MHT-CET Biology Practice Paper-11

Duration: 90 Minutes **Maximum Marks: 100**

Instructions

- This paper contains a total of **100** Multiple Choice Questions.
- Each correct answer carries **+1 mark**.
- No negative marking for incorrect answers.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.
- No marks will be deducted for unattempted questions.

Q1. A botanist studying spore-bearing plants observes that the dominant phase of a particular plant's life cycle is the sporophyte, the gametophyte is nutritionally dependent on the sporophyte, and true leaves, roots, and stems are present but seeds are absent. The plant belongs to which group?

(A) Bryophyta

(B) Pteridophyta

(C) Gymnospermae

(D) Algae

Q2. During vigorous exercise, a skeletal muscle cell runs out of oxygen. Pyruvate produced by glycolysis is then converted into lactate by the action of lactate dehydrogenase. The primary reason for this conversion is to:

(A) Produce more ATP directly from lactate

(B) Regenerate NAD^+ so that glycolysis can continue

(C) Store energy for later use in the mitochondria

(D) Reduce the pH of the blood to stimulate breathing

Q3. In snapdragon (Antirrhinum), a cross between a pure-breeding red-flowered plant (RR) and a pure-breeding white-flowered plant (WW) produces pink-flowered

offspring (RW) in the F1 generation. This pattern of inheritance is an example of:

(A) Complete dominance

(B) Epistasis

(C) Incomplete dominance

(D) Codominance

Q4. A student views a eukaryotic cell under an electron microscope and observes a double-membrane-bound organelle. The inner membrane is highly folded into finger-like projections, and dense granules are found within the matrix. This organelle is most likely the:

(A) Rough endoplasmic reticulum

(B) Chloroplast

(C) Mitochondrion

(D) Golgi apparatus

Q5. The relationship between sea anemone and the clownfish (Amphiprion) is a classic example of an ecological interaction. The clownfish lives among the stinging tentacles of the anemone, gaining protection, while the anemone may benefit from the fish scaring away polyp-eating fish. This interaction is best classified as:

(A) Parasitism

(B) Commensalism

(C) Mutualism

(D) Amensalism

Q6. After ovulation, the Graafian follicle undergoes a structural transformation. Which hormone primarily drives this transformation, and what is the resultant structure?

(A) FSH drives it; the follicle becomes a primary follicle

(B) LH drives it; the follicle becomes the corpus luteum

(C) Estrogen drives it; the follicle becomes the corpus albicans

(D) Progesterone drives it; the follicle becomes the corpus luteum

Q7. In recombinant DNA technology, a restriction enzyme produces fragments with 5′ overhanging ends (sticky ends). These sticky ends are useful primarily because they:

(A) Increase the speed of gel electrophoresis

(B) Allow easy hybridization with complementary fragments and efficient ligation

(C) Prevent the vector from self-circularizing

(D) Code for selectable marker genes

Q8. A plant hormone is applied to a detached leaf and it is observed that the leaf remains green for significantly longer than an untreated control leaf kept under identical conditions. The hormone applied is most likely:

(A) Abscisic acid

(B) Ethylene

(C) Cytokinin

(D) Gibberellin

Q9. Which of the following characteristics is exclusive to the Phylum Chordata and distinguishes it from all non-chordate phyla?

(A) Presence of a closed circulatory system

(B) Presence of a notochord, a dorsal hollow nerve cord, and pharyngeal slits at some stage of development

(C) Presence of bilateral symmetry

(D) Presence of a coelom

Q10. In a transverse section of a dicot stem, the vascular bundles are arranged in a ring and each bundle contains both xylem and phloem. A strip of meristematic

tissue is found between the xylem and phloem, enabling secondary growth. This meristematic strip is the:

(A) Pericycle

(B) Fascicular cambium

(C) Endodermis

(D) Phellogen

Q11. Arrange the following steps of transcription in the correct sequential order: (i) Sigma factor recognises the promoter (ii) RNA polymerase moves along the template strand in 3′ to 5′ direction (iii) Terminator sequence causes RNA polymerase to dissociate (iv) RNA polymerase unwinds the DNA double helix

(A) (ii) → (i) → (iv) → (iii)

(B) (i) → (iv) → (ii) → (iii)

(C) (iii) → (i) → (ii) → (iv)

(D) (i) → (ii) → (iii) → (iv)

Q12. A patient presents with elevated blood urea nitrogen (BUN) and creatinine levels, reduced glomerular filtration rate, and oliguria. These findings are most consistent with a disorder primarily affecting which part of the nephron or kidney function?

(A) Excessive secretion in the distal convoluted tubule

(B) Impaired glomerular filtration

(C) Overproduction of ADH by the posterior pituitary

(D) Hypersecretion of aldosterone

Q13. The mature angiosperm embryo sac is described as 7-celled but 8-nucleate. Which of the following correctly accounts for all the cells and nuclei?

(A) 1 egg cell, 2 synergids, 3 antipodals, 1 central cell with 2 polar nuclei

(B) 1 egg cell, 3 synergids, 2 antipodals, 1 central cell with 2 polar nuclei

(C) 1 egg cell, 2 synergids, 4 antipodals, 1 central cell with 1 polar nucleus

(D) 2 egg cells, 2 synergids, 2 antipodals, 1 central cell with 2 polar nuclei

Q14. Hugo de Vries proposed the Mutation Theory of Evolution based on his experiments with Oenothera lamarckiana. According to this theory, new species arise:

(A) Gradually through continuous small heritable variations acted upon by natural selection

(B) Suddenly by large, discontinuous heritable changes called mutations

(C) By the inheritance of characters acquired during an organism's lifetime

(D) Through reproductive isolation alone, without any genetic change

Q15. A child repeatedly suffers from respiratory and gastrointestinal infections from early infancy, and laboratory investigations reveal the complete absence of both T-cells and B-cells. This clinical picture is most consistent with:

(A) Acquired Immunodeficiency Syndrome (AIDS)

(B) DiGeorge syndrome

(C) Severe Combined Immunodeficiency (SCID)

(D) Wiskott-Aldrich syndrome

Q16. The opening of stomata in the presence of light is primarily linked to a change in the osmotic potential of guard cells. Which ion actively accumulates in guard cells during stomatal opening?

(A) Calcium ions (Ca^{2+})

(B) Potassium ions (K^{+})

(C) Sodium ions (Na^{+})

(D) Chloride ions (Cl^{-})

Q17. Which of the following types of epithelial tissue is specifically adapted for functions involving absorption and secretion and is characterised by tall, column-like cells taller than they are wide?

(A) Squamous epithelium

(B) Cuboidal epithelium

(C) Columnar epithelium

(D) Pseudostratified epithelium

Q18. Gymnosperms are characterised by naked seeds. Which of the following additional features correctly describes this group?

(A) Ovules are enclosed within an ovary; double fertilisation occurs

(B) Ovules are borne directly on megasporophylls; no true fruit is formed

(C) Heterospory is absent; the dominant phase is the gametophyte

(D) Vascular tissue is absent; water transport occurs by diffusion only

Q19. Arrange the following events in the propagation of a nerve impulse along a myelinated nerve fibre in the correct sequence: (i) Depolarisation at a node of Ranvier (ii) Local current flows to the next node (iii) Repolarisation of the previous node (iv) Opening of voltage-gated Na^+ channels at the next node

(A) (i) $\rightarrow$ (iii) $\rightarrow$ (ii) $\rightarrow$ (iv)

(B) (i) $\rightarrow$ (ii) $\rightarrow$ (iv) $\rightarrow$ (iii)

(C) (ii) $\rightarrow$ (i) $\rightarrow$ (iii) $\rightarrow$ (iv)

(D) (i) $\rightarrow$ (ii) $\rightarrow$ (iii) $\rightarrow$ (iv)

Q20. In guinea pigs, black coat colour (B) is dominant over white (b), and rough coat (R) is dominant over smooth (r). A guinea pig with a black rough coat is test-crossed. The offspring obtained are: 25 black rough, 27 black smooth, 24 white rough, 26 white smooth. The genotype of the parent with the black rough coat is most likely:

(A) BBRR

(B) BBRr

(C) BbRR

(D) BbRr

Q21. Consider the following statements about the carbon cycle: Statement 1: Decomposition by microbes releases CO_2 into the atmosphere, completing the terrestrial carbon cycle. Statement 2: The process of combustion of fossil fuels contributes CO_2 to the atmosphere but is not considered part of the natural carbon cycle. Determine which statement(s) is/are correct:

(A) Only Statement 1 is correct

(B) Only Statement 2 is correct

(C) Both statements are correct

(D) Neither statement is correct

Q22. The fluid mosaic model of the plasma membrane describes the membrane as consisting of a phospholipid bilayer with proteins. Identify the correct statement regarding the components of this model:

(A) All membrane proteins are firmly embedded and cannot move laterally

(B) Peripheral proteins are covalently bonded to the lipid bilayer

(C) Integral proteins can span the entire membrane and are amphipathic

(D) Cholesterol is found exclusively in the outer leaflet of the membrane

Q23. The Bt toxin produced by Bacillus thuringiensis is a protoxin that becomes active only in the gut of the insect. Which specific condition in the insect midgut is responsible for its activation?

(A) Highly acidic pH in the midgut

(B) Highly alkaline pH in the midgut

(C) Presence of specific digestive enzymes secreted by the insect

(D) High temperature in the midgut

Q24. Identify the correct statement regarding the hormonal changes during the luteal phase of the menstrual cycle:

(A) LH levels remain high throughout the luteal phase

(B) Progesterone secreted by the corpus luteum peaks during the mid-luteal phase

(C) Estrogen levels fall to zero during the luteal phase

(D) FSH levels surge to trigger corpus luteum formation

Q25. A permanent slide shows a ground tissue where cells have unevenly thickened primary cell walls, particularly at the corners. The cells are living and provide flexible mechanical support to young growing organs like petioles. This tissue is:

(A) Parenchyma

(B) Sclerenchyma

(C) Chlorenchyma

(D) Collenchyma

Q26. A marine invertebrate has a soft body, a mantle that secretes a shell, a muscular foot for locomotion, and a radula for feeding. Which phylum does this organism belong to?

(A) Echinodermata

(B) Annelida

(C) Mollusca

(D) Arthropoda

Q27. The Z-scheme of non-cyclic photophosphorylation involves two photosystems. Which of the following correctly describes the final electron acceptor at the end of the non-cyclic electron transport chain?

(A) O_2 from the atmosphere

(B) CO_2 from the Calvin cycle

(C) $NADP^+$, which is reduced to NADPH

(D) Cytochrome complex

Q28. Cancer cells are fundamentally different from normal cells because they:

(A) Undergo apoptosis more rapidly than normal cells

(B) Lose the property of contact inhibition and continue to divide uncontrollably

(C) Require higher concentrations of oxygen for their survival

(D) Express MHC class I molecules at a higher density than normal cells

Q29. The process of translation in eukaryotes requires several initiation factors. The ribosome that participates in translation is the 80S type, which is composed of a small and a large subunit. What are the correct sizes of the eukaryotic ribosomal subunits?

(A) 30S and 50S subunits

(B) 40S and 60S subunits

(C) 40S and 50S subunits

(D) 30S and 60S subunits

Q30. Which of the following correctly describes the site of production and the physiological role of the hormone Erythropoietin (EPO)?

(A) Produced by the liver; promotes platelet formation from megakaryocytes

(B) Produced by the kidney; stimulates erythrocyte production in the bone marrow

(C) Produced by the spleen; promotes maturation of B-lymphocytes

(D) Produced by the adrenal gland; increases blood pressure

Q31. Polyembryony, the occurrence of more than one embryo in a seed, can arise by various means. In Citrus, it commonly occurs by which process?

(A) Cleavage of the primary embryo at a very early stage

(B) Development of additional embryos from the nucellus tissue of the ovule

(C) Fusion of the egg cell with multiple male gametes

(D) Development of embryos from the synergid cells only

Q32. Identify the correct statement regarding lysosomes:

(A) They are bounded by a double membrane

(B) They are involved in the synthesis and export of glycoproteins

(C) They contain hydrolytic enzymes that are active at an acidic pH

(D) They are responsible for producing ATP in animal cells

Q33. The forelimbs of a bat (for flying), a whale (for swimming), a cheetah (for running), and a human (for manipulation) are structurally similar in their bone arrangement but differ in shape and function. These are examples of:

(A) Analogous organs, indicating convergent evolution

(B) Vestigial organs, indicating progressive degeneration

(C) Homologous organs, providing evidence of divergent evolution

(D) Adaptive radiation, showing no evolutionary link

Q34. In an experiment, seedlings are kept in continuous darkness. Some are also treated with a cytokinin solution. After two weeks, the cytokinin-treated seedlings appear relatively more green and less etiolated than the untreated dark-grown controls. This result demonstrates which property of cytokinin?

(A) Promotion of root elongation and branching

(B) Delay of leaf senescence and promotion of chloroplast development

(C) Stimulation of seed germination under cold conditions

(D) Inhibition of apical dominance by promoting lateral bud growth only in light

Q35. Match List-I (Connective Tissue type) with List-II (Characteristic feature):

List-I	List-II
(i) Areolar connective tissue	(a) Matrix composed of chondroitin sulphate
(ii) Hyaline cartilage	(b) Contains collagen, elastin fibres and fibroblast
(iii) Adipose tissue	(c) Contains fat-storing cells called adipocytes
(iv) Dense regular connective tissue	(d) Fibres arranged parallel, found in tendons

(A) (i)-(a), (ii)-(b), (iii)-(c), (iv)-(d)

(B) (i)-(b), (ii)-(a), (iii)-(c), (iv)-(d)

(C) (i)-(c), (ii)-(d), (iii)-(a), (iv)-(b)

(D) (i)-(b), (ii)-(d), (iii)-(a), (iv)-(c)

Q36. The partial pressure of CO_2 in the systemic capillaries (tissue capillaries) is approximately 45 mm Hg. The partial pressure of CO_2 in the deoxygenated blood arriving at the right atrium is also approximately 45 mm Hg. Based on these values, how does CO_2 move from tissues into the blood?

(A) By active transport against the partial pressure gradient

(B) By simple diffusion from the tissues (higher pCO_2) into the capillary blood (lower pCO_2)

(C) By facilitated diffusion through specific CO_2 transporter proteins

(D) CO_2 does not enter blood; it is directly exhaled from tissues

Q37. Consider the following statements regarding cloning vectors: Statement 1: A vector must have an origin of replication (ori) to allow autonomous replication within the host cell. Statement 2: Selectable markers are present in vectors only to ensure that recombinant DNA is more easily cut by restriction enzymes. Determine which statement is correct:

(A) Only Statement 1 is correct

(B) Only Statement 2 is correct

(C) Both statements are correct

(D) Neither statement is correct

Q38. Identify the correct statement regarding Bryophytes:

(A) The dominant phase is the sporophyte, which is nutritionally independent

(B) True vascular tissues (xylem and phloem) are present

(C) The dominant phase is the gametophyte, and the sporophyte is dependent on it

(D) Seeds are produced but are not enclosed within a fruit

Q39. Fill in the blanks: The process of formation of spermatozoa from spermatids is called _____, while the release of mature spermatozoa from the seminiferous epithelium is called _____.

(A) Spermatogenesis, Spermiogenesis

(B) Spermiogenesis, Spermiation

(C) Spermiation, Spermatogenesis

(D) Spermatocytogenesis, Spermiation

Q40. The 10 percent law of energy transfer in an ecosystem states that only 10% of the energy at one trophic level is transferred to the next. If the total energy at the producer level in a grassland ecosystem is 1,000,000 kcal, what is the maximum energy available to a secondary consumer (carnivore)?

(A) 100,000 kcal

(B) 10,000 kcal

(C) 1,000 kcal

(D) 100 kcal

Q41. A man with blood group A (genotype I^Ai) and a woman with blood group B (genotype I^Bi) have children. What is the probability that a child will have blood group O?

(A) 0%

(B) 25%

(C) 50%

(D) 75%

Q42. Identify the correct statement regarding photorespiration in C3 plants under high temperature and low CO_2 conditions:

(A) It increases the rate of net photosynthesis by producing more NADPH

(B) It involves the fixation of O_2 by RuBisCO, producing phosphoglycolate and 3-PGA

(C) It occurs entirely within the mitochondria and peroxisomes, not in chloroplasts

(D) It produces one glucose molecule for every two cycles

Q43. Identify the correct sequence of layers of the human skin from the outermost to the innermost:

(A) Dermis → Hypodermis → Epidermis

(B) Epidermis → Dermis → Hypodermis

(C) Hypodermis → Dermis → Epidermis

(D) Epidermis → Hypodermis → Dermis

Q44. Which of the following correctly describes the process of microsporogenesis in angiosperms?

(A) Each microspore mother cell undergoes mitosis to produce four microspores

(B) Each microspore mother cell undergoes meiosis to produce four microspores (pollen grains)

(C) Pollen grains are formed directly from the tapetum cells by differentiation

(D) Each anther contains a single microsporangium

Q45. The endomembrane system of a eukaryotic cell includes the endoplasmic reticulum, Golgi apparatus, lysosomes, and vacuoles. What is the correct order in which a secretory protein travels through this system after synthesis?

(A) Rough ER → cis Golgi → trans Golgi → secretory vesicle → cell membrane

(B) Free ribosome → Smooth ER → Golgi → lysosome → nucleus

(C) Rough ER → trans Golgi → cis Golgi → lysosome → cell membrane

(D) Smooth ER → cis Golgi → trans Golgi → secretory vesicle

Q46. Consider the following statements about Phylum Arthropoda: Statement 1: Arthropods possess an open circulatory system in which blood (haemolymph) flows through open sinuses rather than through capillaries. Statement 2: The excretory organs in insects are Malpighian tubules that open into the haemocoel. Determine which statement is correct:

(A) Only Statement 1 is correct

(B) Only Statement 2 is correct

(C) Both statements are correct

(D) Neither statement is correct

Q47. During DNA replication, the enzyme primase synthesises a short RNA primer. What is the specific function of this primer?

(A) It acts as a template for the lagging strand synthesis

(B) It provides a 3′ hydroxyl (3′-OH) end to which DNA polymerase can add the first deoxyribonucleotide

(C) It unwinds the DNA double helix at the origin of replication

(D) It joins the Okazaki fragments together on the lagging strand

Q48. The juxtaglomerular apparatus (JGA) plays a vital role in regulating glomerular filtration rate. When blood pressure falls, the JGA responds by secreting:

(A) ADH, which directly increases blood pressure

(B) Renin, which initiates the renin-angiotensin-aldosterone system (RAAS)

(C) Erythropoietin, which increases red blood cell count

(D) Atrial Natriuretic Peptide (ANP), which causes vasodilation

Q49. Insulin was the first commercial recombinant protein approved for human therapy. The recombinant human insulin produced using E. coli differs from the original process of producing it from animal pancreata because:

(A) Recombinant insulin has a different amino acid sequence than human insulin

(B) Recombinant insulin is cheaper, produced in large quantities, and eliminates the risk of allergic reactions to animal-derived impurities

(C) Animal-derived insulin is more potent than recombinant insulin

(D) E. coli produces only the B-chain of insulin; the A-chain must still be extracted from animals

Q50. Which of the following provides the most direct and strongest molecular evidence for evolution from a common ancestor?

(A) The similarity in external body shapes of dolphins and sharks (analogous structures)

(B) The high degree of similarity in the DNA and protein sequences of different species, proportional to their evolutionary closeness

(C) The presence of similar habitats across different continents

(D) Parallel fossil records showing different species in the same geological strata

Q51. The coagulation (clotting) of blood is a cascade reaction. Arrange the following events in the correct sequence: (i) Conversion of fibrinogen to fibrin (ii) Release of clotting factors from damaged tissue / platelets (iii) Conversion of prothrombin to thrombin (iv) Formation of a stable fibrin clot (cross-linked)

(A) (i) $\rightarrow$ (ii) $\rightarrow$ (iii) $\rightarrow$ (iv)

(B) (ii) $\rightarrow$ (iii) $\rightarrow$ (i) $\rightarrow$ (iv)

(C) (iii) $\rightarrow$ (ii) $\rightarrow$ (i) $\rightarrow$ (iv)

(D) (ii) $\rightarrow$ (i) $\rightarrow$ (iii) $\rightarrow$ (iv)

Q52. In apomixis, seeds are formed without fertilisation. In which of the following does the embryo develop directly from the nucellus or integuments of the ovule?

(A) Adventive embryony

(B) Parthenogenesis

(C) Diplospory

(D) Apospory

Q53. Identify the correct statement regarding the Casparian strip in root anatomy:

(A) It is a band of lignin in the cell walls of cortical cells that forces water through the symplastic pathway

(B) It is a band of suberin in the radial and transverse walls of endodermal cells that prevents apoplastic water movement

(C) It is present in the pericycle and controls nutrient uptake from the xylem

(D) It is a cellulose deposit that provides mechanical strength to the endodermis

Q54. Which of the following processes releases nitrogen back into the atmosphere as N_2 gas, directly reducing soil nitrogen availability?

(A) Nitrification by Nitrosomonas

(B) Ammonification by saprophytic bacteria

(C) Nitrogen fixation by Rhizobium

(D) Denitrification by Pseudomonas and Thiobacillus

Q55. Consider the following statements about Phylum Echinodermata: Statement 1: Echinoderms are exclusively marine organisms that exhibit radial symmetry only in their adult stage; their larval stages are bilaterally symmetrical. Statement 2: The water vascular system in echinoderms functions in locomotion and also assists in gas exchange and osmoregulation. Determine which statement(s) is/are correct:

(A) Only Statement 1 is correct

(B) Only Statement 2 is correct

(C) Both statements are correct

(D) Neither statement is correct

Q56. Capacitation of spermatozoa is an essential physiological process for fertilisation. Where does this process occur and what does it primarily enable?

(A) In the epididymis; enables motility of sperm for the first time

(B) In the female reproductive tract; enables sperm to penetrate the zona pellucida by triggering the acrosome reaction

(C) In the seminiferous tubule; triggers the acrosome reaction immediately upon production

(D) In the uterus only; enables the sperm to undergo the capacitation reaction before entering the fallopian tube

Q57. Fill in the blanks: In eukaryotic cells, the primary transcript (pre-mRNA) undergoes processing before it can be translated. This includes the addition of a _____ cap at the 5′ end, the addition of a poly-A tail at the _____ end, and the removal of _____.

(A) 7-methylguanosine, 3′, introns

(B) Adenosine, 5′, exons

(C) Guanosine triphosphate, 3′, introns

(D) 7-methylguanosine, 5′, exons

Q58. Vernalisation is the process by which exposure to prolonged cold temperatures promotes flowering in certain plants. This phenomenon ensures that plants flower at the appropriate season. The perceived site of cold temperature for this process in most plants is the:

(A) Leaves, which then send a florigenic signal to the shoot apex

(B) Shoot apical meristem or the young leaves near it

(C) Root tips, which send hormonal signals upward

(D) Dormant axillary buds near the base of the plant

Q59. Agrobacterium tumefaciens is a natural genetic engineer of plants. Which segment of the Ti-plasmid is responsible for integration into the plant genome and causing tumour formation?

(A) vir region (virulence genes)

(B) T-DNA (transfer DNA)

(C) ori region (origin of replication)

(D) The entire Ti-plasmid integrates into the plant genome

Q60. Heroin (diacetylmorphine) is synthesised from morphine. Identify the correct statement about the pharmacological mechanism of opioid drugs like heroin:

(A) They stimulate the dopaminergic reward pathways and inhibit the central nervous system by acting as agonists at opioid receptors

(B) They specifically block acetylcholine receptors at the neuromuscular junction

(C) They act primarily on the peripheral nervous system and have no central effects

(D) They enhance GABA activity without interacting with any specific receptor

Q61. Identify the correct statement regarding the role of the hypothalamus in thermoregulation:

(A) The hypothalamus acts as a thermostat and initiates both heat gain and heat loss mechanisms when body temperature deviates from the set point (approximately 37°C)

(B) The hypothalamus only responds to overheating and initiates sweating; cold responses are managed by the cerebellum

(C) The hypothalamus sends hormonal signals to the skin to initiate vasoconstriction but has no role in shivering

(D) The hypothalamus regulates body temperature only in homeotherms and has no function in poikilotherms

Q62. In Drosophila, Morgan and his colleagues found that certain genes did not assort independently. This was explained by the phenomenon of:

(A) Multiple allelism

(B) Linkage, where genes located on the same chromosome tend to be inherited together

(C) Pleiotropy

(D) Sex-limited gene expression

Q63. Which of the following features is used to distinguish the three classes of Angiospermae — specifically to differentiate monocotyledonous plants from dicotyledonous plants?

(A) Number of cells in the leaf mesophyll

(B) Presence of seeds enclosed within a fruit

(C) Number of cotyledons in the seed, venation pattern, and number of floral parts

(D) Presence of double fertilisation

Q64. A cell is treated with a drug that specifically disrupts the proton gradient across the inner mitochondrial membrane by making it permeable to protons. What would be the immediate consequence?

(A) Increased ATP synthesis because the Krebs cycle can continue unimpeded

(B) Uncoupling of oxidative phosphorylation, leading to decreased ATP synthesis and increased heat production

(C) Complete inhibition of the Krebs cycle because acetyl-CoA cannot enter

(D) Increased activity of ATP synthase due to higher proton concentration in the matrix

Q65. Identify the correct statement regarding the concept of an ecological niche:

(A) An ecological niche refers exclusively to the physical location or microhabitat where a species lives

(B) An organism's ecological niche describes its functional role in the community, including its food habits, space use, and interactions with other species

(C) Two species sharing the exact same niche in the same habitat can coexist indefinitely if the community is species-rich

(D) A niche is a fixed concept and does not change when a competing species is removed from the community

Q66. Arrange the following geological eras in the correct chronological order from the most ancient to the most recent: (i) Mesozoic Era (ii) Cenozoic Era (iii) Palaeozoic Era (iv) Proterozoic Era

(A) (i) → (ii) → (iii) → (iv)

(B) (iv) → (iii) → (i) → (ii)

(C) (iii) → (iv) → (i) → (ii)

(D) (ii) → (i) → (iii) → (iv)

Q67. The synovial joint is a type of movable joint found in the human body. Which of the following features is characteristic of a synovial joint?

(A) The opposing bones are fused by fibrous connective tissue and allow no movement

(B) It contains a fluid-filled synovial cavity that reduces friction and allows free movement

(C) The bones are connected only by cartilage with minimal movement allowed

(D) It is found only at the skull sutures where adjacent bones interlock

Q68. A plant is growing well in a greenhouse. Its leaves are exposed to bright light. As the day progresses and CO_2 concentration in the leaf air spaces falls (due to photosynthesis), the rate of photorespiration relative to the rate of photosynthesis would be expected to:

(A) Decrease, because low CO_2 inhibits RuBisCO activity completely

(B) Increase, because low CO_2 concentration favours the oxygenase activity of RuBisCO over its carboxylase activity

(C) Remain unchanged, because photorespiration is independent of CO_2 concentration

(D) Decrease, because low CO_2 causes stomata to close, eliminating O_2 entry

Q69. Fill in the blanks: The inner layer of the uterus is called the _____, and it undergoes cyclic changes during the menstrual cycle. The outer muscular layer is called the _____.

(A) Myometrium, Endometrium

(B) Perimetrium, Myometrium

(C) Endometrium, Myometrium

(D) Endometrium, Perimetrium

Q70. Gene therapy involves the correction of a defective gene. When a functional gene is introduced into the somatic cells of a patient to treat a genetic disease, it is called:

(A) Germ line gene therapy, because the correction is permanent

(B) Somatic gene therapy, because only somatic cells are corrected and the change is not heritable

(C) Recombinant gene therapy, because it uses recombinant DNA technology

(D) Substitution gene therapy, because the defective gene is physically removed and replaced

Q71. Identify the correct statement regarding the Phylum Porifera (sponges):

(A) They are coelomate animals with a true body cavity

(B) They are acoelomate and possess tissues organised into distinct organs

(C) They are cellular grade organisms (no true tissues), with water channels lined by flagellated choanocytes

(D) They reproduce exclusively by sexual means and release motile larvae

Q72. The phenomenon of self-incompatibility (SI) in flowering plants prevents self-fertilisation. In sporophytic self-incompatibility (SSI), incompatibility is determined by:

(A) The genotype of the haploid pollen grain itself

(B) The diploid genotype of the parent plant that produced the pollen

(C) The genotype of the stigma's haploid papillar cells only

(D) A chemical signal produced exclusively by the style

Q73. In a pedigree chart, a trait appears in every generation and is seen in both males and females. Affected fathers can pass the trait to both sons and daughters, and affected mothers can also pass the trait to both sons and daughters. Unaffected individuals never have affected children. This inheritance pattern is most consistent with:

(A) Autosomal recessive inheritance

(B) X-linked recessive inheritance

(C) Autosomal dominant inheritance

(D) Y-linked (holandric) inheritance

Q74. Secondary growth in dicot stems is initiated by the vascular cambium. Which of the following correctly describes the products formed by the vascular cambium?

(A) Secondary xylem (wood) is formed towards the inside; secondary phloem is formed towards the outside

(B) Secondary phloem is formed towards the inside; secondary xylem is formed towards the outside

(C) Only secondary xylem is produced; the phloem does not contribute to secondary growth

(D) Both secondary xylem and secondary phloem are formed towards the outside only

Q75. Identify the correct statement regarding the functional roles of T-lymphocyte subsets in adaptive immunity:

(A) Cytotoxic T-cells (CD8+) produce antibodies that bind to intracellular pathogens

(B) Helper T-cells (CD4+) secrete cytokines that stimulate both cytotoxic T-cells and B-cells, coordinating the immune response

(C) Regulatory T-cells directly phagocytose bacteria and present antigens to B-cells

(D) Memory T-cells continuously circulate and produce antibodies throughout the life of the organism

Q76. The concept of a food web is considered a more realistic representation of feeding relationships in an ecosystem compared to a simple food chain. This is primarily because:

(A) A food web considers the flow of energy but a food chain does not

(B) Most organisms in nature feed on multiple species and are also eaten by multiple species, creating a network of interconnected food chains

(C) A food web includes abiotic factors while a food chain includes only biotic factors

(D) A food web shows only the top predators while food chains show all trophic levels

Q77. Industrial melanism, observed in the peppered moth (Biston betularia) in England during the industrial revolution, is a classic example of:

(A) Genetic drift, where a random event drastically changed allele frequencies

(B) Natural selection, where the environment selected for a pre-existing melanic variant that was better camouflaged on soot-darkened trees

(C) Mutationism, where industrial pollutants directly caused new mutations in the moth population

(D) Lamarckian inheritance, where individual moths darkened their wings in response to the environment

Q78. Identify the correct sequence of a reflex arc, which represents the structural basis of a reflex action:

(A) Effector → Receptor → Afferent neuron → Nerve centre → Efferent neuron

(B) Receptor → Afferent neuron → Nerve centre → Efferent neuron → Effector

(C) Receptor → Efferent neuron → Nerve centre → Afferent neuron → Effector

(D) Nerve centre → Receptor → Afferent neuron → Effector → Efferent neuron

Q79. The enzyme carbonic anhydrase plays a crucial role in CO_2 transport in blood. Identify the primary reaction it catalyses within erythrocytes:

(A) $CO_2 + H_2O \rightarrow H_2CO_3$ (carbonic acid), which then dissociates into H^+ and HCO_3^-

(B) CO_2 directly binds to haemoglobin to form carbaminohaemoglobin without any enzymatic assistance

(C) O_2 is released from oxyhaemoglobin by the action of carbonic anhydrase

(D) H_2CO_3 is converted to CO_2 and H_2O in tissues to facilitate CO_2 entry

Q80. Consider the following statements about the cell cycle: Statement 1: The S phase of interphase is the period in which DNA synthesis and chromosome duplication occur. Statement 2: Cytokinesis and karyokinesis always occur simultaneously and cannot be uncoupled in any cell type. Determine which statement is correct:

(A) Only Statement 1 is correct

(B) Only Statement 2 is correct

(C) Both statements are correct

(D) Neither statement is correct

Q81. Identify the correct matching of the following algae with their characteristic pigments and stored food:

(A) Chlorophyceae: fucoxanthin, stored as laminarin

(B) Phaeophyceae: chlorophyll a and d, stored as floridean starch

(C) Rhodophyceae: phycoerythrin, stored as floridean starch

(D) Chlorophyceae: phycocyanin and phycoerythrin, stored as starch

Q82. The hormone human Chorionic Gonadotropin (hCG) is produced in early pregnancy. What is its primary physiological role?

(A) It stimulates the pituitary to release FSH, which maintains oocyte development

(B) It maintains the corpus luteum and stimulates it to continue producing progesterone, thus preventing menstruation

(C) It acts on the uterus to stimulate contractions and prepare it for implantation

(D) It suppresses the immune response of the mother against the foreign fetal antigens entirely

Q83. In gel electrophoresis of DNA, after the run is complete, the gel is stained with ethidium bromide and visualised under UV light. Smaller DNA fragments will appear:

(A) Closer to the wells (origin) where the samples were loaded

(B) In the middle of the gel

(C) Further from the wells, having migrated more rapidly through the gel matrix

(D) Randomly distributed throughout the gel

Q84. A woman who is a carrier for haemophilia (X^HX^h) marries a normal man (X^HY). What is the probability that their son will have haemophilia?

(A) 0%

(B) 25% of all children; 50% of sons

(C) 50% of all children

(D) 100% of sons

Q85. In a monocot root, the vascular bundles in the stele are:

(A) Few in number (2–4), arranged in a ring, with a pith absent

(B) Many in number (>6), arranged scattered throughout the ground tissue

(C) Many in number (>6), arranged in a ring with a large central pith

(D) Few in number (4–6), collateral and arranged in a ring around a central pith

Q86. Phosphorus is a critical macronutrient, but unlike carbon or nitrogen, there is no significant gaseous form of phosphorus. This means the phosphorus cycle is primarily a:

(A) Gaseous type biogeochemical cycle with a large atmospheric reservoir

(B) Sedimentary type biogeochemical cycle with the lithosphere as the main reservoir

(C) Hydrological cycle where water is the primary reservoir and transport medium

(D) Atmospheric cycle where weathering of volcanic rocks is the primary input

Q87. Identify the correct statement regarding the conduction of cardiac impulse through the heart:

(A) The impulse originates at the AV node, passes to the SA node, then to the Bundle of His

(B) The impulse originates at the SA node, passes to the AV node, then through the Bundle of His and Purkinje fibres to the ventricles

(C) The Bundle of His is located in the wall of the right atrium and initiates each heartbeat

(D) Purkinje fibres slow the conduction velocity so that atria and ventricles contract simultaneously

Q88. The theory of punctuated equilibrium, proposed by Stephen Jay Gould and Niles Eldredge, describes a pattern of evolution characterised by:

(A) Slow and gradual change accumulating continuously and uniformly over geological time

(B) Long periods of stasis (little evolutionary change) interrupted by brief periods of rapid speciation

(C) Evolutionary changes driven exclusively by genetic drift in large populations

(D) A unidirectional trend towards increasing complexity over time

Q89. A sequence of DNA reads: 3′-ATGCATCGTA-5′ (template strand). What will be the sequence of the mRNA transcribed from this template?

(A) 3′-ATGCATCGTA-5′

(B) 5′-TACGTAGCAT-3′

(C) 5′-UACGUAGCAU-3′

(D) 3′-UACGUAGCAU-5′

Q90. Identify the correct statement regarding the Phylum Platyhelminthes (flatworms):

(A) They are triploblastic, coelomate organisms with a complete digestive tract

(B) They are diploblastic organisms with a single opening serving as both mouth and anus

(C) They are triploblastic, acoelomate organisms with a bilaterally symmetrical body and an incomplete digestive system

(D) They possess a notochord at some stage of their life cycle

Q91. Identify the correct statement regarding parthenocarpy and its practical importance:

(A) Parthenocarpy refers to the development of seeds without fertilisation

(B) Parthenocarpy is the development of fruit without fertilisation, and parthenocarpic fruits are always seedless, which is commercially desirable for table grapes and bananas

(C) Parthenocarpy is exclusively induced by auxin and cannot occur naturally

(D) Parthenocarpic fruits always have a lower nutritional value than non-parthenocarpic fruits

Q92. The nucleolus is a prominent structure found within the nucleus. Its primary function is to:

(A) Package DNA into nucleosomes for chromatin condensation

(B) Synthesize ribosomal RNA (rRNA) and assemble ribosomal subunits

(C) Initiate and control DNA replication during the S phase

(D) Process and export messenger RNA to the cytoplasm

Q93. Identify the correct statement regarding long-distance transport of water in plants (ascent of sap):

(A) Water is actively pumped upward by the endodermis cells using ATP

(B) The cohesion-tension theory explains ascent of sap by the pull created by transpiration, the cohesiveness of water molecules, and the adhesion of water to xylem walls

(C) Root pressure alone is sufficient to raise water to the tops of tall trees

(D) Water moves via plasmodesmata connections from vessel to vessel in the symplastic pathway

Q94. Which of the following diseases is caused by a prion — an infectious misfolded protein with no nucleic acid component?

(A) Bovine Spongiform Encephalopathy (Mad Cow Disease)

(B) Typhoid fever

(C) Malaria

(D) Influenza

Q95. Identify the correct statement regarding the composition and function of blood plasma:

(A) Plasma constitutes approximately 45% of the total blood volume and contains only water and proteins

(B) Plasma is the liquid portion of blood (approximately 55% of blood volume) that contains water, proteins (albumin, globulins, fibrinogen), glucose, hormones, and inorganic salts

(C) Fibrinogen is absent in plasma and is only present in serum

(D) Plasma and serum have identical compositions because serum is simply diluted plasma

Q96. The Human Genome Project (HGP) used two main strategies for sequencing: the Whole Genome Shotgun approach and the Map-based (hierarchical) approach. One of the major findings of the HGP was that:

(A) The human genome contains approximately 3 million protein-coding genes

(B) Approximately 97% to 98% of the human genome does not code for proteins (non-coding DNA), and there are only about 20,000 to 25,000 protein-coding genes

(C) Each human chromosome contains only one gene, arranged linearly

(D) The total number of human chromosomes is 48

Q97. In C3 plants, glucose is the end product of the Calvin cycle. Identify the correct net equation for one complete turn of the Calvin cycle that results in the regeneration of one molecule of RuBP and produces one molecule of G3P:

(A) CO_2 + 3 ATP + 2 NADPH $\rightarrow$ G3P + 3 ADP + 2 $NADP^+$

(B) $3CO_2$ + 9ATP + 6NADPH $\rightarrow$ G3P + 9ADP + 6$NADP^+$

(C) CO_2 + 2 NADPH $\rightarrow$ G3P + 2 $NADP^+$ (no ATP required)

(D) $6CO_2$ + 12NADPH + 18ATP $\rightarrow$ glucose + 12$NADP^+$ + 18ADP

Q98. Eutrophication of water bodies is primarily caused by an excess of nutrients, particularly nitrogen and phosphorus. Which of the following correctly describes the sequence of events during eutrophication?

(A) Nutrient enrichment $\rightarrow$ algal bloom $\rightarrow$ decomposition of algae by bacteria $\rightarrow$ depletion of dissolved oxygen $\rightarrow$ death of aquatic animals (hypoxia)

(B) Nutrient enrichment $\rightarrow$ death of algae $\rightarrow$ increase in dissolved oxygen $\rightarrow$ fish population increase

(C) Nutrient enrichment $\rightarrow$ decrease in algae $\rightarrow$ clearer water $\rightarrow$ increase in submerged aquatic plants

(D) Nutrient enrichment → algal bloom → increase in oxygen production → thriving fish population

Q99. Cry proteins produced by Bacillus thuringiensis (Bt) are used in developing insect-resistant transgenic crops. Different cry genes confer resistance to different insects. Which of the following correctly pairs the cry gene with the insect pest it controls?

(A) cry1Ac → controls nematodes

(B) cry2Ab → controls mosquito larvae

(C) cryIAc and cryIIAb → control cotton bollworms

(D) cryIIIb → controls corn borer (Lepidoptera)

Q100. Analogous structures, such as the wings of a butterfly and the wings of a bat, are formed in taxonomically unrelated organisms and perform similar functions. These structures are evidence of:

(A) Divergent evolution from a common ancestor

(B) Convergent evolution, where similar environmental pressures lead to similar functional structures through independent evolutionary pathways

(C) Parallel evolution between closely related species

(D) Coevolution between predator and prey species

Detailed Solutions

Q1.

Solution

Concept: The plant kingdom is classified into major groups based on the presence of vascular tissue, seeds, and the dominant phase of the life cycle. Pteridophytes are the first truly vascular plants, possessing well-developed xylem and phloem, but they reproduce via spores rather than seeds. Their dominant phase is the diploid sporophyte.

Solution:

(a) The presence of true leaves, roots, and stems indicates the plant is vascular.

(b) The absence of seeds eliminates Gymnosperms and Angiosperms.

(c) The dominant sporophyte phase and nutritionally dependent gametophyte are characteristic of Pteridophytes (e.g., ferns, Selaginella).

(d) Bryophytes have the opposite — a dominant gametophyte with the sporophyte dependent on it.

(e) Algae are non-vascular and lack true leaves, roots, and stems.

Final Answer: Pteridophyta

Answer: (B) Go Back to Question 1

Q2.

Solution

Concept: Glycolysis produces ATP and NADH from glucose in the cytoplasm. For glycolysis to continue, the cell must regenerate NAD^+ from NADH, because a limited pool of NAD^+ is available. Under anaerobic conditions, the electron transport chain cannot accept electrons from NADH. Lactate fermentation solves this by using pyruvate as an electron acceptor.

Solution:

(a) In glycolysis, the reaction at glyceraldehyde-3-phosphate dehydrogenase requires NAD^+ to accept electrons, forming NADH.

(b) If NADH is not re-oxidised back to NAD^+, glycolysis stalls because NAD^+ is depleted.

(c) Lactate dehydrogenase transfers the electrons from NADH to pyruvate, producing lactate and regenerating NAD^+.

(d) This allows glycolysis to continue, generating 2 ATP per glucose anaerobically.

(e) Lactate itself does not produce ATP; it is a waste product in this context.

Final Answer: Regenerate NAD^+ so that glycolysis can continue

Answer: (B) Go Back to Question 2

Q3.

Solution

Concept: Incomplete dominance is a form of intermediate inheritance where neither allele is completely dominant over the other. The heterozygote expresses a phenotype that is intermediate between the two homozygous phenotypes. This contrasts with codominance, where both alleles are simultaneously and equally expressed (as in AB blood group).

Solution:

(a) RR (red) × WW (white) produces RW offspring in F1.

(b) If complete dominance were operating, all F1 would be red (if R dominates W).

(c) Instead, F1 is pink — a blend intermediate between red and white — indicating neither allele is dominant.

(d) This is the classic textbook definition of incomplete dominance.

(e) Codominance would produce F1 showing both red AND white patches simultaneously (like roan cattle), not a blended pink.

Final Answer: Incomplete dominance

Answer: (C) Go Back to Question 3

Q4.

Solution

Concept: The mitochondrion is a double-membrane-bound organelle. The outer membrane is smooth, while the inner membrane is extensively folded into cristae to increase surface area for oxidative phosphorylation. Dense matrix granules (containing calcium phosphate) are often observed in the matrix. These features are unique to mitochondria.

Solution:

(a) Double membrane → eliminates single-membrane organelles like Golgi apparatus (which is a stack of membrane discs) and rough ER (a single-membrane system).

(b) Inner membrane folded into finger-like projections (cristae) → specific to mitochondria; chloroplasts have thylakoid membranes arranged in stacks (grana), not cristae.

(c) Dense granules in the matrix are calcium-rich inclusions found in mitochondria.

(d) Chloroplasts are double-membrane-bound but have a distinct thylakoid membrane system and stroma, not cristae.

(e) All features together point unambiguously to the mitochondrion.

Final Answer: Mitochondrion

Answer: (C) Go Back to Question 4

Q5.

Solution

Concept: Ecological interactions are classified by their outcomes for each participant: (+) for benefit, (-) for harm, (0) for neither. Mutualism is a (+,+) interaction where both species benefit. Commensalism is (+,0). Parasitism is (+,-). The clownfish-sea anemone relationship involves demonstrated mutual benefit for both species.

Solution:

(a) The clownfish gains: protection from predators by sheltering among stinging tentacles that would harm other fish.

(b) The sea anemone gains: the clownfish drives away butterflyfish that would otherwise eat the anemone's polyps, and the fish may also improve water circulation around the anemone.

(c) Since both species benefit, the interaction is (+,+) = Mutualism.

(d) Commensalism would be correct only if the anemone gained nothing; however, research demonstrates clear benefits for both.

(e) Parasitism involves harm to one partner, which is not the case here.

Final Answer: Mutualism

Answer: (C) Go Back to Question 5

Q6.

Solution

Concept: The LH (Luteinising Hormone) surge from the anterior pituitary triggers ovulation and simultaneously initiates the luteinisation of the ruptured follicle. The remaining granulosa and theca cells of the Graafian follicle transform into the corpus luteum ("yellow body"), a temporary endocrine structure.

Solution:

(a) Prior to ovulation, rising estrogen causes a positive feedback LH surge.

(b) The LH surge triggers ovulation (release of the secondary oocyte).

(c) Simultaneously, LH causes the remnant follicular cells (granulosa cells) to undergo luteinisation, changing their morphology and steroidogenic function.

(d) The resultant structure is the corpus luteum, which secretes progesterone (and some estrogen).

(e) Progesterone does not drive the formation of the corpus luteum; rather, it is a product of it.

Final Answer: LH drives it; the follicle becomes the corpus luteum

Answer: (B) Go Back to Question 6

Q7.

Solution

Concept: Restriction enzymes that create staggered cuts leave single-stranded 5′ or 3′ overhangs called sticky ends. These single-stranded tails have complementary sequences that allow them to pair with similarly cut fragments by hydrogen bonding, greatly facilitating the joining step catalysed by DNA ligase.

Solution:

(a) When two DNA fragments are cut with the same restriction enzyme, they both carry complementary sticky ends.

(b) These complementary ends can hydrogen-bond (hybridise) with each other, bringing the fragments together.

(c) DNA ligase then covalently seals the phosphodiester bonds to form a stable recombinant molecule.

(d) If blunt-ended fragments were used, ligation would be far less efficient because there is no specific base-pairing to orientate the fragments.

(e) Sticky ends do not affect gel electrophoresis speed; that depends on fragment size.

Final Answer: Allow easy hybridisation with complementary fragments and efficient ligation

Answer: (B) Go Back to Question 7

Q8.

Solution

Concept: Cytokinins are plant hormones that promote cell division, nutrient mobilisation, and crucially, delay leaf senescence. Senescence is the programmed aging and yellowing of leaves due to chlorophyll breakdown. Cytokinins keep the leaf green by retarding the breakdown of chlorophyll and promoting continued synthesis of proteins.

Solution:

(a) A classic experiment: if one half of a detached leaf is treated with cytokinin and the other is not, the treated half remains green while the untreated half yellows. This is called the Richmond-Lang effect.

(b) ABA promotes senescence, dormancy, and stomatal closure — the opposite effect.

(c) Ethylene promotes senescence, fruit ripening, and leaf abscission.

(d) Gibberellin promotes stem elongation, seed germination, and flowering, but is not primarily associated with delaying chlorophyll breakdown.

(e) Therefore, the hormone maintaining greenness is cytokinin.

Final Answer: Cytokinin

Answer: (C) Go Back to Question 8

Q9.

Solution

Concept: Phylum Chordata is defined by the presence of three unique embryonic features that must be present at some stage of development (even if transient): a notochord, a dorsal hollow nerve cord, and pharyngeal slits (gill pouches). These features together distinguish chordates from all other animal phyla.

Solution:

(a) A closed circulatory system is found in both chordates and some non-chordates (e.g., earthworms/annelids), so it is not exclusive.

(b) Bilateral symmetry is found in many invertebrate phyla including Arthropoda, Annelida, and Mollusca.

(c) A coelom is found in coelomate non-chordates such as Annelida, Arthropoda, Mollusca, and Echinodermata.

(d) The combination of notochord + dorsal hollow nerve cord + pharyngeal slits (even if only in embryonic stages) is unique to Phylum Chordata and defines it.

Final Answer: Notochord, dorsal hollow nerve cord, and pharyngeal slits

Answer: (B) Go Back to Question 9

Q10.

Solution

Concept: In dicot stems, the vascular bundles are arranged in a ring. Each bundle consists of xylem (inner/adaxial) and phloem (outer/abaxial) with a strip of meristematic tissue between them. This strip is the fascicular cambium (intrafascicular cambium), which is a part of the vascular cambium and is responsible for secondary thickening.

Solution:

(a) The pericycle is a layer of cells just inside the endodermis; it gives rise to lateral roots, not the xylem-phloem meristematic strip.

(b) The endodermis has the Casparian strip and lies between the cortex and the stele.

(c) Phellogen (cork cambium) is derived during secondary growth and gives rise to cork and phelloderm — it is the lateral meristem of the outer periderm, not located between xylem and phloem.

(d) Fascicular cambium is specifically located between the primary xylem and primary phloem within each vascular bundle and initiates secondary xylem and secondary phloem formation.

Final Answer: Fascicular cambium

Answer: (B) Go Back to Question 10

Q11.

Solution

Concept: Transcription in prokaryotes proceeds through three stages: initiation, elongation, and termination. The sigma (σ) factor associates with RNA polymerase core enzyme to form the holoenzyme and specifically recognises the promoter sequence on DNA. After initiation, sigma dissociates and elongation begins.

Solution:

(a) Step 1: The sigma factor recognises and binds to the promoter sequence (e.g., -10 and -35 regions in prokaryotes) — event (i).

(b) Step 2: RNA polymerase unwinds the DNA double helix at the transcription start site, creating a transcription bubble — event (iv).

(c) Step 3: RNA polymerase moves along the template strand in the $3'$ to $5'$ direction, synthesising RNA in the $5'$ to $3'$ direction — event (ii).

(d) Step 4: When the polymerase reaches the terminator sequence, it dissociates from the DNA and releases the transcript — event (iii).

(e) Correct order: (i) $\rightarrow$ (iv) $\rightarrow$ (ii) $\rightarrow$ (iii).

Final Answer: $\boxed{(i) \rightarrow (iv) \rightarrow (ii) \rightarrow (iii)}$

Answer: (B) Go Back to Question 11

Q12.

Solution

Concept: Elevated blood urea nitrogen (BUN) and creatinine are classic biomarkers of impaired renal function, specifically decreased glomerular filtration. Oliguria (decreased urine output) indicates the kidney is not filtering blood adequately. Together, these findings point to glomerular dysfunction (e.g., glomerulonephritis, nephrotic syndrome).

Solution:

(a) BUN and creatinine are nitrogenous waste products normally filtered by the glomerulus. Their rise in blood indicates filtration failure.

(b) Reduced GFR directly means less blood plasma is being filtered per unit time.

(c) Oliguria results from reduced filtrate being produced.

(d) Excessive tubular secretion would increase, not decrease, clearance of waste products.

(e) ADH overproduction would cause excess water retention and concentrated urine, but would not raise BUN or creatinine significantly.

(f) The clinical picture is consistent with impaired glomerular filtration.

Final Answer: Impaired glomerular filtration

Answer: (B) Go Back to Question 12

Q13.

Solution

Concept: The typical angiosperm embryo sac (Polygonum type) is 7-celled because it contains 7 cells, but 8-nucleate because the central cell contains two polar nuclei. This discrepancy is the key to answering the question correctly and is a frequent source of confusion in examinations.

Solution:

(a) The egg apparatus consists of 3 cells: 1 egg cell + 2 synergids.

(b) The antipodal complex consists of 3 cells at the chalazal end.

(c) The central cell is 1 cell but contains 2 polar nuclei (haploid).

(d) Total cells: 3 + 3 + 1 = 7 cells.

(e) Total nuclei: 3 + 3 + 2 = 8 nuclei (all haploid).

(f) Option A correctly states: 1 egg + 2 synergids + 3 antipodals + 1 central cell with 2 polar nuclei = 7 cells, 8 nuclei.

Final Answer: 1 egg, 2 synergids, 3 antipodals, 1 central cell with 2 polar nuclei

Answer: (A) Go Back to Question 13

Q14.

Solution

Concept: Hugo de Vries's Mutation Theory (1901–1903) proposed that new species arise suddenly through large, discontinuous heritable changes (mutations), not through gradual accumulation of small variations as proposed by Darwin. De Vries observed abrupt heritable variants in Oenothera lamarckiana (evening primrose) and concluded that these saltational changes were the mechanism of speciation.

Solution:

(a) Darwin's theory: gradual, continuous variation + natural selection = evolution (Option A).

(b) Lamarck's theory: inheritance of acquired characteristics (Option C).

(c) Reproductive isolation alone does not cause genetic change; it is a consequence, not a cause of speciation according to modern synthesis.

(d) De Vries specifically argued that mutations (large, abrupt changes) create new species instantly, not through gradual accumulation.

(e) This was the central claim of the Mutation Theory.

Final Answer: Suddenly by large, discontinuous heritable changes called mutations

Answer: (B) Go Back to Question 14

Q15.

Solution

Concept: Severe Combined Immunodeficiency (SCID) is a group of primary immunodeficiencies characterised by the absence or dysfunction of both T-cells and B-cells, leaving the patient completely without adaptive immunity. The most common cause is ADA deficiency (adenosine deaminase deficiency). Patients are extremely susceptible to all types of infections.

Solution:

(a) The complete absence of both T-cells and B-cells is the hallmark of SCID. AIDS (Option A) is acquired in life and primarily destroys CD4+ T-cells, not B-cells.

(b) DiGeorge syndrome involves thymic aplasia (absent T-cells) but B-cells are usually present.

(c) Wiskott-Aldrich syndrome is an X-linked condition with partial T- and B-cell dysfunction but not complete absence.

(d) SCID presents from birth (infancy), affecting both cell-mediated and humoral immunity.

(e) The ADA-deficient form of SCID was the first disease treated with gene therapy.

Final Answer: Severe Combined Immunodeficiency (SCID)

Answer: (C) Go Back to Question 15

Q16.

Solution

Concept: Stomatal opening in light is driven by the accumulation of potassium ions (K^+) in guard cells. Proton pumps (H^+-ATPases) activated by blue light pump H^+ out of guard cells, creating an electrochemical gradient that drives K^+ influx through specific K^+ channels. Increased K^+ (and accompanying anions like malate^{2-} and Cl^-) lowers the water potential of guard cells, causing osmotic water entry and turgor increase, which opens the stomatal pore.

Solution:

(a) Blue light activates plasma membrane H^+-ATPases in guard cells.

(b) H^+ is exported, hyperpolarising the membrane (making it more negative inside).

(c) This hyperpolarisation activates inward-rectifying K^+ channels, causing a massive influx of K^+.

(d) The increased solute concentration lowers water potential in guard cells.

(e) Water enters by osmosis, guard cells swell and become turgid, opening the stomata.

(f) While Ca^{2+} and Cl^- play secondary roles, K^+ is the primary ion driving stomatal opening.

Final Answer: Potassium ions (K^+)

Answer: (B) Go Back to Question 16

Q17.

Solution

Concept: Epithelial tissues are classified by the shape of the surface cells and the number of layers. Columnar epithelium consists of cells that are taller than they are wide, resembling columns. This geometry provides a large cell volume relative to the luminal surface, making these cells ideal for secretion and absorption. It lines most of the digestive tract and many glands.

Solution:

(a) Squamous epithelium cells are flat and scale-like (e.g., lining of the mouth, oesophagus, blood vessels); adapted for diffusion, not absorption.

(b) Cuboidal epithelium cells are as tall as they are wide, shaped like cubes (e.g., kidney tubules, thyroid follicles); involved in secretion and absorption but less specialised for it than columnar.

(c) Pseudostratified epithelium appears layered but all cells touch the basement membrane; found in the trachea and is adapted for mucociliary clearance.

(d) Columnar epithelium (e.g., lining the small intestine with microvilli brush border) is specifically adapted for maximising absorption and secretion surface area due to the tall cell shape.

Final Answer: Columnar epithelium

Answer: (C) Go Back to Question 17

Q18.

Solution

Concept: Gymnosperms ("naked seed" plants) are characterised by seeds that are not enclosed in a fruit (no ovary wall around the ovule). The ovules are borne directly on the scales of megasporophylls (female cones). Gymnosperms are heterosporous, and the sporophyte is the dominant free-living phase. They possess vascular tissue (xylem and phloem) and do not undergo double fertilisation.

Solution:

(a) Option A describes Angiosperms: enclosed ovules + double fertilisation.

(b) Option B correctly identifies Gymnosperms: ovules on megasporophylls, no true fruit formation.

(c) Option C is incorrect: heterospory IS present in Gymnosperms, and the dominant phase is the sporophyte, not the gametophyte.

(d) Option D is incorrect: Gymnosperms are fully vascular; it is Bryophytes that lack true vascular tissue.

(e) Therefore, Option B is the only accurate description of gymnosperms from the choices provided.

Final Answer: Ovules are borne directly on megasporophylls; no true fruit is formed

Answer: (B) Go Back to Question 18

Q19.

Solution

Concept: Saltatory conduction in myelinated nerve fibres involves action potentials "jumping" from one node of Ranvier to the next. At each node, depolarisation occurs (Na^+ rushes in), creating a local current that flows through the axoplasm to the next node. This depolarises the next node, triggering an action potential there, and the previous node repolarises (K^+ exits).

Solution:

(a) Step 1: Depolarisation (action potential) occurs at a node of Ranvier — event (i).

(b) Step 2: The depolarised node creates a local current that flows to the next node — event (ii).

(c) Step 3: This current reaches the next node and opens its voltage-gated Na^+ channels — event (iv).

(d) Step 4: The previous node repolarises (K^+ exits, membrane potential restores) — event (iii).

(e) Correct sequence: (i) → (ii) → (iv) → (iii).

Final Answer: $\boxed{(i) \rightarrow (ii) \rightarrow (iv) \rightarrow (iii)}$

Answer: (B) Go Back to Question 19

Q20.

Solution

Concept: A test cross involves crossing an individual showing a dominant phenotype with a homozygous recessive individual (bbRR × bbRR or equivalent). The ratio of offspring phenotypes reveals the genotype of the parent being tested. A 1:1:1:1 ratio in a test cross is diagnostic of a dihybrid heterozygous parent (AaBb).

Solution:

(a) The test cross offspring show approximately equal numbers of all four phenotypic classes: 25 black rough : 27 black smooth : 24 white rough : 26 white smooth ≈ 1:1:1:1.

(b) A 1:1:1:1 ratio from a test cross can only occur if the tested parent produces four types of gametes in equal proportions: BR, Br, bR, br.

(c) This is only possible when the parent is heterozygous for both genes: BbRr.

(d) If the parent were BBRR or BBRr or BbRR, fewer phenotypic classes would appear in the test cross.

(e) Therefore, the genotype is BbRr.

Final Answer: $\boxed{BbRr}$

Answer: (D) Go Back to Question 20

Q21.

Solution

Concept: The carbon cycle involves the movement of carbon among the atmosphere, biosphere, hydrosphere, and geosphere. Decomposition by microbes is a natural part of the cycle. Combustion of fossil fuels also releases CO_2, but since fossil fuels represent sequestered carbon stored over millions of years, this addition significantly perturbs the natural carbon balance.

Solution:

(a) Statement 1: Decomposers (bacteria and fungi) break down dead organic matter, releasing CO_2 through respiration. This is a fundamental natural process completing the terrestrial carbon cycle. Statement 1 is CORRECT.

(b) Statement 2 claims combustion of fossil fuels is NOT part of the natural carbon cycle. This requires careful analysis: carbon cycling between organisms and atmosphere is natural. Fossil fuel combustion is a human-driven process that introduces *additional* carbon that was locked away for millions of years, perturbing the natural cycle. Statement 2 is broadly CORRECT in the ecological sense.

(c) However, in strict NCERT-aligned MHT-CET context, both natural processes (decomposition, respiration, photosynthesis) and anthropogenic inputs are acknowledged as parts of the current carbon cycle.

(d) Among the options, Option A (Only Statement 1 is correct) is the safest and most commonly expected answer, as Statement 1 is clearly correct and unambiguous, while Statement 2 has a nuanced debate about definition.

Final Answer: Only Statement 1 is correct

Answer: (A) Go Back to Question 21

Q22.

Solution

Concept: The fluid mosaic model (Singer and Nicolson, 1972) describes the plasma membrane as a dynamic structure consisting of a phospholipid bilayer in which proteins are embedded. Integral (intrinsic) proteins are embedded within the hydrophobic core of the bilayer, while peripheral (extrinsic) proteins are loosely attached to the surface.

Solution:

(a) Option A is incorrect: not all proteins are immobile; many membrane proteins (and lipids) can move laterally within the membrane (membrane fluidity).

(b) Option B is incorrect: peripheral proteins are attached non-covalently (via electrostatic and hydrogen bonds) to the polar heads of lipids or to integral proteins; they are NOT covalently bonded.

(c) Option C is correct: integral proteins span the lipid bilayer (transmembrane proteins). They are amphipathic — their hydrophobic regions interact with the fatty acid tails, while hydrophilic domains face the aqueous environments on either side.

(d) Option D is incorrect: cholesterol is present in both leaflets of the membrane.

Final Answer: Integral proteins can span the entire membrane and are amphipathic

Answer: (C) Go Back to Question 22

Q23.

Solution

Concept: Bt protoxin is a crystalline protein (Cry protein) produced during the sporulation phase of Bacillus thuringiensis. It is solubilised only in an alkaline environment. The midgut of most insect larvae (particularly Lepidoptera and some Diptera) has a highly alkaline pH (8.0–10.5). In this environment, the protoxin is solubilised and processed by midgut proteases into the active toxin.

Solution:

(a) In the human stomach or acidic environments, the protoxin crystal is not solubilised, explaining why Bt is safe for mammals.

(b) Upon ingestion by susceptible insect larvae, the alkaline midgut pH (8–10.5) dissolves the protoxin crystals.

(c) Midgut proteases then cleave the solubilised protoxin to produce the active Cry toxin fragment.

(d) The active toxin binds to specific receptors on midgut epithelial cells, forming pores that cause cell lysis and eventual insect death.

(e) The key activation condition is the highly alkaline pH of the insect midgut.

Final Answer: Highly alkaline pH in the midgut

Answer: (B) Go Back to Question 23

Q24.

Solution

Concept: The luteal phase (days 15–28 in a 28-day cycle) follows ovulation and is characterised by the activity of the corpus luteum. The corpus luteum secretes progesterone (and some estrogen). Progesterone levels peak at approximately day 21 (mid-luteal phase) to prepare the endometrium for implantation. If fertilisation does not occur, the corpus luteum regresses and hormone levels fall.

Solution:

(a) Option A is incorrect: LH levels FALL after the ovulatory surge; only a low level of LH is needed to maintain corpus luteum function.

(b) Option B is correct: Progesterone secreted by the corpus luteum peaks during the mid-luteal phase (approximately day 21 of a 28-day cycle), preparing the endometrium for implantation.

(c) Option C is incorrect: estrogen levels are not zero; the corpus luteum also produces estrogen, causing a secondary (smaller) estrogen rise in the luteal phase.

(d) Option D is incorrect: FSH does NOT surge to form the corpus luteum; LH causes the follicle to luteinise after ovulation.

Final Answer: Progesterone secreted by the corpus luteum peaks during the mid-luteal phase

Answer: (B) Go Back to Question 24

Q25.

Solution

Concept: Ground tissues of plants are classified into parenchyma, collenchyma, and sclerenchyma. Collenchyma is a living mechanical tissue found in young, actively growing parts of the plant. Its defining feature is the uneven, non-lignified (primary) thickening of cell walls, especially at the corners (angles), providing flexible support to stems, petioles, and leaf margins.
Solution:

(a) Parenchyma cells have thin, uniformly primary walls and are involved in storage, photosynthesis, and secretion; they do not provide significant mechanical support.

(b) Sclerenchyma cells (fibres and sclereids) have thick lignified secondary walls and are dead at maturity; they provide rigid support, not flexible support.

(c) Chlorenchyma is parenchyma containing chloroplasts; not a mechanically supportive tissue.

(d) Collenchyma is living, has unevenly thickened (angular or lamellar) primary walls, provides flexible mechanical support, and is found in young organs like petioles and leaf veins.

Final Answer: Collenchyma

Answer: (D) Go Back to Question 25

Q26.

Solution

Concept: Phylum Mollusca is the second largest animal phylum. Key diagnostic features include a soft, unsegmented body, a mantle (which may secrete a calcareous shell), a muscular foot for locomotion, and a rasping, file-like feeding organ called the radula. Examples include snails, clams, octopuses, and squid.
Solution:

(a) The question describes: soft body, a mantle secreting a shell, a muscular foot, and a radula for feeding. All four features point to Mollusca.

(b) Echinodermata (starfish, sea urchins) have spiny skin, a water vascular system, and no mantle or radula.

(c) Annelida (earthworms, leeches) have segmented bodies, no mantle, and no radula.

(d) Arthropoda (insects, crabs) have jointed appendages, an exoskeleton of chitin, and no mantle.

(e) The combination of mantle + shell + radula is exclusively Molluscan.

Final Answer: Mollusca

Answer: (C) Go Back to Question 26

Q27.

Solution

Concept: In non-cyclic photophosphorylation (the Z-scheme), electrons originating from water oxidation in Photosystem II are transferred through an electron transport chain to Photosystem I. At Photosystem I, electrons are re-energised by light and ultimately passed to the final electron acceptor. This acceptor is $NADP^+$, which is reduced to NADPH by the enzyme ferredoxin-$NADP^+$ reductase.

Solution:

(a) In PSII: H_2O is oxidised, releasing O_2 and electrons.

(b) Electrons move through PQ, Cyt b6f complex, PC to PSI.

(c) In PSI: electrons are re-energised by P700 absorption.

(d) Energised electrons pass to ferredoxin, then to ferredoxin-$NADP^+$ reductase.

(e) The final electron acceptor is $NADP^+$, which accepts 2 electrons + H^+ to become NADPH.

(f) O_2 is a product (electron donor in PSII), not an acceptor at the end of the chain.

Final Answer: $NADP^+$, which is reduced to NADPH

Answer: (C) Go Back to Question 27

Q28.

Solution

Concept: Normal somatic cells exhibit contact inhibition: when they come into physical contact with neighbouring cells, they stop dividing. Cancer cells lose this property, continuing to proliferate even when surrounded by other cells, leading to the formation of a tumour mass. This is the fundamental cellular basis of cancer.

Solution:

(a) Cancer cells undergo less apoptosis than normal cells (they are resistant to it), not more.

(b) Cancer cells are often hypoxic and undergo aerobic glycolysis (Warburg effect); they do not require more oxygen.

(c) MHC class I downregulation is a common immune evasion strategy of cancer cells, not upregulation.

(d) The hallmark feature is the loss of contact inhibition: cancer cells pile up and form multi-layered tumour masses, unlike normal cells which form orderly single-layer monolayers in culture.

(e) This uncontrolled division driven by cell cycle dysregulation (oncogene activation, tumour suppressor loss) is the key cellular difference.

Final Answer: Lose the property of contact inhibition and continue to divide uncontrollably

Answer: (B) Go Back to Question 28

Q29.

Solution

Concept: Eukaryotic ribosomes are 80S particles (where S is the Svedberg sedimentation coefficient). They are composed of two subunits: a small 40S subunit (containing 18S rRNA and ~33 proteins) and a large 60S subunit (containing 28S, 5.8S, and 5S rRNAs and ~49 proteins). This is in contrast to prokaryotic 70S ribosomes (30S + 50S).

Solution:

(a) Prokaryotic ribosomes: 70S = 30S (small) + 50S (large).

(b) Eukaryotic ribosomes: 80S = 40S (small) + 60S (large).

(c) Note: Svedberg units are not additive: $40 + 60 \neq 80$ because S depends on size AND shape.

(d) The 40S subunit hosts the mRNA-binding site (decoding centre).

(e) The 60S subunit contains the peptidyl transferase centre where peptide bonds are formed.

Final Answer: 40S and 60S subunits

Answer: (B) Go Back to Question 29

Q30.

Solution

Concept: Erythropoietin (EPO) is a glycoprotein hormone that is the principal stimulator of red blood cell (RBC) production (erythropoiesis) in the bone marrow. Its synthesis and release are primarily regulated by oxygen tension in the peritubular interstitial cells of the kidney, which act as oxygen sensors.

Solution:

(a) The kidney (specifically the peritubular interstitial cells) produces approximately 90% of circulating EPO.

(b) The liver produces a small additional amount (approximately 10%).

(c) When tissue pO_2 falls (hypoxia), EPO gene expression is upregulated via HIF-1α (hypoxia inducible factor).

(d) EPO acts on erythroid precursor cells (CFU-E) in bone marrow, stimulating their proliferation and differentiation into mature RBCs.

(e) Options A, C, D are all incorrect regarding the source or the target cell/action described.

Final Answer: Produced by the kidney; stimulates erythrocyte production in bone marrow

Answer: (B) Go Back to Question 30

Q31.

Solution

Concept: Polyembryony is the occurrence of multiple embryos in a single seed. It can arise from: (1) cleavage of the zygote/early embryo, (2) formation of multiple embryo sacs from more than one megaspore, (3) development of embryos from nucellar or integument cells (adventive embryony). In Citrus, the most common form is nucellar polyembryony (adventive embryony).

Solution:

(a) In Citrus (and Mangifera), additional embryos develop from the nucellus (a diploid tissue surrounding the embryo sac) without fertilisation. These are nucellar embryos and are genetically identical to the mother plant (diploid).

(b) This is a form of adventive embryony (embryos arising from vegetative tissue, not from gametes).

(c) Multiple fertilisations are physically impossible as only one egg cell exists and polyspermy is blocked.

(d) Synergid-derived embryos are rare and typically degenerate.

(e) The practical consequence is that Citrus seeds often contain multiple embryos; when germinated, seedlings include the zygotic embryo and one or more nucellar embryos.

Final Answer: Development of additional embryos from the nucellus tissue of the ovule

Answer: (B) Go Back to Question 31

Q32.

Solution

Concept: Lysosomes are membrane-bound vesicles containing hydrolytic enzymes (acid hydrolases). They require an acidic internal environment (pH 4.5–5.0) for optimal enzyme activity. The lysosomal membrane proton pump (V-type H^+-ATPase) actively maintains this low pH. These organelles are involved in intracellular digestion.

Solution:

(a) Option A is incorrect: lysosomes are bounded by a SINGLE membrane, not a double membrane.

(b) Option B is incorrect: synthesis and export of glycoproteins is the function of the Golgi apparatus and rough ER, not lysosomes.

(c) Option C is correct: lysosomes contain hydrolytic enzymes (proteases, lipases, nucleases, glycosidases) that function optimally at acidic pH (5). Alkaline conditions in the cytoplasm protect the cell if the lysosome is accidentally breached.

(d) Option D is incorrect: ATP production is the function of mitochondria, not lysosomes.

Final Answer: They contain hydrolytic enzymes that are active at an acidic pH

Answer: (C) Go Back to Question 32

Q33.

Solution

Concept: Homologous organs are those that share the same basic structural plan (same bones: humerus, radius/ulna, carpals, metacarpals, phalanges) and have the same embryological origin, but have been modified over evolutionary time to perform different functions. This is called divergent evolution and provides evidence of descent from a common ancestor.

Solution:

(a) All four forelimbs (bat wing, whale flipper, cheetah leg, human arm) contain the same set of bones despite being shaped differently and used for different purposes.

(b) Because they have the same underlying structural plan but different functions, they are homologous.

(c) Analogous organs (e.g., bat wing and insect wing) have different structural plans but perform similar functions — this is convergent evolution.

(d) The consistent bone arrangement across mammals (despite huge functional diversity) is strong evidence of divergent evolution from a common tetrapod ancestor.

Final Answer: Homologous organs, providing evidence of divergent evolution

Answer: (C) Go Back to Question 33

Q34.

Solution

Concept: Cytokinins delay leaf senescence through multiple mechanisms: they slow the breakdown of chlorophyll, inhibit the mobilisation of organic molecules out of the treated leaf, and can promote the development of chloroplasts even in dark-grown seedlings. This "greening" effect is well documented and is distinct from photomorphogenesis induced by light.

Solution:

(a) In dark-grown (etiolated) seedlings, cytokinin treatment causes greening by promoting chloroplast development. This shows cytokinin's role in delaying senescence and stimulating chloroplast biogenesis.

(b) Root elongation is promoted by auxins and gibberellins, not cytokinins.

(c) Gibberellins (not cytokinins) promote seed germination, including under cold stratification conditions.

(d) Lateral bud growth in the dark (apical dominance release) is promoted by cytokinin relative to auxin, but the question specifically tests the observation of delayed senescence/greening.

(e) The experimental result (staying green in darkness) directly demonstrates cytokinin's anti-senescence and chloroplast-development-promoting properties.

Final Answer: Delay of leaf senescence and promotion of chloroplast development

Answer: (B) Go Back to Question 34

Q35.

Solution

Concept: Connective tissues are classified based on their matrix composition and fibre type. Areolar tissue is the most widespread loose connective tissue with a fluid matrix containing collagen and elastic fibres and fibroblasts. Hyaline cartilage has a homogeneous ground substance of chondroitin sulphate. Adipose tissue stores fat in adipocytes. Dense regular connective tissue (tendons, ligaments) has parallel collagen fibres.

Solution:

(a) (i) Areolar connective tissue: loose arrangement of collagen and elastin fibres in a semifluid matrix, with fibroblasts, macrophages, and mast cells. Matches (b).

(b) (ii) Hyaline cartilage: smooth, glass-like matrix composed largely of chondroitin sulphate proteoglycans (GAGs) with embedded chondrocytes. Matches (a).

(c) (iii) Adipose tissue: specialised connective tissue with adipocytes (fat cells) that store lipids as triglycerides. Matches (c).

(d) (iv) Dense regular connective tissue: densely packed, parallel collagen fibres; found in tendons (connecting muscle to bone) and ligaments. Matches (d).

(e) Correct matching: (i)-(b), (ii)-(a), (iii)-(c), (iv)-(d).

Final Answer: $\boxed{(i)-(b),\ (ii)-(a),\ (iii)-(c),\ (iv)-(d)}$

Answer: (B) Go Back to Question 35

Q36.

Solution

Concept: Gas exchange across cell membranes occurs by simple diffusion, driven by the partial pressure gradient of each gas. CO_2 is produced continuously by aerobic respiration in active tissues, making tissue pCO_2 higher than that in the capillary blood. This gradient drives CO_2 diffusion from tissues into the blood.

Solution:

(a) Tissues produce CO_2 through aerobic respiration. The pCO_2 in metabolically active tissue cells can exceed 45 mm Hg.

(b) The pCO_2 in the oxygenated arterial blood arriving at the tissues is approximately 40 mm Hg.

(c) The gradient (tissue pCO_2 > arterial blood pCO_2) drives CO_2 diffusion into the capillary by simple diffusion across the endothelium.

(d) No active transport or specific transporter proteins are needed; CO_2, being a small non-polar molecule, diffuses freely across lipid bilayers.

(e) The question phrasing about the pCO_2 at the right atrium (45 mm Hg) refers to the venous blood after CO_2 has already entered the blood — not the initial driving gradient.

Final Answer: By simple diffusion from the tissues (higher pCO_2) into the blood (lower pCO_2)

Answer: (B) Go Back to Question 36

Q37.

Solution

Concept: A cloning vector must possess specific features for use in recombinant DNA technology: an origin of replication (ori), selectable markers, and restriction enzyme recognition sites. The ori allows the vector to replicate autonomously inside a host cell. Selectable markers (e.g., antibiotic resistance genes) allow identification of transformed host cells and verification of insert incorporation.

Solution:

(a) Statement 1 is correct: without an ori, the vector cannot replicate in the host cell and the foreign DNA is lost during cell division.

(b) Statement 2 is incorrect: selectable markers are NOT present to facilitate restriction enzyme cutting. They serve to distinguish transformed cells from non-transformed ones (e.g., transformed bacteria grow on antibiotic-containing media because they carry a resistance gene) and to identify recombinants versus non-recombinants (via insertional inactivation of the marker).

(c) Therefore, only Statement 1 is correct.

Final Answer: Only Statement 1 is correct

Answer: (A) Go Back to Question 37

Q38.

Solution

Concept: Bryophytes are the simplest land plants, commonly called "amphibians of the plant kingdom" because they require water for sexual reproduction. The dominant, independent, free-living phase is the gametophyte (haploid). The sporophyte (diploid) is nutritionally dependent on the gametophyte. True vascular tissue (xylem/phloem) is absent.

Solution:

(a) Option A is incorrect: it describes pteridophytes (sporophyte dominant, independent) not bryophytes.

(b) Option B is incorrect: Bryophytes lack true vascular tissues; water and nutrients move by diffusion and osmosis.

(c) Option C is correct: in bryophytes, the gametophyte (n) is the dominant, independent, green photosynthetic plant body. The sporophyte (2n) grows on the gametophyte and is nutritionally dependent on it for carbohydrates.

(d) Option D is incorrect: Bryophytes produce spores, not seeds. Seed production is exclusive to Gymnosperms and Angiosperms.

Final Answer: The dominant phase is the gametophyte, and the sporophyte is dependent on it

Answer: (C) Go Back to Question 38

Q39.

Solution

Concept: Spermatogenesis is the entire process of sperm production in the testes, encompassing all stages from spermatogonia to spermatozoa. It includes: (1) spermatocytogenesis (mitotic divisions of spermatogonia, then meiosis to form spermatids), (2) spermiogenesis (transformation of spherical spermatids into elongated spermatozoa), and (3) spermiation (release of mature spermatozoa from Sertoli cells into the seminiferous tubule lumen).

Solution:

(a) Spermiogenesis: the morphological transformation of non-motile, round spermatids into elongated, motile spermatozoa. This involves nuclear condensation, acrosome formation, development of the flagellum, and loss of most cytoplasm.

(b) Spermiation: the process by which mature spermatozoa are released from the cytoplasmic bridges connecting them to Sertoli cells and enter the lumen of the seminiferous tubule.

(c) The question asks for the name of formation from spermatids (= spermiogenesis) and the name of the release process (= spermiation).

Final Answer: Spermiogenesis, Spermiation

Answer: (B) Go Back to Question 39

Q40.

Solution

Concept: The 10 percent law (Lindeman, 1942) states that only 10% of energy at any trophic level is transferred to the next level; the remaining 90% is lost as heat through metabolic processes. Producers are the first trophic level; primary consumers are the second; secondary consumers (carnivores) are the third.

Solution:

(a) Energy at producer level (Trophic Level 1) = 1,000,000 kcal.

(b) Energy at primary consumer level (Trophic Level 2) = 10% of 1,000,000 = 100,000 kcal.

(c) Energy at secondary consumer level (Trophic Level 3) = 10% of 100,000 = 10,000 kcal.

(d) The question asks for energy available to the secondary consumer (TL3), which is 10,000 kcal.

(e) A common mistake is applying only one step of the 10% law. The secondary consumer is two steps above the producers, so two applications are needed.

Final Answer: 10,000 kcal

Answer: (B) Go Back to Question 40

Q41.

Solution

Concept: The ABO blood group system involves three alleles: I^A, I^B, and i. I^A and I^B are both dominant over i, and are codominant with each other. Blood group O results from the genotype ii (homozygous recessive).

Solution:

(a) Father: I^Ai. Gametes produced: I^A and i (in equal proportions).

(b) Mother: I^Bi. Gametes produced: I^B and i (in equal proportions).

(c) Punnett square cross: $I^Ai \times I^Bi$: I^AI^B (blood group AB), I^Ai (blood group A), I^Bi (blood group B), ii (blood group O).

(d) Probability of ii (blood group O) = $1/4 = 25\%$.

Final Answer: 25%

Answer: (B) Go Back to Question 41

Q42.

Solution

Concept: Photorespiration occurs when RuBisCO acts as an oxygenase rather than a carboxylase. The first reaction of photorespiration is the fixation of O_2 to RuBP (5C) by RuBisCO, producing one molecule of 3-phosphoglycerate (3C) and one molecule of 2-phosphoglycolate (2C). Photorespiration involves three organelles: chloroplast, peroxisome, and mitochondrion.

Solution:

(a) Option A is incorrect: photorespiration decreases net photosynthesis because it releases CO_2 without producing ATP or NADPH net.

(b) Option B is correct: RuBisCO adds O_2 to RuBP (oxygenase reaction), producing one molecule of 3-PGA and one molecule of 2-phosphoglycolate.

(c) Option C is incorrect: the initial oxygenation reaction occurs in chloroplasts; processing of phosphoglycolate occurs in peroxisomes and mitochondria. All three organelles are involved.

(d) Option D is incorrect: photorespiration is a wasteful pathway that cannot produce glucose; it actually loses fixed carbon as CO_2.

Final Answer: Involves fixation of O_2 by RuBisCO, producing phosphoglycolate and 3-PGA

Answer: (B) Go Back to Question 42

Q43.

Solution

Concept: The skin (integument) consists of two main layers: the superficial epidermis and the deeper dermis. Beneath the dermis lies the hypodermis (subcutaneous layer), which anchors the skin to underlying muscles and bones. The outermost layer of the epidermis is the stratum corneum, which provides the barrier function.

Solution:

(a) Outermost layer: Epidermis (stratified squamous epithelium, avascular).

(b) Middle layer: Dermis (dense connective tissue, contains blood vessels, hair follicles, sweat glands, sensory receptors).

(c) Innermost (deepest) layer: Hypodermis (subcutaneous tissue, loose connective tissue rich in adipocytes for insulation and energy storage).

(d) The sequence from outside to inside is: Epidermis → Dermis → Hypodermis.

(e) Other options reverse or scramble this well-established anatomical ordering.

Final Answer: Epidermis → Dermis → Hypodermis

Answer: (B) Go Back to Question 43

Q44.

Solution

Concept: Microsporogenesis is the process of formation of microspores (pollen grains) within the microsporangia (pollen sacs) of anthers. Each microspore mother cell (MMC) is diploid (2n) and undergoes meiosis to produce a tetrad of four haploid (n) microspores. This is a critical event in the male gametophyte development of angiosperms.

Solution:

(a) Each MMC undergoes meiosis I followed by meiosis II, resulting in four haploid microspores arranged in a tetrad.

(b) These microspores later develop into mature pollen grains (microgametophytes) by mitotic divisions.

(c) Option A is incorrect: MMCs undergo meiosis, not mitosis.

(d) Tapetum cells nourish the developing pollen but do not directly form pollen.

(e) Each anther contains typically four microsporangia (pollen sacs), not one.

Final Answer: Each microspore mother cell undergoes meiosis to produce four microspores

Answer: (B) Go Back to Question 44

Q45.

Solution

Concept: Secretory proteins destined for secretion are synthesised by ribosomes on the rough endoplasmic reticulum (rough ER). They enter the ER lumen, are packaged into transport vesicles, and move to the Golgi apparatus for processing, sorting, and packaging. From the Golgi, they travel in secretory vesicles to the plasma membrane for exocytosis.

Solution:

(a) Synthesis of secretory proteins begins on ribosomes attached to the rough ER.

(b) Proteins are translocated into the ER lumen, where initial glycosylation occurs.

(c) Transport vesicles bud from the rough ER and fuse with the cis face of the Golgi apparatus.

(d) Proteins move through the cis, medial, and trans cisternae of the Golgi, being processed (glycosylated, phosphorylated, sulphated) at each stage.

(e) From the trans Golgi network, secretory vesicles bud and move to the plasma membrane.

(f) At the plasma membrane, the vesicle fuses and releases the protein by exocytosis.

(g) Correct route: Rough ER → cis Golgi → trans Golgi → secretory vesicle → cell membrane.

Final Answer: Rough ER → cis Golgi → trans Golgi → secretory vesicle → cell membrane

Answer: (A) Go Back to Question 45

Q46.

Solution

Concept: Arthropoda is characterised by jointed appendages, a chitinous exoskeleton, and segmented bodies. Their circulatory system is open: haemolymph bathes organs in open sinuses (haemocoel) rather than being confined to vessels and capillaries. Malpighian tubules are excretory structures that open into the midgut-hindgut junction and extract nitrogenous waste from the haemolymph.

Solution:

(a) Statement 1 is correct: Arthropods (including insects, crustaceans, and arachnids) have an open circulatory system where haemolymph flows through open sinuses.

(b) Statement 2 requires careful evaluation: Malpighian tubules open into the junction of the midgut and hindgut (not the haemocoel directly). They are bathed by haemolymph on their outer surface and absorb waste products from the haemolymph into the tubule lumen. So technically they open into the gut, not the haemocoel.

(c) However, in the context of MHT-CET NCERT-based questions, Statement 2 is considered INCORRECT because Malpighian tubules open into the alimentary canal (midgut-hindgut junction), not the haemocoel.

(d) Therefore, only Statement 1 is correct.

Final Answer: Only Statement 1 is correct

Answer: (A) Go Back to Question 46

Q47.

Solution

Concept: DNA polymerases cannot initiate a new strand de novo; they can only extend an existing strand by adding nucleotides to a free 3′-OH group. Primase (an RNA polymerase) synthesises short RNA primers complementary to the template, providing the 3′-OH end that DNA polymerase III needs to begin DNA synthesis.

Solution:

(a) DNA polymerase III (in prokaryotes) or DNA polymerase α/δ (in eukaryotes) requires a pre-existing strand with a free 3′-OH terminus.

(b) Primase creates a short (5–10 nucleotide) RNA primer base-paired to the DNA template.

(c) This primer provides the 3′-OH group to which DNA polymerase adds the first deoxyribonucleotide (dNTP).

(d) Primers are later removed and replaced with DNA by DNA polymerase I (in prokaryotes); the remaining nicks are sealed by DNA ligase.

(e) Helicase unwinds DNA; ligase joins fragments; primase only provides the primer.

Final Answer: Provides a 3'-OH end to which DNA polymerase can add the first deoxyribonucleotide

Answer: (B) Go Back to Question 47

Q48.

Solution

Concept: The Renin-Angiotensin-Aldosterone System (RAAS) is the primary hormonal mechanism for long-term blood pressure regulation and sodium/water homeostasis. When blood pressure or filtrate flow to the JGA decreases, juxtaglomerular cells release renin, the first enzyme in the cascade.

Solution:

(a) The JGA is located where the distal convoluted tubule contacts the afferent arteriole.

(b) JG cells (granular cells) of the afferent arteriole sense decreased blood pressure (stretch) or decreased Na^+ delivery.

(c) They release Renin (a proteolytic enzyme).

(d) Renin cleaves angiotensinogen (from liver) $\rightarrow$ Angiotensin I.

(e) ACE (Angiotensin Converting Enzyme) converts Angiotensin I $\rightarrow$ Angiotensin II.

(f) Angiotensin II causes vasoconstriction and stimulates aldosterone release (Na^+ and water reabsorption), ultimately raising blood pressure.

Final Answer: Renin, which initiates the RAAS

Answer: (B) Go Back to Question 48

Q49.

Solution

Concept: Before recombinant DNA technology, insulin was extracted from the pancreata of pigs and cattle. The first genetically engineered human insulin (Humulin) was produced by inserting the human insulin A- and B-chain genes into separate E. coli cultures. The advantages include: identical sequence to human insulin, large-scale production, and no animal-sourced protein contaminants.

Solution:

(a) Recombinant human insulin has the identical amino acid sequence as endogenous human insulin (not different, ruling out Option A).

(b) Diabetic patients previously using porcine or bovine insulin could develop immune reactions to the slightly different sequence; recombinant human insulin eliminates this risk.

(c) Recombinant production is scalable and does not depend on the slaughter of animals.

(d) In the original E. coli process, the A-chain and B-chain were produced separately and then combined (with S-S bond formation); however, current yeast-based processes can produce intact proinsulin. This does not mean one chain still requires animal extraction (Option D is wrong).

Final Answer: Cheaper, large-scale production, eliminates risk of allergic reactions to animal-derived impurities

Answer: (B) Go Back to Question 49

Q50.

Solution

Concept: Molecular evidence for evolution — specifically the comparison of DNA sequences, amino acid sequences of conserved proteins (like cytochrome c), and rRNA sequences — provides the most direct and quantitative measure of evolutionary relationships. The degree of molecular similarity is directly proportional to how recently two species diverged from a common ancestor.

Solution:

(a) Option A describes analogous structures (convergent evolution) — these do NOT indicate common ancestry; they indicate similar environmental pressures.

(b) Option B is correct: sequence similarity in DNA and proteins reflects the inheritance from a common ancestor. The more similar the sequences, the more recently the species shared a common ancestor (e.g., humans and chimpanzees share >98% DNA identity).

(c) Similar habitats (Option C) explain convergent evolution but provide no direct ancestral lineage information.

(d) Fossil records in same strata can indicate similar ages but not molecular ancestry.

Final Answer: Similarity in DNA and protein sequences proportional to evolutionary closeness

Answer: (B) Go Back to Question 50

Q51.

Solution

Concept: Blood coagulation is a complex cascade involving intrinsic and extrinsic pathways that converge on a common pathway. The cascade amplifies the initial signal, ultimately producing a fibrin clot. The sequence involves activation of clotting factors, conversion of prothrombin (inactive) to thrombin (active), and finally conversion of fibrinogen (soluble) to fibrin (insoluble) mesh.

Solution:

(a) Trigger (event ii): Vascular injury exposes collagen and tissue factor (TF); platelets aggregate and release clotting factors (Factor III, Ca^{2+}, etc.)

(b) The clotting factor cascade leads to the activation of prothrombinase complex.

(c) Prothrombin (Factor II, inactive) is converted to Thrombin (active) by prothrombinase (event iii).

(d) Thrombin cleaves fibrinogen (soluble plasma protein) to fibrin monomers (event i).

(e) Fibrin monomers polymerise; Factor XIII (activated by thrombin) cross-links them covalently to form a stable, insoluble clot (event iv).

(f) Correct sequence: (ii) $\rightarrow$ (iii) $\rightarrow$ (i) $\rightarrow$ (iv).

Final Answer: $\boxed{(ii) \rightarrow (iii) \rightarrow (i) \rightarrow (iv)}$

Answer: (B) Go Back to Question 51

Q52.

Solution

Concept: Apomixis encompasses various mechanisms of asexual reproduction through seeds. Adventive embryony occurs when embryos develop directly from diploid somatic cells of the nucellus or integuments (not from a gametophyte), bypassing meiosis and fertilisation entirely. Parthenogenesis is the development of an unfertilised egg into an embryo. Diplospory and Apospory involve the formation of embryo sacs without meiosis.

Solution:

(a) Adventive embryony (also called sporophytic budding): embryos arise vegetatively from nucellar cells or integument cells. Since these are diploid somatic cells, the resultant embryos are diploid and genetically identical to the mother plant.

(b) This is common in Citrus, Mangifera (mango), and Opuntia.

(c) Parthenogenesis: embryo develops from an unfertilised egg cell (within the gametophyte).

(d) Diplospory: the megaspore mother cell divides mitotically (instead of meiotically) to form an unreduced embryo sac.

(e) Apospory: somatic cells of the ovule (nucellus) develop into an embryo sac, but without forming an embryo from the egg by normal fertilisation.

(f) Among the options, adventive embryony specifically names embryo development from the nucellus or integuments.

Final Answer: Adventive embryony

Answer: (A) Go Back to Question 52

Q53.

Solution

Concept: The Casparian strip is a band of waterproof, suberin-impregnated cell wall material found in the radial (side) and transverse (top and bottom) walls of endodermal cells. It prevents water and dissolved minerals from passing between endodermal cells (apoplastic pathway), forcing solutes to enter the cytoplasm (symplastic route) before crossing into the stele.

Solution:

(a) The Casparian strip is made of suberin (a waxy, impermeable polymer), NOT lignin.

(b) It is located in the radial and transverse walls of endodermal cells only.

(c) Its function is to block the apoplastic pathway at the endodermis, ensuring that all water and solutes must pass through the plasma membrane and cytoplasm (symplast) to enter the vascular stele.

(d) This selective barrier allows the plant to regulate the composition of xylem sap.

(e) Option A incorrectly states it is lignin and in cortical cells. Option C misidentifies the location as pericycle.

Final Answer: A band of suberin in the radial and transverse walls of endodermal cells

Answer: (B) Go Back to Question 53

Q54.

Solution

Concept: The nitrogen cycle consists of several processes: nitrogen fixation, nitrification, denitrification, and ammonification. Denitrification is carried out by anaerobic bacteria (e.g., Pseudomonas, Thiobacillus) that reduce nitrates (NO_3^-) to N_2 gas (and sometimes N_2O), returning nitrogen to the atmosphere and reducing soil fertility.

Solution:

(a) Nitrification by Nitrosomonas: converts $NH_3 \rightarrow NO_2^-$ (increases soil nitrogen availability as plant-usable nitrate, not N_2 gas).

(b) Ammonification: decomposition of organic nitrogen to NH_3 (keeps nitrogen in soil, doesn't return it to atmosphere as N_2).

(c) Nitrogen fixation by Rhizobium: converts atmospheric $N_2 \rightarrow NH_3$ (adds nitrogen to soil).

(d) Denitrification: $NO_3^- \rightarrow N_2O \rightarrow N_2$ (removes nitrogen from soil and returns it to the atmosphere as gas). Carried out by Pseudomonas and Thiobacillus under anaerobic conditions (waterlogged soils).

Final Answer: Denitrification by Pseudomonas and Thiobacillus

Answer: (D) Go Back to Question 54

Q55.

Solution

Concept: Echinoderms (starfish, sea urchins, sea cucumbers) are exclusively marine, deuterostome invertebrates. Their adults show pentamerous (five-fold) radial symmetry, while their larvae are bilaterally symmetrical (a feature suggesting evolutionary relationship with bilateral ancestral chordates). The water vascular system (WVS) is a unique hydraulic system serving multiple functions.

Solution:

(a) Statement 1 is correct: adult echinoderms are radially symmetrical (pentamerous), but their free-swimming larvae (e.g., bipinnaria, pluteus) are bilaterally symmetrical, supporting their phylogenetic link to bilateral ancestors.

(b) Statement 2 is correct: the WVS of echinoderms uses hydraulic pressure to operate tube feet (podia) for locomotion and prey manipulation. It is also involved in gas exchange (oxygen diffusion) and osmoregulation in some species.

(c) Both statements are accurate. Option C is the correct answer.

Final Answer: Both statements are correct

Answer: (C) Go Back to Question 55

Q56.

Solution

Concept: Capacitation is a series of biochemical and physiological changes that spermatozoa must undergo in the female reproductive tract (primarily the fallopian tube) before they can fertilise an egg. These changes make the sperm hyperactivated and capable of undergoing the acrosome reaction, which is necessary to penetrate the zona pellucida.

Solution:

(a) Sperm acquire motility in the epididymis (not by capacitation), making Option A incorrect.

(b) Capacitation occurs in the female reproductive tract, specifically in the uterus and fallopian tube. The process lasts 5–6 hours.

(c) During capacitation, the sperm's surface glycoproteins and cholesterol are altered, the membrane becomes more fluid, and the sperm becomes hyperactivated (vigorous whiplash tail movements).

(d) Crucially, capacitation enables the acrosome reaction: when the capacitated sperm encounters the zona pellucida, the acrosome (membrane-bound organelle in the sperm head) releases its hydrolytic enzymes (e.g., hyaluronidase, acrosin) to penetrate the zona and reach the egg membrane.

(e) Thus, capacitation primarily enables sperm to penetrate the zona pellucida by triggering the acrosome reaction.

Final Answer: In the female reproductive tract; enables the acrosome reaction to penetrate the zona pellucida

Answer: (B) Go Back to Question 56

Q57.

Solution

Concept: Eukaryotic pre-mRNA undergoes three major processing steps in the nucleus: (1) 5′ capping with a 7-methylguanosine (m^7G) cap, (2) 3′ polyadenylation (addition of ~200 adenine residues — the poly-A tail) at the 3′ end, and (3) RNA splicing (removal of introns and joining of exons).

Solution:

(a) 5′ cap: 7-methylguanosine (m^7G) is added to the 5′ end of the pre-mRNA soon after transcription begins. It protects mRNA from 5′ exonucleases and is recognised by ribosomes for translation initiation.

(b) Poly-A tail: a string of adenine nucleotides added to the 3′ end by poly-A polymerase after cleavage of the pre-mRNA downstream of the AAUAAA signal sequence. It stabilises the mRNA and aids in export to the cytoplasm.

(c) Splicing: introns (non-coding intervening sequences) are removed by the spliceosome; exons are joined to form the continuous coding sequence.

(d) Option A is correct: 7-methylguanosine at 5′ end, poly-A at 3′ end, removal of introns.

Final Answer: 7-methylguanosine cap at 5′ end, poly-A tail at 3′ end, removal of introns

Answer: (A) Go Back to Question 57

Q58.

Solution

Concept: Vernalisation was first studied in detail by Lyubimenko and further elucidated by Purvis and Gregory. The site of cold perception is the shoot apical meristem (SAM) in most cases, where the actively dividing cells in or near the growing point perceive and respond to cold temperatures. Young leaves near the apex also participate in some species.

Solution:

(a) Leaves are the site of photoperiodic perception (phytochrome system), NOT vernalisation.

(b) Root tips do not perceive cold in the context of vernalisation signalling.

(c) Dormant axillary buds may receive cold, but they are not the primary perception site.

(d) The shoot apical meristem (and young, actively dividing cells near it) perceive the cold stimulus. This was demonstrated by localised cooling and warming experiments that showed: cooling the apex while keeping the rest warm induced flowering; cooling only the leaves did not.

(e) The cold signal is converted to a molecular memory (epigenetic modification of FLC gene in Arabidopsis), and the apex retains the memory through subsequent cell divisions.

Final Answer: Shoot apical meristem or the young leaves near it

Answer: (B) Go Back to Question 58

Q59.

Solution

Concept: The Ti-plasmid of Agrobacterium tumefaciens contains two important regions: (1) the T-DNA (transfer DNA), a segment that is excised from the plasmid and integrated into the plant nuclear genome, and (2) the vir region (virulence genes), which encode the proteins responsible for the excision, transfer, and integration of T-DNA into the plant genome.

Solution:

(a) The vir region genes (virA, virB, virD, virE, etc.) produce proteins that form the excision/transfer machinery, but the vir genes themselves do NOT integrate into the plant genome.

(b) The T-DNA (Transfer DNA) is the specific segment (typically 15–25 kb) flanked by direct repeat border sequences that is excised from the Ti-plasmid and transferred into the plant cell nucleus.

(c) Once inside the nucleus, T-DNA integrates semi-randomly into the plant chromosomal DNA.

(d) In nature, T-DNA carries genes for opine synthesis (nutritional benefit for the bacterium) and phytohormone biosynthesis (causing the tumour/crown gall). In recombinant work, these genes are removed and replaced with the gene of interest.

(e) The ori region stays in the bacterium; it does not move to the plant.

Final Answer: T-DNA (transfer DNA)

Answer: (B) Go Back to Question 59

Q60.

Solution

Concept: Opioid drugs (morphine, heroin, codeine) act as agonists at opioid receptors (mu, delta, kappa) that are normally activated by endogenous peptides (endorphins, enkephalins, dynorphins). These receptors are found in the CNS (brain and spinal cord), peripheral nervous system, and gastrointestinal tract. Activation produces analgesia, euphoria, and CNS depression.

Solution:

(a) Opioids bind to mu-opioid receptors in the mesolimbic pathway (ventral tegmental area → nucleus accumbens), increasing dopamine release and causing intense euphoria/reward.

(b) Simultaneously, opioids are CNS depressants: they inhibit ascending pain signals, decrease respiratory rate, cause sedation, and depress the cough reflex.

(c) They are agonists at opioid receptors, not antagonists.

(d) They do NOT specifically block acetylcholine receptors at the neuromuscular junction (that would be a curare-like effect).

(e) They act strongly on the CNS; Option C is incorrect.

(f) Option A correctly combines both the dopaminergic reward effect (euphoria/addiction) and the CNS inhibitory effect.

Final Answer: Stimulate dopaminergic reward pathways and inhibit CNS as agonists at opioid receptors

Answer: (A) Go Back to Question 60

Q61.

Solution

Concept: The hypothalamus contains the thermoregulatory centre, often called the body's "thermostat." It receives continuous input from thermoreceptors in the skin and blood and compares this to the set-point (~37°C). When temperature deviates above or below the set-point, the hypothalamus initiates appropriate corrective responses — both heating and cooling mechanisms.

Solution:

(a) The hypothalamus has both a heat-gain centre (posterior hypothalamus) and a heat-loss centre (anterior hypothalamus).

(b) When overheated: anterior hypothalamus activates sweating, vasodilation, and behavioural cooling.

(c) When too cold: posterior hypothalamus activates shivering, vasoconstriction, piloerection, and increases metabolic rate.

(d) Option A correctly states that the hypothalamus acts as a thermostat and initiates BOTH heat gain and heat loss responses.

(e) The cerebellum coordinates movement and has no primary thermoregulatory role (Option B is incorrect).

(f) Shivering IS controlled by the hypothalamus via somatic motor pathways (Option C is incorrect).

Final Answer: The hypothalamus acts as a thermostat and initiates both heat gain and heat loss mechanisms

Answer: (A) Go Back to Question 61

Q62.

Solution

Concept: Linkage refers to the tendency of genes located on the same chromosome to be inherited together rather than independently (as Mendel's law of independent assortment would predict for genes on different chromosomes). Morgan's work on Drosophila provided the first experimental evidence for linkage and established the concept of chromosome maps.

Solution:

(a) Mendel's Law of Independent Assortment holds only for genes on different (non-homologous) chromosomes.

(b) Genes on the same chromosome are physically connected and tend to be inherited as a unit (linked).

(c) Morgan and co-workers observed that certain Drosophila traits did not show a 9:3:3:1 ratio in dihybrid crosses and showed departures from independent assortment.

(d) This was explained by linkage: the genes were on the same chromosome and thus not free to assort independently.

(e) Recombination (crossing over) can separate linked genes, but the frequency of recombination is less than 50% for linked genes, unlike the 50% expected for independently assorting genes.

Final Answer: Linkage, where genes located on the same chromosome tend to be inherited together

Answer: (B) Go Back to Question 62

Q63.

Solution

Concept: Angiosperms are divided into two main classes: Monocotyledonae (monocots) and Dicotyledonae (dicots) based on several distinguishing features. The most fundamental is the number of seed leaves (cotyledons). Associated characters include venation, number of floral parts, root system type, and vascular bundle arrangement.

Solution:

(a) Monocots: 1 cotyledon, parallel venation, trimerous flowers (3 or multiples of 3 petals/sepals), fibrous root system.

(b) Dicots: 2 cotyledons, reticulate (net) venation, tetramerous or pentamerous flowers (4 or 5 petals/sepals), tap root system.

(c) Both monocots and dicots produce seeds enclosed in fruits — that feature is common to all Angiosperms and does NOT distinguish between them (Option B incorrect).

(d) Double fertilisation occurs in ALL angiosperms, not just monocots or dicots (Option D incorrect).

(e) Number of mesophyll layers does not reliably differentiate monocots from dicots.

(f) The combination of: number of cotyledons + venation pattern + floral part number is the standard set of distinguishing features.

Final Answer: Number of cotyledons, venation pattern, and number of floral parts

Answer: (C) Go Back to Question 63

Q64.

Solution

Concept: Oxidative phosphorylation (the synthesis of ATP by ATP synthase) requires a proton gradient (proton-motive force) across the inner mitochondrial membrane. Protons pumped by the electron transport chain accumulate in the intermembrane space. As they flow back through ATP synthase into the matrix, their electrochemical energy drives ATP synthesis. If the membrane becomes proton-permeable (uncoupled), the gradient dissipates and ATP synthesis stops; energy is released as heat instead.

Solution:

(a) When the inner mitochondrial membrane is made permeable to protons (as by uncouplers like DNP or the mechanism described), protons leak back across the membrane without passing through ATP synthase.

(b) The proton-motive force ($\Delta p = \Delta\psi + \Delta\text{pH}$) collapses.

(c) Without the proton gradient, ATP synthase cannot rotate (chemiosmotic mechanism requires proton flow through the c-ring).

(d) ATP synthesis stops or is greatly reduced, causing cellular energy crisis.

(e) The energy from electron transport is released directly as heat instead of being captured as ATP.

(f) This is why uncouplers are used in weight-loss research (thermogenesis) but are toxic at high doses.

Final Answer: Uncoupling of oxidative phosphorylation, leading to decreased ATP synthesis and increased heat

Answer: (B) Go Back to Question 64

Q65.

Solution

Concept: An ecological niche is not merely the physical location (habitat) of a species; it encompasses the complete functional role of a species in its community, including all its biotic interactions, food habits, time of activity, and space use. The niche is often described as a species's "profession" in the community, as opposed to its "address" (habitat).

Solution:

(a) Option A is incorrect: that definition describes the *habitat*, not the niche. The niche is more than just location.

(b) Option B is correct: the ecological niche describes the species's full functional role — what it eats, what eats it, how it modifies its environment, temporal patterns of activity, and how it interacts with abiotic and biotic factors.

(c) Option C violates the Competitive Exclusion Principle (Gause's law); two species cannot share the exact same niche indefinitely.

(d) Option D is incorrect: niches are dynamic; when a competing species is removed (e.g., through predator removal experiments), the surviving species may expand its realised niche (niche expansion/release), demonstrating that niches change with biotic context.

Final Answer: Describes a species's functional role including food habits, space use, and species interactions

Answer: (B) Go Back to Question 65

Q66.

Solution

Concept: The geological timescale divides Earth's history into eons, eras, and periods. The Precambrian (including the Proterozoic) is the oldest recognised major division. The Palaeozoic ("ancient life") follows and includes major animal diversification. The Mesozoic ("middle life") is the age of reptiles and dinosaurs. The Cenozoic ("recent life") is the current era, characterised by mammal and angiosperm dominance.

Solution:

(a) (iv) Proterozoic Era: 2500–541 million years ago. Pre-dating the Palaeozoic; largely Precambrian, featuring early eukaryotes.

(b) (iii) Palaeozoic Era: 541–252 million years ago. Cambrian explosion, fish, amphibians, reptiles.

(c) (i) Mesozoic Era: 252–66 million years ago. Dinosaurs, early mammals, and first angiosperms.

(d) (ii) Cenozoic Era: 66 million years ago to present. Age of mammals, birds, and flowering plants.

(e) Correct chronological order (most ancient to most recent): (iv) → (iii) → (i) → (ii).

Final Answer: $\boxed{(iv) \rightarrow (iii) \rightarrow (i) \rightarrow (ii)}$

Answer: (B) Go Back to Question 66

Q67.

Solution

Concept: Joints are classified as fibrous (immovable/synarthroses), cartilaginous (slightly movable/amphiarthroses), or synovial (freely movable/diarthroses). The synovial joint is the most common and most mobile type. Its defining feature is the synovial cavity between the articulating bones, lined by the synovial membrane that secretes synovial fluid.

Solution:

(a) Option A describes a fibrous joint (e.g., skull sutures) — immovable, no cavity.

(b) Option C describes a cartilaginous joint (e.g., pubic symphysis, intervertebral discs) — slightly movable.

(c) Option D describes fibrous sutures at the skull — these are fibrous, not synovial.

(d) Option B correctly describes the synovial joint: bones are connected by a fibrous joint capsule; the articular surfaces are covered with hyaline cartilage; a fluid-filled synovial cavity (containing synovial fluid) lubricates the joint and reduces friction; the cavity allows wide-ranging free movements.

Final Answer: Contains a fluid-filled synovial cavity that reduces friction and allows free movement

Answer: (B) Go Back to Question 67

Q68.

Solution

Concept: Photorespiration is initiated by the oxygenase activity of RuBisCO. At high CO_2/O_2 ratios, carboxylase activity dominates and Calvin cycle proceeds normally. When CO_2 concentration falls (as it does on a hot, bright day when stomata may also close) or when O_2 concentration is relatively higher, the oxygenase activity of RuBisCO is favoured.

Solution:

(a) RuBisCO can bind either CO_2 (carboxylase) or O_2 (oxygenase) at its active site. The ratio of CO_2 to O_2 determines which reaction predominates.

(b) In a greenhouse, bright light drives rapid photosynthesis, consuming CO_2. If ventilation is limited, the CO_2 concentration in the leaf air spaces decreases.

(c) As CO_2 falls, the concentration gradient between CO_2 and O_2 shifts: less CO_2 competes with O_2 for the RuBisCO active site.

(d) Therefore, the oxygenase activity (and thus photorespiration rate) increases relative to carboxylase activity.

(e) This is why the rate of net photosynthesis is lower in C3 plants under bright light at high temperatures compared to C4 plants.

Final Answer: Increase, because low CO_2 favours oxygenase activity of RuBisCO

Answer: (B) Go Back to Question 68

Q69.

Solution

Concept: The uterus is a hollow, pear-shaped muscular organ consisting of three layers: the perimetrium (thin outer serosal layer), the myometrium (thick middle muscular layer of smooth muscle), and the endometrium (inner mucous membrane). The endometrium undergoes monthly cyclical changes during the menstrual cycle, preparing for potential implantation.

Solution:

(a) Endometrium: innermost glandular mucosal lining of the uterus. It proliferates under estrogen during the follicular phase, becomes secretory under progesterone during the luteal phase, and is shed during menstruation if implantation does not occur.

(b) Myometrium: thick middle layer of smooth muscle that contracts during labour (under oxytocin influence) to expel the fetus.

(c) Perimetrium: thin outer serous layer (visceral peritoneum).

(d) The question asks for inner layer (endometrium) and outer muscular layer (myometrium).

(e) Option C correctly identifies: endometrium as the inner layer, myometrium as the outer muscular layer.

Final Answer: Endometrium (inner), Myometrium (muscular)

Answer: (C) Go Back to Question 69

Q70.

Solution

Concept: Gene therapy is classified based on the target cell type. Somatic gene therapy introduces therapeutic genes into the somatic cells of a patient to correct a disorder in that individual. The genetic change is not passed to the next generation. Germ-line gene therapy would involve modification of germline (egg or sperm) cells, making the change heritable.

Solution:

(a) When the introduced gene corrects a defect in somatic cells (e.g., white blood cells in ADA-SCID), the patient benefits but the change is NOT heritable.

(b) This is by definition somatic gene therapy.

(c) Germ-line gene therapy would involve modifying eggs, sperm, or embryos — making the correction heritable to all future generations; this is ethically controversial and not routinely done clinically.

(d) The term is specifically "somatic" because only somatic (body) cells are targeted, not the gametes.

(e) The first successful gene therapy (1990) for ADA-SCID was somatic gene therapy: lymphocytes were isolated, transfected with functional ADA gene, and reinfused.

Final Answer: Somatic gene therapy; only somatic cells are corrected; the change is not heritable

Answer: (B) Go Back to Question 70

Q71.

Solution

Concept: Sponges (Phylum Porifera) are the most primitive multicellular animals. They represent the cellular grade of organisation — cells are specialised but are not organised into true tissues. The choanocytes (collar cells) are flagellated cells that line the water channels and drive water flow for filter-feeding.

Solution:

(a) Porifera are acoelomate (no coelom) and have no organs, eliminating Options A (coelomate) and B (tissues and organs).

(b) They do reproduce sexually AND asexually (by gemmules and budding), so Option D is incorrect.

(c) Option C is correct: sponges are at the cellular grade of organisation (no true tissues), have a canal system of water channels, and are lined by choanocytes (flagellated collar cells). Water enters through pores (ostia), passes through the spongocoel, and exits through the osculum.

Final Answer: Cellular grade organisms with water channels lined by flagellated choanocytes

Answer: (C) Go Back to Question 71

Q72.

Solution

Concept: Self-incompatibility (SI) is a genetic mechanism that prevents self-fertilisation in flowering plants, promoting outcrossing and genetic diversity. In sporophytic SI (SSI, as in Brassica), incompatibility is determined by the S-genotype of the diploid parent that produced the pollen, not by the haploid genotype of the pollen grain itself.

Solution:

(a) In Gametophytic SI (GSI, e.g., Petunia, Nicotiana): compatibility is determined by the haploid S-allele expressed in the pollen grain itself. Option A describes GSI, not SSI.

(b) In Sporophytic SI (SSI, e.g., Brassica): the pollen coat carries proteins encoded by the diploid S-genotype of the parent plant that produced the pollen. The stigma recognises these coat proteins and rejects compatible pollen based on S-allele matching.

(c) Thus, in SSI, the incompatibility phenotype of the pollen is determined by the diploid sporophyte parent, not the haploid pollen grain genotype.

(d) Option B correctly states: "The diploid genotype of the parent plant that produced the pollen."

Final Answer: The diploid genotype of the parent plant that produced the pollen

Answer: (B) Go Back to Question 72

Q73.

Solution

Concept: Pedigree analysis allows determination of the mode of inheritance based on the pattern of the trait across generations. Key clues: every-generation expression indicates dominant inheritance; unaffected parents never having affected children suggests no carriers of recessives in those lines; father-to-son transmission rules out X-linked; presence in both sexes rules out Y-linked.

Solution:

(a) Trait appears in every generation → indicates dominant inheritance (recessive would skip generations when heterozygotes are present).

(b) Affected fathers pass it to sons → rules out X-linked dominant (affected fathers would pass their X to all daughters, not sons; sons get Y from father).

(c) Affected mothers pass it to both sons and daughters → consistent with autosomal dominant.

(d) Unaffected individuals never have affected children → no individuals carry a silent dominant allele; fully penetrant dominant.

(e) All clues together indicate Autosomal dominant inheritance.

Final Answer: Autosomal dominant inheritance

Answer: (C) Go Back to Question 73

Q74.

Solution

Concept: Secondary growth in dicot stems involves the vascular cambium, a lateral meristem. The vascular cambium is a cylindrical layer of cells between the secondary xylem and secondary phloem. During cell division, cells produced towards the inside differentiate into secondary xylem (wood); cells produced towards the outside differentiate into secondary phloem.

Solution:

(a) The vascular cambium divides periclinally (parallel to the stem surface).

(b) New cells cut off towards the interior (centripetal division) become secondary xylem (vessel elements, fibres, parenchyma).

(c) New cells cut off towards the exterior (centrifugal division) become secondary phloem (sieve elements, companion cells, parenchyma).

(d) More secondary xylem is produced than secondary phloem, so the stem widens greatly over years (annual rings = secondary xylem rings).

(e) Option A correctly states: secondary xylem formed inward, secondary phloem formed outward.

Final Answer: Secondary xylem formed towards inside; secondary phloem formed towards outside

Answer: (A) Go Back to Question 74

Q75.

Solution

Concept: The adaptive immune response involves two main arms: humoral (antibody-mediated, via B-cells) and cell-mediated immunity (CMI, via T-cells). Within CMI, helper T-cells (CD4+) play a central coordinating role by releasing cytokines that activate cytotoxic T-cells (CD8+) and also provide essential co-stimulatory signals to B-cells for antibody production.

Solution:

(a) Option A is incorrect: cytotoxic T-cells (CD8+) do NOT produce antibodies; they kill infected cells directly using perforin and granzymes.

(b) Option B is correct: Helper T-cells (CD4+) are the conductors of the immune orchestra. They secrete cytokines (IL-2, IL-4, IFN-γ, etc.) that activate CD8+ T-cells (making them cytotoxic), stimulate B-cells to undergo clonal expansion and class switching, and activate macrophages.

(c) Option C is incorrect: Regulatory T-cells suppress (not stimulate) immune responses and do not phagocytose bacteria.

(d) Option D is incorrect: memory T-cells do NOT continuously produce antibodies; they provide rapid re-activation on secondary antigen exposure but antibodies are produced by plasma B-cells.

Final Answer: Helper T-cells (CD4+) secrete cytokines coordinating both cytotoxic T-cells and B-cells

Answer: (B) Go Back to Question 75

Q76.

Solution

Concept: Food webs provide a more realistic representation of energy flow in ecosystems because organisms generally have multiple food sources and are preyed upon by multiple predators. A simple food chain (linear: Producer → Herbivore → Carnivore) is a simplified abstraction; real ecosystems involve a network of overlapping food chains.

Solution:

(a) A food web is simply an interconnected network of food chains, showing the true complexity of feeding relationships in a community.

(b) Most animals are omnivores or generalists that consume from multiple trophic levels (e.g., a fox eats rabbits, birds, berries, and insects).

(c) This network structure makes the ecosystem more stable (redundancy): if one prey species declines, a predator can switch to another.

(d) Both food chains and food webs consider energy flow; Option A is incorrect.

(e) Abiotic factors are not exclusively in food webs; Option C is incorrect.

Final Answer: Most organisms feed on multiple species and are eaten by multiple species, creating a network

Answer: (B) Go Back to Question 76

Q77.

Solution

Concept: Industrial melanism is a classic example of directional natural selection acting on a pre-existing genetic variation in a population. Before industrialisation, the melanic (dark) form of the peppered moth was rare because it was conspicuous on lichen-covered, light tree bark. After soot darkened the bark, the light-coloured moths became conspicuous to predators while melanic moths survived better.

Solution:

(a) The melanic allele pre-existed in the population before industrialisation — it was not created by industrial pollutants (ruling out mutationism, Option C).

(b) Natural selection (predation by birds) simply changed the frequencies of the two pre-existing forms.

(c) Before industrial pollution: light-coloured moths were camouflaged on light bark → survived; melanics were eaten.

(d) After industrial pollution: soot darkened bark → melanics were camouflaged; light moths were eaten.

(e) Allele frequency shifted from predominantly light to predominantly dark — this is directional natural selection.

(f) Lamarck's theory (Option D) would say the moths actively darkened their wings in response; this is incorrect.

Final Answer: Natural selection; the environment selected for a pre-existing melanic variant

Answer: (B) Go Back to Question 77

Q78.

Solution

Concept: A reflex arc is the structural and functional unit of the nervous system for carrying out a reflex action. It consists of five components arranged in a specific sequence that allows a rapid, involuntary response to a stimulus without higher brain centres necessarily being involved (as in spinal reflexes).

Solution:

(a) Step 1: A sensory receptor detects the stimulus (mechanical, thermal, chemical).

(b) Step 2: An afferent (sensory) neuron carries the impulse towards the central nervous system (spinal cord/brainstem).

(c) Step 3: The nerve centre (interneuron in the spinal cord or brainstem) processes the signal.

(d) Step 4: An efferent (motor) neuron carries the impulse away from the CNS.

(e) Step 5: An effector (muscle or gland) produces the response.

(f) Correct sequence: Receptor → Afferent neuron → Nerve centre → Efferent neuron → Effector.

Final Answer: Receptor → Afferent neuron → Nerve centre → Efferent neuron → Effector

Answer: (B) Go Back to Question 78

Q79.

Solution

Concept: Carbon dioxide produced in tissues must be transported to the lungs for exhalation. Three mechanisms carry CO_2 in blood: (1) dissolved in plasma (~7%), (2) as bicarbonate ions (HCO_3^-, ~70%), and (3) as carbaminohaemoglobin (~23%). The enzyme carbonic anhydrase (CA), found in high concentrations in red blood cells, catalyses the rapid, reversible hydration of CO_2.

Solution:

(a) In tissues: CO_2 diffuses into RBCs. CA catalyses: $CO_2 + H_2O \rightleftharpoons H_2CO_3$ (carbonic acid).

(b) H_2CO_3 spontaneously dissociates: $H_2CO_3 \rightarrow H^+ + HCO_3^-$.

(c) HCO_3^- moves into plasma (chloride shift), and H^+ is buffered by haemoglobin.

(d) In the lungs, the reverse reaction occurs: HCO_3^- re-enters RBCs, re-combines with H^+ to form H_2CO_3, which CA converts back to $CO_2 + H_2O$; CO_2 diffuses into alveoli and is exhaled.

(e) Option A describes the forward reaction in tissues, which is the primary reaction catalysed by carbonic anhydrase.

Final Answer: $\boxed{CO_2 + H_2O \xrightarrow{CA} H_2CO_3 \rightarrow H^+ + HCO_3^-}$

Answer: (A) Go Back to Question 79

Q80.

Solution

Concept: The cell cycle consists of interphase (G1, S, G2) and mitotic phase (M phase). During the S (Synthesis) phase of interphase, each chromosome is duplicated (DNA replication occurs), resulting in sister chromatids joined at the centromere. Cytokinesis (cytoplasmic division) and karyokinesis (nuclear division) are separable events in some biological contexts.

Solution:

(a) Statement 1 is correct: DNA replication (and thus chromosome duplication) occurs during the S phase of interphase. Each chromosome is copied, producing sister chromatid pairs.

(b) Statement 2 is incorrect: cytokinesis and karyokinesis can be uncoupled. In certain organisms and cell types, karyokinesis occurs multiple times without cytokinesis, producing multinucleate cells (syncytia). Examples include: endosperm cells in plants (nuclear divisions without cell plate formation), skeletal muscle fibres (multinucleate), and some fungi.

(c) Therefore, only Statement 1 is correct.

Final Answer: Only Statement 1 is correct

Answer: (A) Go Back to Question 80

Q81.

Solution

Concept: Algae are classified into three main divisions based on their photosynthetic pigments and stored food materials. Chlorophyceae (green algae) contain chlorophyll a and b with stored starch. Phaeophyceae (brown algae) contain chlorophyll a, c and fucoxanthin, storing laminarin and mannitol. Rhodophyceae (red algae) contain phycoerythrin and phycocyanin, storing floridean starch.

Solution:

(a) Option A: assigns fucoxanthin and laminarin to Chlorophyceae. Incorrect: fucoxanthin and laminarin belong to Phaeophyceae (brown algae).

(b) Option B: assigns chlorophyll a and d and floridean starch to Phaeophyceae. Incorrect: Rhodophyceae have chlorophyll d (some), not Phaeophyceae; floridean starch belongs to Rhodophyceae.

(c) Option C is correct: Rhodophyceae (red algae) contain phycoerythrin (the dominant pigment giving them their red colour), phycocyanin, chlorophyll a, and store floridean starch (a form of amylopectin).

(d) Option D: assigns phycocyanin and phycoerythrin to Chlorophyceae. Incorrect: these are biliproteins found in Rhodophyceae (and Cyanobacteria), not Chlorophyceae.

Final Answer: Rhodophyceae: phycoerythrin, stored as floridean starch

Answer: (C) Go Back to Question 81

Q82.

Solution

Concept: Human Chorionic Gonadotropin (hCG) is a glycoprotein hormone produced by the syncytiotrophoblast cells of the developing placenta shortly after implantation. Its structure is similar to LH, and it serves a crucial role in maintaining early pregnancy by acting as a luteinotropic hormone on the corpus luteum.

Solution:

(a) After implantation, the embryo needs a continuous supply of progesterone to maintain the endometrium and prevent menstruation.

(b) Progesterone is initially produced by the corpus luteum.

(c) Without hCG, the corpus luteum would regress after about 14 days (as in a normal non-pregnant cycle), progesterone would fall, and the endometrium would be shed (menstruation = early pregnancy failure).

(d) hCG, structurally similar to LH, binds to LH receptors on the corpus luteum, preventing its regression and stimulating continued progesterone secretion.

(e) This is why a urine or blood pregnancy test (detecting hCG) indicates pregnancy; hCG is detectable as early as 10–12 days post-fertilisation.

Final Answer: Maintains the corpus luteum and stimulates it to continue producing progesterone

Answer: (B) Go Back to Question 82

Q83.

Solution

Concept: In agarose gel electrophoresis, an electric field drives negatively charged DNA molecules toward the positive electrode (anode). The gel matrix acts as a molecular sieve. Smaller DNA fragments experience less resistance from the gel pores and migrate faster (travel farther from the wells). Larger fragments migrate more slowly and remain closer to the wells.

Solution:

(a) Samples are loaded into wells at the negative electrode (cathode) end.

(b) All DNA migrates toward the positive electrode (anode) as it is negatively charged.

(c) Smaller fragments migrate faster (greater distance from wells) while larger fragments migrate slower (shorter distance from wells).

(d) After ethidium bromide staining and UV illumination, smaller fragments appear as bright bands further from the wells.

(e) A DNA size ladder (molecular weight marker) confirms this: the smallest size marker migrates furthest.

Final Answer: Further from the wells, having migrated more rapidly through the gel matrix

Answer: (C) Go Back to Question 83

Q84.

Solution

Concept: Haemophilia is an X-linked recessive disorder. X^H represents the normal allele, X^h represents the defective allele. Sons inherit their X chromosome from their mother and their Y from their father. Therefore, the father's genotype does not determine whether sons are affected; only the mother's X chromosomes matter for sons' haemophilia risk.

Solution:

(a) Mother: X^HX^h (carrier, phenotypically normal). Father: X^HY (normal).

(b) Cross: $X^HX^h \times X^HY$.

(c) Gametes from mother: X^H and X^h (50:50).

(d) Gametes from father: X^H and Y (50:50).

(e) Offspring genotypes: X^HX^H (normal female), X^HX^h (carrier female), X^HY (normal male), X^hY (affected male).

(f) Probability of haemophilic son among all children = 1/4 = 25%. But among sons specifically: X^HY (normal) and X^hY (affected) $\rightarrow$ 50% of sons will be affected.

(g) Option B is correct: 25% of all children; 50% of sons.

Final Answer: 25% of all children; 50% of sons

Answer: (B) Go Back to Question 84

Q85.

Solution

Concept: A key anatomical difference between monocot and dicot roots lies in the stele (the central vascular cylinder). In dicot roots, vascular bundles are few (2–6), while in monocot roots, the vascular bundles are more numerous (>6, sometimes up to 20+), arranged in a ring around a large parenchymatous pith. This contrasts with dicots which often lack a prominent pith.

Solution:

(a) In monocot roots: the stele contains many xylem and phloem bundles arranged in an alternating radial pattern in a ring; there is a large central pith composed of parenchyma cells; the number of bundles typically exceeds 6 (polyarch).

(b) In dicot roots: the stele is typically diarch to hexarch (2–6 xylem poles); the centre is often solid xylem with no pith.

(c) Option A is incorrect: few bundles in a ring with no pith describes a dicot root.

(d) Option B describes the arrangement of vascular bundles in monocot stems (scattered), not monocot roots.

(e) Option C correctly describes monocot roots: many bundles (>6), ring arrangement, large central pith.

Final Answer: Many (> 6), arranged in a ring with a large central pith

Answer: (C) Go Back to Question 85

Q86.

Solution

Concept: Biogeochemical cycles are classified as gaseous (with a large atmospheric or oceanic reservoir, e.g., carbon, nitrogen cycles) or sedimentary (with a lithospheric/crustal reservoir, e.g., phosphorus, sulphur cycles). The phosphorus cycle has no significant gaseous phase; the main reservoir is rock (apatite minerals) that releases phosphate through weathering.

Solution:

(a) Unlike carbon (gaseous CO_2) and nitrogen (gaseous N_2), phosphorus exists as phosphate (PO_4^{3-}) in soil, water, and organisms, and as rock minerals in the lithosphere.

(b) There is no significant volatile or gaseous form of phosphorus at Earth's surface temperatures under normal conditions.

(c) Phosphate is released from rocks by weathering (chemical and physical), absorbed by plants, passed through food chains, and returned to the soil by decomposers.

(d) Without a gaseous phase, phosphorus cannot return quickly to terrestrial systems once it is deposited in ocean sediments; this makes phosphorus a potentially limiting nutrient over geological timescales.

(e) The phosphorus cycle is therefore a sedimentary biogeochemical cycle.

Final Answer: Sedimentary type biogeochemical cycle with the lithosphere as the main reservoir

Answer: (B) Go Back to Question 86

Q87.

Solution

Concept: The cardiac conduction system generates and conducts electrical impulses that coordinate the rhythmic contraction of the heart. The SA node (sinoatrial node), located in the right atrium near the superior vena cava junction, acts as the primary pacemaker. Impulses propagate in a defined sequence to ensure atrial contraction precedes ventricular contraction.

Solution:

(a) The SA node spontaneously depolarises at 70–75 times per minute, generating the resting heart rate.

(b) The impulse spreads across both atria via internodal pathways and the Bachmann's bundle, causing atrial contraction.

(c) The impulse reaches the AV node (atrioventricular node) in the interatrial septum, where it is delayed by ~0.1 seconds (allowing atria to complete contraction before ventricles begin).

(d) From the AV node, the impulse travels through the Bundle of His (atrioventricular bundle) in the interventricular septum.

(e) It then splits into left and right bundle branches, and finally disperses through the Purkinje fibre network throughout the ventricular myocardium, causing rapid, coordinated ventricular contraction.

(f) Option B correctly describes the entire sequence.

Final Answer: $\boxed{\text{SA node} \rightarrow \text{AV node} \rightarrow \text{Bundle of His} \rightarrow \text{Purkinje fibres} \rightarrow \text{ventricles}}$

Answer: (B) Go Back to Question 87

Q88.

Solution

Concept: Two major models describe the tempo of evolution. Gradualism (Darwin's view) proposes slow, continuous change over geological time. Punctuated Equilibrium (Gould and Eldredge, 1972) proposes that species remain morphologically stable (stasis) for long periods and that most evolutionary change occurs rapidly during brief speciation events, often associated with environmental disruptions or the colonisation of new habitats.

Solution:

(a) Punctuated equilibrium was proposed by Gould and Eldredge to explain gaps in the fossil record — the absence of transitional forms — which Darwinian gradualism had difficulty explaining.

(b) According to this model, a species may remain essentially unchanged for millions of years (stasis = equilibrium), then undergo rapid morphological change in a geologically short period (punctuation) usually at speciation events.

(c) Option A describes phyletic gradualism, not punctuated equilibrium.

(d) Option B correctly defines punctuated equilibrium: long stasis interrupted by rapid speciation events.

(e) Option C (genetic drift in large populations) is not the mechanism proposed; PE is more associated with allopatric speciation in small peripheral populations.

Final Answer: Long periods of stasis interrupted by brief periods of rapid speciation

Answer: (B) Go Back to Question 88

Q89.

Solution

Concept: In transcription, RNA polymerase reads the DNA template strand in the 3′ to 5′ direction and synthesises the mRNA in the 5′ to 3′ direction. The mRNA sequence is complementary to the template (antisense) strand, and therefore has the same sequence as the coding (sense) strand, but with U replacing T.

Solution:

(a) Template (antisense) strand: 3′-ATGCATCGTA-5′. RNA polymerase reads this in the 3′ to 5′ direction.

(b) mRNA is synthesised complementary and antiparallel to the template: A→U, T→A, G→C, C→G.

(c) Reading template 3′-ATGCATCGTA-5′, the mRNA is built 5′ to 3′:

- A → U
- T → A
- G → C
- C → G
- A → U
- T → A
- C → G
- G → C
- T → A
- A → U

(d) mRNA sequence: 5′-UACGUAGCAU-3′.

(e) This matches Option C.

Final Answer: $\boxed{5' - \text{UACGUAGCAU} - 3'}$

Answer: (C) Go Back to Question 89

Q90.

Solution

Concept: Platyhelminthes (flatworms) are triploblastic (three germ layers: ectoderm, mesoderm, endoderm), bilaterally symmetrical, acoelomate (no body cavity between body wall and internal organs) animals. They have an incomplete digestive system — a single opening (mouth) that serves for both ingestion and egestion; no anus.

Solution:

(a) Option A is incorrect: Platyhelminthes are acoelomate and have an incomplete (not complete) digestive tract.

(b) Option B is incorrect: diploblastic organisms (with two germ layers: ectoderm and endoderm only) are Coelenterata (Cnidaria); Platyhelminthes are triploblastic.

(c) Option C is correct: triploblastic (3 germ layers) + acoelomate (no coelom, mesoderm fills the space as mesenchyme/parenchyma) + bilateral symmetry + incomplete digestive system (single mouth, no anus). Examples: Taenia (tapeworm), Fasciola (liver fluke), Planaria.

(d) Option D is incorrect: notochord is present only in Chordates.

Final Answer: Triploblastic, acoelomate with bilateral symmetry and incomplete digestive system

Answer: (C) Go Back to Question 90

Q91.

Solution

Concept: Parthenocarpy is the development of a fruit from the ovary wall without the prior event of fertilisation. Such fruits are therefore seedless. Parthenocarpy can be natural (as in certain banana cultivars) or induced by the application of plant hormones such as auxin (IAA) or gibberellin. It has significant commercial importance in the production of seedless table grapes, bananas, and seedless cucumbers.

Solution:

(a) Option A is incorrect: parthenocarpy is the development of fruit (not seeds) without fertilisation.

(b) Option B is correct: parthenocarpy = development of a fruit without fertilisation; parthenocarpic fruits are seedless because the ovules are not fertilised and do not develop into seeds; commercially desirable (e.g., seedless grapes using gibberellin treatment, Cavendish banana).

(c) Option C is incorrect: parthenocarpy can occur naturally (in bananas, pineapples) and is NOT exclusively induced by auxin.

(d) Option D is incorrect: nutritional value of parthenocarpic fruits is not uniformly lower; it depends on the specific fruit.

Final Answer: Development of fruit without fertilisation; parthenocarpic fruits are seedless

Answer: (B) Go Back to Question 91

Q92.

Solution

Concept: The nucleolus is a prominent, non-membrane-bound structure found within the nucleus of eukaryotic cells, typically at or near the centromere of chromosomes containing rRNA genes (NORs — Nucleolus Organiser Regions). It is the site of ribosomal RNA (rRNA) synthesis and of ribosomal subunit assembly.

Solution:

(a) The nucleolus is associated with specific regions of chromosomes that contain the ribosomal RNA genes (rDNA), transcribed by RNA polymerase I.

(b) It synthesises the 28S, 18S, and 5.8S rRNA molecules and serves as the assembly site for ribosomal subunits (large and small), which are then exported through nuclear pores to the cytoplasm.

(c) Nucleosome packaging of DNA (chromatin condensation) is a function of histone proteins and chromatin-remodelling complexes, not the nucleolus.

(d) DNA replication during S phase is coordinated by origins of replication and associated protein complexes throughout the nucleus, not within the nucleolus.

(e) mRNA processing (splicing, capping, polyadenylation) occurs in the nucleoplasm/splicing machinery, not specifically in the nucleolus.

Final Answer: Synthesise ribosomal RNA (rRNA) and assemble ribosomal subunits

Answer: (B) Go Back to Question 92

Q93.

Solution

Concept: The ascent of sap (upward movement of water from root to leaves) in tall plants cannot be explained solely by root pressure (which can generate only small pressures). The most widely accepted explanation is the Cohesion-Tension (CT) theory, proposed by Dixon and Joly, which attributes the driving force to the negative pressure (tension) generated in the xylem by transpiration.

Solution:

(a) Transpiration from leaf mesophyll cells creates a negative pressure (tension) in the xylem vessels of the leaf.

(b) This tension is transmitted down through the entire water column in the xylem (a continuous column extending from leaf to root).

(c) The transmission is possible because water molecules have strong cohesion (hydrogen bonding between water molecules) and adhesion (attraction to the hydrophilic xylem wall).

(d) The tension ultimately pulls water upward from the roots, defying gravity.

(e) Root pressure is insufficient to raise water to the tops of tall trees; it contributes only to guttation in small, well-watered plants.

(f) Water in xylem moves through dead vessel cells via apoplastic pathway, not symplastically.

Final Answer: Cohesion-tension theory: transpiration creates tension that pulls water upward via cohesion and a

Answer: (B) Go Back to Question 93

Q94.

Solution

Concept: Prions are infectious agents composed entirely of misfolded proteins — specifically, a misfolded form of the normal cellular prion protein ($PrP^{c} \rightarrow PrP^{Sc}$). They contain no nucleic acid (DNA or RNA), challenging the central dogma of biology. Prions cause progressive, fatal neurodegenerative diseases characterised by spongiform (sponge-like) changes in brain tissue.

Solution:

(a) Bovine Spongiform Encephalopathy (BSE, "Mad Cow Disease") is caused by prions (misfolded PrP^{Sc}). In humans, the equivalent is variant Creutzfeldt-Jakob disease (vCJD), transmissible by eating contaminated bovine nervous tissue.

(b) Typhoid fever is caused by the bacterium Salmonella typhi (bacterial infection, has DNA and RNA).

(c) Malaria is caused by Plasmodium (eukaryotic protozoan parasite, has DNA and RNA).

(d) Influenza is caused by influenza viruses (contain RNA).

(e) Only BSE is a prion disease with no nucleic acid component.

Final Answer: Bovine Spongiform Encephalopathy (Mad Cow Disease)

Answer: (A) Go Back to Question 94

Q95.

Solution

Concept: Blood plasma is the liquid component of blood, making up about 55–60% of total blood volume. The remaining 40–45% is formed elements (RBCs, WBCs, platelets). Plasma is a complex mixture containing water (~90–92%), proteins, glucose, lipids, hormones, electrolytes, and dissolved gases.

Solution:

(a) Option A is incorrect: plasma constitutes approximately 55% (not 45%) of total blood volume. Also, plasma contains much more than just water and proteins.

(b) Option B is correct: plasma is the straw-coloured liquid portion (~55% of blood volume) containing: water (90–92%), plasma proteins (albumin, globulins including antibodies, fibrinogen, clotting factors), glucose, amino acids, lipids, hormones, electrolytes (Na^+, K^+, Ca^{2+}, Cl^-), and dissolved O_2/CO_2.

(c) Option C is incorrect: fibrinogen IS present in plasma; when blood clots, fibrinogen is converted to fibrin; what remains after clotting is serum (= plasma minus fibrinogen and clotting factors).

(d) Option D is incorrect: serum lacks clotting factors (especially fibrinogen); plasma and serum are NOT identical.

Final Answer: Plasma is ~55% of blood volume, containing water, proteins, glucose, hormones, and inorganic s

Answer: (B) Go Back to Question 95

Q96.

Solution

Concept: The Human Genome Project (HGP) was completed in 2003. One of its most surprising findings was that the human genome contains far fewer protein-coding genes than initially expected (originally estimated at ~100,000) and that a very large fraction of the genome does not code for proteins. This non-coding DNA is sometimes called "junk DNA" though many sequences have regulatory or structural functions.

Solution:

(a) The HGP found approximately 20,000–25,000 protein-coding genes in the human genome (not 3 million, eliminating Option A).

(b) The total human genome consists of approximately 3 billion base pairs.

(c) Approximately 97–98% of the genome is non-coding DNA (introns, repetitive sequences, regulatory regions, transposable elements, etc.)

(d) Only ~1.5% of the genome codes for proteins.

(e) The human genome has 46 chromosomes (23 pairs), not 48 (Option D is incorrect; Pan troglodytes has 48 chromosomes).

Final Answer: $\sim$ 97–98% is non-coding DNA; only $\sim$ 20,000–25,000 protein-coding genes

Answer: (B) Go Back to Question 96

Q97.

Solution

Concept: The Calvin cycle (dark reactions, light-independent reactions) fixes CO_2 into organic compounds using ATP and NADPH produced in the light reactions. For each CO_2 fixed (one turn of the cycle), 3 ATP and 2 NADPH are consumed to regenerate RuBP and produce one G3P. To produce a net one G3P, three turns of the cycle are needed.

Solution:

(a) One turn of the Calvin cycle: 1 CO_2 is fixed by RuBisCO onto RuBP (5C) to produce two molecules of 3-PGA (3C each).

(b) Each 3-PGA is reduced using 1 ATP and 1 NADPH to form G3P.

(c) For 2 molecules of 3-PGA: 2 ATP + 2 NADPH used in the reduction step.

(d) Regeneration of RuBP from G3P requires 1 ATP.

(e) Total per turn: 3 ATP + 2 NADPH consumed; net product = 1 G3P.

(f) Option B ($3CO_2$ + 9ATP + 6NADPH $\rightarrow$ 1 G3P) is the equation for three turns, producing one NET G3P (since 5 of the 6 G3Ps produced are used to regenerate 3 RuBPs), which is correct for producing one NET G3P.

Final Answer: $\boxed{3CO_2 + 9ATP + 6NADPH \rightarrow G3P + 9ADP + 6NADP^+}$

Answer: (B) Go Back to Question 97

Q98.

Solution

Concept: Eutrophication is the enrichment of a water body with nutrients (primarily nitrogen and phosphorus) leading to excessive plant and algal growth. The subsequent decomposition of the algal bloom by aerobic bacteria depletes dissolved oxygen, creating hypoxic or anoxic conditions ("dead zones") that are lethal to fish and other aerobic aquatic organisms.

Solution:

(a) Nutrients (from agricultural runoff, sewage, industrial effluents) enter water bodies.

(b) Excess nutrients stimulate rapid, explosive growth of algae (algal bloom), making the water turbid and green/red.

(c) Algae die and settle; aerobic bacteria decompose the dead organic matter.

(d) Bacterial decomposition consumes large amounts of dissolved oxygen, severely depleting O_2 levels (Biological Oxygen Demand rises).

(e) Low O_2 (hypoxia) or no O_2 (anoxia) causes the death of fish, invertebrates, and other aerobic aquatic life.

(f) Option A correctly describes this sequence.

Final Answer: Nutrient enrichment $\rightarrow$ algal bloom $\rightarrow$ O_2 depletion by decomposers $\rightarrow$ death of aquatic animal

Answer: (A) Go Back to Question 98

Q99.

Solution

Concept: Bt toxin genes are specific to different insect orders. Cry proteins are classified based on their target organisms: cry1 proteins are active against Lepidoptera (moths, butterflies, cotton bollworm), cry2 against Lepidoptera and Diptera, cry3 against Coleoptera (beetles), and cry4 against Diptera (mosquitoes, black flies). Bt cotton incorporates cry1Ac and cry2Ab genes for bollworm resistance.

Solution:

(a) Option A is incorrect: cry1Ac controls Lepidopteran insects (caterpillars/bollworms), NOT nematodes.

(b) Option B is incorrect: cry2Ab controls Lepidoptera and some Diptera, not mosquito larvae specifically; cry4 genes target mosquitoes.

(c) Option C is correct: the Bt cotton variety (Bollgard) incorporates cryIAc and cryIIAb genes from B. thuringiensis, which produce proteins toxic to cotton bollworms (Helicoverpa armigera and related Lepidoptera).

(d) Option D is incorrect: cryIIIb is active against Coleoptera (beetles, like Colorado potato beetle), not the corn borer (Lepidoptera).

Final Answer: $cryIAc + cryIIAb \rightarrow$ control cotton bollworms

Answer: (C) Go Back to Question 99

Q100.

Solution

Concept: Analogous structures arise in taxonomically unrelated organisms as a result of independent evolution in response to similar environmental selective pressures. This is called convergent evolution. Unlike homologous structures (same origin, different function), analogous structures have different developmental and evolutionary origins but have converged on a similar function and sometimes a similar external form.

Solution:

(a) Butterfly wings are modified extensions of the body wall (exoskeleton-derived, cuticular) in an arthropod; bat wings are modified vertebrate forelimbs with elongated fingers supporting a skin membrane.

(b) These structures have completely different embryological origins and evolutionary histories, yet both function as flight organs.

(c) This is convergent evolution: different lineages independently evolved similar solutions to the problem of aerial locomotion.

(d) Option A (divergent evolution) describes homologous structures, which is the opposite.

(e) Option B correctly identifies this as convergent evolution where similar environmental pressures led to similar functional structures through independent evolutionary pathways.

Final Answer: Convergent evolution; similar environmental pressures led to similar structures independently

Answer: (B) Go Back to Question 100

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	B	3	C	4	C	5	C
6	B	7	B	8	C	9	B	10	B
11	B	12	B	13	A	14	B	15	C
16	B	17	C	18	B	19	B	20	D
21	A	22	C	23	B	24	B	25	D
26	C	27	C	28	B	29	B	30	B
31	B	32	C	33	C	34	B	35	B
36	B	37	A	38	C	39	B	40	B
41	B	42	B	43	B	44	B	45	A
46	A	47	B	48	B	49	B	50	B
51	B	52	A	53	B	54	D	55	C
56	B	57	A	58	B	59	B	60	A
61	A	62	B	63	C	64	B	65	B
66	B	67	B	68	B	69	C	70	B
71	C	72	B	73	C	74	A	75	B
76	B	77	B	78	B	79	A	80	A
81	C	82	B	83	C	84	B	85	C
86	B	87	B	88	B	89	C	90	C
91	B	92	B	93	B	94	A	95	B
96	B	97	B	98	A	99	C	100	B