinant DNA technology enable the creation of transgenic plants by introducing foreign genetic material into plant cells. This technology has revolutionized crop improvement by allowing the precise insertion of specific genes.

Solution:

- (a) Transgenic plants are organisms that have had foreign DNA (from a different species) stably integrated into their genome.
- (b) Traditional breeding methods (cross-breeding) involve sexual reproduction between compatible plant varieties.
- (c) Radiation and chemical mutagens cause random mutations that cannot be controlled or directed.
- (d) Recombinant DNA technology allows specific genes to be isolated, manipulated, and introduced into plant cells with precision.
- (e) The most common method uses *Agrobacterium tumefaciens*, a bacterium that naturally transfers DNA into plants, as a vector.
- (f) Key steps include: isolating the desired gene, incorporating it into a plasmid or vector, introducing it into plant cells, and selecting transformed cells.
- (g) Transgenic plants have been successfully produced with various traits including herbicide resistance (Roundup Ready crops), pest resistance (Bt corn), and enhanced nutrition (Golden Rice).
- (h) The advantages of transgenic crops include improved yield, reduced chemical inputs, and enhanced nutritional content.
- (i) Transgenic technology represents a major advancement over traditional breeding, which is limited to sexually compatible species.

Final Answer: Recombinant DNA technology

Answer: (C)

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Q22.

Solution**Concept:**

Golden Rice is a landmark achievement in agricultural biotechnology, developed to address vitamin A deficiency in populations relying on rice as a staple. This transgenic crop contains enhanced levels of beta-carotene, a precursor to vitamin A.

Solution:

- (a) Golden Rice was developed through recombinant DNA technology to enrich rice grains with beta-carotene.
- (b) Beta-carotene is a carotenoid pigment that gives the rice its characteristic yellow/golden color.
- (c) The human body converts beta-carotene to vitamin A (retinol) through enzymatic cleavage.
- (d) Vitamin A is essential for vision, immune function, and cellular differentiation.
- (e) Vitamin A deficiency is a major public health problem in developing countries, causing preventable blindness in children.
- (f) The genes for beta-carotene synthesis were introduced into rice using *Agrobacterium tumefaciens* and tissue culture techniques.
- (g) The sources of the introduced genes were from daffodil and bacterial species that naturally produce carotenoids.
- (h) Golden Rice has not significantly reduced vitamin A deficiency globally due to various adoption barriers, but it represents an important technological achievement.
- (i) Other nutrients (protein, iron, calcium) have not been successfully enhanced in Golden Rice to the same extent.
- (j) The development of Golden Rice demonstrates the potential of biotechnology to address nutritional deficiencies.

Final Answer:

Answer: (C)

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Q23.

Solution**Concept:**

Vectors are vehicles used to deliver foreign DNA into plant cells. Different vectors are utilized depending on the target organism and the desired outcome. The most widely used vector for plant genetic engineering is a naturally occurring bacterium.

Solution:

- (a) *Bacillus thuringiensis* is a bacterium that produces toxins lethal to insects; its genes are used in Bt crops but it is not a DNA transfer vector.
- (b) *Agrobacterium tumefaciens* is a soil bacterium that naturally infects plants and transfers DNA into plant cell genomes.
- (c) This bacterium contains a Ti (tumor-inducing) plasmid that carries genes responsible for DNA transfer.
- (d) The T-DNA (transfer DNA) region of the plasmid is the DNA that gets transferred into plant cells.
- (e) Scientists engineered the Ti plasmid as a vector by removing harmful genes and adding foreign DNA of interest.
- (f) The recombinant plasmid is then used to infect plant cells, transferring the desired genes into the plant genome.
- (g) *Escherichia coli* is commonly used in bacterial genetic engineering but is not an effective vector for plant cell transformation due to inability to naturally infect plants.
- (h) *Streptomyces* is an antibiotic-producing bacterium but is not used as a plant transformation vector.
- (i) *Agrobacterium tumefaciens* remains the most widely used and effective vector for plant genetic engineering globally.
- (j) Particle bombardment is an alternative physical method for gene transfer but not a biological vector.

Final Answer:

Answer: (B)

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Q24.

Solution**Concept:**

Potato is susceptible to various fungal diseases that cause significant crop losses. Early blight and late blight are two distinct fungal diseases with different causal agents, symptoms, and management strategies.

Solution:

- (a) Early blight and late blight are two separate diseases of potato, each caused by a different pathogen.
- (b) Early blight is caused by *Alternaria solani*, a fungus that commonly affects potato and tomato.
- (c) *Alternaria solani* produces characteristic symptoms: concentric rings (target-like lesions) on leaves, starting on older leaves first.
- (d) These lesions are surrounded by a yellow halo, making them distinctive.
- (e) Early blight typically appears in warm, dry conditions and is less damaging than late blight.
- (f) *Phytophthora infestans* causes late blight, which is more serious and occurs in cool, wet conditions.
- (g) Late blight lesions are water-soaked and lack the concentric rings characteristic of early blight.
- (h) *Colletotrichum lindemuthianum* causes anthracnose in beans, not potato.
- (i) *Fusarium oxysporum* causes wilt diseases in various crops but not potato early blight.
- (j) Understanding the distinction between these diseases is crucial for proper management and treatment decisions.

Final Answer: **Answer: (B)**[Go Back to Question 24](#)

Q25.

Solution**Concept:**

Integrated Pest Management (IPM) is a comprehensive approach to pest control that combines multiple strategies to minimize crop damage while reducing environmental impact. This approach integrates knowledge of pest biology with various control tactics.

Solution:

- (a) IPM is a holistic pest management philosophy that goes beyond relying on a single control method.
- (b) Chemical control involves the application of synthetic pesticides or natural compounds to kill or repel pests.
- (c) While effective, chemical control alone can lead to pesticide resistance, environmental pollution, and health concerns.
- (d) Biological control uses natural enemies (predators, parasitoids, pathogens) to suppress pest populations.
- (e) This method is sustainable and has no chemical residues but may be slower than chemical control.
- (f) Cultural control includes practices such as crop rotation, removal of crop residues, sanitation, and adjustment of planting dates.
- (g) These practices disrupt pest lifecycles and reduce pest habitat availability.
- (h) Mechanical control involves physical removal of pests through trapping, hand-picking, or other manual methods.
- (i) IPM integrates all these methods based on economic thresholds, pest monitoring, and ecological considerations.
- (j) A successful IPM program uses multiple strategies in a coordinated manner, reducing the need for chemical inputs.
- (k) This approach is particularly important for sustainable agriculture and organic farming systems.

Final Answer: Combined use of multiple control strategies

Answer: (C)

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Q26.

Solution**Concept:**

The body cavity (coelom or hemocoel) is a fundamental characteristic distinguishing major animal groups. The type and lining of the body cavity reflect the evolutionary relationships among animal phyla and determine how internal organs are arranged and function.

Solution:

- (a) The blastocoel is a transient cavity found in the blastula stage of embryonic development; it is not a permanent adult body cavity.
- (b) The coelom (celom) is a true body cavity that develops from the embryonic mesoderm and is lined with peritoneum.
- (c) The coelom is found in most invertebrate phyla and all vertebrates, representing a major evolutionary innovation.
- (d) This cavity allows for separation of organs from the body wall, enabling complex organ systems to develop.
- (e) The hemocoel is found in arthropods and some mollusks, where body fluids bathe organs directly without a peritoneal lining.
- (f) The archenteron is the primordial gut formed during gastrulation, not a body cavity.
- (g) Animals with a coelom (coelomates) have greater body size potential and more complex physiology than acoelomate animals.
- (h) Examples of coelomates include annelids, mollusks, echinoderms, arthropods (though with modified cavities), and all chordates.
- (i) The coelom provides space for organ growth, allows organ movement during bodily functions, and supports the evolution of complex systems.
- (j) Therefore, the coelom is the primary body cavity in most animal phyla.

Final Answer: **Answer: (B)**[Go Back to Question 26](#)

Q27.

Solution**Concept:**

Annelida is characterized by a highly segmented body plan, where the body is divided into repeating segments (metameres). This segmentation is the defining feature of the phylum and distinguishes annelids from other invertebrate groups.

Solution:

- (a) Bilateral symmetry is found in most animal phyla, including annelids, arthropods, and chordates, but is not unique to Annelida.
- (b) Segmentation (metamerism) is the division of the body into repeating linear units (segments or metameres), each separated by septa.
- (c) Each segment in annelids contains its own set of organs, including nerve ganglia, blood vessels, and reproductive organs.
- (d) Segments can specialize for different functions while maintaining the basic body plan (tagmatization).
- (e) Segmentation allows for independent movement of body regions and greater complexity than nonsegmented invertebrates.
- (f) Tentacles are not a characteristic feature of annelids; some annelids have tentacle-like structures (cirri, tentacular crowns), but these are not defining.
- (g) A chitinous exoskeleton is characteristic of arthropods, not annelids, which have soft bodies covered only by a cuticle.
- (h) Annelids include earthworms, polychaetes, and leeches, all clearly segmented.
- (i) The segmented body plan is so distinctive that it gives the phylum its name: Annelida refers to "little rings."

Final Answer: Segmentation**Answer: (B)**[Go Back to Question 27](#)

Q28.

Solution**Concept:**

The circulatory system of earthworms is a closed system where blood flows through vessels, not directly bathing the organs. Understanding the components and arrangement of this system provides insight into invertebrate physiology and comparative anatomy.

Solution:

- (a) Earthworms possess a closed circulatory system where blood is confined within vessels and does not directly contact organs.
- (b) The dorsal vessel runs along the back (dorsal side) of the earthworm and functions as the main contractile pump.
- (c) The ventral vessel runs along the belly (ventral side) and collects blood from the tissues.
- (d) Multiple pairs of hearts (aortic arches) connect the dorsal and ventral vessels in the anterior segments.
- (e) In the earthworm, there are typically 5 pairs of hearts in the first 13 segments.
- (f) These hearts contract rhythmically to pump blood from the ventral vessel into the dorsal vessel, maintaining circulation.
- (g) Smaller connecting vessels (capillaries and arterioles) branch from the main vessels to supply individual organs.
- (h) This arrangement represents a significant advancement over open circulatory systems found in arthropods and some mollusks.
- (i) The closed system allows for higher blood pressure and more efficient oxygen delivery to tissues.
- (j) The diagram correctly shows the hearts connecting dorsal and ventral vessels, with the dorsal vessel serving the heart function of pumping blood forward.

Final Answer: Dorsal and ventral vessels connected by hearts

Answer: (B)

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Q29.

Solution**Concept:**

Aquatic insects face unique respiratory challenges due to the lower oxygen content of water compared to air. Evolution has produced various adaptations for gas exchange in aquatic environments.

Solution:

- (a) Lungs are characteristic of terrestrial vertebrates and are not found in insects, which lack lungs entirely.
- (b) Most insects, both terrestrial and aquatic, possess a tracheal system of tubes for respiration.
- (c) However, aquatic insects have evolved specialized modifications of the tracheal system for gas exchange in water.
- (d) Tracheal gills (also called gill tracheae) are thin-walled extensions of the tracheal system that increase surface area for gas exchange.
- (e) These gills function by diffusion of oxygen from water across the thin gill walls into the tracheal system.
- (f) Examples of aquatic insects with tracheal gills include mayfly nymphs, dragonfly nymphs, and some mosquito larvae.
- (g) Book gills are found in arachnids (spiders, scorpions), not insects, consisting of thin plates resembling book pages.
- (h) Skin respiration is supplementary in aquatic insects but is not their primary respiratory mechanism.
- (i) Some aquatic insects also utilize air bubbles (plastrons) trapped on their bodies, through which gas exchange occurs.
- (j) Tracheal gills represent an elegant adaptation for respiration in the aquatic environment while maintaining the insect body plan.

Final Answer: Tracheal gills

Answer: (B)

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Q30.

Solution**Concept:**

Insects are the largest and most successful group of animals on Earth, with over one million described species. Different orders have achieved tremendous size diversity, with some orders including notably large members.

Solution:

- (a) Lepidoptera includes butterflies and moths. While some species are large, they do not represent the largest insects.
- (b) Coleoptera (beetles) includes over 400,000 species and includes some of the largest insects, such as Hercules beetles and Goliath beetles.
- (c) Giant beetle species can exceed 15 cm in length and constitute some of the heaviest insects.
- (d) Hymenoptera includes ants, bees, and wasps. While some species are reasonably large, they do not include the largest insects.
- (e) Orthoptera includes grasshoppers, crickets, and katydids. Some species are large, but not the largest insects overall.
- (f) Coleoptera dominance in size, biomass, and species diversity makes it the most successful insect order.
- (g) The success of Coleoptera is attributed to the protective elytra (hardened forewings), which allow colonization of diverse habitats.
- (h) Fossil evidence suggests that some extinct insects (dragonflies, mayflies) reached larger sizes than most modern insects.
- (i) Therefore, among modern insect orders, Coleoptera contains the largest members.

Final Answer: **Answer: (B)**[Go Back to Question 30](#)

Q31.

Solution**Concept:**

Dengue fever is a major vector-borne disease affecting millions of people globally. Understanding the specific vector is crucial for disease prevention and control strategies.

Solution:

- (a) Vector-borne diseases are transmitted by arthropods such as mosquitoes, ticks, and flies.
- (b) Anopheles mosquitoes are the primary vector for malaria parasites, not dengue.
- (c) Culex mosquitoes are vectors for lymphatic filariasis and West Nile virus, not the primary dengue vector.
- (d) Aedes mosquitoes, particularly *Aedes aegypti* and *Aedes albopictus*, are the principal vectors of dengue fever.
- (e) *Aedes aegypti* is the primary vector and is highly anthropophilic (attracted to humans), living in urban and peri-urban areas.
- (f) The virus is transmitted when an infected mosquito takes a blood meal from a person, injecting the virus into the bloodstream.
- (g) Dengue fever is characterized by fever, headache, muscle and joint pain, and rash (hence "breakbone fever").
- (h) There are four serotypes of dengue virus, and infection with one serotype confers lifelong immunity to that serotype but not others.
- (i) Control measures include reducing *Aedes* mosquito breeding sites and using insecticide-treated nets and repellents.
- (j) Houseflies are mechanical vectors for various bacterial diseases but not dengue fever.

Final Answer: Mosquito (*Aedes*)

Answer: (B)

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Q32.

Solution**Concept:**

Parasitic worms, particularly helminths, have complex life cycles involving multiple stages. Understanding the terminology for these life stages is essential in parasitology and medical biology.

Solution:

- (a) Cercaria is a fork-tailed larval stage of trematodes (flukes) that is free-swimming in water and seeks a suitable second intermediate host.
- (b) Miracidium is the ciliated, free-swimming larval stage produced by trematode eggs, which infects freshwater snails.
- (c) Plerocercus is a larval stage of certain cestodes (tapeworms) found in the second intermediate host (usually a fish or freshwater crustacean).
- (d) Metacercaria is a juvenile stage of some trematodes that develops in the second intermediate host after the cercarial stage.
- (e) For tapeworms specifically, plerocercus is the larval stage that develops in the second intermediate host and is infective to the definitive host (humans).
- (f) The life cycle of tapeworms typically involves an intermediate host (fish or crustacean) where the plerocercus stage develops.
- (g) When a person eats raw or undercooked infected fish, they ingest the plerocercus, which develops into an adult tapeworm.
- (h) The question asks specifically about the tapeworm larval stage, making plerocercus the correct answer.
- (i) Understanding these life cycle stages is crucial for understanding transmission dynamics and developing control strategies.

Final Answer: **Answer:** (C)[Go Back to Question 32](#)

Q33.

Solution**Concept:**

Parasitic roundworms (nematodes) have complex life cycles adapted to their mode of transmission. Understanding which stage is infective to humans is critical for understanding disease transmission and developing prevention strategies.

Solution:

- (a) Roundworm life cycles typically involve eggs, larval stages (L1-L4), and adults.
- (b) Adult worms live in the host's intestine, where they feed and reproduce, producing eggs.
- (c) Eggs are expelled in feces and contaminate soil in areas with poor sanitation.
- (d) Eggs develop in warm, moist soil conditions into embryonic larvae, eventually becoming infective-stage larvae.
- (e) For many roundworm species (like *Ascaris lumbricoides* and Hookworm), the infective-stage larvae remain in the soil and infect humans through ingestion (*Ascaris*) or skin penetration (Hookworm).
- (f) The infective larval stage in soil represents the transmissible form of the parasite to new hosts.
- (g) Infection occurs through ingestion of contaminated food or water containing infective larvae (for *Ascaris*) or skin contact with contaminated soil (for Hookworm).
- (h) Adult worms in the host are not infective to new hosts; they continue to reproduce within the infected person.
- (i) Eggs alone are not infective immediately upon excretion; they require development time in the soil.
- (j) The infective-stage larva in soil is the crucial link in the transmission cycle, representing the stage that initiates infection in new hosts.

Final Answer: Infective larva in soil

Answer: (C)

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Q34.

Solution**Concept:**

Insects have evolved efficient mechanisms for removing nitrogenous waste while conserving water. Malpighian tubules are the primary excretory organs in insects and represent an important adaptation to terrestrial life.

Solution:

- (a) Malpighian tubules are slender, closed-ended tubes that arise from the junction of the midgut and hindgut in insects.
- (b) These tubules extend into the hemocoel (body cavity) where they are bathed in hemolymph.
- (c) The tubules absorb nitrogenous waste (uric acid), excess water, and other metabolic wastes from the hemolymph.
- (d) Uric acid is the primary nitrogenous waste product, which is relatively non-toxic and requires minimal water for excretion.
- (e) The excretory fluid (urine) produced in the tubules flows into the lumen and passes into the rectum and hindgut.
- (f) The rectum has specialized cells that reabsorb water and valuable ions from the excretory fluid.
- (g) This reabsorption produces a concentrated, semi-solid waste (frass) that minimizes water loss.
- (h) This water-conserving mechanism is particularly important for insects living in dry environments.
- (i) Respiration in insects is accomplished by tracheal systems, not Malpighian tubules.
- (j) Circulation of hemolymph occurs through open systems in insects, not through Malpighian tubules.
- (k) Digestion occurs in the alimentary canal (esophagus, crop, gizzard, midgut, hindgut), not in Malpighian tubules.

Final Answer: Excretion**Answer:** (C)[Go Back to Question 34](#)

Q35.

Solution**Concept:**

Metamorphosis in insects is the dramatic transformation from larva to adult, involving profound morphological changes. This process is orchestrated by hormones that trigger developmental events at precise times.

Solution:

- (a) Metamorphosis in insects is controlled by two primary hormones: juvenile hormone (JH) and ecdysone.
- (b) Ecdysone is the molting hormone (20-hydroxyecdysone in insects) that triggers the shedding of the exoskeleton and larval development.
- (c) Ecdysone levels increase before each molt, initiating the shedding of the old exoskeleton and formation of a new one.
- (d) Juvenile hormone maintains larval characteristics during development; when JH levels are high, the insect remains in larval form despite molting.
- (e) As an insect approaches the final larval instar, JH levels decrease while ecdysone levels remain high.
- (f) This hormone combination (high ecdysone + low JH) triggers metamorphosis, the transformation from larva to pupa to adult.
- (g) Different insects have different numbers of larval instars and different JH titre patterns, reflecting their specific life histories.
- (h) Insulin is primarily involved in glucose metabolism and is not the primary metamorphosis regulator in insects.
- (i) The JH-ecdysone balance is a classic example of hormonal regulation of development in invertebrates.

Final Answer: Both JH and ecdysone

Answer: (C)

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Q36.

Solution**Concept:**

Hemoglobin is a protein in red blood cells that plays a crucial role in respiratory physiology. Understanding its primary function and how it interacts with gases is fundamental to understanding oxygen transport.

Solution:

- (a) Hemoglobin is a tetrameric protein consisting of four subunits, each containing an iron-containing heme group.
- (b) The primary function of hemoglobin is to bind oxygen in the lungs where oxygen is abundant and has high partial pressure.
- (c) Hemoglobin transports oxygen through the bloodstream to tissues where oxygen is needed.
- (d) At the tissue level, where oxygen partial pressure is low, hemoglobin releases oxygen for cellular respiration.
- (e) This oxygen-binding and oxygen-releasing function is the main physiological role of hemoglobin.
- (f) While hemoglobin can also transport carbon dioxide (as carbaminohemoglobin and through the Bohr effect), this is a secondary function.
- (g) Most CO₂ transport occurs through other mechanisms: dissolved in plasma, as bicarbonate ions, and bound to plasma proteins.
- (h) Hemoglobin does not directly transport nutrients; nutrients are transported by other plasma proteins.
- (i) While hemoglobin can stimulate some immune responses, immune response is not its primary function.
- (j) The allosteric properties of hemoglobin (cooperative binding) ensure efficient oxygen loading and unloading.

Final Answer:

Answer: (A)

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Q37.

Solution**Concept:**

Vitamins are essential organic compounds required for normal metabolism, growth, and development. While most vitamins must be obtained from dietary sources, some are synthesized by the body or by symbiotic microorganisms.

Solution:

- (a) Vitamin A (retinol) is obtained primarily from dietary sources; limited synthesis may occur in the body, but not in the intestine.
- (b) Vitamin K is a fat-soluble vitamin essential for blood clotting and bone metabolism.
- (c) Vitamin K1 (phylloquinone) is obtained from green leafy vegetables, while vitamin K2 is synthesized by gut bacteria.
- (d) The intestinal microbiota (normal flora) synthesize vitamin K2, particularly in the large intestine.
- (e) This synthesis by bacteria and absorption by the intestine provide a significant portion of the body's vitamin K requirement.
- (f) Vitamin C (ascorbic acid) is a water-soluble vitamin that humans cannot synthesize and must obtain from dietary sources.
- (g) Vitamin D can be synthesized in the skin upon exposure to ultraviolet light, but synthesis does not occur in the intestine.
- (h) The symbiotic relationship between humans and gut bacteria that synthesize vitamin K demonstrates the importance of maintaining healthy intestinal flora.
- (i) Certain antibiotics that eliminate gut bacteria can lead to vitamin K deficiency if intake is insufficient.
- (j) Therefore, vitamin K is the vitamin synthesized by intestinal bacteria.

Final Answer: **Answer: (B)**[Go Back to Question 37](#)

Q38.

Solution**Concept:**

A balanced diet must contain appropriate proportions of macronutrients to support all physiological functions. The recommended ratios reflect nutritional requirements for normal growth, development, and metabolic function.

Solution:

- (a) Macronutrients are carbohydrates, proteins, and fats, which provide energy and building materials for the body.
- (b) Carbohydrates are the primary energy source, providing 4 calories per gram.
- (c) Proteins are essential for tissue building, enzyme synthesis, and various metabolic functions, providing 4 calories per gram.
- (d) Fats provide concentrated energy (9 calories per gram) and are essential for hormone synthesis and cellular structure.
- (e) The recommended proportion for a balanced diet is approximately: carbohydrates 50-60%, protein 10-15%, and fat 20-25% of total calories.
- (f) When expressed as a simple ratio, this approximates: carbohydrates : protein : fat = 5:1:1.
- (g) This ratio reflects the emphasis on carbohydrates as the primary energy source while maintaining adequate protein and fat intake.
- (h) A ratio of 4:1:1 would provide slightly less carbohydrate and slightly more protein/fat than optimal.
- (i) A ratio of 3:1:1 would provide insufficient carbohydrates for normal energy needs.
- (j) A ratio of 2:1:1 would result in excessive fat and protein intake and insufficient carbohydrates.
- (k) Individual dietary requirements may vary based on age, activity level, and health status.

Final Answer: Carbohydrate : Protein : Fat = 5:1:1

Answer: (C)

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Q39.

Solution**Concept:**

Protein digestion is initiated in the stomach by a specific protease, where the acidic environment is optimal for its activity. Understanding the sequence of protein-digesting enzymes in different regions of the digestive tract is essential to digestion physiology.

Solution:

- (a) Trypsin is a serine protease produced by the pancreas and secreted into the small intestine.
- (b) Trypsin is an endopeptidase that cleaves peptide bonds at specific sites in the interior of proteins.
- (c) While trypsin is a major protease, it is not the enzyme that initiates protein digestion in the stomach.
- (d) Pepsin is a protease produced in the stomach by gastric chief cells as the inactive precursor pepsinogen.
- (e) Pepsinogen is activated to pepsin by the acidic environment (pH 2-3) through autocatalytic cleavage.
- (f) Pepsin is an endopeptidase that specifically cleaves peptide bonds adjacent to aromatic amino acids.
- (g) Pepsin is adapted to the acidic stomach environment and functions optimally at pH 2-3, unlike other proteases.
- (h) The action of pepsin breaks proteins into smaller polypeptides that can be further digested by trypsin and other intestinal proteases.
- (i) Chymotrypsin is another pancreatic protease similar to trypsin but has different substrate specificity.
- (j) Amylase is a carbohydrate-digesting enzyme, not a protease.
- (k) Pepsin is the unique enzyme that initiates protein digestion in the stomach.

Final Answer: Pepsin**Answer: (B)**[Go Back to Question 39](#)

Q40.

Solution**Concept:**

Lipid (fat) digestion and absorption occur in the small intestine with the aid of bile salts and pancreatic lipase. The small intestine is specifically adapted for this function through increased surface area and intestinal epithelial specialization.

Solution:

- (a) Fats are largely insoluble in water and require special mechanisms for digestion and absorption.
- (b) The stomach performs minimal fat digestion; gastric lipase is present but accounts for only a small portion of fat digestion.
- (c) The large intestine is responsible for water and electrolyte absorption and houses beneficial bacteria but is not the primary fat absorption site.
- (d) The esophagus is simply a conduit for food and does not participate in digestion or absorption.
- (e) The small intestine is lined with millions of intestinal villi, which dramatically increase the surface area for absorption.
- (f) Each villus is covered with microvilli, creating an additional enormous absorptive surface (brush border).
- (g) Bile salts (from the gallbladder) emulsify fats into smaller micelles, increasing the surface area for enzyme action.
- (h) Pancreatic lipase breaks down triglycerides into monoglycerides and fatty acids in the small intestine.
- (i) Fatty acids and monoglycerides are incorporated into micelles and transported to the epithelial cells for absorption.
- (j) The absorbed lipids are re-esterified into triglycerides in the epithelial cells and packaged as chylomicrons for transport.
- (k) Therefore, the small intestine is the main site of fat absorption.

Final Answer: **Answer:** (C)[Go Back to Question 40](#)

Answer Key

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

