MHT-CET Biology Sample Paper-13

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

Instructions

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

Q1. Which of the following describes the correct sequence of electron flow in the light-dependent reactions of photosynthesis when both photosystems are involved?

(A) $P_{700} \rightarrow$ Pheophytin $\rightarrow P_{680} \rightarrow$ PQ

(B) $P_{680} \rightarrow$ Pheophytin $\rightarrow$ Cyt $b_6f \rightarrow$ PC $\rightarrow P_{700}$

(C) $P_{680} \rightarrow$ PQ $\rightarrow P_{700} \rightarrow$ Cyt b_6f

(D) $P_{700} \rightarrow$ PC $\rightarrow$ Cyt $b_6f \rightarrow P_{680}$

Q2. During the process of secondary growth in a dicot stem, which tissues are responsible for the formation of the periderm?

(A) Vascular cambium and Xylem

(B) Phellogen (Cork cambium)

(C) Phloem and Cortex

(D) Epidermis only

Q3. An experimental plant cell is placed in a solution where the osmotic pressure is significantly higher than the cell sap. Identify the immediate physiological response of the vacuole.

(A) Exosmosis and Plasmolysis

(B) Endosmosis and Turgidity

(C) No change in volume

(D) Rapid increase in internal pressure

Q4. In the context of Human Physiology, what is the role of the chloride shift (Hamburger phenomenon) in the transport of carbon dioxide?

(A) Entry of Cl^- into RBCs to maintain ionic balance

(B) Exit of Cl^- from RBCs to increase acidity

(C) Transport of O_2 from plasma to RBC

(D) Neutralization of Lactic acid

Q5. Which specific stage of Prophase I in meiosis is characterized by the appearance of the "recombination nodules"?

(A) Leptotene

(B) Zygotene

(C) Pachytene

(D) Diplotene

Q6. Arrange the following steps of the C_4 pathway in the correct sequential order: (i) Decarboxylation in bundle sheath cells, (ii) Fixation of CO_2 by PEP carboxylase, (iii) Transport of C_4 acids to bundle sheath, (iv) Regeneration of PEP in mesophyll.

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

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

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

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

Q7. Arrange the floral parts of a typical angiosperm flower from the outermost whorl to the innermost whorl: (i) Gynoecium, (ii) Calyx, (iii) Corolla, (iv) Androecium.

(A) (ii) → (iii) → (iv) → (i)

(B) (i) → (iv) → (iii) → (ii)

(C) (ii) → (iv) → (iii) → (i)

(D) (iii) → (ii) → (i) → (iv)

Q8. Statement: The loop of Henle is longer in juxtamedullary nephrons compared to cortical nephrons, allowing for a higher concentration of urine.

(A) True

(B) False

Q9. Statement: In a double-stranded DNA molecule, the ratio of Adenine to Thymine is always variable depending on the species complexity.

(A) True

(B) False

Q10. Which enzyme is primarily responsible for the "charging" of tRNA during the translation process in protein synthesis?

(A) DNA Polymerase

(B) RNA Polymerase

(C) Aminoacyl-tRNA synthetase

(D) Peptidyl transferase

Q11. Identify the cofactor required for the activity of the enzyme carbonic anhydrase in RBCs.

(A) Mg^{2+}

(B) Zn^{2+}

(C) Fe^{2+}

(D) Cu^{2+}

Q12. In the lac operon model, the repressor protein binds to which specific region to inhibit transcription?

(A) Structural gene

(B) Promoter region

(C) Operator region

(D) Inducer

Q13. During the cardiac cycle, the "Lubb" sound is produced by the closure of which valves?

(A) Semilunar valves

(B) Mitral and Tricuspid valves

(C) Aortic valve

(D) Pulmonary valve

Q14. Which phytohormone is predominantly responsible for promoting apical dominance and inhibiting the growth of lateral buds?

(A) Gibberellin

(B) Cytokinin

(C) Auxin

(D) Ethylene

Q15. Match List-I (Process) with List-II (Location/Feature):

List-I	List-II
(A) Glycolysis	(I) Mitochondrial Matrix
(B) Kreb's Cycle	(II) Cytoplasm
(C) ETC	(III) Inner Mitochondrial Membrane
(D) Fermentation	(IV) Partial oxidation of glucose

(A) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

(B) (A)-(I), (B)-(II), (C)-(IV), (D)-(III)

(C) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

(D) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

Q16. In the process of oogenesis, at which stage is the primary oocyte arrested until puberty?

(A) Metaphase I

(B) Prophase I

(C) Anaphase II

(D) Prophase II

Q17. Which immunoglobulin class is the most abundant in the human body and capable of crossing the placental barrier?

(A) IgA

(B) IgM

(C) IgG

(D) IgE

Q18. The "Girdling experiment" was performed by early botanists to demonstrate the transport of which substance through which tissue?

(A) Water through Xylem

(B) Food through Phloem

(C) Minerals through Phloem

(D) Water through Phloem

Q19. Which part of the human brain is the primary center for regulating body temperature and hunger?

(A) Cerebellum

(B) Thalamus

(C) Hypothalamus

(D) Medulla Oblongata

Q20. In recombinant DNA technology, which enzyme is known as "molecular glue"?

(A) DNA Polymerase

(B) DNA Ligase

(C) Restriction Endonuclease

(D) Reverse Transcriptase

Q21. What is the phenotypic ratio of a dihybrid cross in the F_2 generation according to Mendel's Law of Independent Assortment?

(A) 3:1

(B) 9:3:3:1

(C) 1:2:1

(D) 1:1:1:1

Q22. Which of the following is a classic example of "Point Mutation" resulting in a change in the shape of hemoglobin?

(A) Down Syndrome

(B) Sickle Cell Anemia

(C) Turner Syndrome

(D) Thalassemia

Q23. The transition from the juvenile phase to the reproductive phase in plants is primarily regulated by the interaction of which two factors?

(A) Soil pH and Water

(B) Hormones and Environmental cues

(C) Gravity and Nutrients

(D) Root pressure and Transpiration

Q24. During anaerobic respiration in yeast, how many net ATP molecules are produced per molecule of glucose?

(A) 36 ATP

(B) 38 ATP

(C) 2 ATP

(D) 4 ATP

Q25. Which ecological pyramid is always upright and can never be inverted in a stable ecosystem?

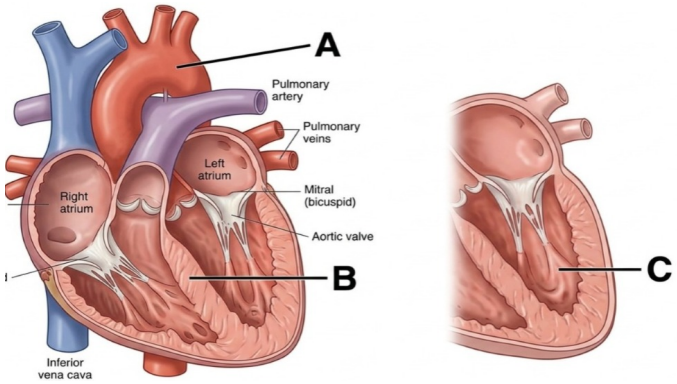
(A) Pyramid of Numbers

(B) Pyramid of Biomass

(C) Pyramid of Energy

(D) Pyramid of Species

Q26. Observe the provided diagram of the human heart. Identify the labeled parts A, B, and C, and select the option that correctly describes the function of B.



(A) A-Aorta, B-Left Ventricle, C-Right Atrium; B pumps oxygenated blood to the body.

(B) A-Pulmonary Artery, B-Right Ventricle, C-Left Atrium; B pumps deoxygenated blood to lungs.

(C) A-Vena Cava, B-Left Atrium, C-Right Ventricle; B receives blood from lungs.

(D) A-Aorta, B-Septum, C-Left Ventricle; B separates oxygenated and deoxygenated blood.

Q27. Which of the following organelles is known as the "Semiautonomous organelle" due to the presence of its own DNA and ribosomes?

(A) Lysosome

(B) Mitochondria

(C) Golgi Apparatus

(D) Endoplasmic Reticulum

Q28. In a DNA molecule, if the percentage of Cytosine is 20%, what would be the percentage of Adenine?

(A) 20%

(B) 40%

(C) 30%

(D) 60%

Q29. Which phase of the cell cycle is marked by the replication of genomic DNA?

(A) G_1 phase

(B) G_2 phase

(C) S phase

(D) M phase

Q30. The "Fluid Mosaic Model" of the plasma membrane was proposed by which scientists?

(A) Watson and Crick

(B) Schleiden and Schwann

(C) Singer and Nicolson

(D) Robert Brown

Q31. Which of the following is a structural polysaccharide found in the exoskeleton of arthropods and the cell walls of fungi?

(A) Cellulose

(B) Glycogen

(C) Chitin

(D) Starch

Q32. The primary acceptor of CO_2 in C_3 plants is a 5-carbon compound known as:

(A) Oxaloacetic acid (OAA)

(B) Phosphoenolpyruvate (PEP)

(C) Ribulose 1,5-bisphosphate (RuBP)

(D) Phosphoglyceric acid (PGA)

Q33. During the process of glycolysis, which enzyme catalyzes the conversion of Glucose to Glucose-6-Phosphate?

(A) Phosphofructokinase

(B) Hexokinase

(C) Aldolase

(D) Pyruvate kinase

Q34. Which cranial nerve is primarily responsible for the sensation of hearing and balance?

(A) Optic nerve

(B) Vagus nerve

(C) Auditory (Vestibulocochlear) nerve

(D) Olfactory nerve

Q35. The functional unit of the human kidney, responsible for urine formation, is the:

(A) Neuron

(B) Nephron

(C) Nephridia

(D) Alveoli

Q36. Identify the condition caused by the deficiency of ADH (Antidiuretic Hormone) leading to excessive thirst and dilute urine.

(A) Diabetes mellitus

(B) Diabetes insipidus

(C) Goitre

(D) Acromegaly

Q37. Match List-I (Phytohormone) with List-II (Function):

List-I	List-II
(A) Ethylene	(I) Fruit Ripening
(B) Abscisic Acid	(II) Stress Hormone
(C) Cytokinin	(III) Delay of Senescence
(D) Gibberellin	(IV) Bolting

(A) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(B) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(C) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(D) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

Q38. Which type of natural selection favors individuals at both extremes of the phenotypic range?

(A) Stabilizing selection

(B) Directional selection

(C) Disruptive selection

(D) Artificial selection

Q39. The interaction where one species is benefited and the other is neither harmed nor benefited is called:

(A) Parasitism

(B) Mutualism

(C) Commensalism

(D) Amensalism

Q40. What is the correct floral formula for the family Fabaceae?

(A) $\% \uparrow K_{(5)}C_{1+2+(2)}A_{(9)+1}\underline{G}_{1}$

(B) $\oplus \uparrow K_{(5)}C_{(5)}A_{5}\underline{G}_{(2)}$

(C) $\% \uparrow K_{5}C_{5}A_{10}\underline{G}_{1}$

(D) $\oplus \uparrow P_{3+3}A_{3+3}\underline{G}_{(3)}$

Q41. Which theory of evolution was proposed by Hugo de Vries based on his work on the evening primrose?

(A) Theory of Natural Selection

(B) Theory of Inheritance of Acquired Characters

(C) Mutation Theory

(D) Modern Synthetic Theory

Q42. In the human respiratory system, the actual site of gaseous exchange between blood and atmospheric air is:

(A) Trachea

(B) Bronchioles

(C) Alveoli

(D) Nasal cavity

Q43. The inner wall of the small intestine contains thousands of finger-like outgrowths called _____, which increase the surface area for _____.

(A) Villi; digestion

(B) Villi; absorption

(C) Alveoli; respiration

(D) Lumen; transport

Q44. The junction between two neurons is called a _____, across which impulses are transmitted via chemicals called _____.

(A) Node of Ranvier; neurotransmitters

(B) Synapse; neurotransmitters

(C) Synapse; hormones

(D) Axon; electrolytes

Q45. Which method of contraception involves the surgical removal or tying of a small part of the fallopian tube?

(A) Vasectomy

(B) Tubectomy

(C) IUD

(D) Barrier method

Q46. The pioneer species in a primary succession on bare rocks are usually:

(A) Mosses

(B) Lichens

(C) Ferns

(D) Liverworts

Q47. Which enzyme is used in the PCR (Polymerase Chain Reaction) technique because of its high-temperature stability?

(A) DNA Ligase

(B) RNA Polymerase

(C) Taq Polymerase

(D) Helicase

Q48. In the ABO blood grouping system, which blood group is considered the universal donor?

(A) AB positive

(B) O negative

(C) A positive

(D) B negative

Q49. The process of formation of mRNA from a DNA template is known as:

(A) Replication

(B) Translation

(C) Transcription

(D) Reverse Transcription

Q50. Which vitamin is essential for the coagulation of blood?

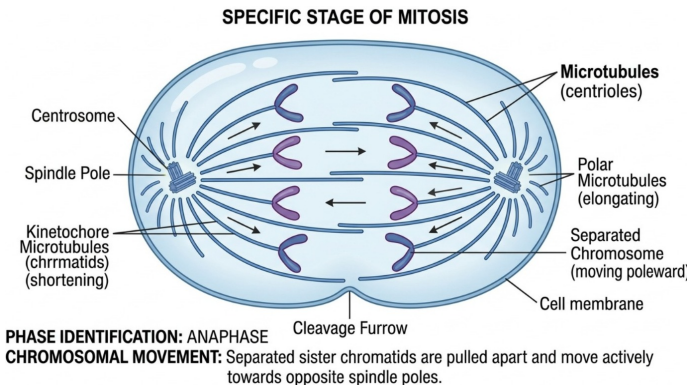
(A) Vitamin A

(B) Vitamin C

(C) Vitamin K

(D) Vitamin D

Q51. Observe the provided diagram representing a specific stage of mitosis. Identify the phase and select the option that correctly describes the chromosomal movement observed.



(A) Prophase; Chromosomes condense and nuclear envelope disappears.

(B) Metaphase; Chromosomes align at the equatorial plate.

(C) Anaphase; Centromeres split and sister chromatids move to opposite poles.

(D) Telophase; Chromosomes reach poles and nuclear envelope reforms.

Q52. Which of the following organelles is responsible for the synthesis of lipids and the detoxification of drugs?

(A) Rough Endoplasmic Reticulum

(B) Smooth Endoplasmic Reticulum

(C) Lysosomes

(D) Nucleolus

Q53. The oxygen dissociation curve of hemoglobin is typically described as being:

(A) Linear

(B) Hyperbolic

(C) Sigmoid

(D) Parabolic

Q54. Which part of the human brain is primarily responsible for maintaining posture, equilibrium, and muscle tone?

(A) Cerebrum

(B) Thalamus

(C) Cerebellum

(D) Medulla Oblongata

Q55. The end product of anaerobic respiration in human muscle cells during vigorous exercise is:

(A) Ethanol and CO_2

(B) Lactic acid and energy

(C) Pyruvic acid

(D) Acetic acid

Q56. Which of the following is an example of a vestigial organ in humans?

(A) Nictitating membrane

(B) Wisdom teeth

(C) Vermiform appendix

(D) All of the above

Q57. The concept of "Omnis cellula-e cellula" (all cells arise from pre-existing cells) was proposed by:

(A) Robert Hooke

(B) Matthias Schleiden

(C) Rudolf Virchow

(D) Theodore Schwann

Q58. In the structural organization of a flower, the gynoecium represents the:

(A) Male reproductive organ

(B) Sterile part of the flower

(C) Female reproductive organ

(D) Accessory whorl

Q59. Which of the following enzymes is responsible for "unzipping" the DNA double helix during replication?

(A) DNA Polymerase

(B) DNA Ligase

(C) Helicase

(D) Primase

Q60. The "Lock and Key" hypothesis of enzyme action was originally proposed by:

(A) Emil Fischer

(B) Daniel Koshland

(C) Louis Pasteur

(D) Buchner

Q61. Which type of epithelial tissue is found in the lining of the fallopian tubes to help move the egg?

(A) Squamous epithelium

(B) Ciliated epithelium

(C) Cuboidal epithelium

(D) Sensory epithelium

Q62. Match List-I (Organism) with List-II (Reproduction):

List-I	List-II
(A) Amoeba	(I) Binary Fission
(B) Hydra	(II) Budding
(C) Planaria	(III) True Regeneration
(D) Penicillium	(IV) Conidia

(A) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(B) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(C) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(D) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

Q63. Which part of the embryo is responsible for the formation of the root system?

(A) Plumule

(B) Radicle

(C) Cotyledon

(D) Endosperm

Q64. The primary function of the Leydig cells in the human male reproductive system is the secretion of:

(A) Estrogen

(B) Progesterone

(C) Testosterone (Androgens)

(D) Inhibin

Q65. Which technique is used to separate DNA fragments based on their size?

(A) PCR

(B) Gel Electrophoresis

(C) ELISA

(D) Bioreactor

Q66. In an ecosystem, the pyramid of biomass in a deep aquatic system (sea) is generally:

(A) Upright

(B) Inverted

(C) Spindle-shaped

(D) Urn-shaped

Q67. Which of the following is a non-reducing sugar?

(A) Glucose

(B) Fructose

(C) Lactose

(D) Sucrose

Q68. The process of water movement through a plant and its evaporation from aerial parts is called _____, which occurs mainly through small openings called _____.

(A) Osmosis; Xylem

(B) Transpiration; Stomata

(C) Guttation; Hydathodes

(D) Diffusion; Lenticels

Q69. The thin, muscular wall that separates the right and left atria is the _____, while the one separating the ventricles is the _____.

(A) Inter-atrial septum; Inter-ventricular septum

(B) Atrio-ventricular septum; Septum lucidum

(C) Valve; Chordae tendineae

(D) Pericardium; Myocardium

Q70. Which autoimmune disorder affects the neuromuscular junction, leading to fatigue and paralysis of skeletal muscles?

(A) Arthritis

(B) Myasthenia gravis

(C) Muscular dystrophy

(D) Tetany

Q71. The "Golden Rice" variety has been genetically engineered to be rich in:

(A) Vitamin C

(B) Vitamin A (β-carotene)

(C) Vitamin B12

(D) Iron

Q72. Which law of Mendel states that the two alleles for a trait separate during gamete formation?

(A) Law of Dominance

(B) Law of Segregation

(C) Law of Independent Assortment

(D) Law of Purity of Gametes (not an official law)

Q73. The Montreal Protocol was signed in 1987 to control the emission of:

(A) Greenhouse gases

(B) Ozone depleting substances

(C) Toxic heavy metals

(D) Non-biodegradable waste

Q74. Which specialized cells in the leaves of C_4 plants are characterized by having a large number of chloroplasts and thick walls?

(A) Mesophyll cells

(B) Bundle sheath cells

(C) Epidermal cells

(D) Guard cells

Q75. The presence of which hormone in the urine is used as an indicator for a positive pregnancy test?

(A) Prolactin

(B) Human Chorionic Gonadotropin (hCG)

(C) Oxytocin

(D) Progesterone

Q76. Which of the following is a structural and functional unit of the liver?

(A) Nephron

(B) Hepatic lobule

(C) Alveoli

(D) Neuron

Q77. The "Powerhouse of the cell" refers to which organelle?

(A) Ribosome

(B) Mitochondria

(C) Golgi body

(D) Lysosome

Q78. In which part of the plant does the majority of photosynthesis occur?

(A) Roots

(B) Stem

(C) Leaves

(D) Flowers

Q79. What is the main function of the hormone Insulin in the human body?

(A) Increases blood glucose levels

(B) Decreases blood glucose levels

(C) Stimulates growth

(D) Regulates calcium levels

Q80. Which of the following is a fat-soluble vitamin?

(A) Vitamin B12

(B) Vitamin C

(C) Vitamin K

(D) Vitamin B6

Q81. The process of double fertilization is a characteristic feature of:

(A) Bryophytes

(B) Pteridophytes

(C) Gymnosperms

(D) Angiosperms

Q82. Which component of the blood is responsible for carrying oxygen to the tissues?

(A) White blood cells

(B) Platelets

(C) Red blood cells

(D) Plasma proteins

Q83. The theory of Natural Selection was famously articulated by:

(A) Jean-Baptiste Lamarck

(B) Charles Darwin

(C) Gregor Mendel

(D) Thomas Hunt Morgan

Q84. Which of the following is considered the primary lymphoid organ?

(A) Spleen

(B) Bone marrow

(C) Peyer's patches

(D) Lymph nodes

Q85. What is the biological term for the "voice box"?

(A) Pharynx

(B) Larynx

(C) Trachea

(D) Esophagus

Q86. Match List-I (Disease) with List-II (Pathogen):

List-I	List-II
(A) Typhoid	(I) Salmonella typhi
(B) Pneumonia	(II) Streptococcus pneumoniae
(C) Malaria	(III) Plasmodium
(D) Filariasis	(IV) Wuchereria bancrofti

(A) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(B) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(C) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(D) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

Q87. Which of the following organelles is responsible for protein synthesis?

(A) Centriole

(B) Ribosome

(C) Vacuole

(D) Peroxisome

Q88. The standard Mendelian ratio for a dihybrid cross in the F2 generation is:

(A) 3:1

(B) 9:3:3:1

(C) 1:2:1

(D) 1:1:1:1

Q89. Which enzyme is found in human saliva that begins the digestion of starch?

(A) Pepsin

(B) Salivary Amylase

(C) Trypsin

(D) Lipase

Q90. The "Restriction Endonucleases" are also known as:

(A) Molecular glue

(B) Molecular scissors

(C) Molecular carriers

(D) Molecular markers

Q91. Which nitrogenous base is present in RNA but absent in DNA?

(A) Adenine

(B) Thymine

(C) Uracil

(D) Cytosine

Q92. The rhythmic contraction and relaxation of the muscles in the digestive tract to push food forward is called _____.

(A) Peristalsis

(B) Deglutition

(C) Mastication

(D) Emulsification

Q93. The green pigment in plants that captures light energy for photosynthesis is called _____.

(A) Carotenoid

(B) Xanthophyll

(C) Chlorophyll

(D) Anthocyanin

Q94. In the human heart, the _____ ventricle pumps oxygenated blood to the rest of the body.

(A) Right

(B) Left

(C) Middle

(D) Superior

Q95. Which type of bond connects two amino acids in a protein chain?

(A) Glycosidic bond

(B) Peptide bond

(C) Phosphodiester bond

(D) Hydrogen bond

Q96. The smallest functional unit of a muscle fiber is the:

(A) Sarcomere

(B) Myofibril

(C) Fascicle

(D) Tendon

Q97. Which gas is predominantly released by plants during the night?

(A) Oxygen

(B) Carbon dioxide

(C) Nitrogen

(D) Hydrogen

Q98. The phenomenon of "Industrial Melanism" is a classic example of:

(A) Genetic drift

(B) Mutation

(C) Natural selection

(D) Adaptive radiation

Q99. Which hormone is often referred to as the "Fight or Flight" hormone?

(A) Thyroxine

(B) Adrenaline (Epinephrine)

(C) Estrogen

(D) Growth hormone

Q100. The ecological relationship between an orchid and the tree it grows upon is:

(A) Parasitism

(B) Mutualism

(C) Commensalism

(D) Competition

Detailed Solutions

Q1.

Solution

Concept:

The Non-cyclic photophosphorylation (Z-scheme) in plants involves two photosystems working in series. It describes the pathway of electron transport from water to NADP+ during the light-dependent reactions of photosynthesis.

Solution:

(a) The process begins when light energy is absorbed by the reaction center of Photosystem II (P_{680}).

(b) Excitation of P_{680} leads to the ejection of electrons, which are first captured by a primary electron acceptor called Pheophytin.

(c) From Pheophytin, electrons move through a series of carriers: Plastoquinone (PQ), the Cytochrome b_6f complex, and Plastocyanin (PC).

(d) Finally, these electrons are transferred to Photosystem I (P_{700}) to replace the electrons lost by it when it was excited by light.

(e) This continuous flow allows for the generation of ATP and the reduction of NADP to NADPH, providing the chemical energy needed for the Calvin Cycle.

Final Answer: The correct sequence is $P_{680} \rightarrow$ Pheophytin $\rightarrow$ Cyt $b_6f \rightarrow$ PC $\rightarrow P_{700}$.

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept:

Secondary growth in dicotyledonous stems involves the activity of lateral meristems, specifically the vascular cambium and the cork cambium (phellogen), to increase the girth of the plant.

Solution:

(a) As the stem increases in thickness due to the activity of the vascular cambium, the outer cortical and epidermal layers break down.

(b) To provide protection and replace these layers, a new lateral meristem called Phellogen (Cork Cambium) develops in the cortical region.

(c) The Phellogen undergoes periclinal divisions, producing Phellem (Cork) towards the outside and Phelloderm (Secondary Cortex) towards the inside.

(d) These three layers—Phellogen, Phellem, and Phelloderm—collectively constitute the Periderm.

(e) The Periderm acts as a secondary protective tissue that prevents water loss and provides a barrier against mechanical injury and pathogens.

Final Answer: The tissue responsible for periderm formation is Phellogen (Cork cambium).

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept:

Osmosis is the movement of water molecules from a region of higher water potential to a region of lower water potential through a semi-permeable membrane. Plant cells react differently based on the tonicity of the external solution.

Solution:

(a) When a plant cell is placed in a hypertonic solution (one where the osmotic pressure is higher than the cell sap), water potential outside is lower.

(b) This triggers Exosmosis, where water moves out of the cell's vacuole and cytoplasm into the surrounding medium.

(c) As the vacuole loses water, it shrinks, and the protoplast begins to pull away from the rigid cell wall.

(d) This physiological state is known as Plasmolysis.

(e) The cell becomes flaccid, and if the process continues, the space between the cell wall and the shrunken protoplast is filled with the external hypertonic solution.

Final Answer: The response is Exosmosis and Plasmolysis.

Answer: (A)

Go Back to Question 3

Q4.

Solution

Concept:

Carbon dioxide transport in the blood occurs in three forms, with the majority (around 70%) being transported as bicarbonate ions (HCO_3^-). The chloride shift is a crucial mechanism to maintain electrochemical neutrality within the erythrocytes.

Solution:

(a) Inside the Red Blood Cells (RBCs), CO_2 reacts with water to form carbonic acid, catalyzed by carbonic anhydrase. This acid dissociates into H^+ and HCO_3^-.

(b) As the concentration of bicarbonate ions increases, they diffuse out of the RBCs into the plasma along their concentration gradient.

(c) To compensate for the loss of negative charge and maintain the electrical balance (ionic equilibrium), chloride ions (Cl^-) from the plasma move into the RBCs.

(d) This exchange is known as the Chloride Shift or the Hamburger Phenomenon.

(e) This mechanism ensures that the blood pH remains stable and the transport of CO_2 from tissues to the lungs is efficient.

Final Answer: It is the entry of Cl^- into RBCs to maintain ionic balance.

Answer: (A)

Go Back to Question 4

Q5.

Solution

Concept:

Meiosis I, specifically Prophase I, is a complex stage divided into five sub-stages: Leptotene, Zygotene, Pachytene, Diplotene, and Diakinesis. It is where genetic variation is introduced through crossing over.

Solution:

(a) In Pachytene, the bivalent chromosomes (paired homologs from Zygotene) become clearly visible as tetrads.

(b) Large protein complexes called "recombination nodules" appear at intervals along the synaptonemal complex.

(c) These nodules are the sites where crossing over occurs between non-sister chromatids of homologous chromosomes.

(d) Crossing over involves the exchange of genetic material mediated by the enzyme recombinase.

(e) The completion of crossing over leaves the chromosomes linked at the points of exchange, ensuring genetic diversity in the resulting gametes.

Final Answer: The stage is Pachytene.

Answer: (C)

Go Back to Question 5

Q6.

Solution

Concept:

The C_4 pathway, also known as the Hatch-Slack pathway, is an evolutionary adaptation in certain plants like maize and sugarcane to minimize photorespiration. It involves a spatial separation of carbon fixation between two different types of photosynthetic cells: mesophyll cells and bundle sheath cells.

Solution:

(a) The process initiates in the mesophyll cells where atmospheric carbon dioxide is first fixed. Unlike C_3 plants, the primary acceptor here is Phosphoenolpyruvate (PEP). The enzyme PEP carboxylase catalyzes the fixation of CO_2 to form a four-carbon acid called oxaloacetic acid (OAA).

(b) This OAA is then converted into other four-carbon compounds like malic acid or aspartic acid, which are transported from the mesophyll cells into the thick-walled bundle sheath cells through plasmodesmata.

(c) Once inside the bundle sheath cells, these C_4 acids undergo decarboxylation. This reaction releases a molecule of CO_2 and a three-carbon compound (pyruvate). The release of CO_2 in the bundle sheath cells ensures a high concentration of carbon dioxide around the enzyme RuBisCO, effectively suppressing photorespiration and favoring the Calvin Cycle.

(d) Finally, the three-carbon pyruvate is transported back to the mesophyll cells. Here, it is used to regenerate the original CO_2 acceptor, Phosphoenolpyruvate (PEP), consuming ATP in the process to complete the cycle and prepare for the next round of fixation.

Final Answer: The correct sequence is (ii) → (iii) → (i) → (iv).

Answer: (A)

Go Back to Question 6

Q7.

Solution

Concept:

A typical angiosperm flower is a modified shoot that functions as the reproductive unit of the plant. It consists of four distinct sets of floral whorls arranged on the thalamus or receptacle. These whorls are categorized into accessory whorls (non-reproductive) and essential whorls (reproductive).

Solution:

(a) The outermost whorl of the flower is the Calyx. It is composed of individual units called sepals, which are usually green and leaf-like. Their primary function is to protect the flower in the bud stage and sometimes assist in photosynthesis.

(b) Just inner to the calyx is the Corolla, which consists of petals. Petals are generally brightly colored and often fragrant to attract pollinators like insects and birds. Both the calyx and corolla are accessory organs as they do not directly participate in gamete formation.

(c) Moving further inward, we encounter the first essential whorl, the Androecium. This is the male reproductive part of the flower and is made up of stamens. Each stamen consists of a filament and an anther, where pollen grains (male gametophytes) are produced.

(d) The innermost whorl at the very center of the flower is the Gynoecium (or Pistil/Carpel). This represents the female reproductive part. It typically consists of an ovary at the base, a style, and a stigma at the top. The ovary contains ovules which, after fertilization, develop into seeds.

Final Answer: The sequence from outermost to innermost is (ii) → (iii) → (iv) → (i).

Answer: (A)

Go Back to Question 7

Q8.

Solution

Concept:

The mammalian kidney contains two types of nephrons classified based on their location in the renal cortex and the length of their Henle's loops. These are the cortical nephrons and the juxtamedullary nephrons. The structural difference is directly linked to the kidney's ability to concentrate urine through the countercurrent mechanism.

Solution:

(a) Cortical nephrons make up about 85% of the total nephrons in the human kidney. Their glomeruli are located in the outer cortex, and they have very short loops of Henle that barely penetrate into the renal medulla. These are primarily responsible for basic filtration and reabsorption under normal conditions.

(b) In contrast, juxtamedullary nephrons constitute the remaining 15%. Their glomeruli are situated close to the junction of the cortex and medulla. Most importantly, they possess very long loops of Henle that extend deep into the renal medulla.

(c) The long loop of Henle in juxtamedullary nephrons, along with the associated vasa recta, is essential for establishing and maintaining a high osmotic gradient in the medullary interstitium.

(d) This gradient allows for the passive reabsorption of water from the collecting ducts under the influence of Antidiuretic Hormone (ADH). Consequently, mammals with a higher proportion of juxtamedullary nephrons or longer loops can produce highly concentrated urine, which is a vital adaptation for water conservation.

Final Answer: The statement is True.

Answer: (A)

Go Back to Question 8

Q9.

Solution

Concept:

Chargaff's Rules, formulated by biochemist Erwin Chargaff, provide the fundamental chemical principles governing the structure of double-stranded DNA. These rules were instrumental in helping Watson and Crick develop the double-helix model of DNA.

Solution:

(a) Chargaff's first rule states that in any double-stranded DNA molecule, the total number of purines is always equal to the total number of pyrimidines ($A + G = T + C$). This is a mathematical necessity of the base-pairing mechanism.

(b) Specifically, the rule establishes that the amount of Adenine (A) is always equal to the amount of Thymine (T), and the amount of Guanine (G) is always equal to the amount of Cytosine (C). This occurs because Adenine always pairs with Thymine via two hydrogen bonds, and Guanine pairs with Cytosine via three hydrogen bonds.

(c) Therefore, the ratio of A to T (A/T) and the ratio of G to C (G/C) is always constant and equal to 1, regardless of the species, its complexity, or the total length of the DNA molecule.

(d) While the ratio of $(A+T)/(G+C)$ can vary significantly between different species (known as the base ratio), the 1:1 relationship between Adenine and Thymine within a double strand is a rigid chemical constant. The statement in the question suggests this ratio is variable, which contradicts established biological facts.

Final Answer: The statement is False.

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept:

Translation is the process by which a cell makes proteins using the genetic information carried in messenger RNA (mRNA). For translation to occur accurately, each transfer RNA (tRNA) must be linked to its specific amino acid. This process is known as aminoacylation or "charging" of tRNA.

Solution:

(a) The accuracy of protein synthesis depends heavily on the correct matching of amino acids to their corresponding tRNA molecules. This critical task is performed by a group of enzymes called aminoacyl-tRNA synthetases.

(b) There is typically a specific aminoacyl-tRNA synthetase for each of the 20 standard amino acids. The reaction occurs in two main steps and requires the consumption of energy in the form of ATP.

(c) In the first step, the enzyme binds the amino acid and a molecule of ATP, catalyzing the formation of an aminoacyl-adenylate complex while releasing inorganic pyrophosphate. This activates the amino acid.

(d) In the second step, the activated amino acid is transferred to the 3' end of the specific tRNA molecule. The resulting "charged" tRNA (aminoacyl-tRNA) is then released from the enzyme and is ready to participate in polypeptide chain elongation at the ribosome.

(e) Without the high fidelity of these enzymes, the genetic code would not be translated correctly, leading to the production of non-functional or harmful proteins.

Final Answer: The enzyme is Aminoacyl-tRNA synthetase.

Answer: (C)

Go Back to Question 10

Q11.

Solution

Concept:

Enzymes often require non-protein components called cofactors to become catalytically active. Carbonic anhydrase is a vital enzyme found in high concentrations within red blood cells (RBCs) and is responsible for the rapid interconversion of carbon dioxide and water into bicarbonate and hydrogen ions.

Solution:

(a) Carbonic anhydrase is one of the fastest known enzymes, accelerating the reaction rate by up to a million times. This speed is essential for the efficient transport of respiratory gases between tissues and the lungs.

(b) To function, this enzyme requires a metal ion cofactor that is tightly bound to its active site. For carbonic anhydrase, this specific cofactor is the divalent Zinc ion (Zn^{2+}).

(c) The Zinc ion is coordinated by three histidine residues within the protein structure. Its primary role is to polarize a water molecule, facilitating the formation of a nucleophilic hydroxide ion (OH^{-}) at physiological pH.

(d) This hydroxide ion then attacks the carbon dioxide molecule, leading to the formation of bicarbonate. Without the presence of Zn^{2+}, the enzyme would be inactive, and the body would be unable to transport CO_2 fast enough to sustain life.

(e) Other ions like Magnesium (Mg^{2+}) or Iron (Fe^{2+}) serve as cofactors for different enzymes, such as hexokinase or catalase, but they cannot replace the specific structural and chemical role that Zinc plays in carbonic anhydrase.

Final Answer: The required cofactor is Zn^{2+}.

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept:

The lac operon is a classic model for understanding gene regulation in prokaryotes, specifically in *Escherichia coli*. It demonstrates how a cell can turn genes on or off based on the availability of nutrients, such as lactose, to conserve energy and resources.

Solution:

(a) The operon consists of structural genes (lacZ, lacY, lacA), a promoter, and an operator. Additionally, a regulatory gene (lacI) constitutively produces a repressor protein.

(b) In the absence of an inducer like lactose or allolactose, the repressor protein is active. It is designed with a specific high-affinity binding site that recognizes the DNA sequence of the operator region.

(c) When the repressor binds to the operator, it creates a physical blockage on the DNA strand. This prevents the enzyme RNA polymerase from moving past the promoter and onto the structural genes.

(d) Consequently, transcription is inhibited, and the enzymes needed to digest lactose are not produced. This is a form of negative regulation.

(e) When lactose is present, it acts as an inducer by binding to the repressor and changing its shape. This conformational change prevents the repressor from binding to the operator, allowing RNA polymerase to proceed and transcribe the genes.

Final Answer: The repressor protein binds to the Operator region.

Answer: (C)

Go Back to Question 12

Q13.

Solution

Concept:

The cardiac cycle involves a series of electrical and mechanical events that result in the rhythmic contraction and relaxation of the heart. The characteristic heart sounds, often described as "Lubb-Dupp," are produced by the physical closure of heart valves which prevents the backflow of blood.

Solution:

(a) The first heart sound, "Lubb," is associated with the beginning of ventricular systole (contraction). As the ventricles start to contract, the pressure within them rises rapidly.

(b) This rising pressure forces the blood backward against the Atrioventricular (AV) valves. The AV valves include the Tricuspid valve (between the right atrium and ventricle) and the Mitral/Bicuspid valve (between the left atrium and ventricle).

(c) The sudden closure of these valves, along with the vibration of the surrounding heart wall and the turbulent blood flow, creates the low-pitched, relatively long-duration "Lubb" sound.

(d) Closing these valves is essential to ensure that blood is pumped out through the aorta and pulmonary artery rather than leaking back into the atria.

(e) The second heart sound, "Dupp," occurs later when the ventricles relax (ventricular diastole), causing the semilunar valves to close to prevent blood from flowing back from the great arteries into the ventricles.

Final Answer: The sound is produced by the closure of Mitral and Tricuspid valves.

Answer: (B)

Go Back to Question 13

Q14.

Solution

Concept:

Plant growth and development are regulated by chemical messengers known as phytohormones. Apical dominance is a phenomenon where the central stem of the plant grows more vigorously than the side branches, often leading to a tall, conical growth habit.

Solution:

(a) Apical dominance is primarily controlled by the hormone Auxin (specifically Indole-3-acetic acid or IAA). Auxin is synthesized in the shoot apical meristem and the young developing leaves at the tip of the plant.

(b) From the apex, auxin is transported downward (basipetal transport) through the stem. High concentrations of auxin in the vicinity of the lateral (axillary) buds inhibit their growth and development into branches.

(c) This evolutionary strategy allows the plant to invest more energy into growing taller to reach sunlight, which is especially important in competitive environments.

(d) If the apical bud is removed (decapitation), the source of auxin is eliminated. This causes a sudden drop in auxin levels in the lower stem, allowing lateral buds to break dormancy and grow, resulting in a bushier appearance.

(e) While other hormones like Cytokinins promote lateral bud growth and Gibberellins promote stem elongation, Auxin remains the master regulator of the inhibitory signal that maintains the dominance of the main shoot.

Final Answer: The phytohormone responsible is Auxin.

Answer: (C)

Go Back to Question 14

Q15.

Solution

Concept:

Cellular respiration is the process by which cells break down glucose to release energy in the form of ATP. It involves several distinct pathways that occur in different compartments of the cell, each serving a unique role in the metabolic breakdown of organic molecules.

Solution:

(a) Glycolysis is the initial stage of respiration and takes place in the Cytoplasm. It does not require oxygen and involves the breakdown of one glucose molecule into two molecules of pyruvate.

(b) The Kreb's Cycle (or TCA cycle) occurs within the Mitochondrial Matrix. Here, the derivatives of pyruvate are completely oxidized into carbon dioxide, and high-energy electron carriers like NADH and $FADH_2$ are generated.

(c) The Electron Transport Chain (ETC) is located on the Inner Mitochondrial Membrane (Cristae). This is where the majority of ATP is produced through oxidative phosphorylation as electrons are passed along a series of complexes to oxygen.

(d) Fermentation is an anaerobic process that occurs in the Cytoplasm when oxygen is absent. It involves the partial oxidation of glucose to either lactic acid or ethanol, yielding significantly less energy than aerobic respiration.

(e) Understanding the localization of these processes is key to understanding how cells efficiently manage their energy budget and compartmentalize complex biochemical reactions.

Final Answer: (a)-(2), (b)-(1), (c)-(3), (d)-(4).

Answer: (A)

Go Back to Question 15

Q16.

Solution

Concept:

Oogenesis is the biological process of formation of a mature female gamete or ovum. Unlike spermatogenesis, which begins at puberty, oogenesis is initiated during the embryonic development stage when a couple of million gamete mother cells (oogonia) are formed within each fetal ovary.

Solution:

(a) The oogonia start division and enter into Prophase I of the meiotic division. However, they do not complete this division and get temporarily arrested at this stage.

(b) These arrested cells are called primary oocytes. Each primary oocyte then gets surrounded by a layer of granulosa cells and is then called a primary follicle.

(c) A large number of these follicles degenerate during the phase from birth to puberty. Therefore, at puberty, only about 60,000 to 80,000 primary follicles are left in each ovary.

(d) The primary oocyte within the follicle remains in the arrested state of Prophase I (specifically the diplotene stage) for many years, until the onset of puberty.

(e) Upon reaching puberty, hormonal changes (specifically the surge in FSH and LH) stimulate the completion of the first meiotic division within the graafian follicle, leading to the formation of a secondary oocyte and a first polar body.

Final Answer: The primary oocyte is arrested at Prophase I.

Answer: (B)

Go Back to Question 16

Q17.

Solution

Concept:

Immunoglobulins, also known as antibodies, are glycoprotein molecules produced by plasma cells (B-cells) that act as a critical part of the immune response by specifically recognizing and binding to particular antigens, such as bacteria or viruses.

Solution:

(a) There are five main classes of immunoglobulins in humans: IgA, IgD, IgE, IgG, and IgM. Each class has a distinct role in the body's defense mechanism.

(b) IgG is the most abundant class of immunoglobulins in the serum, constituting approximately 75 percent to 80 percent of the total circulating antibodies.

(c) A unique and vital characteristic of IgG is its ability to cross the placental barrier from the mother to the fetus. This provides essential passive immunity to the newborn during the first few months of life when its own immune system is still developing.

(d) IgG is involved in neutralizing toxins, viruses, and bacteria, and it also plays a significant role in opsonization, which marks pathogens for destruction by phagocytes.

(e) Because of its high concentration and long half-life, IgG is the primary antibody used in long-term immunity and is the main antibody produced during a secondary immune response after a previous exposure to a pathogen.

Final Answer: The immunoglobulin is IgG.

Answer: (C)

Go Back to Question 17

Q18.

Solution

Concept:

The transport of nutrients and water in plants occurs through specialized vascular tissues called xylem and phloem. To understand the specific functions of these tissues, early plant physiologists conducted several experiments, one of the most famous being the girdling experiment.

Solution:

(a) In a girdling experiment, a ring of bark (up to the depth of the phloem layer) is carefully removed from the trunk of a tree, while leaving the xylem intact.

(b) Since the xylem is located deeper in the stem, the upward movement of water and minerals to the leaves continues uninterrupted. However, the downward movement of photosynthetic products (food/sucrose) from the leaves is blocked at the site of the girdle.

(c) After a few weeks, it is observed that the portion of the bark just above the ring becomes swollen. This swelling is caused by the accumulation of organic solutes and sugars that cannot pass further down.

(d) Eventually, the roots die first because they are deprived of the energy source required for their growth and metabolic activities, leading to the eventual death of the entire plant.

(e) This experiment provided definitive proof that the phloem is the tissue responsible for the translocation of food (organic matter) from the source (leaves) to the sink (roots and other storage organs).

Final Answer: It demonstrates the transport of food through Phloem.

Answer: (B)

Go Back to Question 18

Q19.

Solution

Concept:

The human brain is divided into the forebrain, midbrain, and hindbrain. The forebrain consists of the cerebrum, thalamus, and hypothalamus. Each region is highly specialized for maintaining homeostasis and processing information.

Solution:

(a) The hypothalamus, located at the base of the thalamus, is a small but extremely vital part of the brain that serves as the master control center for many autonomic functions.

(b) It contains several groups of neurosecretory cells that produce hormones regulating the pituitary gland. Beyond hormonal control, it is the primary center for thermoregulation.

(c) When body temperature deviates from the set point, the hypothalamus triggers physiological responses like sweating or shivering to bring the temperature back to normal.

(d) Additionally, the hypothalamus contains specific centers that control hunger (the feeding center) and thirst (the satiety center). It monitors blood glucose levels and signals the body when it needs more energy.

(e) It also plays a significant role in emotional behavior, circadian rhythms (sleep-wake cycles), and the regulation of sexual drive, making it a central hub for the survival and balance of the human body.

Final Answer: The center is the Hypothalamus.

Answer: (C)

Go Back to Question 19

Q20.

Solution

Concept:

Recombinant DNA technology, also known as genetic engineering, involves the manipulation of DNA to create new genetic combinations. This process requires a set of specialized tools, primarily enzymes that can cut, copy, and join DNA fragments.

Solution:

(a) Restriction endonucleases are often called "molecular scissors" because they cut DNA at specific palindromic sequences, creating "sticky" or "blunt" ends.

(b) Once DNA fragments from different sources (like a vector and a foreign gene) are cut with the same restriction enzyme, they possess complementary ends that can pair with each other.

(c) To permanently join these DNA fragments, an enzyme called DNA ligase is used. This enzyme facilitates the formation of a phosphodiester bond between the 3' hydroxyl group of one nucleotide and the 5' phosphate group of another.

(d) Because of its ability to link separate strands of DNA together to form a continuous molecule, DNA ligase is popularly referred to as "molecular glue."

(e) This ligation process is essential for creating recombinant DNA molecules, such as plasmids containing human insulin genes, which can then be inserted into host cells like E. coli for mass production of therapeutic proteins.

Final Answer: The enzyme is DNA Ligase.

Answer: (B)

Go Back to Question 20

Q21.

Solution

Concept:

Mendel's Law of Independent Assortment is the third law of inheritance, which states that when two pairs of traits are combined in a hybrid, the segregation of one pair of characters is independent of the other pair. This principle is best demonstrated through a dihybrid cross, where two distinct traits, such as seed shape and seed color, are tracked simultaneously.

Solution:

(a) In his classic experiment, Mendel crossed pea plants that were true-breeding for round and yellow seeds (RRYY) with plants having wrinkled and green seeds (rryy).

(b) The F_1 generation resulted in all dihybrids (RrYy), which exhibited the dominant phenotypes: round and yellow.

(c) When these F_1 plants were self-pollinated to produce the F_2 generation, the alleles segregated and recombined in all possible combinations.

(d) This results in four different phenotypes: Round-Yellow, Round-Green, Wrinkled-Yellow, and Wrinkled-Green.

(e) The mathematical probability of these combinations results in a specific phenotypic ratio of 9:3:3:1. Specifically, 9 out of 16 plants show both dominant traits, 3 show the first dominant and second recessive, 3 show the first recessive and second dominant, and 1 shows both recessive traits.

Final Answer: The phenotypic ratio is 9:3:3:1.

Answer: (B)

Go Back to Question 21

Q22.

Solution

Concept:

A point mutation is a type of genetic mutation where a single nucleotide base is changed, inserted, or deleted from a DNA or RNA sequence. While seemingly minor, a point mutation can have profound effects on the resulting protein if it occurs within a coding region, potentially altering the entire physiological function of an organism.

Solution:

(a) Sickle Cell Anemia is the most well-known clinical example of a point mutation in humans. It is an autosomal recessive disorder affecting the hemoglobin molecules in red blood cells.

(b) The mutation occurs in the gene coding for the beta-globin chain of hemoglobin. Specifically, a single base substitution happens at the sixth codon, where the DNA sequence GAG is changed to GTG.

(c) This results in the substitution of the amino acid Glutamic acid by Valine in the beta-globin polypeptide. Because Valine is hydrophobic and Glutamic acid is hydrophilic, this change significantly alters the protein's folding.

(d) Under low oxygen tension, the mutant hemoglobin molecules undergo polymerization, causing the normally disc-shaped red blood cells to deform into a rigid, sickle-like shape.

(e) These sickled cells can block small blood vessels, leading to tissue damage, pain crises, and anemia, demonstrating how a change in just one nitrogenous base can lead to a systemic disease.

Final Answer: The example is Sickle Cell Anemia.

Answer: (B)

Go Back to Question 22

Q23.

Solution

Concept:

The life cycle of a sexually reproducing organism includes a juvenile phase (period of growth) followed by a reproductive phase. The timing of the transition between these phases is critical for the survival and reproductive success of the species, especially in plants that must time their flowering with favorable seasonal conditions.

Solution:

(a) The transition from the vegetative (juvenile) state to the reproductive state in plants is a complex physiological shift known as floral induction.

(b) This process is primarily regulated by the internal hormonal balance of the plant. Phytohormones like Gibberellins and the hypothetical "Florigen" signal are known to initiate the change in the shoot apical meristem from producing leaves to producing floral organs.

(c) However, internal signals alone are usually insufficient. Plants also rely heavily on environmental cues to ensure they flower at the right time of year.

(d) Key environmental factors include Photoperiodism (the duration of light and dark periods) and Vernalization (exposure to low temperatures).

(e) The interaction between these external environmental factors and the internal hormonal signaling pathways ensures that the plant has reached sufficient maturity and that the environment is conducive to pollination and seed development.

Final Answer: It is regulated by Hormones and Environmental cues.

Answer: (B)

Go Back to Question 23

Q24.

Solution

Concept:

Anaerobic respiration, or fermentation, is a metabolic process that occurs in the absence of oxygen. Organisms like yeast (Saccharomyces cerevisiae) perform alcoholic fermentation to regenerate the NAD^+ needed to keep glycolysis running, allowing them to produce energy even in oxygen-poor environments.

Solution:

(a) In yeast, the process begins with glycolysis in the cytoplasm, where one molecule of glucose is broken down into two molecules of pyruvate.

(b) During glycolysis, 4 ATP molecules are produced by substrate-level phosphorylation, but 2 ATP molecules are consumed in the initial "investment" phase. This results in a net gain of 2 ATP per glucose molecule.

(c) Under anaerobic conditions, the pyruvate does not enter the mitochondria for the Kreb's cycle. Instead, it is decarboxylated to acetaldehyde and then reduced to ethanol.

(d) Importantly, the steps following glycolysis do not generate any additional ATP. Their primary purpose is to oxidize $NADH$ back to NAD^+.

(e) Because the Kreb's cycle and the Electron Transport Chain (which together produce roughly 34 additional ATP in aerobic conditions) are bypassed, the total net energy yield for anaerobic respiration remains stuck at the 2 ATP produced during glycolysis.

Final Answer: The net production is 2 ATP.

Answer: (C)

Go Back to Question 24

Q25.

Solution

Concept:

An ecological pyramid is a graphical representation designed to show the biomass or bio-productivity at each trophic level in a given ecosystem. While pyramids of numbers or biomass can sometimes be inverted (e.g., many insects feeding on a single tree), the flow of energy follows strict thermodynamic laws.

Solution:

(a) The Pyramid of Energy represents the total amount of energy consumed by each trophic level over a specific period.

(b) According to the Ten Percent Law proposed by Raymond Lindeman, only about 10% of the energy available at one trophic level is transferred to the next level. The remaining 90% is lost as heat during respiration and metabolic processes.

(c) Because energy is lost at every step and can never be recycled or "gained" as it moves up the food chain, the energy available to the higher trophic levels (carnivores) is always significantly less than the energy available at the producer level (plants).

(d) Consequently, the base of the energy pyramid is always the widest, and it narrows progressively toward the top.

(e) Even in aquatic ecosystems where the pyramid of biomass might be inverted due to the rapid turnover of phytoplankton, the pyramid of energy remains strictly upright because it accounts for the rate of energy production rather than the standing crop at a single moment.

Final Answer: The Pyramid of Energy is always upright.

Answer: (C)

Go Back to Question 25

Q26.

Solution

Concept:

The human heart is a sophisticated muscular organ designed to keep oxygenated and deoxygenated blood separate while ensuring efficient circulation throughout the body. It consists of four chambers: two upper atria and two lower ventricles, each serving a specific role in the pulmonary and systemic circuits.

Solution:

(a) In the provided diagram, Label A identifies the Aorta. The aorta is the largest artery in the human body, emerging from the left ventricle. Its primary role is to carry oxygenated blood under high pressure to all the systemic tissues and organs.

(b) Label B identifies the Left Ventricle. This is the thickest and most muscular chamber of the heart. The massive muscular wall is necessary because the left ventricle must generate enough force to pump blood throughout the entire body, from the brain down to the toes.

(c) Label C identifies the Right Atrium. This chamber receives deoxygenated blood returning from the body via the superior and inferior vena cava. It then passes this blood into the right ventricle through the tricuspid valve.

(d) Understanding the anatomy of the heart is crucial for comprehending how the cardiac cycle operates. The left ventricle (B) is specifically responsible for systemic circulation, making it the most critical pump in the cardiovascular system.

Final Answer: A-Aorta, B-Left Ventricle, C-Right Atrium; B pumps oxygenated blood to the body.

Answer: (A)

Go Back to Question 26

Q27.

Solution

Concept:

Semiautonomous organelles are specialized structures within eukaryotic cells that possess a degree of independence from the cell's nucleus. These organelles, specifically mitochondria and chloroplasts, have their own genetic material and the machinery required to synthesize some of their own proteins.

Solution:

(a) Mitochondria are often called the powerhouses of the cell because they produce ATP through aerobic respiration. However, they are also genetically unique. They contain their own circular DNA, which is similar to bacterial DNA, and 70S ribosomes.

(b) Because they have their own DNA, mitochondria can replicate independently of the nucleus through a process similar to binary fission. This allows cells with high energy demands to increase the number of mitochondria as needed.

(c) The term "semiautonomous" is used because, while they can produce some proteins, they still rely on the nucleus for many other enzymes and structural proteins. This relationship is a cornerstone of the endosymbiotic theory.

(d) Other organelles like lysosomes and the Golgi apparatus do not possess their own DNA and are entirely dependent on the instructions provided by the nuclear DNA. Therefore, they are not considered semiautonomous.

Final Answer: The organelle is Mitochondria.

Answer: (B)

Go Back to Question 27

Q28.

Solution

Concept:

Chargaff's Rules are essential for determining the base composition of double-stranded DNA. These rules state that in a stable DNA molecule, the total amount of purines equals the total amount of pyrimidines, and specifically, Adenine pairs with Thymine while Guanine pairs with Cytosine.

Solution:

(a) Given that the percentage of Cytosine (C) is 20%, we can immediately determine the percentage of Guanine (G). Since G always pairs with C, their percentages must be equal. Therefore, Guanine is also 20%.

(b) Combined, the total percentage of Cytosine and Guanine (G + C) is 40% (20% + 20%).

(c) Since the total percentage of all four bases (A + T + G + C) must equal 100%, the remaining percentage for Adenine and Thymine (A + T) must be 60% (100% - 40%).

(d) Because Adenine (A) always pairs with Thymine (T) in a 1:1 ratio, the 60% must be divided equally between them.

(e) Thus, the percentage of Adenine (A) is 30%, and the percentage of Thymine (T) is also 30%. This calculation shows how base-pairing consistency allows for predictable genomic mapping.

Final Answer: The percentage of Adenine is 30%.

Answer: (C)

Go Back to Question 28

Q29.

Solution

Concept:

The cell cycle is an ordered series of events involving cell growth and division that produces two new daughter cells. It is divided into interphase and the mitotic phase. Interphase itself consists of three distinct stages: G_1, S, and G_2 phases, each with specific metabolic tasks.

Solution:

(a) The S phase (Synthesis phase) is the most critical part of interphase for genetic continuity. During this stage, the cell replicates its entire nuclear DNA, ensuring that each daughter cell will receive a complete set of genetic instructions.

(b) During DNA replication, the amount of DNA in the cell doubles (from 2C to 4C). However, the chromosome number remains the same because the replicated strands remain attached as sister chromatids.

(c) In animal cells, the centrosome also duplicates in the cytoplasm during the S phase, which is essential for the later formation of the spindle apparatus during mitosis.

(d) The G_1 phase is focused on cell growth and protein synthesis, while the G_2 phase is the final check and preparation for division. If replication in the S phase is incomplete or faulty, the cell cycle will be arrested at checkpoints to prevent mutations.

Final Answer: The stage is S phase.

Answer: (C)

Go Back to Question 29

Q30.

Solution

Concept:

The plasma membrane is the outer boundary of the cell that regulates the movement of substances in and out. For many years, various models were proposed to explain its structure, but the one that best fits experimental evidence is the Fluid Mosaic Model.

Solution:

(a) The Fluid Mosaic Model was proposed by Jonathan Singer and Garth Nicolson in 1972. It replaced earlier, more rigid models by suggesting that the membrane is a dynamic, shifting structure.

(b) According to this model, the membrane consists of a phospholipid bilayer with embedded proteins. The lipids are "fluid," meaning they can move laterally within the layer, giving the membrane flexibility and self-healing properties.

(c) The "mosaic" part of the name refers to the various proteins scattered throughout the lipid sea. These proteins serve as channels, receptors, and markers, and they can move about like icebergs in water.

(d) This model accounts for many physiological processes, including selective permeability, cell signaling, and endocytosis. It emphasizes that the membrane is not just a passive barrier but an active, functional part of the cell's life.

Final Answer: Proposed by Singer and Nicolson.

Answer: (C)

Go Back to Question 30

Q31.

Solution

Concept:

Polysaccharides are complex carbohydrates formed by the polymerization of numerous monosaccharide units. They serve two primary functions in biological systems: energy storage and structural support. Chitin is a specialized structural polysaccharide that provides rigidity and protection to various organisms.

Solution:

(a) Chitin is a homopolymer consisting of N-acetyl-D-glucosamine units linked by beta-1,4-glycosidic bonds. This chemical structure is similar to cellulose but with an acetylated amino group replacing a hydroxyl group at the carbon-2 position.

(b) In the animal kingdom, chitin is the primary component of the exoskeleton of arthropods, including insects, crabs, and lobsters. It provides a tough, protective outer layer that prevents desiccation and offers mechanical support for muscle attachment.

(c) In the kingdom Fungi, chitin replaces cellulose as the fundamental structural element of the cell wall. It ensures that fungal cells can withstand internal osmotic pressure and external environmental stress.

(d) Because of its strength and biocompatibility, chitin and its derivative, chitosan, are widely used in medical applications, such as surgical threads that biodegrade as a wound heals.

(e) Unlike starch or glycogen, which are branched and used for energy, chitin forms long, straight chains that pack closely together to create high-tensile strength fibers, making it the second most abundant natural polymer on Earth after cellulose.

Final Answer: The polysaccharide is Chitin.

Answer: (C)

Go Back to Question 31

Q32.

Solution

Concept:

The Calvin Cycle, or the C_3 pathway, is the set of chemical reactions that take place in the chloroplast stroma during photosynthesis to fix atmospheric carbon dioxide into glucose. The process is named the C_3 pathway because the first stable product formed is a three-carbon molecule.

Solution:

(a) The first and most critical step of the Calvin Cycle is carboxylation. For this to occur, a specific molecule must act as the primary acceptor of the incoming CO_2.

(b) In C_3 plants, this primary acceptor is a five-carbon ketose sugar called Ribulose 1,5-bisphosphate (RuBP).

(c) The enzyme RuBisCO (Ribulose-1,5-bisphosphate carboxylase/oxygenase) catalyzes the reaction between CO_2 and RuBP. This reaction briefly creates a highly unstable six-carbon intermediate.

(d) This unstable intermediate immediately splits into two molecules of 3-phosphoglyceric acid (3-PGA), which is a three-carbon compound.

(e) Understanding that RuBP is the starting point is essential for grasping how plants invest energy from the light reactions (ATP and NADPH) to regenerate this acceptor, allowing the cycle to continue and produce the organic matter that supports almost all life on Earth.

Final Answer: The primary acceptor is Ribulose 1,5-bisphosphate (RuBP).

Answer: (C)

Go Back to Question 32

Q33.

Solution

Concept:

Glycolysis is the universal metabolic pathway that breaks down glucose into pyruvate to release energy. It takes place in the cytosol and is divided into the preparatory phase (energy investment) and the pay-off phase (energy recovery). The first step is a regulatory "priming" reaction.

Solution:

(a) Upon entering the cell, glucose is immediately phosphorylated to prevent it from diffusing back across the plasma membrane and to prepare it for subsequent metabolic steps.

(b) This phosphorylation reaction is catalyzed by the enzyme Hexokinase. It involves the transfer of a phosphate group from a molecule of ATP to the sixth carbon of the glucose molecule, forming Glucose-6-phosphate.

(c) Hexokinase requires divalent magnesium ions (Mg^{2+}) as a cofactor to shield the negative charges of the ATP phosphate groups, making the terminal phosphorus atom more susceptible to nucleophilic attack.

(d) This step is irreversible under physiological conditions and serves as a major checkpoint for the entry of glucose into various metabolic pathways, including glycolysis, the pentose phosphate pathway, and glycogen synthesis.

(e) By converting glucose into a charged phosphate ester, the cell effectively traps the sugar inside and maintains a concentration gradient that favors the continued facilitated diffusion of glucose into the cell through GLUT transporters.

Final Answer: The enzyme is Hexokinase.

Answer: (B)

Go Back to Question 33

Q34.

Solution

Concept:

Cranial nerves are the 12 pairs of nerves that emerge directly from the brain and brainstem. Each pair is specialized for specific sensory, motor, or mixed functions. The eighth cranial nerve is uniquely designed to handle the complex physics of sound and gravity.

Solution:

(a) The eighth cranial nerve is known as the Vestibulocochlear nerve (or Auditory nerve). As the name suggests, it is composed of two distinct branches that originate in the inner ear.

(b) The cochlear branch is responsible for the sensation of hearing. It carries impulses generated by the organ of Corti in the cochlea, which transforms mechanical sound vibrations into electrical signals.

(c) The vestibular branch is responsible for the sense of balance and equilibrium. It transmits signals from the semicircular canals and the vestibule (utricle and saccule), which detect head position and linear or angular acceleration.

(d) These signals are sent to the medulla oblongata and the cerebellum, where they are integrated to maintain posture, coordinate eye movements, and perceive the auditory environment.

(e) Disorders of this nerve can lead to symptoms such as hearing loss, tinnitus (ringing in the ears), or vertigo (dizziness), highlighting its dual importance in how we navigate and interact with the world spatially and socially.

Final Answer: The nerve is the Auditory (Vestibulocochlear) nerve.

Answer: (C)

Go Back to Question 34

Q35.

Solution

Concept:

The kidney is the primary organ for osmoregulation and excretion in humans. To filter the entire volume of blood multiple times a day, each kidney contains over a million microscopic structural and functional units that perform the complex tasks of filtration, reabsorption, and secretion.

Solution:

(a) The Nephron is the functional unit of the kidney. Each nephron consists of two main parts: the renal corpuscle (which includes the glomerulus and Bowman's capsule) and the renal tubule.

(b) The process begins with ultrafiltration in the glomerulus, where high pressure forces water and small solutes out of the blood and into the Bowman's capsule to form the glomerular filtrate.

(c) This filtrate then travels through various segments of the tubule: the proximal convoluted tubule (PCT), the loop of Henle, and the distal convoluted tubule (DCT).

(d) In these tubular segments, the nephron selectively reabsorbs essential substances like glucose, amino acids, and water back into the blood while secreting waste products like urea, creatinine, and excess ions into the tubule.

(e) The final product, urine, is then passed into the collecting duct. Without the coordinated activity of these millions of nephrons, the body would be unable to maintain its internal chemical balance, leading to the toxic buildup of metabolic waste.

Final Answer: The functional unit is the Nephron.

Answer: (B)

Go Back to Question 35

Q36.

Solution

Concept:

Hormonal regulation of water balance in the human body is primarily controlled by the Antidiuretic Hormone (ADH), also known as vasopressin. This hormone is synthesized in the hypothalamus and released by the posterior pituitary gland in response to increased blood osmolarity or decreased blood volume. It acts specifically on the distal convoluted tubules and collecting ducts of the kidney to increase water reabsorption.

Solution:

(a) When there is a deficiency of ADH, or if the kidneys fail to respond to it, the collecting ducts become impermeable to water. This results in a failure to reabsorb water from the glomerular filtrate back into the bloodstream.

(b) As a consequence, the individual produces vast quantities of extremely dilute urine, a condition known as polyuria. This leads to severe dehydration and a compensatory increase in thirst, known as polydipsia.

(c) This clinical condition is called Diabetes insipidus. It is fundamentally different from Diabetes mellitus, which involves insulin and blood sugar regulation. In Diabetes insipidus, the "insipid" refers to the fact that the urine is tasteless and colorless because it lacks glucose.

(d) There are two main types: Central Diabetes insipidus (caused by a lack of ADH production) and Nephrogenic Diabetes insipidus (where the kidneys do not respond to ADH).

(e) Without proper management, such as the administration of synthetic vasopressin, the body cannot maintain its fluid homeostatic balance, leading to electrolyte imbalances and chronic fatigue.

Final Answer: The condition is Diabetes insipidus.

Answer: (B)

Go Back to Question 36

Q37.

Solution

Concept:

Plant Growth Regulators (PGRs) or phytohormones are small, simple molecules that have diverse chemical compositions and regulate various physiological processes in plants. They can be broadly classified into growth promoters (like Auxins and Gibberellins) and growth inhibitors (like Abscisic Acid), though some like Ethylene can fit into both categories.

Solution:

(a) Ethylene is a gaseous phytohormone primarily associated with the ripening of fruits. It accelerates metabolic processes like the breakdown of starch into sugars and the softening of cell walls, making fruits palatable.

(b) Abscisic Acid (ABA) is widely known as the "stress hormone." It plays a critical role in closing stomata during water stress to prevent transpiration and induces seed dormancy to ensure survival during unfavorable conditions.

(c) Cytokinins are essential for cell division and help in overcoming apical dominance. A very notable function is the delay of leaf senescence (the Richmond-Lang effect) by promoting nutrient mobilization towards older tissues.

(d) Gibberellins are responsible for the elongation of internodes. In "rosette" plants like cabbage, the sudden elongation of the stem just prior to flowering is called bolting, which is triggered by the application of gibberellic acid.

(e) Proper coordination between these hormones allows the plant to respond dynamically to its environment, ensuring that growth and reproduction occur only when conditions are optimal for success.

Final Answer: (a)-(1), (b)-(2), (c)-(3), (d)-(4).

Answer: (A)

Go Back to Question 37

Q38.

Solution

Concept:

Natural selection is one of the fundamental mechanisms of evolution, proposed by Charles Darwin. It describes how environmental pressures lead to the differential survival and reproduction of individuals with specific phenotypes. Based on how it affects the distribution of traits in a population, selection can be categorized into three main types.

Solution:

(a) Disruptive selection (also known as diversifying selection) occurs when environmental conditions favor individuals at both extreme ends of the phenotypic spectrum while selecting against the intermediate or average individuals.

(b) This type of selection often happens in environments that are fragmented or offer distinct types of resources. For example, in a population of birds, if only very small seeds and very large seeds are available, birds with small beaks and large beaks will survive better than those with medium-sized beaks.

(c) Over time, disruptive selection can lead to a bimodal distribution of traits within the population. If the two extreme groups become reproductively isolated, it can ultimately lead to the formation of two distinct species (speciation).

(d) This is the opposite of stabilizing selection, which favors the average individual and reduces variation, and directional selection, which shifts the entire population toward one single extreme.

(e) Understanding these patterns helps biologists predict how populations will adapt to changing environments and how new biological diversity is generated through the pressures of survival.

Final Answer: The type is Disruptive selection.

Answer: (C)

Go Back to Question 38

Q39.

Solution

Concept:

Biological interactions or population interactions describe how individuals of different species living in the same community influence each other's survival and reproduction. These interactions are fundamental to the structure of ecosystems and are classified based on whether they are beneficial (+), harmful (-), or neutral (0) to the participants.

Solution:

(a) Commensalism is a type of interspecific interaction where one species (the commensal) derives a benefit, while the other species (the host) is neither significantly helped nor harmed by the presence of the other.

(b) A classic example of commensalism is the relationship between an orchid growing as an epiphyte on a mango branch. The orchid gets a stable platform and better access to sunlight, while the mango tree remains unaffected.

(c) Another common example is the cattle egret and grazing cattle. The egrets follow the cattle, which stir up insects from the grass as they move. The egrets get an easy meal, but the cattle do not gain or lose anything from the birds' presence nearby.

(d) It is important to distinguish this from mutualism, where both species benefit, and parasitism, where one benefits at the expense of the other.

(e) Commensalism highlights the complexity of ecological niches and shows how species can share space and resources without necessarily competing or cooperating directly for survival.

Final Answer: The interaction is Commensalism.

Answer: (C)

Go Back to Question 39

Q40.

Solution

Concept:

A floral formula is a symbolic representation of the structure of a flower, providing details about the number and arrangement of its parts, its symmetry, and its sexuality. The family Fabaceae (formerly Papilionaceae) is a major group of flowering plants known for its distinctive zygomorphic flowers and nitrogen-fixing root nodules.

Solution:

(a) The flowers of Fabaceae are zygomorphic, meaning they have bilateral symmetry, represented by the percentage symbol (%). They are typically bisexual (↑).

(b) The calyx consists of five fused sepals ($K_{(5)}$), showing a gamosepalous condition. The corolla is unique, featuring five petals in a vexillary aestivation pattern: one large standard petal, two lateral wings, and two fused petals forming the keel ($C_{1+2+(2)}$).

(c) The androecium is characterized by ten stamens arranged in a diadelphous condition. Usually, nine stamens are fused into a tube while one remains free, represented as $A_{(9)+1}$.

(d) The gynoecium is monocarpellary with a superior ovary, containing a single locule with many ovules. This is denoted as $\underline{G}_1$.

(e) This specific structural arrangement is highly specialized for insect pollination, where the weight of the insect on the wing petals triggers the release of the keel to brush pollen onto the pollinator's body.

Final Answer: $\% \uparrow K_{(5)}C_{1+2+(2)}A_{(9)+1}\underline{G}_1$.

Answer: (A)

Go Back to Question 40

Q41.

Solution

Concept:

Evolutionary biology explores the mechanisms by which species change over time. While Charles Darwin emphasized gradualism through natural selection, the Dutch botanist Hugo de Vries introduced a different perspective based on his observations of the evening primrose (Oenothera lamarckiana). His work led to the formulation of the Mutation Theory of evolution.

Solution:

(a) Hugo de Vries observed that some individual plants of the evening primrose showed sudden, large phenotypic differences from their parents. He termed these spontaneous, inheritable changes as "mutations."

(b) According to his Mutation Theory, evolution is a discontinuous process rather than a gradual one. He believed that new species are not formed by the slow accumulation of small variations, but by sudden, large-scale mutations.

(c) He coined the term "saltation" to describe a single-step large mutation that could result in the immediate formation of a new species. This was a significant departure from Darwinian thought, which viewed evolution as a slow, continuous journey.

(d) While modern genetics has shown that most evolution occurs through small mutations filtered by natural selection, de Vries' work was revolutionary because it shifted the focus to the genetic material as the source of variation.

(e) The Modern Synthetic Theory eventually reconciled these views, acknowledging that while mutations provide the raw material for variation, natural selection determines which of those mutations persist in a population over generations.

Final Answer: The theory is Mutation Theory.

Answer: (C)

Go Back to Question 41

Q42.

Solution

Concept:

The human respiratory system is designed to transport oxygen from the atmosphere into the bloodstream and remove carbon dioxide. This process involves a series of conducting passages that lead to the respiratory zone, where the actual physiological exchange of gases occurs between the air and the circulatory system.

Solution:

(a) Air travels through the nostrils, pharynx, larynx, trachea, and a branching network of bronchi and bronchioles. However, these structures are part of the conducting zone; they do not participate in gas exchange.

(b) The respiratory zone begins at the end of the terminal bronchioles, which lead into millions of microscopic, thin-walled, balloon-like structures called alveoli.

(c) The alveoli are the primary sites of gas exchange. Their walls are composed of a single layer of squamous epithelial cells, and they are surrounded by a dense network of pulmonary capillaries.

(d) The interface between the alveolar wall and the capillary wall is known as the respiratory membrane. It is extremely thin, measuring less than one micrometer, which allows for the rapid diffusion of gases.

(e) Oxygen diffuses from the high concentration in the alveoli into the blood, while carbon dioxide diffuses from the blood into the alveoli to be exhaled. The massive total surface area of the alveoli (roughly 70 to 100 square meters) makes this exchange incredibly efficient.

Final Answer: The site is the Alveoli.

Answer: (C)

Go Back to Question 42

Q43.

Solution

Concept:

The small intestine is the primary site for the chemical digestion and absorption of nutrients in the human body. To maximize the efficiency of nutrient uptake, the internal anatomy of the small intestine is highly specialized to provide the largest possible surface area within a limited physical space.

Solution:

(a) The inner lining (mucosa) of the small intestine is not smooth. It is folded into millions of tiny, finger-like projections known as villi.

(b) Each villus is approximately 0.5 to 1.5 millimeters long and is covered by a layer of epithelial cells that further possess microscopic projections called microvilli, collectively forming a "brush border."

(c) The primary function of the villi is to increase the surface area for absorption by nearly 600 times compared to a simple tube. This ensures that the products of digestion, such as glucose, amino acids, and fatty acids, have ample opportunity to enter the bloodstream.

(d) Inside each villus, there is a rich supply of blood capillaries and a large central lymph vessel called a lacteal. While the capillaries absorb water-soluble nutrients, the lacteal is responsible for the absorption of fats and fat-soluble vitamins.

(e) Once absorbed, these nutrients are transported via the hepatic portal system to the liver for processing. Without the extensive surface area provided by the villi, the body would be unable to absorb sufficient energy and building blocks to sustain life.

Final Answer: Villi; absorption.

Answer: (B)

Go Back to Question 43

Q44.

Solution

Concept:

The nervous system functions through a network of specialized cells called neurons that transmit information as electrical impulses. However, neurons are not physically connected to one another. To pass a signal from one cell to the next, the nervous system employs a specialized communication point.

Solution:

(a) The functional junction between the axon terminal of one neuron and the dendrite or cell body of another is called a synapse. A typical synapse consists of a presynaptic membrane, a postsynaptic membrane, and a microscopic gap called the synaptic cleft.

(b) When an electrical impulse (action potential) reaches the end of the presynaptic neuron, it triggers the opening of voltage-gated calcium channels. The influx of calcium causes synaptic vesicles to fuse with the membrane and release their contents.

(c) These contents are chemical messengers known as neurotransmitters. Common examples include acetylcholine, dopamine, and serotonin.

(d) The neurotransmitters diffuse across the narrow synaptic cleft and bind to specific receptors on the postsynaptic membrane. This binding triggers a new electrical signal in the receiving neuron.

(e) This chemical transmission allows the nervous system to process information with high precision and allows for the modulation of signals, which is the basis for learning, memory, and complex behavioral responses. Once the signal is passed, the neurotransmitters are either broken down by enzymes or reabsorbed by the sending neuron.

Final Answer: Synapse; neurotransmitters.

Answer: (B)

Go Back to Question 44

Q45.

Solution

Concept:

Contraception or birth control includes various methods used to prevent pregnancy. These methods range from temporary barriers and hormonal treatments to permanent surgical procedures. Permanent methods, often referred to as sterilization, are intended for individuals who do not wish to have children in the future.

Solution:

(a) In females, the surgical method of sterilization is called a tubectomy. This procedure involves making a small incision in the abdomen or through the vagina to access the fallopian tubes (oviducts).

(b) A small portion of each fallopian tube is either cut and tied or blocked with a clip or ring. Since the fallopian tubes are the site where the egg and sperm typically meet, this blockage physically prevents fertilization.

(c) It is important to note that a tubectomy does not affect the production of eggs in the ovaries or the hormonal cycle. Ovulation still occurs, but the egg simply cannot travel down the tube to meet the sperm, and it is eventually reabsorbed by the body.

(d) In males, the corresponding procedure is called a vasectomy, where the vasa deferentia are cut and tied to prevent the transport of sperm from the testes.

(e) Tubectomy is a highly effective, one-time procedure with a very low failure rate. However, it is considered irreversible, as the surgical reversal process is complex and often unsuccessful. It is a key component of family planning programs worldwide.

Final Answer: The method is Tubectomy.

Answer: (B)

Go Back to Question 45

Q46.

Solution

Concept:

Ecological succession is the process of change in the species structure of an ecological community over time. Primary succession occurs in essentially lifeless areas—regions in which the soil is incapable of sustaining life as a result of such factors as lava flows, newly formed sand dunes, or rocks left from a retreating glacier.

Solution:

(a) In a primary succession on bare rocks (xerarch succession), the environment is extremely harsh, with no soil and limited water availability. The first organisms to colonize such a barren area are known as pioneer species.

(b) Lichens are the most common pioneer species for bare rock. They are unique symbiotic associations between an alga and a fungus, allowing them to survive in nutrient-poor environments.

(c) Lichens secrete organic acids, such as carbonic acid, which chemically weather the rock surface. This process breaks down the rock into smaller mineral particles, initiating the formation of soil.

(d) As the lichens die and decompose, they add organic matter (humus) to the newly formed soil. This change in the substrate makes the environment slightly more hospitable for the next group of organisms, typically mosses.

(e) Mosses have small rhizoids that help trap more soil particles and moisture, eventually leading to the arrival of grasses, shrubs, and finally, a stable climax community such as a forest. This transition highlights how biological activity can fundamentally transform a geological landscape over centuries.

Final Answer: The pioneer species are Lichens.

Answer: (B)

Go Back to Question 46

Q47.

Solution

Concept:

Polymerase Chain Reaction (PCR) is a molecular biology technique used to amplify a single copy or a few copies of a specific segment of DNA across several orders of magnitude, generating thousands to millions of copies. A key requirement for this process is a DNA polymerase that can withstand the high temperatures used for DNA denaturation.

Solution:

(a) A standard PCR cycle involves three main steps: denaturation (at approximately 94 degrees Celsius), annealing, and extension. Most proteins and enzymes, including human DNA polymerase, would be permanently denatured and rendered non-functional at such high temperatures.

(b) To overcome this, scientists utilize a specialized enzyme called Taq Polymerase. This enzyme was originally isolated from the bacterium Thermus aquaticus, which lives in hot springs and hydrothermal vents.

(c) Because T. aquaticus is an extremophile, its enzymes are naturally evolved to remain stable and active at temperatures near boiling point. Taq Polymerase has an optimum activity temperature of around 75 to 80 degrees Celsius.

(d) The use of Taq Polymerase allows the PCR process to be automated in a thermal cycler. Once the enzyme is added to the reaction mixture, it does not need to be replaced after every denaturation step, making the technique efficient and scalable.

(e) This breakthrough revolutionized genetics, enabling applications such as DNA fingerprinting, the diagnosis of infectious diseases, and the study of ancient DNA where the starting material is often very limited.

Final Answer: The enzyme is Taq Polymerase.

Answer: (C)

Go Back to Question 47

Q48.

Solution

Concept:

The ABO blood group system is the most important blood type system in human blood transfusion. It is based on the presence or absence of specific antigens (A and B) on the surface of red blood cells and the corresponding antibodies (anti-A and anti-B) in the plasma.

Solution:

(a) Compatibility between the donor's antigens and the recipient's antibodies is critical to prevent a transfusion reaction, which can be fatal. If a recipient receives blood with antigens that their immune system recognizes as foreign, their antibodies will attack and clump (agglutinate) the donor's red blood cells.

(b) Individuals with blood group O have neither Antigen A nor Antigen B on their red blood cells. Because these cells lack the surface markers that trigger an immune response, they can be safely transfused into individuals of any ABO blood type.

(c) Within the O group, O negative (O-) is the true universal donor. This is because it also lacks the Rhesus (Rh) factor, meaning it will not cause a reaction in Rh-negative recipients.

(d) In emergency situations where a patient's blood type is unknown, O negative blood is often used because it is the safest option for immediate transfusion.

(e) While O negative donors are universal for red blood cells, they are actually the universal recipients for plasma, because their plasma contains both anti-A and anti-B antibodies. Conversely, AB positive is the universal recipient for red blood cells but the universal donor for plasma.

Final Answer: The universal donor is O negative.

Answer: (B)

Go Back to Question 48

Q49.

Solution

Concept:

The Central Dogma of molecular biology describes the flow of genetic information within a biological system. It states that information is transferred from DNA to RNA and then from RNA to protein. The first step of this flow involves copying the genetic code from the master blueprint (DNA) into a portable message (mRNA).

Solution:

(a) Transcription is the process by which a specific segment of DNA is copied into RNA by the enzyme RNA polymerase. This occurs within the nucleus of eukaryotic cells or the cytoplasm of prokaryotic cells.

(b) During transcription, the DNA double helix unwinds, and one strand (the template strand) serves as a guide. The RNA polymerase matches complementary RNA nucleotides to the DNA template. In RNA, uracil (U) is used instead of thymine (T) to pair with adenine (A).

(c) The resulting molecule is a single-stranded messenger RNA (mRNA). This mRNA carries the genetic instructions from the chromosome to the ribosome, the cell's protein-making machinery.

(d) It is important to distinguish transcription from replication and translation. Replication is the process of copying DNA to make more DNA, while translation is the process where the ribosome reads the mRNA code to assemble a chain of amino acids into a protein.

(e) Transcription allows the cell to keep the original DNA safe in the nucleus while producing multiple copies of the instructions for protein synthesis, enabling high levels of gene expression when needed.

Final Answer: The process is Transcription.

Answer: (C)

Go Back to Question 49

Q50.

Solution

Concept:

Blood coagulation, or clotting, is a complex physiological process that prevents excessive bleeding when a blood vessel is injured. It involves a cascade of reactions where various clotting factors (proteins) are activated in a specific sequence, eventually leading to the formation of a stable fibrin mesh.

Solution:

(a) Vitamins are organic compounds that the body needs in small amounts to function correctly. Vitamin K is a fat-soluble vitamin that plays a vital role as a cofactor for the synthesis of several key clotting factors in the liver.

(b) Specifically, Vitamin K is required for the post-translational modification of factors II (prothrombin), VII, IX, and X. These proteins require a chemical change called gamma-carboxylation to become active and bind to calcium ions on cell surfaces.

(c) Without sufficient Vitamin K, these clotting factors remain in an inactive precursor form. As a result, the blood takes much longer to clot, which can lead to easy bruising, nosebleeds, or even life-threatening internal hemorrhaging.

(d) Humans obtain Vitamin K from green leafy vegetables (like spinach and kale) and through the activity of beneficial bacteria residing in the large intestine.

(e) Anticoagulant medications like warfarin work by interfering with the recycling of Vitamin K, effectively slowing down the clotting process in patients at risk of strokes or heart attacks. This highlights how critical this single vitamin is to maintaining the delicate balance of the circulatory system.

Final Answer: The vitamin is Vitamin K.

Answer: (C)

Go Back to Question 50

Q51.

Solution

Concept:

Mitosis is the process of cell division that results in two genetically identical daughter cells. It is a continuous process but is typically divided into four stages: prophase, metaphase, anaphase, and telophase. Each phase is characterized by specific movements of the chromosomes and changes in the cellular architecture.

Solution:

(a) The diagram illustrates Anaphase. This is the third stage of mitosis and is arguably the most dynamic. The hallmark of anaphase is the synchronous splitting of the centromeres, which previously held the sister chromatids together.

(b) Once the centromeres divide, the sister chromatids are officially considered individual chromosomes. They begin to move toward opposite poles of the cell, led by their centromeres with the chromosomal arms trailing behind.

(c) This movement is facilitated by the shortening of the kinetochore microtubules attached to the centromeres. As these fibers depolymerize, they pull the chromosomes toward the spindle poles.

(d) Simultaneously, the non-kinetochore microtubules (polar microtubules) elongate, pushing the poles further apart and causing the cell to lengthen. This ensures that when the cell eventually divides, each new nucleus will contain exactly one copy of every chromosome.

(e) Identifying anaphase is relatively simple in microscopy because the chromosomes appear as "V" or "J" shaped structures moving in two distinct groups toward opposite ends of the cell, leaving the center relatively clear.

Final Answer: Anaphase; Centromeres split and sister chromatids move to opposite poles.

Answer: (C)

Go Back to Question 51

Q52.

Solution

Concept:

The Endoplasmic Reticulum (ER) is an extensive network of membrane-enclosed sacs and tubules that extends throughout the cytoplasm. It is divided into two types based on the presence or absence of ribosomes: the Rough ER (RER) and the Smooth ER (SER). Each type has specialized functions related to the metabolic needs of the cell.

Solution:

(a) The Smooth Endoplasmic Reticulum (SER) is characterized by a lack of ribosomes on its surface, giving it a smooth appearance under an electron microscope. Because it lacks ribosomes, it is not involved in protein synthesis.

(b) Instead, the SER is the primary site for the synthesis of lipids, including phospholipids and cholesterol. In animal cells, it is also responsible for the synthesis of steroid hormones such as testosterone and estrogen.

(c) Another critical function of the SER is the detoxification of drugs and poisons. This is particularly evident in liver cells (hepatocytes), where the SER is highly developed. It contains enzymes that modify hydrophobic toxins to make them more water-soluble, allowing them to be excreted from the body.

(d) The SER also plays a role in carbohydrate metabolism and serves as a storage site for calcium ions (Ca^{2+}). In muscle cells, a specialized form of SER called the sarcoplasmic reticulum releases these ions to trigger muscle contraction.

(e) Understanding the compartmentalization of the ER allows us to see how a single organelle can manage such diverse tasks as building cell membranes and protecting the body from chemical harm.

Final Answer: The organelle is the Smooth Endoplasmic Reticulum.

Answer: (B)

Go Back to Question 52

Q53.

Solution

Concept:

Hemoglobin is the oxygen-carrying protein in red blood cells. Its ability to bind oxygen is not linear; instead, it is highly regulated by the partial pressure of oxygen (PO_2) and other environmental factors. This relationship is graphically represented by the oxygen-hemoglobin dissociation curve.

Solution:

(a) The oxygen dissociation curve of hemoglobin is typically described as being sigmoid or S-shaped. This shape is a direct result of a phenomenon known as "cooperative binding" or "cooperativity."

(b) Hemoglobin is a tetramer with four subunits, each containing a heme group that can bind one molecule of O_2. When the first oxygen molecule binds to one subunit, it causes a conformational change in the entire protein.

(c) This structural shift increases the affinity of the remaining three subunits for oxygen, making it much easier for subsequent oxygen molecules to bind. This explains the steep rise in the middle of the curve.

(d) Conversely, as the partial pressure of oxygen decreases (as in active tissues), the release of the first oxygen molecule makes it easier for the others to follow. This ensures efficient delivery of oxygen where it is needed most.

(e) The sigmoid shape is physiologicaly advantageous because it allows hemoglobin to be almost fully saturated in the lungs (high PO_2) while being very sensitive to small changes in PO_2 at the tissue level, allowing for rapid unloading during metabolic demand.

Final Answer: The curve is Sigmoid.

Answer: (C)

Go Back to Question 53

Q54.

Solution

Concept:

The human brain is divided into the forebrain, midbrain, and hindbrain, each containing specialized structures that coordinate various involuntary and voluntary activities. The hindbrain is particularly involved in the "housekeeping" tasks and motor coordination required for everyday survival.

Solution:

(a) The Cerebellum, often called the "little brain," is located at the back of the skull, tucked under the cerebral hemispheres. Although it accounts for only 10% of the brain's volume, it contains more than half of the brain's neurons.

(b) The primary function of the cerebellum is to coordinate voluntary movements. It does not initiate the movement (the cerebrum does), but it ensures that the movement is smooth, precise, and timed correctly.

(c) It is the primary center for maintaining posture and equilibrium. By receiving sensory input from the inner ear (vestibular system) and proprioceptors in the muscles and joints, it makes micro-adjustments to keep the body balanced.

(d) The cerebellum also maintains muscle tone, which is the constant state of partial contraction in skeletal muscles that allows us to stay upright without conscious effort.

(e) Damage to the cerebellum results in ataxia, a condition characterized by clumsy, uncoordinated movements and a loss of balance, similar to the effects of alcohol intoxication, which directly suppresses cerebellar function.

Final Answer: The part is the Cerebellum.

Answer: (C)

Go Back to Question 54

Q55.

Solution

Concept:

Respiration is the process by which cells break down glucose to produce energy in the form of ATP. While aerobic respiration (using oxygen) is the most efficient, cells can switch to anaerobic respiration (without oxygen) when the demand for energy exceeds the supply of oxygen reaching the tissues.

Solution:

(a) During vigorous or strenuous exercise, the cardiovascular system may fail to deliver oxygen to skeletal muscles fast enough to support aerobic metabolism. In this state, the muscles must rely on anaerobic pathways to continue producing ATP.

(b) In human muscle cells, this process is known as lactic acid fermentation. Glucose is broken down through glycolysis into pyruvic acid, yielding a small amount of ATP.

(c) Instead of entering the mitochondria for further oxidation, the pyruvic acid is reduced to lactic acid by the enzyme lactate dehydrogenase. This step is crucial because it regenerates NAD^+, allowing glycolysis to continue and produce a steady, albeit small, stream of energy.

(d) The accumulation of lactic acid in the muscles leads to a drop in pH, which contributes to the sensation of muscle fatigue and "burning."

(e) Once the exercise stops and oxygen becomes available again, the lactic acid is transported to the liver. There, it is converted back into pyruvic acid and eventually glucose via the Cori cycle, which helps resolve the "oxygen debt" incurred during the activity.

Final Answer: Lactic acid and energy.

Answer: (B)

Go Back to Question 55

Q56.

Solution

Concept:

Vestigial organs are anatomical structures or organs that were fully functional in the ancestors of a species but have lost most or all of their original function through the process of evolution. These structures serve as significant evidence for common descent, showing how biological lineages adapt to changing environments and lifestyles over millions of years.

Solution:

(a) The vermiform appendix is perhaps the most famous example in humans. In our herbivorous ancestors, it was a much larger structure used for the digestion of cellulose. As our diet shifted toward more easily digestible food, it shrunk and lost its primary digestive role, though it may still play minor roles in the immune system.

(b) Wisdom teeth (third molars) were essential for our ancestors who consumed a diet of raw meat, tough roots, and coarse vegetation. With the advent of cooking and softer diets, human jaws have become smaller, often leaving no room for these teeth to erupt properly, making them largely unnecessary today.

(c) The nictitating membrane, or the "third eyelid," is visible in humans as the plica semilunaris in the inner corner of the eye. While fully functional in birds, reptiles, and some mammals for protection and moisture, it is reduced to a non-functional fold in humans.

(d) Other examples include the coccyx (tailbone), which is a remnant of a tail found in our primate ancestors, and the auricular muscles, which allowed earlier mammals to move their ears to localize sound.

(e) The presence of these organs highlights that evolution is not a process of perfection but of modification. Organs that are no longer under selective pressure for survival tend to degenerate over time but often persist in a reduced state.

Final Answer: All of the above.

Answer: (D)

Go Back to Question 56

Q57.

Solution

Concept:

The Cell Theory is one of the unifying principles of biology. While the initial groundwork was laid by Matthias Schleiden and Theodore Schwann in the 1830s, their version of the theory was incomplete because it could not explain how new cells were formed. It was not until the mid-19th century that the theory was finalized.

Solution:

(a) In 1855, the German pathologist Rudolf Virchow added the final, crucial component to the cell theory. He famously stated, "Omnis cellula-e cellula," which translates from Latin as "all cells arise from pre-existing cells."

(b) This statement was revolutionary because it challenged the prevailing idea of spontaneous generation, which suggested that living organisms could arise from non-living matter or "vital forces."

(c) Virchow's addition established that life is a continuous chain of cell divisions. It shifted the focus of biological research toward understanding the mechanisms of mitosis, meiosis, and heredity, as it implied that every cell carries a genetic link to its ancestors.

(d) Modern cell theory now comprises three main tenets: all living organisms are composed of one or more cells; the cell is the basic structural and functional unit of life; and all cells arise from pre-existing cells through division.

(e) Rudolf Virchow is often called the "father of modern pathology" because his work emphasized that diseases do not arise in whole organs or tissues by chance, but rather originate at the cellular level, changing our fundamental approach to medicine and biology.

Final Answer: Proposed by Rudolf Virchow.

Answer: (C)

Go Back to Question 57

Q58.

Solution

Concept:

A typical flower consists of four concentric whorls or layers of modified leaves: the calyx (sepals), corolla (petals), androecium (stamens), and gynoecium (carpels). These whorls are arranged on the receptacle and are categorized into accessory whorls and essential whorls based on their direct involvement in reproduction.

Solution:

(a) The gynoecium is the innermost whorl of the flower and represents the female reproductive organ. It is composed of one or more individual units called carpels or pistils.

(b) A typical carpel consists of three distinct parts: the stigma, the style, and the ovary. The stigma is the receptive tip that catches pollen, the style is the stalk that connects it to the base, and the ovary is the enlarged basal portion.

(c) Inside the ovary are the ovules, which contain the female gametes (eggs). After fertilization occurs, the ovules develop into seeds, while the ovary itself matures into a fruit.

(d) The gynoecium is considered an "essential whorl" because reproduction cannot occur without it. It can be monocarpellary (one carpel) or multicarpellary (many carpels), and the carpels may be free (apocarpous) or fused (syncarpous).

(e) Understanding the structure of the gynoecium is fundamental to plant taxonomy and agriculture, as it determines how the plant interacts with pollinators and how the resulting fruits and seeds will be distributed.

Final Answer: Female reproductive organ.

Answer: (C)

Go Back to Question 58

Q59.

Solution

Concept:

DNA replication is the process by which a cell makes an identical copy of its genome before division. Because DNA is a double-stranded helix held together by hydrogen bonds between nitrogenous bases, the two strands must be physically separated to allow the replication machinery to read the genetic code.

Solution:

(a) Helicase is the enzyme responsible for "unzipping" or unwinding the DNA double helix. It acts like a molecular motor that travels along the phosphate backbone, breaking the hydrogen bonds between adenine-thymine and guanine-cytosine pairs.

(b) This unzipping process creates a Y-shaped structure known as the replication fork. As helicase moves forward, it generates tension (supercoiling) in the DNA ahead of the fork, which is managed by other enzymes like topoisomerase.

(c) The energy required for helicase to move and break these bonds is derived from the hydrolysis of ATP. Without helicase, the DNA strands would remain tightly coiled, making the genetic information inaccessible for copying.

(d) Once the strands are separated, single-strand binding proteins (SSBs) coat the individual strands to prevent them from re-annealing or forming secondary structures, while DNA polymerase begins synthesizing new complementary strands.

(e) Helicase is highly efficient and operates at great speeds. Mutations in the genes encoding helicase can lead to genomic instability and are associated with several human disorders, including certain types of premature aging and cancer susceptibility.

Final Answer: The enzyme is Helicase.

Answer: (C)

Go Back to Question 59

Q60.

Solution

Concept:

Enzymes are biological catalysts that speed up chemical reactions by lowering the activation energy. The specificity of an enzyme—why it acts on one specific substrate but not another—is explained by the physical interaction between the enzyme's active site and the substrate molecule.

Solution:

(a) The "Lock and Key" hypothesis was the first major model proposed to explain enzyme-substrate specificity. It was introduced by the German chemist Emil Fischer in 1894.

(b) Fischer suggested that the enzyme's active site (the "lock") and the substrate (the "key") have complementary rigid geometric shapes. Just as a specific key is required to open a specific lock, only a substrate with the exact matching shape can fit into an enzyme's active site.

(c) This model successfully explained the high degree of specificity observed in biological reactions. It suggested that if the shape of the substrate or the enzyme is altered, the reaction will not proceed.

(d) While the Lock and Key model provided a foundational understanding, it was later refined by Daniel Koshland's "Induced Fit" hypothesis. Koshland argued that the enzyme is not perfectly rigid but instead changes its shape slightly to grip the substrate more tightly upon binding.

(e) Despite the advancements of the Induced Fit model, Fischer's original hypothesis remains a cornerstone of biochemistry education because it clearly illustrates the fundamental concept of molecular recognition and structural complementarity.

Final Answer: Proposed by Emil Fischer.

Answer: (A)

Go Back to Question 60

Q61.

Solution

Concept:

Epithelial tissues are categorized based on the shape of the cells and the specific modifications they possess to perform specialized functions. In organs where the movement of particles or mucus in a specific direction is required, the epithelium features hair-like cytoplasmic outgrowths that facilitate this transport.

Solution:

(a) Ciliated epithelium is a specialized form of columnar or cuboidal epithelium that bears fine, hair-like projections called cilia on its free surface. These cilia are capable of rhythmic, wave-like movements.

(b) In the female reproductive system, the fallopian tubes (oviducts) are lined with ciliated columnar epithelium. The primary role of these cilia is to create a current that gently pushes the non-motile ovum (egg) or the zygote from the ovary toward the uterus.

(c) Without the mechanical action of these cilia, the egg would remain stationary, as it lacks its own means of locomotion. This movement is essential for successful fertilization and subsequent implantation in the uterine wall.

(d) Similar tissue is also found in the respiratory tract, specifically the trachea and bronchi, where the cilia move mucus and trapped dust particles upward toward the throat to keep the lungs clear.

(e) Other types of epithelium, such as squamous (flat cells for diffusion) or cuboidal (cube-shaped for secretion), do not possess these specialized structures and therefore cannot facilitate the directional movement of extracellular particles.

Final Answer: Ciliated epithelium.

Answer: (B)

Go Back to Question 61

Q62.

Solution

Concept:

Asexual reproduction allows organisms to produce offspring without the fusion of gametes. Different species have evolved unique strategies for this, ranging from simple cell division to the development of specialized reproductive structures or the complete regrowth of body parts from fragments.

Solution:

(a) Amoeba undergoes binary fission, a process where a single parent cell divides into two approximately equal-sized daughter cells. The nucleus divides first (karyokinesis), followed by the division of the cytoplasm (cytokinesis).

(b) Hydra reproduces through budding. A small outgrowth or bud develops due to repeated cell division at one specific site. This bud eventually grows into a tiny individual, develops a mouth and tentacles, and then detaches from the parent to live independently.

(c) Planaria is famous for its high capacity for true regeneration. If the organism is cut into several pieces, each piece can regrow the missing body parts to form a complete, new individual. This is a specialized form of reproduction where fragmentation leads to new life.

(d) Penicillium, a genus of ascomycetous fungi, reproduces asexually through the formation of non-motile spores called conidia. These spores are produced at the tips of specialized hyphae called conidiophores and are dispersed by air currents.

(e) Correctly matching these methods highlights the diversity of biological strategies used to ensure population continuity. These mechanisms are highly efficient as they do not require a mate and can rapidly increase the number of individuals in a favorable environment.

Final Answer: (A)-(I), (B)-(II), (C)-(III), (D)-(IV).

Answer: (A)

Go Back to Question 62

Q63.

Solution

Concept:

A seed contains the embryo of a future plant, which consists of an embryonal axis and one or two cotyledons. The embryonal axis is divided into specific regions, each destined to differentiate into the primary organs of the plant—the shoot and the root—during the process of germination.

Solution:

(a) The radicle is the embryonic root. It is the part of the embryo located at the lower end of the embryonal axis. During germination, the radicle is typically the first part of the embryo to emerge from the seed coat.

(b) Once it emerges, the radicle grows downward into the soil, where it develops into the primary root system. It anchors the seedling and begins the vital task of absorbing water and minerals for the growing plant.

(c) In contrast, the plumule is the embryonic shoot. It is located at the upper end of the embryonal axis and gives rise to the stem and leaves. The movement of the plumule is generally upward toward the light (phototropism).

(d) The cotyledons serve as food storage organs or photosynthetic structures for the young seedling, while the endosperm is a separate nutritive tissue found in many seeds that provides energy until the plant can perform photosynthesis.

(e) Understanding the distinction between the radicle and the plumule is fundamental in botany, as it defines the polarity of the plant and ensures that the root and shoot systems develop in their respective appropriate environments.

Final Answer: The Radicle.

Answer: (B)

Go Back to Question 63

Q64.

Solution

Concept:

The male reproductive system is regulated by a complex interplay of hormones. Within the testes, specific cells are dedicated to the production of sperm, while others function as endocrine units, secreting the primary male sex hormones required for the development of male characteristics and the maintenance of fertility.

Solution:

(a) Leydig cells, also known as interstitial cells, are located in the connective tissue surrounding the seminiferous tubules in the testes. Their primary function is the synthesis and secretion of androgens, specifically testosterone.

(b) The production of testosterone by Leydig cells is stimulated by Luteinizing Hormone (LH), which is released from the anterior pituitary gland. This is why LH is sometimes referred to as Interstitial Cell Stimulating Hormone (ICSH) in males.

(c) Testosterone is essential for the process of spermatogenesis (sperm production). It also stimulates the development of secondary sexual characteristics such as facial hair, deepening of the voice, and increased muscle mass during puberty.

(d) Other hormones like estrogen and progesterone are primary female sex hormones, although they are present in very small amounts in males. Inhibin is produced by Sertoli cells to provide negative feedback on the secretion of Follicle Stimulating Hormone (FSH).

(e) The health and proper functioning of Leydig cells are crucial; a deficiency in testosterone can lead to various reproductive and systemic issues, including infertility, low libido, and reduced bone density.

Final Answer: Testosterone (Androgens).

Answer: (C)

Go Back to Question 64

Q65.

Solution

Concept:

In molecular biology, scientists often need to analyze DNA fragments resulting from digestion by restriction enzymes or PCR amplification. Because DNA molecules are too small to be seen individually, their physical properties must be exploited to separate and visualize them. Gel electrophoresis is the standard technique used for this purpose.

Solution:

(a) Gel electrophoresis utilizes an electric field to move negatively charged DNA molecules through a porous matrix, typically made of agarose or polyacrylamide. Since the phosphate backbone of DNA is negatively charged, the fragments migrate toward the positive electrode (anode).

(b) The gel matrix acts as a molecular sieve. Smaller DNA fragments move through the pores of the gel more easily and quickly than larger fragments. Consequently, over a set period, the fragments are separated purely based on their molecular size or length.

(c) To determine the actual size of the fragments, a DNA ladder (a mixture of DNA fragments of known lengths) is run alongside the samples for comparison.

(d) Once the run is complete, the DNA is visualized by staining the gel with a fluorescent dye, such as ethidium bromide, and placing it under ultraviolet light. The DNA appears as distinct bands at different positions on the gel.

(e) This technique is fundamental for DNA profiling, forensic analysis, and verifying the success of genetic engineering experiments, as it allows researchers to confirm if the desired DNA segment has been isolated or amplified correctly.

Final Answer: The technique is Gel Electrophoresis.

Answer: (B)

Go Back to Question 65

Q66.

Solution

Concept:

An ecological pyramid is a graphical representation designed to show the biomass or bio-productivity at each trophic level in a given ecosystem. While pyramids of energy are always upright, pyramids of biomass can vary depending on the reproductive rate and longevity of the organisms involved.

Solution:

(a) In many terrestrial ecosystems, the pyramid of biomass is upright because the combined weight of the primary producers (plants) is far greater than the weight of the herbivores and carnivores they support.

(b) However, in a deep aquatic ecosystem like the sea, the pyramid of biomass is generally inverted. This means that the biomass of the primary producers is actually much lower than the biomass of the consumers at higher trophic levels.

(c) The primary producers in the ocean are phytoplankton. Although they are extremely numerous, they are microscopic and have very little individual mass. Furthermore, they have an incredibly high turnover rate; they reproduce and are consumed very rapidly.

(d) Because the phytoplankton are eaten almost as soon as they are produced, their "standing crop" biomass at any single point in time is small. In contrast, the consumers, such as large fish and whales, are long-lived and accumulate significant biomass over time.

(e) This inverted structure is sustainable only because the high productivity (rate of energy capture) of the phytoplankton provides enough energy to support the larger mass of consumers, even though the instantaneous biomass of the producers remains low.

Final Answer: The pyramid is Inverted.

Answer: (B)

Go Back to Question 66

Q67.

Solution

Concept:

Carbohydrates are classified as reducing or non-reducing sugars based on their ability to act as reducing agents. This property depends on the presence of a free or potentially free aldehydic or ketonic group within the sugar's molecular structure, which can reduce alkaline solutions of metal metallic salts like Benedict's or Fehling's reagents.

Solution:

(a) All monosaccharides, whether they are aldoses (like glucose) or ketoses (like fructose), are reducing sugars because they possess a free reactive group. Some disaccharides like lactose and maltose are also reducing because one of their two sugar units retains a free hemiacetal group.

(b) Sucrose, commonly known as table sugar, is a notable non-reducing sugar. It is a disaccharide composed of one glucose molecule and one fructose molecule.

(c) In the formation of sucrose, the glycosidic bond is formed between the reducing group of glucose (carbon 1) and the reducing group of fructose (carbon 2). This means that both reactive functional groups are involved in the bond and are not free to participate in reduction reactions.

(d) Because it lacks these free reactive groups, sucrose does not react with Benedict's solution, and the solution remains blue upon heating.

(e) This non-reducing nature makes sucrose more chemically stable than other sugars. It is likely for this reason that plants use sucrose as the primary form of carbohydrate for transport through the phloem, as it is less likely to react with other molecules during transit.

Final Answer: The sugar is Sucrose.

Answer: (D)

Go Back to Question 67

Q68.

Solution

Concept:

Plants require a constant supply of water for photosynthesis, cooling, and structural support. The movement of water from the soil, through the roots and stem, and out into the atmosphere is driven by a physiological process that creates a continuous "pull" or tension within the plant's vascular system.

Solution:

(a) Transpiration is the process of water loss from the aerial parts of a plant in the form of water vapor. It is essentially an "unavoidable evil" for plants, as the same openings required for carbon dioxide intake also allow water to escape.

(b) The majority of transpiration occurs through the stomata, which are microscopic pores located primarily on the underside of leaves. Each stoma is flanked by two guard cells that regulate its opening and closing.

(c) As water evaporates from the leaf cells into the air spaces, it creates a negative pressure (suction) that pulls more water molecules up through the xylem. This is known as the Transpiration-Cohesion-Adhesion mechanism.

(d) This process serves several vital functions: it facilitates the transport of minerals from the soil to the leaves, provides water for photosynthesis, and helps maintain the turgidity of plant cells.

(e) Additionally, the evaporation of water has a significant cooling effect on the leaf surface, preventing the plant from overheating in direct sunlight. Environmental factors such as light intensity, temperature, humidity, and wind speed significantly influence the rate of transpiration.

Final Answer: Transpiration; Stomata.

Answer: (B)

Go Back to Question 68

Q69.

Solution

Concept:

The human heart is designed to function as a dual-pump system, keeping oxygenated and deoxygenated blood completely separate to maximize the efficiency of gas transport. This separation is maintained by internal walls or partitions that prevent the mixing of blood between the different chambers.

Solution:

(a) The heart is divided into four chambers: the right and left atria (receiving chambers) and the right and left ventricles (pumping chambers). These chambers are separated by muscular walls known as septa.

(b) The inter-atrial septum is a thin, muscular wall that separates the right atrium from the left atrium. In the fetal heart, this septum contains an opening called the foramen ovale, which normally closes shortly after birth to ensure the separation of pulmonary and systemic blood.

(c) The inter-ventricular septum is the much thicker, more robust muscular wall that separates the right ventricle from the left ventricle. This thickness is necessary to withstand the high pressures generated during ventricular contraction.

(d) These septa are critical for cardiovascular health. If a hole exists in either septum (known as an atrial or ventricular septal defect), oxygen-rich and oxygen-poor blood will mix, forcing the heart to work harder and potentially leading to heart failure or lung damage.

(e) By ensuring that only deoxygenated blood is sent to the lungs and only oxygenated blood is sent to the body, these septal divisions allow for the high metabolic rates found in mammals and birds.

Final Answer: Inter-atrial septum; Inter-ventricular septum.

Answer: (A)

Go Back to Question 69

Q70.

Solution

Concept:

An autoimmune disorder occurs when the body's immune system mistakenly identifies its own healthy cells as foreign invaders and produces antibodies to attack them. When these attacks target the communication system between the nervous system and the muscular system, it results in severe motor impairment.

Solution:

(a) Myasthenia gravis is a chronic autoimmune neuromuscular disease. It is characterized by varying degrees of weakness in the skeletal muscles of the body, which are the muscles under voluntary control.

(b) The primary mechanism of the disease involves the production of antibodies that block, alter, or destroy the receptors for acetylcholine at the neuromuscular junction. Acetylcholine is the neurotransmitter required for nerve impulses to trigger muscle contraction.

(c) When these receptors are damaged or blocked, the muscle receives fewer nerve signals, leading to muscle weakness that typically worsens with activity and improves with rest.

(d) The first symptoms often involve the eye muscles (drooping eyelids or double vision), but the condition can progress to affect facial expressions, chewing, swallowing, and speaking. In severe cases, the muscles used for breathing can be affected, which is a life-threatening medical emergency.

(e) While there is currently no known cure for Myasthenia gravis, various treatments—including medications that increase acetylcholine levels and therapies that suppress the immune system—can help manage the symptoms and allow individuals to lead relatively normal lives.

Final Answer: The disorder is Myasthenia gravis.

Answer: (B)

Go Back to Question 70

Q71.

Solution

Concept:

Biofortification is the process of increasing the nutritional value of food crops through selective breeding or genetic engineering. One of the most significant achievements in this field is the development of Golden Rice, which was created to address micronutrient deficiencies in populations that rely on rice as their primary staple food.

Solution:

(a) Rice is a major source of calories for billions of people, but the polished grain lacks several essential vitamins. This deficiency, particularly of Vitamin A, can lead to severe health issues such as xerophthalmia, permanent blindness, and a weakened immune system, especially in children.

(b) Golden Rice is a variety of Oryza sativa produced through genetic engineering to biosynthesize beta-carotene, which is a precursor of Vitamin A. The presence of beta-carotene gives the rice its characteristic golden-yellow color.

(c) To achieve this, scientists inserted three genes into the rice genome: two from the daffodil plant and one from a soil bacterium. these genes complete the metabolic pathway that allows the grain to produce carotenoids in the endosperm.

(d) When consumed, the human body converts beta-carotene into active Vitamin A as needed. This makes Golden Rice a sustainable and cost-effective method for delivering vitamins to remote or impoverished areas where supplement programs are difficult to maintain.

(e) Despite its potential to save millions of lives, Golden Rice has faced significant regulatory and environmental debates. However, its development remains a landmark example of how biotechnology can be used for humanitarian purposes to combat global malnutrition.

Final Answer: Rich in Vitamin A (β-carotene).

Answer: (B)

Go Back to Question 71

Q72.

Solution

Concept:

Gregor Mendel, the father of modern genetics, conducted extensive hybridization experiments on pea plants (Pisum sativum). His observations led to the formulation of fundamental principles of inheritance. One of his most important insights was that the "factors" (now known as alleles) governing a trait do not blend but remain distinct within an individual.

Solution:

(a) The Law of Segregation (Mendel's First Law) states that although an individual possesses two alleles for a particular trait, these alleles separate or "segregate" from each other during the process of gamete formation (meiosis).

(b) This means that each gamete (sperm or egg) receives only one of the two alleles present in the somatic cells of the parent. The diploid state is later restored during fertilization when two gametes fuse to form a zygote.

(c) Mendel derived this law by observing monohybrid crosses. He noticed that even if a recessive trait (like dwarfism) disappeared in the F1 generation, it reappeared in the F2 generation in a 3:1 ratio. This proved that the recessive allele was not lost or mixed with the dominant one; it was simply hidden.

(d) This law is universal for all sexually reproducing organisms and ensures genetic variation through the random combination of alleles. It also provides the basis for the Law of Purity of Gametes, which implies that a gamete is always "pure" for a specific trait.

(e) Understanding the Law of Segregation is essential for predicting the probability of offspring inheriting specific genetic conditions or physical characteristics, making it a cornerstone of both basic biology and clinical genetics.

Final Answer: The Law of Segregation.

Answer: (B)

Go Back to Question 72

Q73.

Solution

Concept:

The ozone layer in the stratosphere acts as a protective shield for the Earth, absorbing most of the sun's harmful ultraviolet (UV) radiation. In the late 20th century, scientists discovered that human-made chemicals were causing a significant thinning of this layer, particularly over Antarctica.

Solution:

(a) The Montreal Protocol on Substances that Deplete the Ozone Layer is an international treaty designed to protect the ozone layer by phasing out the production and consumption of numerous substances that are responsible for ozone depletion.

(b) The primary targets of this protocol were Chlorofluorocarbons (CFCs), which were widely used in refrigeration, air conditioning, and as aerosol propellants. When CFCs reach the stratosphere, they are broken down by UV light, releasing chlorine atoms that catalyze the destruction of ozone molecules (O_3).

(c) Signed in 1987 and becoming effective in 1989, the protocol is considered one of the most successful environmental agreements in history. It has been ratified by every country in the world, making it the first United Nations treaty to achieve universal participation.

(d) Since its implementation, the atmospheric concentrations of the most important ozone-depleting substances have decreased, and the ozone layer is showing clear signs of recovery.

(e) The success of the Montreal Protocol serves as a powerful model for international cooperation in solving global environmental challenges, demonstrating that coordinated policy and technological innovation can effectively reverse ecological damage.

Final Answer: Ozone depleting substances.

Answer: (B)

Go Back to Question 73

Q74.

Solution

Concept:

Plants that inhabit hot, dry environments have evolved specialized photosynthetic pathways to minimize photorespiration, a wasteful process that occurs when the enzyme RuBisCO binds with oxygen instead of carbon dioxide. This adaptation is known as the C_4 pathway or the Hatch-Slack pathway.

Solution:

(a) The leaves of C_4 plants (like maize and sugarcane) exhibit a unique anatomy called "Kranz anatomy" (Kranz means wreath). In this arrangement, the vascular bundles are surrounded by two distinct layers of photosynthetic cells: mesophyll cells and bundle sheath cells.

(b) The bundle sheath cells are characterized by having thick walls that are impervious to gas exchange and a high density of specialized chloroplasts. Unlike the mesophyll cells, these chloroplasts often lack grana (agranal) and are focused on the Calvin Cycle.

(c) In C_4 plants, atmospheric CO_2 is initially fixed in the mesophyll cells into a four-carbon compound (oxaloacetic acid). This compound is then transported into the bundle sheath cells.

(d) Inside the bundle sheath cells, the four-carbon compound is decarboxylated to release a high concentration of CO_2 directly around the RuBisCO enzyme.

(e) This high internal CO_2 concentration ensures that RuBisCO functions exclusively as a carboxylase, virtually eliminating photorespiration. This allows C_4 plants to maintain high rates of photosynthesis even when their stomata are partially closed to conserve water, giving them a significant competitive advantage in tropical climates.

Final Answer: Bundle sheath cells.

Answer: (B)

Go Back to Question 74

Q75.

Solution

Concept:

Pregnancy involves complex hormonal changes designed to support the developing embryo and maintain the uterine environment. Shortly after a fertilized egg (blastocyst) implants into the uterine wall, specialized cells begin to produce a unique hormone that signals the body to maintain the corpus luteum and continue progesterone production.

Solution:

(a) Human Chorionic Gonadotropin (hCG) is the hormone primarily responsible for maintaining pregnancy in its early stages. It is produced by the syncytiotrophoblast cells, which are part of the developing placenta.

(b) Because hCG is produced only during pregnancy, its presence in maternal blood or urine is a highly specific and reliable biomarker. Home pregnancy tests are designed to detect this hormone using a technique called lateral flow immunoassay.

(c) In these tests, antibodies specific to hCG are embedded in a test strip. If hCG is present in the urine sample, it binds to the antibodies, triggering a color change that indicates a positive result.

(d) The levels of hCG rise rapidly during the first trimester, typically doubling every 48 to 72 hours, before peaking and then gradually declining as the placenta takes over the role of hormone production.

(e) In addition to its role in pregnancy testing, monitoring hCG levels can provide clinical insights into the health of the pregnancy, helping to identify potential issues such as ectopic pregnancies or miscarriages. it is one of the most vital chemical signals in human reproductive biology.

Final Answer: Human Chorionic Gonadotropin (hCG).

Answer: (B)

Go Back to Question 75

Q76.

Solution

Concept:

The liver is the largest gland in the human body and performs a staggering array of biochemical tasks. To manage these diverse functions, the liver tissue is organized into repeating microscopic units that allow for maximum contact between blood flowing from the digestive tract and the liver cells.

Solution:

(a) The hepatic lobule is the structural and functional unit of the liver. Each lobule is a hexagonal or polygonal cylinder consisting of plates of liver cells, called hepatocytes, arranged like the spokes of a wheel around a central vein.

(b) At each corner of the hexagon, there is a "portal triad" containing a branch of the hepatic artery (providing oxygen), a branch of the hepatic portal vein (providing nutrients from the gut), and a bile duct.

(c) Blood from the artery and vein flows through narrow channels called sinusoids toward the central vein. As blood passes, hepatocytes filter out toxins, store vitamins, and regulate glucose and fat levels.

(d) Simultaneously, hepatocytes produce bile, which flows in the opposite direction through tiny canals (canaliculi) toward the bile ducts.

(e) This intricate architecture ensures that every hepatocyte is in constant contact with the blood, allowing the liver to act as the body's primary chemical processing plant. Without this lobular organization, the liver would be unable to maintain the homeostatic balance required for survival.

Final Answer: The unit is the Hepatic lobule.

Answer: (B)

Go Back to Question 76

Q77.

Solution

Concept:

The survival of a cell depends on its ability to extract energy from nutrients. This energy is stored in a universal molecular currency known as Adenosine Triphosphate (ATP). The majority of ATP production occurs through a complex series of reactions that require oxygen, localized within a specific double-membraned organelle.

Solution:

(a) Mitochondria are known as the "powerhouses of the cell." They are unique organelles with their own DNA and ribosomes, suggesting an evolutionary origin from ancient bacteria.

(b) Their primary function is aerobic respiration, specifically the Krebs Cycle and the Electron Transport Chain. These processes take place in the mitochondrial matrix and on the inner membrane, which is folded into cristae to increase the available surface area for enzyme activity.

(c) During these reactions, the energy stored in the chemical bonds of glucose and fatty acids is converted into ATP. This molecule then travels to other parts of the cell to power everything from muscle contraction to DNA repair.

(d) The number of mitochondria in a cell varies based on its metabolic activity. For example, heart muscle cells and sperm cells are packed with mitochondria, whereas skin cells have relatively few.

(e) By compartmentalizing these high-energy reactions, mitochondria prevent the release of dangerous reactive oxygen species into the main cytoplasm, thereby protecting the cell's delicate machinery while providing the fuel needed for life.

Final Answer: The organelle is Mitochondria.

Answer: (B)

Go Back to Question 77

Q78.

Solution

Concept:

Photosynthesis is the fundamental biological process by which plants convert light energy into chemical energy. While it can occur in any green part of a plant containing chlorophyll, evolution has produced specialized organs optimized for gas exchange and light absorption.

Solution:

(a) The leaves are the primary organs of photosynthesis in most plants. Their broad, flat shape (lamina) provides a large surface area to capture sunlight, while their thin profile ensures that light can reach all the internal layers.

(b) Inside the leaf, the mesophyll tissue is specifically designed for this process. It contains a high concentration of chloroplasts, the organelles where photosynthesis actually takes place.

(c) The upper layer, called the palisade mesophyll, consists of tightly packed cells that catch the majority of direct light. The lower layer, the spongy mesophyll, has large air spaces that allow for the efficient diffusion of carbon dioxide and oxygen.

(d) The stomata, located mainly on the underside of the leaf, regulate the entry of carbon dioxide needed for the Calvin cycle and the exit of the oxygen byproduct.

(e) Without leaves, plants would be unable to produce the sugars required for growth and reproduction. Although some desert plants like cacti perform photosynthesis in their stems to conserve water, the leaf remains the most efficient photosynthetic factory in the plant kingdom.

Final Answer: The majority occurs in the Leaves.

Answer: (C)

Go Back to Question 78

Q79.

Solution

Concept:

Maintaining a stable concentration of glucose in the blood is critical because the brain and other organs rely on it as their primary energy source. This regulation is managed by a pair of hormones produced in the islets of Langerhans within the pancreas.

Solution:

(a) Insulin is a peptide hormone secreted by the beta cells of the pancreas. Its main role is to lower blood glucose levels when they become too high, such as after a meal.

(b) Insulin acts like a key that unlocks the cells of the body. It binds to receptors on the surface of muscle and fat cells, triggering the insertion of glucose transporters (GLUT4) into the cell membrane.

(c) This allows glucose to move from the bloodstream into the cells, where it is either used for energy or stored as glycogen in the liver and muscles.

(d) Furthermore, insulin inhibits the liver from producing more glucose from non-carbohydrate sources, ensuring that the blood sugar concentration does not spiral out of control.

(e) If the body does not produce enough insulin, or if the cells become resistant to its effects, glucose remains in the blood, leading to the condition known as Diabetes mellitus. This highlights insulin's central role in metabolic homeostasis and long-term health.

Final Answer: Decreases blood glucose levels.

Answer: (B)

Go Back to Question 79

Q80.

Solution

Concept:

Vitamins are essential micronutrients that the body cannot synthesize in sufficient quantities. They are classified into two groups based on their solubility: water-soluble vitamins (B-complex and C) and fat-soluble vitamins (A, D, E, and K). This classification determines how they are absorbed, transported, and stored.

Solution:

(a) Vitamin K is a fat-soluble vitamin. Unlike water-soluble vitamins, which are easily excreted in urine and must be consumed daily, fat-soluble vitamins are absorbed along with dietary fats in the small intestine.

(b) Once absorbed, they are stored in the body's fatty tissues and the liver. This storage allows the body to maintain a reserve, meaning daily intake is not always necessary, but it also increases the risk of toxicity if consumed in excessive amounts.

(c) Vitamin K is primarily known for its role in blood coagulation. It is a necessary cofactor for the synthesis of several proteins required for the clotting cascade, such as prothrombin.

(d) Deficiency in Vitamin K can lead to prolonged bleeding and easy bruising. It is also increasingly recognized for its role in bone health by helping to regulate calcium deposition.

(e) Good dietary sources include green leafy vegetables like spinach and kale. Additionally, beneficial bacteria in the human gut synthesize a form of Vitamin K that contributes significantly to the body's requirements.

Final Answer: Vitamin K.

Answer: (C)

Go Back to Question 80

Q81.

Solution

Concept:

Double fertilization is a sophisticated reproductive mechanism that is unique to the group of plants known as Angiosperms (flowering plants). This process involves two distinct fusion events occurring simultaneously within the embryo sac, ensuring that the development of the nutrient-rich storage tissue is synchronized with the development of the embryo.

Solution:

(a) When a pollen grain lands on the stigma, it germinates and produces a pollen tube that carries two male gametes (sperm cells) toward the ovule. Upon reaching the embryo sac, the pollen tube releases both sperm cells.

(b) The first sperm cell fuses with the egg cell to form a diploid zygote. This event is called syngamy and represents the actual fertilization that eventually gives rise to the new plant embryo.

(c) The second sperm cell moves toward the center of the embryo sac and fuses with the two polar nuclei. Since this involves the fusion of three haploid nuclei, it is termed triple fusion.

(d) The result of triple fusion is a triploid nucleus called the Primary Endosperm Nucleus (PEN). This nucleus divides to form the endosperm, a specialized tissue that provides essential nutrients to the developing embryo.

(e) Because two separate fertilizations occur within the same embryo sac, the process is called double fertilization. This efficient system prevents the plant from wasting energy on nutrient storage unless an embryo has been successfully formed, a key evolutionary advantage of Angiosperms.

Final Answer: Characteristic feature of Angiosperms.

Answer: (D)

Go Back to Question 81

Q82.

Solution

Concept:

Human blood is a complex liquid connective tissue consisting of plasma and various formed elements, including white blood cells, platelets, and red blood cells. Each component has a specialized role, but the transport of respiratory gases is the primary responsibility of the most numerous cell type in the blood.

Solution:

(a) Red blood cells (RBCs), or erythrocytes, are highly specialized for their role as oxygen carriers. In humans and most mammals, mature RBCs are biconcave discs and lack a nucleus. This unique shape increases the surface area for gas exchange and allows them to fold as they pass through narrow capillaries.

(b) The most critical feature of the RBC is the presence of hemoglobin, a complex iron-containing protein. Hemoglobin has a high affinity for oxygen, allowing it to bind readily to O_2 molecules in the lungs where the oxygen concentration is high.

(c) As the blood circulates to the tissues, where oxygen levels are lower, the hemoglobin releases the oxygen. The iron at the center of the heme group is what physically binds the oxygen, which is why iron deficiency can lead to anemia and fatigue.

(d) RBCs also play a role in transporting carbon dioxide back to the lungs, though a significant portion of CO_2 is carried as bicarbonate ions in the plasma.

(e) A typical adult has millions of RBCs per microliter of blood, and each cell lives for about 120 days. The constant production of these cells in the bone marrow is essential for maintaining the aerobic metabolism of every cell in the body.

Final Answer: Red blood cells.

Answer: (C)

Go Back to Question 82

Q83.

Solution

Concept:

Evolutionary biology seeks to explain the diversity of life on Earth and how species change over time. While many scientists contributed to these ideas, the mechanism of natural selection provided the first scientifically rigorous explanation for how adaptation occurs without a conscious designer.

Solution:

(a) Charles Darwin is the scientist most famously associated with the theory of natural selection. In his 1859 book, On the Origin of Species, he proposed that individuals within a population show variations in their traits, and many of these variations are heritable.

(b) Darwin observed that populations produce more offspring than the environment can support, leading to a "struggle for existence." In this competition, individuals with traits better suited to their environment are more likely to survive and reproduce.

(c) This differential reproductive success is the core of natural selection. Over many generations, the advantageous traits become more common in the population, eventually leading to the formation of new species or the significant modification of existing ones.

(d) While Alfred Russel Wallace independently arrived at similar conclusions around the same time, Darwin's extensive collection of evidence from his voyage on the HMS Beagle made his work the definitive foundation of modern evolutionary thought.

(e) It is important to note that Darwin formulated this theory without knowing about the existence of genes. The later integration of Darwinian selection with Mendelian genetics created the modern evolutionary synthesis used by biologists today.

Final Answer: Articulated by Charles Darwin.

Answer: (B)

Go Back to Question 83

Q84.

Solution

Concept:

The immune system is supported by the lymphatic system, which consists of a network of vessels and organs. Lymphoid organs are classified into primary and secondary types based on whether they are involved in the production and maturation of immune cells or the initiation of the actual immune response.

Solution:

(a) Primary lymphoid organs are the sites where lymphocytes (a type of white blood cell) are generated and where they undergo maturation and differentiation. This process ensures that the cells are capable of recognizing foreign antigens while remaining tolerant of the body's own tissues.

(b) The bone marrow is a critical primary lymphoid organ. It is the site of hematopoiesis, where all blood cells, including B-lymphocytes and T-lymphocytes, are produced from stem cells. B-cells also complete their entire maturation process within the bone marrow.

(c) The thymus is the other primary lymphoid organ, where immature T-cells migrate from the bone marrow to mature and become "immunocompetent."

(d) In contrast, secondary lymphoid organs like the spleen, lymph nodes, and Peyer's patches are the "battlegrounds" of the immune system. These are the locations where mature lymphocytes encounter pathogens and initiate an active immune response.

(e) Without the primary lymphoid organs, the body would be unable to replenish its supply of immune cells, leading to severe immunodeficiency. The bone marrow's role in creating the basic building blocks of immunity makes it fundamental to human survival.

Final Answer: The primary lymphoid organ is Bone marrow.

Answer: (B)

Go Back to Question 84

Q85.

Solution

Concept:

The human respiratory system is designed not only for gas exchange but also for the production of sound. As air is exhaled from the lungs, it passes through a specialized structure in the neck that contains delicate membranes capable of vibrating at different frequencies.

Solution:

(a) The larynx is the biological term for the "voice box." It is a hollow, tubular structure located at the top of the trachea (windpipe) and below the pharynx. It is composed primarily of cartilage, including the prominent thyroid cartilage often called the "Adam's apple."

(b) The primary function of the larynx is to protect the lower respiratory tract by closing the airway during swallowing, a task managed by the epiglottis. However, its most recognizable role is phonation, or the production of vocal sounds.

(c) Inside the larynx are two folds of mucous membrane called the vocal cords. When we speak, muscles pull these cords tight, and the air expelled from the lungs causes them to vibrate, creating sound waves.

(d) The pitch of the sound is determined by the tension and length of the vocal cords. Higher tension results in a higher pitch, while relaxed cords produce a lower pitch. This sound is then modified by the tongue, lips, and oral cavity to form speech.

(e) Inflammation of this structure is known as laryngitis, which typically results in hoarseness or a temporary loss of voice. Because the larynx is the gateway to the lungs, maintaining its health is vital for both communication and breathing.

Final Answer: The term is Larynx.

Answer: (B)

Go Back to Question 85

Q86.

Solution

Concept:

Human health is frequently challenged by various pathogens, including bacteria, viruses, fungi, and protozoans. Understanding the specific causative agent for a disease is the first step in medical diagnosis and the development of effective treatment protocols such as antibiotics or vaccinations.

Solution:

(a) Typhoid is a bacterial infection caused by Salmonella typhi. It is primarily spread through contaminated food and water. The pathogen enters the small intestine and then migrates into the bloodstream, causing sustained high fever, weakness, and stomach pain.

(b) Pneumonia is a respiratory infection that inflames the air sacs in one or both lungs. While it can be caused by viruses or fungi, the most common bacterial cause is Streptococcus pneumoniae. The infection leads to the accumulation of fluid or pus in the alveoli, making breathing difficult.

(c) Malaria is a life-threatening disease caused by protozoan parasites of the genus Plasmodium. It is transmitted to humans through the bites of infected female Anopheles mosquitoes. The parasite multiplies in the liver and then infects red blood cells, causing recurring bouts of chills and fever.

(d) Filariasis, specifically lymphatic filariasis (Elephantiasis), is caused by parasitic roundworms. The most common species is Wuchereria bancrofti. These worms are transmitted by mosquitoes and reside in the lymphatic system, often causing severe swelling of the limbs or genitals.

(e) Correctly matching these pathogens to their respective diseases is fundamental in epidemiology. For example, identifying a bacterial versus a protozoan cause dictates whether a patient receives an antibiotic or an antimalarial drug.

Final Answer: (a)-(1), (b)-(2), (c)-(3), (d)-(4).

Answer: (A)

Go Back to Question 86

Q87.

Solution

Concept:

The central dogma of molecular biology describes the flow of genetic information from DNA to RNA and finally to protein. While DNA holds the master blueprint in the nucleus, the actual construction of the protein occurs in the cytoplasm on specialized molecular machines.

Solution:

(a) Ribosomes are the cellular organelles responsible for protein synthesis. They are not membrane-bound, which allows them to be found in both prokaryotic and eukaryotic cells. In eukaryotes, they are found either floating freely in the cytosol or attached to the surface of the Rough Endoplasmic Reticulum.

(b) A ribosome is composed of two subunits: a large subunit and a small subunit, both made of ribosomal RNA (rRNA) and proteins. These subunits come together only when they are actively translating a messenger RNA (mRNA) molecule.

(c) During the process of translation, the ribosome reads the genetic code on the mRNA in groups of three bases called codons. It then facilitates the binding of transfer RNA (tRNA) molecules that carry specific amino acids corresponding to those codons.

(d) The ribosome acts as a catalyst for the formation of peptide bonds between these amino acids, effectively building a polypeptide chain that will eventually fold into a functional protein.

(e) Because proteins are the primary workers of the cell—acting as enzymes, structural components, and signaling molecules—ribosomes are essential for every aspect of cellular life. A cell's protein-making capacity is directly limited by the number of active ribosomes it contains.

Final Answer: The organelle is the Ribosome.

Answer: (B)

Go Back to Question 87

Q88.

Solution

Concept:

A dihybrid cross is a breeding experiment between two organisms that are identical hybrids for two different traits. Gregor Mendel used this method to determine if different traits are inherited together or independently of one another, leading to his Second Law of Inheritance.

Solution:

(a) In Mendel's classic experiment, he crossed pea plants that were homozygous for two traits: round, yellow seeds (RRYY) and wrinkled, green seeds (rryy). The resulting F1 generation was entirely heterozygous (RrYy), showing the dominant traits of round and yellow.

(b) When these F1 plants were allowed to self-pollinate, the F2 generation exhibited four different phenotypes. These included the original parental combinations as well as two new "recombinant" combinations: round-green and wrinkled-yellow.

(c) The standard phenotypic ratio for this F2 generation is 9:3:3:1. Specifically, 9/16 of the plants are dominant for both traits, 3/16 are dominant for the first and recessive for the second, 3/16 are recessive for the first and dominant for the second, and 1/16 are recessive for both.

(d) This predictable mathematical ratio proved the Law of Independent Assortment, which states that the alleles for one trait separate into gametes independently of the alleles for another trait.

(e) This principle holds true as long as the genes for the two traits are located on different chromosomes or are far apart on the same chromosome. The 9:3:3:1 ratio remains the cornerstone of classical genetics for predicting offspring variation in complex crosses.

Final Answer: The ratio is 9:3:3:1.

Answer: (B)

Go Back to Question 88

Q89.

Solution

Concept:

Digestion is the mechanical and chemical breakdown of food into smaller components that can be absorbed into the bloodstream. Chemical digestion does not wait until the food reaches the stomach; it begins the moment food enters the oral cavity through the action of enzymes in the saliva.

Solution:

(a) Salivary Amylase, also known as ptyalin, is the primary enzyme found in human saliva. It is secreted by the three pairs of major salivary glands: the parotid, submandibular, and sublingual glands.

(b) The specific function of salivary amylase is to begin the hydrolysis of starch, a complex carbohydrate (polysaccharide), into simpler sugars like maltose (a disaccharide) and dextrins.

(c) This enzyme works best in a slightly alkaline or neutral environment (pH around 6.8). Because food usually stays in the mouth for a short duration, only about 30 percent of the starch is hydrolyzed here.

(d) Once the food is swallowed and reaches the highly acidic environment of the stomach (pH 1.5 to 2.5), the salivary amylase is denatured and becomes inactive. The digestion of carbohydrates then pauses until it reaches the small intestine.

(e) Despite its brief window of activity, salivary amylase is crucial because it begins the breakdown of the most common energy source in the human diet. It also helps in cleaning the teeth by breaking down starchy food particles that might otherwise encourage bacterial growth.

Final Answer: The enzyme is Salivary Amylase.

Answer: (B)

Go Back to Question 89

Q90.

Solution

Concept:

Recombinant DNA technology, or genetic engineering, relies on the ability to manipulate DNA with extreme precision. Just as a tailor needs scissors and thread to modify a garment, a molecular biologist needs specific tools to cut and paste DNA sequences.

Solution:

(a) Restriction endonucleases are specialized enzymes that "cut" DNA at specific nucleotide sequences known as recognition sites or palindromic sequences. Because of this function, they are commonly referred to as "molecular scissors."

(b) These enzymes were originally discovered in bacteria, where they serve as a defense mechanism against invading viruses (bacteriophages) by cutting the viral DNA into non-functional pieces.

(c) Each restriction enzyme is highly specific; for example, the enzyme EcoRI always cuts at the sequence GAATTC. This specificity allows scientists to isolate exact genes or segments of DNA from a complex genome.

(d) Depending on how they cut, these enzymes can produce "blunt ends" or "sticky ends." Sticky ends are particularly useful in biotechnology because they can easily base-pair with complementary sequences, allowing different DNA fragments to be joined together using another enzyme called DNA ligase (the "molecular glue").

(e) The discovery of these molecular scissors revolutionized biology, enabling the creation of genetically modified organisms (GMOs), the production of human insulin in bacteria, and the development of gene therapies to treat hereditary diseases.

Final Answer: Also known as Molecular scissors.

Answer: (B)

Go Back to Question 90

Q91.

Solution

Concept:

Nucleic acids, namely DNA and RNA, are the primary informational molecules in all living organisms. While they share a similar structural backbone composed of sugar and phosphate groups, they differ in their sugar component and in one of the four nitrogenous bases that make up their genetic code.

Solution:

(a) Both DNA and RNA utilize the purine bases Adenine and Guanine, as well as the pyrimidine base Cytosine. However, the second pyrimidine base differs between the two molecules.

(b) In DNA, the partner for Adenine is Thymine. In RNA, Thymine is replaced by Uracil. This means that while DNA contains the base pair A-T, RNA contains the base pair A-U during processes like transcription or in double-stranded RNA viruses.

(c) Chemically, Uracil is very similar to Thymine, but it lacks a methyl group at the C5 position. This subtle difference makes Uracil energetically "cheaper" for the cell to produce, which is beneficial since RNA is often produced in large quantities and frequently degraded.

(d) The presence of Thymine in DNA instead of Uracil provides a significant advantage for long-term genetic stability. Cytosine can spontaneously deaminate to form Uracil. If DNA naturally contained Uracil, the repair enzymes would not be able to distinguish between a "natural" Uracil and one formed by the damage of Cytosine.

(e) By using Thymine, the cell's repair machinery can easily identify any Uracil in the DNA as a mutation and correct it back to Cytosine, ensuring the high fidelity of the genetic blueprint over generations.

Final Answer: The base is Uracil.

Answer: (C)

Go Back to Question 91

Q92.

Solution

Concept:

The human digestive system is a long, continuous tube through which food must travel to be processed. Because humans do not always eat in a position where gravity can assist this movement, the body relies on a specialized involuntary muscular action to ensure that food moves in one direction from the esophagus to the rectum.

Solution:

(a) Peristalsis is the series of wave-like muscle contractions and relaxations that moves food through the digestive tract. It is controlled by the autonomic nervous system and begins the moment a bolus of food is swallowed and enters the esophagus.

(b) The process involves two layers of smooth muscle: circular muscles and longitudinal muscles. When the circular muscles contract behind the food bolus, they squeeze it forward, while the longitudinal muscles ahead of the bolus shorten the tube to receive it.

(c) This rhythmic coordination ensures that digestion continues efficiently even if a person is lying down or, theoretically, standing on their head. It occurs not only in the esophagus but also in the stomach and the small and large intestines.

(d) In the stomach, these contractions also serve a mechanical purpose, mixing the food with gastric juices to turn it into a semi-liquid state called chyme. In the large intestine, peristalsis helps in the gradual compaction and removal of waste.

(e) If peristalsis is too slow, it can lead to constipation; if it is too fast, it can cause diarrhea. Certain medical conditions or medications can interfere with this "motility," highlighting how essential these rhythmic movements are for nutrient absorption and waste elimination.

Final Answer: The process is Peristalsis.

Answer: (A)

Go Back to Question 92

Q93.

Solution

Concept:

The conversion of solar energy into chemical energy is the foundation of almost all life on Earth. To initiate this process, plants must possess specialized molecules capable of absorbing specific wavelengths of light and funneling that energy into a chemical reaction center.

Solution:

(a) Chlorophyll is the primary green pigment responsible for capturing light energy during photosynthesis. It is located within the thylakoid membranes of chloroplasts. There are several types of chlorophyll, but Chlorophyll a is the essential pigment found in all oxygen-evolving photosynthetic organisms.

(b) The molecular structure of chlorophyll consists of a porphyrin ring with a magnesium atom at its center. This ring is the part that absorbs light. A long lipid-soluble tail, called a phytol chain, anchors the molecule into the thylakoid membrane.

(c) Chlorophyll appears green because it absorbs light most efficiently in the blue and red portions of the electromagnetic spectrum while reflecting green light. This reflected light is what we perceive when we look at a forest or a leaf.

(d) When a photon of light hits a chlorophyll molecule, it excites an electron to a higher energy state. This high-energy electron is then passed through an electron transport chain, eventually generating ATP and NADPH, which are used to build sugar molecules.

(e) Without chlorophyll, plants would be unable to harness the sun's power, and the oxygen levels in our atmosphere would plummet. It is arguably the most important biological pigment because it bridges the gap between the physical energy of the sun and the biological energy of life.

Final Answer: The pigment is Chlorophyll.

Answer: (C)

Go Back to Question 93

Q94.

Solution

Concept:

The human circulatory system is categorized as a "double circulation" system, meaning blood passes through the heart twice for every full circuit of the body. This separation allows the heart to pump deoxygenated blood to the lungs at low pressure and oxygenated blood to the rest of the body at high pressure.

Solution:

(a) The left ventricle is the most powerful chamber of the human heart. Its primary job is to pump oxygenated blood, which has just returned from the lungs, out through the aorta to the entire systemic circulation.

(b) Because the left ventricle must push blood to the furthest extremities of the body—from the brain to the toes—it has walls that are significantly thicker and more muscular than those of the right ventricle.

(c) During the phase of the cardiac cycle called systole, the left ventricle contracts with immense force. This pressure is what we measure as the "systolic" number in a blood pressure reading (the higher number).

(d) The oxygenated blood enters the left ventricle from the left atrium through the mitral valve. When the ventricle contracts, the mitral valve closes to prevent backflow, and the aortic valve opens to allow the blood to exit.

(e) Any weakness in the left ventricle, such as in left-sided heart failure, leads to a decrease in the body's oxygen supply and can cause fluid to back up into the lungs. This demonstrates why the structural integrity of this specific chamber is vital for maintaining life and physical activity.

Final Answer: The Left ventricle.

Answer: (B)

Go Back to Question 94

Q95.

Solution

Concept:

Proteins are large, complex macromolecules composed of long chains of amino acids. The specific sequence and linkage of these amino acids determine the protein's final three-dimensional shape and its biological function. The connection between these individual units is a specific type of covalent bond.

Solution:

(a) A peptide bond is the chemical bond formed between two amino acid molecules. Specifically, it occurs when the carboxyl group (–COOH) of one amino acid reacts with the amino group (–NH2) of the next amino acid.

(b) This reaction is a dehydration synthesis or condensation reaction, meaning that a molecule of water (H_2O) is released during the formation of the bond. The resulting linkage is a carbon-to-nitrogen bond ($C - N$).

(c) When many amino acids are linked together by peptide bonds, the resulting chain is called a polypeptide. A functional protein may consist of one or more such polypeptide chains that have been folded into a specific configuration.

(d) Peptide bonds are remarkably stable and provide the "backbone" of the protein structure. They are relatively rigid and planar, which limits the ways the chain can rotate and helps dictate the secondary structures like alpha-helices and beta-pleated sheets.

(e) In the body, enzymes called proteases can break these bonds through a process called hydrolysis (adding water back), which occurs during digestion. Understanding the peptide bond is fundamental to biochemistry, as it is the basic "stitch" that holds the fabric of life together.

Final Answer: The bond is a Peptide bond.

Answer: (B)

Go Back to Question 95

Q96.

Solution

Concept:

Skeletal muscles are composed of bundles of long, cylindrical cells called muscle fibers. To understand how a muscle actually contracts, one must look at the microscopic arrangement of overlapping protein filaments within these fibers. This arrangement is organized into repeating units that represent the smallest unit capable of contraction.

Solution:

(a) The sarcomere is the functional unit of contraction in a skeletal muscle fiber. It is the segment of a myofibril located between two successive Z-lines. When viewed under a microscope, the repeating pattern of sarcomeres gives skeletal and cardiac muscle their characteristic striated (striped) appearance.

(b) A sarcomere contains two primary types of protein filaments: thick filaments made of myosin and thin filaments made of actin. The interaction between these two proteins is what drives muscle movement.

(c) According to the Sliding Filament Theory, during muscle contraction, the myosin heads attach to the actin filaments and pull them toward the center of the sarcomere. This action shortens the sarcomere, which in turn shortens the myofibril and the entire muscle.

(d) The sarcomere is also divided into different bands and zones. The A-band contains the full length of the thick filaments, while the I-band contains only thin filaments. The H-zone is the central part of the A-band where no actin is present when the muscle is at rest.

(e) Understanding the sarcomere is essential for medicine and physiology, as many muscular diseases and the effects of fatigue are rooted in the breakdown or dysfunction of these microscopic contractile units.

Final Answer: The unit is the Sarcomere.

Answer: (A)

Go Back to Question 96

Q97.

Solution

Concept:

Plants are living organisms that perform two distinct gaseous exchange processes: photosynthesis and respiration. While photosynthesis only occurs in the presence of light, respiration is a continuous process that happens twenty-four hours a day to provide the energy needed for cellular maintenance.

Solution:

(a) During the day, both photosynthesis and respiration occur simultaneously. In bright sunlight, the rate of photosynthesis is much higher than the rate of respiration. Therefore, the carbon dioxide produced by respiration is immediately reused for photosynthesis, and the excess oxygen is released into the atmosphere.

(b) At night, however, the light-dependent reactions of photosynthesis stop because there is no solar energy. As a result, the plant no longer consumes carbon dioxide or produces oxygen.

(c) Respiration continues throughout the night to keep the plant alive. In this process, the plant consumes oxygen and breaks down stored sugars to produce energy, releasing carbon dioxide as a metabolic byproduct.

(d) Because there is no photosynthesis to "recycle" this carbon dioxide, the gas diffuses out of the leaves through the stomata and into the surrounding air. This is the biological reason behind the traditional advice not to sleep under large trees at night in unventilated areas.

(e) This shift in gas exchange is a critical part of the global carbon cycle. While plants are overall "carbon sinks" because they take in more CO_2 than they release over their lifetime, their nocturnal release of carbon dioxide is a fundamental aspect of their daily metabolic rhythm.

Final Answer: Carbon dioxide (CO_2).

Answer: (B)

Go Back to Question 97

Q98.

Solution

Concept:

Evolution is often perceived as a slow process taking millions of years, but certain environmental changes can cause rapid shifts in a population's characteristics. One of the best-documented examples of this occurred in England during the 19th century, involving the peppered moth (Biston betularia).

Solution:

(a) Industrial Melanism refers to the evolutionary process in which a species develops darker pigmentation (melanism) as a result of industrial pollution. This is a classic, real-world example of natural selection in action.

(b) Before the Industrial Revolution, the light-colored version of the peppered moth was more common because it was well-camouflaged against the light-colored lichens covering the tree trunks. Darker moths were rare and easily spotted by birds.

(c) As the Industrial Revolution progressed, heavy soot from coal-burning factories killed the lichens and blackened the tree trunks. In this new environment, the light moths became easy prey, while the rare dark (melanic) moths were suddenly better camouflaged.

(d) Consequently, the dark moths survived longer and produced more offspring. Within a few decades, the population shifted from being predominantly light to being predominantly dark.

(e) This phenomenon demonstrates that "fitness" is not an absolute quality but depends entirely on the environment. When pollution controls were later implemented and trees became cleaner, the population shifted back toward the light-colored variety, further proving that natural selection favors those individuals best adapted to their current surroundings.

Final Answer: Example of Natural Selection.

Answer: (C)

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Q99.

Solution

Concept:

When the human body encounters a sudden threat or a stressful situation, the nervous system triggers an immediate physiological response to prepare the individual for action. This response is coordinated by the endocrine system, which releases a powerful chemical messenger into the bloodstream to alter the function of multiple organs simultaneously.

Solution:

(a) Adrenaline, also known as Epinephrine, is known as the "fight or flight" hormone. It is secreted by the adrenal medulla, which is the inner part of the adrenal glands located on top of the kidneys.

(b) In response to stress, fear, or excitement, adrenaline is rapidly released. It causes the heart rate to increase and the airways to dilate, ensuring that the muscles and brain receive a surge of oxygen-rich blood.

(c) It also stimulates the liver to break down glycogen into glucose, providing an immediate burst of energy. At the same time, it redirects blood flow away from non-essential systems like digestion and toward the skeletal muscles.

(d) Other effects include the dilation of pupils to improve vision and the stimulation of sweat glands to help cool the body during exertion. These changes happen almost instantaneously, allowing a person to either confront a danger or flee from it.

(e) Once the threat has passed, the levels of adrenaline gradually decrease, and the parasympathetic nervous system works to return the body to a state of rest and digest. This hormone is a vital evolutionary tool that has helped humans survive life-threatening situations throughout history.

Final Answer: Adrenaline (Epinephrine).

Answer: (B)

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Q100.

Solution

Concept:

Ecology involves the study of how different species interact within a shared environment. These interactions can be beneficial to both, harmful to one, or, in some cases, beneficial to one species while leaving the other completely unaffected. These relationships are classified based on the "net gain" or "loss" for the participants.

Solution:

(a) Commensalism is a type of symbiotic relationship where one species (the commensal) derives a benefit, while the other species (the host) is neither helped nor harmed. It is represented by a (+, 0) interaction.

(b) A classic example of commensalism is an epiphytic orchid growing on a branch of a larger tree, such as a mango or mahua tree. The orchid benefits significantly because the height of the tree allows it to reach better sunlight and air, which it might not get on the dark forest floor.

(c) The tree, however, derives no benefit from the orchid's presence. Crucially, the orchid is not a parasite; it does not take nutrients or water from the tree's vascular system. It simply uses the tree as physical support.

(d) Because the orchid's roots are designed to absorb moisture and nutrients from the air and rain, and its small size does not weigh down or shade the tree significantly, the host tree remains unaffected.

(e) Other examples of commensalism include barnacles attached to whales or cattle egrets following grazing livestock. Understanding these nuances is important for conservation, as it shows how certain species depend on the structural complexity of an ecosystem without necessarily taxing the resources of their hosts.

Final Answer: The relationship is Commensalism.

Answer: (C)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	B	3	A	4	A	5	C
6	A	7	A	8	A	9	B	10	C
11	B	12	C	13	B	14	C	15	A
16	B	17	C	18	B	19	C	20	B
21	B	22	B	23	B	24	C	25	C
26	A	27	B	28	C	29	C	30	C
31	C	32	C	33	B	34	C	35	B
36	B	37	A	38	C	39	C	40	A
41	C	42	C	43	B	44	B	45	B
46	B	47	C	48	B	49	C	50	C
51	C	52	B	53	C	54	C	55	B
56	D	57	C	58	C	59	C	60	A
61	B	62	A	63	B	64	C	65	B
66	B	67	D	68	B	69	A	70	B
71	B	72	B	73	B	74	B	75	B
76	B	77	B	78	C	79	B	80	C
81	D	82	C	83	B	84	B	85	B
86	A	87	B	88	B	89	B	90	B
91	C	92	A	93	C	94	B	95	B
96	A	97	B	98	C	99	B	100	C