MHT-CET Biology Sample Paper-3

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. A researcher observes a plant cell with a thick lignified secondary wall and noticed the absence of a protoplast at maturity. Upon further investigation, the cell is found to be elongated with tapering ends. This cell is most likely:

(A) A parenchyma cell involved in storage

(B) A tracheid involved in water conduction

(C) A sieve tube element involved in translocation

(D) A collenchyma cell providing mechanical support

Q2. In the context of C4 plants, the primary CO2 fixation occurs in the mesophyll cells via PEP carboxylase. Which of the following best describes the subsequent movement of the four-carbon acid?

(A) It moves to bundle sheath cells to release CO2 for the Calvin cycle

(B) It remains in the mesophyll to be converted into glucose directly

(C) It moves to the epidermis to prevent photorespiration

(D) It is stored in the vacuole until nighttime fixation

Q3. During the process of double fertilization in angiosperms, if the male gamete fuses with the secondary nucleus, the resulting structure will be:

(A) A diploid zygote

(B) A haploid endosperm

(C) A triploid primary endosperm nucleus

(D) A diploid nucellus

Q4. Which of the following hormones is responsible for the "triple response" in plants, including the inhibition of stem elongation and the promotion of lateral expansion?

(A) Abscisic acid

(B) Gibberellic acid

(C) Ethylene

(D) Cytokinin

Q5. A mutation occurs in the lac operon such that the repressor protein cannot bind to the operator. In the absence of lactose, what will be the state of the operon?

(A) It will be constitutively active

(B) It will remain permanently repressed

(C) It will only be active in the presence of glucose

(D) It will degrade immediately

Q6. Arrange the following steps of the Human Cardiac Cycle in the correct chronological order starting from the Atrial Systole: (i) Ventricular Diastole (ii) Ventricular Systole (iii) Joint Diastole (iv) Atrial Systole.

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

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

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

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

Q7. Arrange the following taxonomic categories in descending order of their hierarchy: (i) Family (ii) Class (iii) Order (iv) Genus (v) Phylum.

(A) (v) → (ii) → (iii) → (i) → (iv)

(B) (ii) → (v) → (iii) → (i) → (iv)

(C) (v) → (iii) → (ii) → (iv) → (i)

(D) (iv) → (i) → (iii) → (ii) → (v)

Q8. Consider the following statements regarding Glycolysis: Statement 1: It occurs in the mitochondrial matrix. Statement 2: The net gain of ATP molecules is two. Determine the truth value:

(A) Statement 1 is True, Statement 2 is False

(B) Statement 1 is False, Statement 2 is True

(C) Both statements are True

(D) Both statements are False

Q9. Consider the following statements regarding DNA Replication: Statement 1: DNA polymerase adds nucleotides in the 3' to 5' direction. Statement 2: The leading strand is synthesized continuously. Determine the truth value:

(A) Statement 1 is True, Statement 2 is True

(B) Statement 1 is True, Statement 2 is False

(C) Statement 1 is False, Statement 2 is True

(D) Statement 1 is False, Statement 2 is False

Q10. In the human respiratory system, the partial pressure of oxygen (pO_2) in the alveoli compared to the deoxygenated blood in the pulmonary artery is:

(A) Lower

(B) Higher

(C) Equal

(D) Twice as low

Q11. Which of the following is the correct sequence of layers in the gut wall from the outermost to the innermost side?

(A) Serosa → Muscularis → Sub-mucosa → Mucosa

(B) Mucosa → Sub-mucosa → Muscularis → Serosa

(C) Serosa → Mucosa → Sub-mucosa → Muscularis

(D) Sub-mucosa → Muscularis → Mucosa → Serosa

Q12. A person suffers from an autoimmune disorder where the body attacks the acetylcholine receptors at the neuromuscular junction. This condition is known as:

(A) Muscular dystrophy

(B) Myasthenia gravis

(C) Tetany

(D) Arthritis

Q13. During the process of gel electrophoresis, DNA fragments move towards the anode because:

(A) DNA is positively charged

(B) DNA is negatively charged

(C) DNA is neutral but moves with the buffer flow

(D) DNA fragments are separated by their color

Q14. Restriction enzymes are often called "molecular scissors" because they:

(A) Join two DNA strands together

(B) Cleave phosphodiester bonds at specific sequences

(C) Synthesize RNA from DNA templates

(D) Remove introns from primary transcripts

Q15. Match List-I (Interaction) with List-II (Species A / Species B):

List-I	List-II
(i) Mutualism	(a) (+, 0)
(ii) Commensalism	(b) (+, +)
(iii) Parasitism	(c) (-, 0)
(iv) Amensalism	(d) (+, -)

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

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

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

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

Q16. Identify the correct statement(s) regarding the Henle's Loop in the Nephron: I. The descending limb is permeable to water but impermeable to electrolytes. II. The ascending limb is impermeable to water but allows transport of electrolytes.

(A) Only I is correct

(B) Only II is correct

(C) Both I and II are correct

(D) Neither I nor II is correct

Q17. Identify the correct statement regarding Ecological Pyramids: I. The pyramid of energy is always upright. II. The pyramid of biomass in a sea is generally inverted.

(A) Only I is correct

(B) Only II is correct

(C) Both I and II are correct

(D) Neither I nor II is correct

Q18. The term "Humification" refers to the process in decomposition where:

(A) Dark colored amorphous substance is formed

(B) Inorganic nutrients are released into the soil

(C) Detritus is broken into smaller particles

(D) Water soluble nutrients go down into the soil horizon

Q19. In a population, if the rate of addition of new individuals is higher than the rate of loss of individuals, the age pyramid will show:

(A) A broad base

(B) A narrow base

(C) An urn shape

(D) A bell shape

(E) A stable population

Q20. The Hardy-Weinberg equilibrium is affected by which of the following factors?

(A) Random mating

(B) Large population size

(C) Gene flow and Genetic drift

(D) Absence of mutation

Q21. What is the primary function of the Leydig cells found in the human testes?

(A) To provide nourishment to sperms

(B) To synthesize and secrete testicular hormones (androgens)

(C) To undergo meiotic division for sperm production

(D) To form the blood-testis barrier

Q22. Which of the following represents the correct floral formula of the family Solanaceae?

(A) $\oplus \subsetneq K_{(5)}C_{(5)}A_5\underline{G}_{(2)}$

(B) $\% \subsetneq K_{(5)}C_{1+2+(2)}A_{(9)+1}\underline{G}_1$

(C) $\oplus \subsetneq K_{(5)}C_5A_{(5)}\underline{G}_{(2)}$

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

Q23. If a segment of DNA has 100 adenine and 100 cytosine bases, what will be the total number of nucleotides in that double-stranded segment?

(A) 200

(B) 400

(C) 300

(D) 600

Q24. The hormone Secretin is produced by the Duodenum and its primary action is to:

(A) Stimulate the release of gastric juice

(B) Stimulate the secretion of bicarbonates from the pancreas

(C) Inhibit the contraction of the gall bladder

(D) Stimulate the salivary glands

Q25. A test cross is used to determine the genotype of an individual by crossing it with a:

(A) Homozygous dominant individual

(B) Heterozygous individual

(C) Homozygous recessive individual

(D) Phenotypically similar individual

Q26. The process of photorespiration in C3 plants is initiated by the oxygenase activity of RuBisCO. This process results in the formation of one molecule of 3-PGA and one molecule of:

(A) Phosphoglycolate

(B) Oxaloacetate

(C) Malate

(D) Pyruvate

Q27. Which of the following describes the 'Gause's Competitive Exclusion Principle' most accurately?

(A) Two closely related species competing for the same resources can coexist indefinitely.

(B) Larger organisms always exclude smaller organisms in a shared habitat.

(C) Two closely related species competing for the same resources cannot coexist indefinitely and the competitively inferior one will be eliminated eventually.

(D) Competition always leads to mutualistic evolution between two species.

Q28. In human physiology, the 'Hering-Breuer Reflex' is a mechanism primarily involved in:

(A) Increasing the rate of heart beat during exercise

(B) Preventing the over-inflation of the lungs

(C) Stimulating the secretion of gastric juice

(D) Controlling the movement of food in the esophagus

Q29. If a double stranded DNA has 20% of Cytosine, what will be the percentage of Adenine in it?

(A) 20%

(B) 40%

(C) 30%

(D) 60%

Q30. Which of the following is an example of a 'non-medicated' Intrauterine Device (IUD)?

(A) Lippes loop

(B) CuT

(C) Multiload 375

(D) Progestasert

Q31. The 'Lock and Key' hypothesis of enzyme action suggests that:

(A) Any substrate can bind to any enzyme

(B) The active site of the enzyme is flexible

(C) The enzyme and substrate have complementary geometric shapes

(D) Enzymes are consumed during the chemical reaction

Q32. In an ecosystem, the rate of production of organic matter during photosynthesis is termed as:

(A) Net Primary Productivity

(B) Gross Primary Productivity

(C) Secondary Productivity

(D) Net Community Productivity

Q33. The 'pioneer species' in a primary succession on rocks are usually:

(A) Mosses

(B) Lichens

(C) Ferns

(D) Liverworts

Q34. Which part of the human brain is primarily responsible for maintaining posture and equilibrium?

(A) Cerebrum

(B) Cerebellum

(C) Medulla oblongata

(D) Pons Varolii

Q35. The breakdown of Detritus into smaller particles by earthworms is a process called:

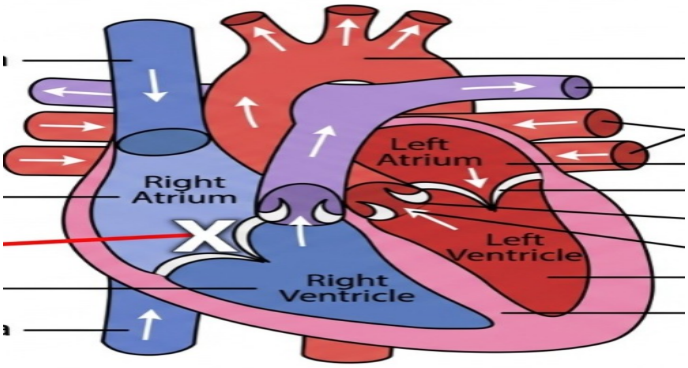
(A) Humification

(B) Mineralization

(C) Catabolism

(D) Fragmentation

Q36. Observe the provided diagram of the human heart. Identify the structure labeled 'X' which prevents the backflow of blood from the right ventricle into the right atrium.



(A) Mitral Valve

(B) Tricuspid Valve

(C) Aortic Valve

(D) Pulmonary Valve

Q37. Match List-I (Genetics terms) with List-II (Definitions):

List-I	List-II
(i) Pleiotropy	(a) Multiple genes control one trait
(ii) Polygenic inheritance	(b) One gene controls multiple traits
(iii) Epistasis	(c) Both alleles express themselves equally
(iv) Codominance	(d) One gene masks the expression of another

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

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

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

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

Q38. Fill in the blanks: In the process of DNA fingerprinting, _____ are used as probes for hybridization, and the separation of DNA fragments is done by _____.

(A) VNTRs, Gel electrophoresis

(B) Plasmids, PCR

(C) Exons, Centrifugation

(D) Introns, Chromatography

Q39. Fill in the blanks: The hormone _____ stimulates the production of RBCs (erythropoiesis), and it is primarily produced by the _____.

(A) Erythropoietin, Kidney

(B) Insulin, Pancreas

(C) Thyroxine, Thyroid

(D) Adrenaline, Adrenal gland

Q40. The specialized parenchyma cells that surround the vascular bundles in C4 plants are known as:

(A) Spongy mesophyll

(B) Palisade mesophyll

(C) Bundle sheath cells

(D) Complementary cells

Q41. In DNA, the two strands are held together by hydrogen bonds between the nitrogenous bases. How many hydrogen bonds are formed between Guanine and Cytosine?

(A) Two

(B) Three

(C) Four

(D) One

Q42. 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 plastics

Q43. Which of the following is the correct sequence of the three steps of PCR?

(A) Extension → Denaturation → Annealing

(B) Denaturation → Annealing → Extension

(C) Annealing → Extension → Denaturation

(D) Denaturation → Extension → Annealing

Q44. The syndrome caused by the presence of an extra copy of chromosome number 21 is:

(A) Turner's syndrome

(B) Klinefelter's syndrome

(C) Down's syndrome

(D) Patau syndrome

Q45. In human males, the hormone that stimulates the process of spermiogenesis is:

(A) FSH

(B) LH

(C) GnRH

(D) Progesterone

Q46. The enzyme used to join bits of DNA together is:

(A) DNA polymerase

(B) DNA ligase

(C) Primase

(D) Helicase

Q47. Which of the following is a structural polysaccharide found in the cell walls of fungi?

(A) Cellulose

(B) Chitin

(C) Glycogen

(D) Starch

Q48. The concentration of a toxicant increases at successive trophic levels. This phenomenon is known as:

(A) Eutrophication

(B) Biomagnification

(C) Bioremediation

(D) Bioaccumulation

Q49. The functional unit of contraction in a muscle fiber is the:

(A) Myofibril

(B) Sarcomere

(C) Sarcoplasm

(D) Fascicle

Q50. Which of the following is NOT an example of ex-situ conservation?

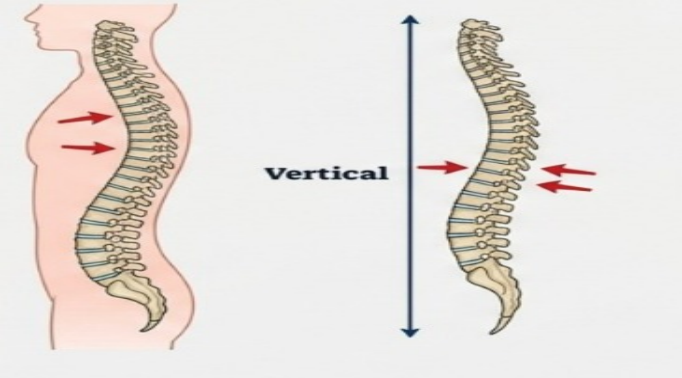
(A) Botanical Gardens

(B) Wildlife Safari Parks

(C) National Parks

(D) Seed Banks

Q51. Observe the image below depicting a specific postural deformity often discussed in Physical Education and Biology. Identify the condition characterized by the abnormal lateral (sideways) curvature of the human spine.



(A) Kyphosis

(B) Lordosis

(C) Scoliosis

(D) Osteoporosis

Q52. Which of the following parts of the human brain acts as the primary relay station for sensory impulses, except for the sense of smell, before they reach the cerebral cortex?

(A) Hypothalamus

(B) Thalamus

(C) Corpus callosum

(D) Hippocampus

Q53. During the process of oogenesis in human females, the first polar body is formed at the completion of:

(A) Mitosis

(B) Meiosis I

(C) Meiosis II

(D) Fertilization

Q54. The volume of air that remains in the lungs even after a forceful expiration is termed as:

(A) Tidal Volume

(B) Residual Volume

(C) Inspiratory Reserve Volume

(D) Vital Capacity

Q55. In a DNA molecule, the distance between two adjacent base pairs is approximately:

(A) 3.4 nm

(B) 0.34 nm

(C) 2 nm

(D) 34 nm

Q56. The enzyme 'ADA' stands for Adenosine Deaminase. The deficiency of this enzyme results in the dysfunction of which system?

(A) Respiratory system

(B) Digestive system

(C) Immune system

(D) Circulatory system

Q57. Which of the following is considered the 'natural pacemaker' of the human heart?

(A) AV Node

(B) Bundle of His

(C) SA Node

(D) Purkinje fibers

Q58. The interaction where one species is inhibited or threatened while the other species remains unaffected is called:

(A) Parasitism

(B) Amensalism

(C) Commensalism

(D) Mutualism

Q59. In the context of the 'Central Dogma' of molecular biology, the process of synthesizing RNA from a DNA template is known as:

(A) Translation

(B) Replication

(C) Transcription

(D) Transformation

Q60. Which plant hormone is primarily responsible for apical dominance, where the central stem grows more strongly than the side stems?

(A) Gibberellin

(B) Cytokinin

(C) Auxin

(D) Abscisic acid

Q61. The condition 'Diabetes Insipidus' is caused due to the deficiency of which hormone?

(A) Insulin

(B) Glucagon

(C) ADH (Vasopressin)

(D) Oxytocin

Q62. Fill in the blanks: In the respiratory system, the site of actual diffusion of gases between blood and atmospheric air is the _____, and the process is driven by _____ gradient.

(A) Alveoli, Pressure

(B) Bronchi, Temperature

(C) Trachea, Concentration

(D) Pleura, Volume

Q63. Fill in the blanks: The _____ is the primary site for the synthesis of Vitamin D in the human body, specifically under the influence of _____ radiation.

(A) Liver, Infrared

(B) Skin, Ultraviolet

(C) Kidney, Gamma

(D) Heart, Visible

Q64. Consider the following statements regarding the Placenta: Statement 1: It acts as an endocrine tissue and produces hCG. Statement 2: It facilitates the supply of oxygen and nutrients to the embryo. Determine which statement is true:

(A) Only Statement 1 is true

(B) Only Statement 2 is true

(C) Both Statement 1 and Statement 2 are true

(D) Neither statement is true

Q65. Consider the following statements regarding Biotechnology: Statement 1: pBR322 is a widely used natural cloning vector in bacteria. Statement 2: Restriction enzymes produce sticky ends to facilitate ligation. Determine which statement is true:

(A) Only Statement 1 is true

(B) Only Statement 2 is true

(C) Both Statement 1 and Statement 2 are true

(D) Neither statement is true

Q66. The sum of total number of individuals of a species per unit area or volume at a given time is known as:

(A) Natality

(B) Mortality

(C) Population Density

(D) Vital Index

Q67. Which type of immunity is responsible for the rejection of a transplanted organ?

(A) Humoral immunity

(B) Cell-mediated immunity

(C) Innate immunity

(D) Passive immunity

Q68. In Mendel's experiments, the phenotypic ratio obtained in a dihybrid cross in the F2 generation is:

(A) 3 : 1

(B) 1 : 2 : 1

(C) 9 : 3 : 3 : 1

(D) 1 : 1 : 1 : 1

Q69. Which of the following is a 'Stop Codon' that signals the termination of protein synthesis?

(A) AUG

(B) UAA

(C) GGG

(D) CCC

Q70. The conversion of ammonia to nitrates by bacteria in the soil is called:

(A) Nitrogen fixation

(B) Nitrification

(C) Denitrification

(D) Ammonification

Q71. Which part of the human eye contains the sensory receptors (rods and cones)?

(A) Sclera

(B) Cornea

(C) Retina

(D) Choroid

Q72. What is the primary function of the 'Corpus Luteum' in the human female reproductive system?

(A) To produce Estrogen only

(B) To produce Progesterone

(C) To stimulate Ovulation

(D) To nourish the Primary Oocyte

Q73. In genetic engineering, the 'Ti-plasmid' used for gene transfer in plants is obtained from:

(A) Escherichia coli

(B) Agrobacterium tumefaciens

(C) Bacillus thuringiensis

(D) Thermus aquaticus

Q74. The 'Lubb' sound of the heart is produced during the closure of:

(A) Semilunar valves

(B) AV valves (Tricuspid and Bicuspid)

(C) Aortic valve

(D) Pulmonary valve

Q75. Which of the following is an example of a vestigial organ in humans?

(A) Heart

(B) Vermiform Appendix

(C) Pancreas

(D) Gall bladder

Q76. Fill in the blanks: The primary lymphoid organs in humans are the _____ and the _____ where immature lymphocytes differentiate into antigen-sensitive lymphocytes.

(A) Spleen, Tonsils

(B) Bone marrow, Thymus

(C) Lymph nodes, Peyer's patches

(D) Appendix, Spleen

Q77. Fill in the blanks: In the Lac Operon, the 'i' gene codes for the _____, while the 'z' gene codes for _____.

(A) Inducer, Permease

(B) Repressor, Beta-galactosidase

(C) Operator, Transacetylase

(D) Promoter, Polymerase

Q78. Match List-I (Respiratory Disorders) with List-II (Key Characteristics):

List-I	List-II
(i) Asthma	(a) Alveolar walls are damaged
(ii) Emphysema	(b) Inflammation of bronchi and bronchioles
(iii) Occupational Disorders	(c) Fibrosis of lung tissues
(iv) Bronchitis	(d) Spasm of bronchial muscles

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

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

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

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

Q79. Select the CORRECT statement regarding the structure of a typical Antibody molecule:

(A) It consists of four identical heavy chains.

(B) The antigen-binding site is present only on the light chain.

(C) It is a glycoprotein represented as H2L2.

(D) The chains are held together by ionic bonds.

Q80. Select the CORRECT statement regarding the 'Global Warming' effect:

(A) It is caused primarily by the depletion of the ozone layer.

(B) Carbon dioxide and Methane are the major greenhouse gases.

(C) It leads to a decrease in the average temperature of the Earth.

(D) It has no impact on the sea levels or polar ice caps.

Q81. The term 'Inbreeding Depression' refers to:

(A) Increased fertility due to cross-breeding.

(B) Reduced fertility and productivity due to continued close inbreeding.

(C) The evolution of a new species through mutation.

(D) The process of selection of superior males only.

Q82. Which of the following is a medicinal plant used to obtain the drug 'Reserpine'?

(A) Papaver somniferum

(B) Rauwolfia serpentina

(C) Cannabis sativa

(D) Atropa belladonna

Q83. The 'Double Fertilization' is a unique characteristic feature of:

(A) Algae

(B) Bryophytes

(C) Pteridophytes

(D) Angiosperms

Q84. In human females, the 'Menstrual Phase' is followed by which phase of the ovarian cycle?

(A) Luteal phase

(B) Follicular phase

(C) Secretory phase

(D) Ovulatory phase

Q85. The process of 'Leaching' in decomposition refers to:

(A) The breakdown of detritus by earthworms.

(B) Water-soluble inorganic nutrients going down into the soil horizon.

(C) The accumulation of dark-colored humus.

(D) The release of inorganic nutrients by microbes.

Q86. Which of the following is NOT a component of the 'Nucleoside'?

(A) Pentose sugar

(B) Nitrogenous base

(C) Phosphate group

(D) None of the above

Q87. The enzyme 'Reverse Transcriptase' is used to synthesize:

(A) RNA from DNA

(B) DNA from RNA

(C) Protein from RNA

(D) DNA from DNA

Q88. Which of the following is an 'Autoimmune disease'?

(A) AIDS

(B) Rheumatoid arthritis

(C) Cancer

(D) Malaria

Q89. The technique 'Amniocentesis' is legally used for:

(A) Determining the sex of the unborn child.

(B) Detecting chromosomal abnormalities in the fetus.

(C) Inducing abortion.

(D) Artificial insemination.

Q90. In an ecosystem, the flow of energy is always:

(A) Bidirectional

(B) Multidirectional

(C) Unidirectional

(D) Cyclic

Q91. Which cell organelle is known as the 'Powerhouse of the cell'?

(A) Ribosome

(B) Golgi apparatus

(C) Mitochondria

(D) Lysosome

Q92. The growth curve of a population in an environment with limited resources is:

(A) J-shaped

(B) S-shaped (Sigmoid)

(C) Linear

(D) Vertical

(E)

Q93. Which of the following is the 'Universal Donor' blood group?

(A) AB positive

(B) O negative

(C) A positive

(D) B negative

Q94. The 'Widal Test' is used for the diagnosis of:

(A) Typhoid

(B) Pneumonia

(C) Tuberculosis

(D) Cholera

Q95. In the 'HGP' (Human Genome Project), the smallest chromosome is:

(A) Chromosome 1

(B) Chromosome X

(C) Chromosome Y

(D) Chromosome 21

Q96. The hormone 'Relaxin' is secreted by the _____ during the later phase of pregnancy.

(A) Uterus

(B) Ovary

(C) Pituitary

(D) Adrenal

Q97. Which of the following is a greenhouse gas?

(A) Nitrogen

(B) Oxygen

(C) Methane

(D) Argon

Q98. The 'Statins' used for lowering blood cholesterol are produced by:

(A) Bacteria

(B) Yeast (Monascus purpureus)

(C) Algae

(D) Virus

Q99. Which cranial nerve is the longest and reaches the abdomen?

(A) Optic nerve

(B) Facial nerve

(C) Vagus nerve

(D) Trigeminal nerve

Q100. The 'Origin of Species' was written by:

(A) Lamarck

(B) Charles Darwin

(C) Hugo de Vries

(D) Mendel

Detailed Solutions

Q1.

Solution

Concept:

Plant anatomy distinguishes between different types of tissues based on their structural characteristics and functional roles. Complex permanent tissues like xylem contain specialized cells for water transport. Tracheids and vessels are the primary conducting elements. Tracheids are characterized by their elongated shape, lignified secondary walls, and the fact that they are dead at maturity, meaning they lack a protoplast.

Solution:

(a) The description mentions a thick lignified secondary wall. Lignin is a complex polymer that provides structural rigidity and is a hallmark of sclerenchyma and certain xylem elements.

(b) The absence of a protoplast at maturity indicates the cell is dead. This rules out parenchyma and collenchyma, as these are living tissues at maturity.

(c) The cell is described as elongated with tapering ends. This specific morphology is the defining feature of tracheids. Vessels, by contrast, are typically shorter, wider, and joined end-to-end to form a continuous tube.

(d) Sieve tube elements are living cells (though they lack a nucleus) and are involved in food transport, not primarily structural support or water conduction in the manner described.

(e) Therefore, a dead, lignified, elongated cell with tapering ends in plant tissue is a tracheid.

Final Answer: The cell is a tracheid involved in water conduction.

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept:

Plant physiology distinguishes between C3 and C4 pathways of carbon fixation. C4 plants have evolved a mechanism to minimize photorespiration by spatially separating the initial CO2 fixation and the Calvin cycle. This involves two distinct cell types: mesophyll cells and bundle sheath cells, a structural arrangement known as Kranz anatomy.

Solution:

(a) In the mesophyll cells of C4 plants, atmospheric CO2 is fixed by the enzyme Phospho-enolpyruvate carboxylase (PEPcase) into a four-carbon acid, usually oxaloacetate, which is then converted to malate or aspartate.

(b) These four-carbon acids are not used for glucose synthesis in the mesophyll because these cells lack the enzyme RuBisCO and the complete machinery for the Calvin cycle.

(c) The four-carbon acid is transported through plasmodesmata into the specialized bundle sheath cells.

(d) Inside the bundle sheath cells, the four-carbon acid undergoes decarboxylation to release CO2. This creates a high concentration of CO2 around RuBisCO, effectively outcompeting oxygen and preventing photorespiration.

(e) The released CO2 then enters the standard C3 pathway (Calvin cycle) to produce sugars.

Final Answer: It moves to bundle sheath cells to release CO2 for the Calvin cycle.

Answer: (A)

Go Back to Question 2

Q3.

Solution

Concept:

Double fertilization is a unique and defining feature of angiosperms (flowering plants). It involves two separate fusion events within the embryo sac. One male gamete fuses with the egg cell, while the second male gamete fuses with the central cell containing the two polar nuclei (or the fused secondary nucleus).

Solution:

(a) The embryo sac of a typical angiosperm is a 7-celled, 8-nucleate structure. The central cell contains two haploid polar nuclei.

(b) Prior to or during fertilization, these two polar nuclei often fuse to form a single diploid (2n) secondary nucleus.

(c) Angiosperm pollen grains produce two haploid (n) male gametes.

(d) The first male gamete (n) fuses with the egg cell (n) to form a diploid (2n) zygote, which later develops into the embryo.

(e) The second male gamete (n) fuses with the diploid (2n) secondary nucleus. This process is called triple fusion.

(f) The result of this triple fusion is a triploid (3n) nucleus called the Primary Endosperm Nucleus (PEN), which subsequently develops into the endosperm tissue to provide nutrition to the developing embryo.

Final Answer: A triploid primary endosperm nucleus.

Answer: (C)

Go Back to Question 3

Q4.

Solution

Concept:

Plant growth regulators (hormones) control various physiological responses. Ethylene is a gaseous plant hormone known for its role in fruit ripening and senescence. However, it also induces a specific morphological change in dicot seedlings known as the "triple response," which helps the seedling navigate obstacles in the soil.

Solution:

(a) When a germinating seedling encounters an obstacle (like a stone), it produces ethylene.

(b) The ethylene triggers three distinct growth changes collectively called the triple response.

(c) First, there is a slowing or inhibition of stem (hypocotyl/epicotyl) elongation.

(d) Second, there is a thickening or lateral expansion of the stem, making it sturdier.

(e) Third, there is a horizontal growth habit or the formation of an exaggerated apical hook to protect the delicate meristem as it pushes through the soil.

(f) Abscisic acid is primarily a stress hormone involved in seed dormancy and stomatal closure. Gibberellins promote stem elongation, and Cytokinins promote cell division.

Final Answer: Ethylene.

Answer: (C)

Go Back to Question 4

Q5.

Solution

Concept:

The lac operon is a classic model of gene regulation in prokaryotes. It consists of structural genes (lacZ, lacY, lacA), an operator site, a promoter, and a regulatory gene (lacI) that produces a repressor protein. Normally, the repressor binds to the operator to prevent RNA polymerase from transcribing the genes when lactose is absent.

Solution:

(a) Under normal conditions, in the absence of the inducer (lactose/allolactose), the repressor protein is active and bound to the operator. This blocks transcription.

(b) The question describes a mutation where the repressor protein is unable to bind to the operator site.

(c) If the repressor cannot bind to the operator, there is nothing to stop RNA polymerase from binding to the promoter and initiating transcription.

(d) This means the structural genes will be transcribed and translated regardless of whether lactose is present or absent in the environment.

(e) Such a state, where genes are expressed continuously without regulation, is termed "constitutive expression."

(f) Therefore, the operon will be constitutively active because the negative control mechanism (the repressor) has failed.

Final Answer: It will be constitutively active.

Answer: (A)

Go Back to Question 5

Q6.

Solution

Concept:

The cardiac cycle refers to the sequence of events that occur from the beginning of one heartbeat to the beginning of the next. It involves alternating periods of contraction (systole) and relaxation (diastole). A complete cycle lasts approximately 0.8 seconds and ensures the efficient movement of blood through the four chambers of the heart and out to the lungs and body.

Solution:

(a) The cycle is often described starting with Atrial Systole (iv), where the atria contract to push the remaining 30

(b) This is followed by Ventricular Systole (ii), where the ventricles contract, increasing pressure, closing the AV valves (S1 sound), and pumping blood into the pulmonary artery and aorta.

(c) Once the ventricles finish contracting, they enter Ventricular Diastole (i). During this phase, ventricular pressure drops, causing the semilunar valves to close (S2 sound).

(d) Finally, the heart enters Joint Diastole (iii), where both the atria and ventricles are in a relaxed state, allowing the chambers to fill passively with blood from the veins.

(e) Following this sequence, the correct chronological order is (iv) Atrial Systole → (ii) Ventricular Systole → (i) Ventricular Diastole → (iii) Joint Diastole.

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

Answer: (A)

Go Back to Question 6

Q7.

Solution

Concept:

Taxonomy is the branch of biology concerned with the classification of living organisms. It uses a hierarchical system of categories, known as the Linnaean hierarchy. As we move from the highest level (Kingdom) to the lowest level (Species), the organisms within each group become more similar and share more specific characteristics.

Solution:

(a) The standard taxonomic hierarchy in descending order is: Kingdom, Phylum (for animals) or Division (for plants), Class, Order, Family, Genus, and Species.

(b) Looking at the options provided: (v) Phylum is the highest level listed.

(c) This is followed by (ii) Class.

(d) The next level down is (iii) Order.

(e) This is followed by (i) Family.

(f) Finally, (iv) Genus is the most specific category in this particular list.

(g) Therefore, the descending order is Phylum → Class → Order → Family → Genus.

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

Answer: (A)

Go Back to Question 7

Q8.

Solution

Concept:

Glycolysis is the first stage of cellular respiration, occurring in all living cells. It involves the breakdown of one molecule of glucose into two molecules of pyruvic acid through a series of enzyme-catalyzed reactions. This process does not require oxygen and serves as the foundation for both aerobic and anaerobic respiration.

Solution:

(a) Statement 1 claims Glycolysis occurs in the mitochondrial matrix. This is incorrect. Glycolysis takes place entirely in the cytoplasm (cytosol) of the cell. The subsequent stages, like the Krebs cycle, occur in the mitochondria.

(b) Statement 2 claims the net gain of ATP molecules is two. This is correct. While 4 ATP molecules are produced during the "pay-off" phase of glycolysis, 2 ATP molecules are consumed during the "preparatory" phase.

(c) Calculation: Gross ATP (4) - Consumed ATP (2) = Net ATP (2).

(d) Additionally, 2 molecules of NADH are produced, but the direct ATP gain is indeed 2.

(e) Since Statement 1 is False and Statement 2 is True, option B is the correct choice.

Final Answer: Statement 1 is False, Statement 2 is True.

Answer: (B)

Go Back to Question 8

Q9.

Solution

Concept:

DNA replication is the process by which a double-stranded DNA molecule is copied to produce two identical DNA molecules. It is a semi-conservative process requiring several enzymes, primarily DNA polymerase. Because DNA strands are antiparallel and DNA polymerase can only function in one direction, the two new strands are synthesized differently.

Solution:

(a) Statement 1 says DNA polymerase adds nucleotides in the 3' to 5' direction. This is incorrect. DNA polymerase can only add new nucleotides to the 3' hydroxyl end of a growing strand, meaning it synthesizes DNA exclusively in the 5' to 3' direction.

(b) Statement 2 says the leading strand is synthesized continuously. This is correct. Because the replication fork opens in a direction that allows DNA polymerase to move in its preferred 5' to 3' direction on one template, that strand (the leading strand) is made without interruption.

(c) The other strand, the lagging strand, must be synthesized in short segments called Okazaki fragments because the template runs in the opposite direction.

(d) Therefore, Statement 1 is False and Statement 2 is True.

Final Answer: Statement 1 is False, Statement 2 is True.

Answer: (C)

Go Back to Question 9

Q10.

Solution

Concept:

Gas exchange in the human body occurs through simple diffusion across the respiratory membrane in the alveoli. Diffusion is driven by a partial pressure gradient, where gases move from an area of higher partial pressure to an area of lower partial pressure until equilibrium is reached.

Solution:

(a) In the alveoli, the partial pressure of oxygen (pO_2) is approximately 104 mm Hg because of the constant intake of fresh atmospheric air.

(b) Deoxygenated blood arriving at the lungs via the pulmonary artery has a low pO_2, typically around 40 mm Hg, because the oxygen has been consumed by the body's tissues.

(c) Because the pO_2 in the alveoli (104 mm Hg) is significantly higher than the pO_2 in the deoxygenated blood (40 mm Hg), oxygen naturally diffuses from the alveoli into the blood capillaries.

(d) This gradient ensures that blood becomes oxygenated before leaving the lungs via the pulmonary vein.

(e) Thus, the pO_2 in the alveoli is higher than in the pulmonary artery.

Final Answer: Higher.

Answer: (B)

Go Back to Question 10

Q11.

Solution

Concept:

The wall of the alimentary canal from the esophagus to the rectum possesses four distinct histological layers. Understanding the arrangement of these layers is fundamental to human physiology and histology. Each layer serves a specific functional purpose, ranging from protection and secretion to mechanical contraction and structural support.

Solution:

(a) The outermost layer is the Serosa. It is composed of a thin mesothelium with some connective tissues and provides a protective outer covering for the visceral organs.

(b) Beneath the serosa lies the Muscularis layer. This is typically arranged into an inner circular and an outer longitudinal layer of smooth muscles. In the stomach, an additional oblique muscle layer may be present. This layer is responsible for peristaltic movements.

(c) The next layer moving inward is the Sub-mucosa. This layer consists of loose connective tissues containing nerves, blood vessels, and lymph vessels. In the duodenum, glands are also found in this layer.

(d) The innermost lining of the lumen of the alimentary canal is the Mucosa. This layer is involved in absorption and secretion, forming irregular folds (rugae) in the stomach and small finger-like foldings (villi) in the small intestine.

(e) Therefore, the correct sequence from outside to inside is Serosa → Muscularis → Sub-mucosa → Mucosa.

Final Answer: Serosa → Muscularis → Sub-mucosa → Mucosa.

Answer: (A)

Go Back to Question 11

Q12.

Solution

Concept:

Myasthenia gravis is a chronic autoimmune neuromuscular disease that causes weakness in the skeletal muscles, which are responsible for breathing and moving parts of the body, including the arms and legs. It is characterized by muscle weakness that worsens after periods of activity and improves after periods of rest.

Solution:

(a) In a healthy individual, a nerve impulse triggers the release of the neurotransmitter acetylcholine from the nerve terminal. Acetylcholine then travels across the neuromuscular junction and binds to acetylcholine receptors on the muscle cell, causing contraction.

(b) In Myasthenia gravis, the body's immune system produces antibodies that block, alter, or destroy the receptors for acetylcholine at the neuromuscular junction.

(c) Because the muscle cannot receive the chemical signal properly, it fails to contract effectively, leading to drooping eyelids, difficulty swallowing, and overall muscle fatigue.

(d) Muscular dystrophy is a genetic disorder involving progressive muscle degeneration. Tetany is caused by low calcium levels leading to wild muscle contractions. Arthritis is the inflammation of joints.

(e) Since the condition specifically involves the immune system attacking acetylcholine receptors, it is identified as Myasthenia gravis.

Final Answer: Myasthenia gravis.

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept:

Gel electrophoresis is a fundamental technique in biotechnology used to separate macromolecules like DNA, RNA, or proteins based on their size and charge. Since DNA molecules have a consistent charge-to-mass ratio, the primary factor determining the rate of migration through the gel matrix (usually agarose) is the physical size of the fragment.

Solution:

(a) DNA (Deoxyribonucleic acid) contains a sugar-phosphate backbone. The phosphate groups in this backbone are negatively charged at physiological pH levels.

(b) During gel electrophoresis, an electric field is applied across the gel.

(c) In physics, like charges repel and opposite charges attract. Therefore, the negatively charged DNA molecules will naturally migrate away from the negative electrode (cathode) and toward the positive electrode (anode).

(d) As the DNA fragments move toward the anode, the porous gel matrix acts as a sieve. Smaller fragments navigate the pores more easily and travel further, while larger fragments move more slowly and remain closer to the starting wells.

(e) The movement is purely driven by the electrical attraction of the negative phosphate groups toward the positive pole.

Final Answer: DNA is negatively charged.

Answer: (B)

Go Back to Question 13

Q14.

Solution

Concept:

Restriction endonucleases, popularly known as "molecular scissors," are enzymes produced by bacteria as a defense mechanism against bacteriophages. In the field of recombinant DNA technology, they are indispensable tools used for precise genetic engineering by allowing scientists to cut DNA at specific, predictable locations.

Solution:

(a) Every restriction enzyme recognizes a specific palindromic nucleotide sequence in the DNA, known as a recognition site.

(b) Once the enzyme finds its specific sequence, it binds to the DNA and cuts each of the two strands of the double helix.

(c) The chemical bond that is broken is the phosphodiester bond, which links the 3' carbon of one sugar molecule to the 5' carbon of another in the DNA backbone.

(d) By breaking these bonds at specific points, the enzyme creates "blunt ends" or "sticky ends" (overhangs), which can later be joined to other DNA fragments using the enzyme DNA ligase.

(e) They do not synthesize RNA, nor do they primarily remove introns; their defining characteristic is the specific cleavage of the DNA backbone.

Final Answer: Cleave phosphodiester bonds at specific sequences.

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept:

Biological interactions describe the relationships between different species within an ecosystem. These interactions are categorized based on whether they are beneficial (+), harmful (-), or neutral (0) to the participants involved. Understanding these dynamics is crucial for studying community ecology and population regulation.

Solution:

(a) Mutualism: This is an obligate or facultative interaction where both species benefit. For example, lichens (fungi and algae). The representation is (+, +).

(b) Commensalism: In this interaction, one species benefits while the other is neither helped nor harmed. An example is an orchid growing on a mango branch. The representation is (+, 0).

(c) Parasitism: One species (the parasite) benefits at the expense of the other (the host), which is harmed. An example is liver flukes in humans. The representation is (+, -).

(d) Amensalism: This is an interaction where one species is harmed while the other remains unaffected. An example is Penicillium producing chemicals that kill bacteria without benefiting the fungus directly. The representation is (-, 0).

(e) Matching the lists: (i) Mutualism matches (b), (ii) Commensalism matches (a), (iii) Parasitism matches (d), and (iv) Amensalism matches (c).

Final Answer: (i)-(b), (ii)-(a), (iii)-(d), (iv)-(c).

Answer: (A)

Go Back to Question 15

Q16.

Solution

Concept:

The Loop of Henle is a critical segment of the nephron responsible for the concentration of urine through a countercurrent multiplier system. It consists of two limbs with distinct permeability characteristics that allow the kidney to create an osmotic gradient in the medullary interstitium.

Solution:

(a) The descending limb of the Loop of Henle is highly permeable to water molecules but almost completely impermeable to electrolytes like sodium and chloride. As filtrate flows down into the salty medulla, water leaves the tubule by osmosis.

(b) The ascending limb of the Loop of Henle has opposite properties; it is impermeable to water but allows the transport of electrolytes, either passively in the thin segment or actively in the thick segment.

(c) Statement I in the question correctly identifies the permeability of the descending limb to water and its impermeability to electrolytes.

(d) Statement II correctly identifies that the ascending limb does not allow water to pass but does facilitate the movement of electrolytes.

(e) Because both statements accurately describe the physiological properties of these segments, the correct option is that both are correct.

Final Answer: Both I and II are correct.

Answer: (C)

Go Back to Question 16

Q17.

Solution

Concept:

Ecological pyramids are graphical representations designed to show the biomass, number, or energy at each trophic level in a given ecosystem. While some pyramids can be upright or inverted depending on the specific ecosystem, others follow universal thermodynamic laws that dictate their shape.

Solution:

(a) The pyramid of energy is a representation of the total amount of energy present at each trophic level. Due to the 10 percent law, where only a fraction of energy is transferred to the next level, energy is always lost as heat. Consequently, the pyramid of energy is always upright and can never be inverted.

(b) The pyramid of biomass represents the total dry weight of living matter. In terrestrial ecosystems, it is usually upright. However, in aquatic ecosystems like the sea, the biomass of consumers (fishes) often far exceeds the biomass of the producers (phytoplankton) at any given time because phytoplankton have very high turnover rates.

(c) Statement I is correct because the laws of thermodynamics ensure energy flow is unidirectional and dissipative.

(d) Statement II is correct because the standing crop of phytoplankton is small compared to the larger, longer-lived fish that feed on them.

(e) Since both statements are scientifically accurate, the choice reflecting both is correct.

Final Answer: Both I and II are correct.

Answer: (C)

Go Back to Question 17

Q18.

Solution

Concept:

Decomposition is a complex biological and chemical process where dead organic matter (detritus) is broken down into inorganic nutrients. It involves several stages, including fragmentation, leaching, catabolism, humification, and mineralization. Humification is a specific phase that occurs within the soil profile.

Solution:

(a) During the process of decomposition, various microorganisms act on the detritus. Humification leads to the accumulation of a dark-colored, amorphous substance called humus.

(b) Humus is highly resistant to microbial action and thus undergoes decomposition at an extremely slow rate.

(c) It serves as a reservoir of nutrients and improves the physical properties of the soil, such as its water-holding capacity and aeration.

(d) Mineralization is the subsequent step where the humus is further degraded by microbes to release inorganic nutrients like CO2, water, and minerals.

(e) Leaching refers to water-soluble inorganic nutrients moving down into the soil, while fragmentation is the physical breakdown of detritus by organisms like earthworms.

(f) Therefore, humification is specifically the formation of the dark amorphous substance known as humus.

Final Answer: Dark colored amorphous substance is formed.

Answer: (A)

Go Back to Question 18

Q19.

Solution

Concept:

An age pyramid is a graphical illustration that shows the distribution of various age groups in a population. It typically consists of three categories: pre-reproductive, reproductive, and post-reproductive individuals. The shape of the pyramid provides insights into the growth status and future trends of that population.

Solution:

(a) When the birth rate is high and the number of pre-reproductive individuals (children) is significantly larger than the reproductive and post-reproductive groups, the population is considered to be expanding or growing.

(b) In such a scenario, the base of the pyramid, which represents the youngest age group, is very wide.

(c) As the pre-reproductive individuals move into the reproductive phase, they will contribute even more to the population growth, maintaining the triangular shape with a broad base.

(d) An urn-shaped pyramid indicates a declining population where the base is narrow, while a bell-shaped pyramid represents a stable population where pre-reproductive and reproductive individuals are roughly equal.

(e) Given that the rate of addition is higher than the rate of loss, the resulting pyramid will feature a broad base.

Final Answer: A broad base.

Answer: (A)

Go Back to Question 19

Q20.

Solution

Concept:

The Hardy-Weinberg principle states that allele and genotype frequencies in a population will remain constant from generation to generation in the absence of other evolutionary influences. This equilibrium describes a theoretical non-evolving population and provides a baseline to measure evolutionary changes.

Solution:

(a) For a population to be in Hardy-Weinberg equilibrium, five specific conditions must be met: no mutation, no gene flow (migration), no natural selection, a very large population size, and random mating.

(b) If any of these conditions are violated, the allele frequencies change, indicating that evolution is occurring.

(c) Gene flow occurs when individuals move into or out of a population, bringing or taking alleles with them. Genetic drift refers to random changes in allele frequencies, which are more pronounced in small populations.

(d) Both gene flow and genetic drift are major factors that disturb the equilibrium and cause evolutionary change.

(e) Factors like random mating and large population size are actually requirements to maintain the equilibrium, not factors that disrupt it.

(f) Therefore, gene flow and genetic drift are the specific agents mentioned that would affect and change the equilibrium.

Final Answer: Gene flow and Genetic drift.

Answer: (C)

Go Back to Question 20

Q21.

Solution

Concept:

The human testes are complex reproductive organs containing various specialized cell types. Within the seminiferous tubules, spermatogenesis occurs, while the connective tissue spaces between these tubules, known as interstitial spaces, house specialized endocrine cells. Understanding the distinct roles of Sertoli cells versus Leydig cells is crucial for grasping how male reproductive physiology is regulated.

Solution:

(a) Leydig cells, also known as interstitial cells, are located in the connective tissue between the seminiferous tubules of the testes.

(b) Their primary and most vital function is the synthesis and secretion of androgens, the most prominent of which is testosterone. This process is triggered by Luteinizing Hormone (LH) secreted by the anterior pituitary gland.

(c) Testosterone is essential for the stimulation of spermatogenesis, the development of secondary sexual characteristics in males, and the maintenance of the male reproductive tract.

(d) In contrast, Sertoli cells are located inside the seminiferous tubules and function primarily to provide mechanical and nutritional support to the developing germ cells.

(e) The blood-testis barrier is also a function of the tight junctions between Sertoli cells, not Leydig cells.

(f) Meiotic division is carried out by the spermatogonia to produce haploid spermatozoa. Therefore, the specific hormonal role of producing androgens is attributed solely to the Leydig cells.

Final Answer: To synthesize and secrete testicular hormones (androgens).

Answer: (B)

Go Back to Question 21

Q22.

Solution

Concept:

A floral formula is a symbolic representation of the structure of a flower, providing information about the symmetry, sex, and number of various floral parts. The Solanaceae family, often referred to as the potato family, includes plants like tomato, brinjal, and chili. The formula describes the relationship between the calyx, corolla, androecium, and gynoecium.

Solution:

(a) Members of the Solanaceae family typically exhibit actinomorphic symmetry, represented by the circle with a cross symbol.

(b) The flowers are usually bisexual, indicated by the combined male and female symbol.

(c) The calyx (K) consists of five sepals that are united (gamosepalous), denoted as (5).

(d) The corolla (C) consists of five petals that are also united (gamopetalous), denoted as (5).

(e) The androecium (A) consists of five stamens that are epipetalous, meaning they are attached to the petals.

(f) The gynoecium (G) is bicarpellary and syncarpous with a superior ovary, represented by a 2 in parentheses with a line underneath.

(g) Comparing this to the options, the formula that correctly captures the actinomorphic nature, five fused sepals, five fused petals, and two fused carpels with a superior ovary is the one specific to Solanaceae.

Final Answer: $\oplus \subsetneq K_{(5)}C_{(5)}A_5\underline{G}_{(2)}$.

Answer: (A)

Go Back to Question 22

Q23.

Solution

Concept:

The structure of DNA follows Chargaff's rules, which state that in a double-stranded DNA molecule, the amount of adenine (A) is always equal to the amount of thymine (T), and the amount of cytosine (C) is always equal to the amount of guanine (G). This base-pairing rule is fundamental to calculating the total composition of a DNA segment when only partial data is provided.

Solution:

(a) The question provides that the segment has 100 Adenine (A) bases. According to Chargaff's rule (A=T), there must also be 100 Thymine (T) bases.

(b) The question provides that the segment has 100 Cytosine (C) bases. According to Chargaff's rule (C=G), there must also be 100 Guanine (G) bases.

(c) To find the total number of nucleotides in the double-stranded segment, we must sum all the individual nitrogenous bases, as each base corresponds to one nucleotide.

(d) Calculation: 100 (A) + 100 (T) + 100 (C) + 100 (G) = 400 total nucleotides.

(e) This logic holds because DNA is double-stranded; every purine on one strand is paired with a specific pyrimidine on the opposite strand.

(f) Thus, if the sum of A and C is 200, the sum of their partners T and G must also be 200, leading to a total of 400.

Final Answer: 400.

Answer: (B)

Go Back to Question 23

Q24.

Solution

Concept:

Digestion is regulated by both neural and hormonal mechanisms. Secretin was the first hormone ever discovered and plays a pivotal role in neutralizing the acidity of the chyme as it enters the small intestine from the stomach. This protection is vital because the enzymes in the small intestine require an alkaline environment to function effectively.

Solution:

(a) When acidic chyme enters the duodenum from the stomach, the S-cells in the duodenal mucosa are stimulated to release the hormone Secretin into the bloodstream.

(b) Secretin travels to the pancreas, where it acts on the pancreatic duct cells to stimulate the secretion of a watery juice rich in bicarbonate ions.

(c) These bicarbonate ions are alkaline and serve to neutralize the hydrochloric acid coming from the stomach, raising the pH in the duodenum.

(d) Secretin also inhibits the secretion of gastric acid in the stomach to further manage acidity levels.

(e) Cholecystokinin (CCK), another hormone, is responsible for stimulating the gall bladder to release bile and the pancreas to release digestive enzymes.

(f) Therefore, the primary and specific action of Secretin among the given options is the stimulation of bicarbonate secretion.

Final Answer: Stimulate the secretion of bicarbonates from the pancreas.

Answer: (B)

Go Back to Question 24

Q25.

Solution

Concept:

In Mendelian genetics, a test cross is a technique used to identify the underlying genotype of an organism that expresses a dominant phenotype. Because an organism with a dominant trait could be either homozygous dominant or heterozygous, a cross with a specific known genotype is required to reveal the hidden allele.

Solution:

(a) An individual showing a dominant phenotype could have the genotype AA or Aa. Visually, these two look identical.

(b) To distinguish between them, the individual is crossed with a "test" organism that is homozygous recessive (aa) for the same trait.

(c) If the unknown individual is homozygous dominant (AA), all resulting offspring from the cross (AA x aa) will show the dominant phenotype (Aa).

(d) If the unknown individual is heterozygous (Aa), the resulting offspring (Aa x aa) will show a 1:1 ratio of dominant to recessive phenotypes.

(e) This ratio provides a clear, phenotypic indication of the parent's genetic makeup.

(f) Crossing with a homozygous dominant or heterozygous individual would not yield a predictable, distinct phenotypic ratio that clearly separates the two possibilities for the unknown parent.

Final Answer: Homozygous recessive individual.

Answer: (C)

Go Back to Question 25

Q26.

Solution

Concept:

Photorespiration is a wasteful pathway that occurs in C3 plants when the enzyme RuBisCO (Ribulose-1,5-bisphosphate carboxylase-oxygenase) acts as an oxygenase rather than a carboxylase. This typically happens under conditions of high light intensity, high temperature, and low CO2 levels relative to O2 levels. It significantly reduces the efficiency of carbon fixation in these plants.

Solution:

(a) In the normal Calvin cycle, RuBisCO binds CO2 to RuBP (a 5-carbon sugar) to produce two molecules of 3-phosphoglycerate (3-PGA).

(b) However, during photorespiration, RuBisCO binds O2 to RuBP. This oxygenation reaction breaks the 5-carbon RuBP into two different molecules.

(c) One of these molecules is 3-phosphoglycerate (3-PGA), which has three carbons and can enter the Calvin cycle.

(d) The second molecule is a two-carbon compound called 2-phosphoglycolate.

(e) This 2-phosphoglycolate is then processed through a series of reactions involving the peroxisomes and mitochondria to recover some of the carbon, a process that consumes ATP and releases CO2.

(f) Therefore, the direct product of the RuBisCO oxygenase reaction along with 3-PGA is phosphoglycolate.

Final Answer: Phosphoglycolate.

Answer: (A)

Go Back to Question 26

Q27.

Solution

Concept:

Competitive Exclusion is a fundamental principle in ecology proposed by the Russian biologist G.F. Gause. It addresses how species with similar niches interact when resources are limited. The principle highlights the importance of niche differentiation in maintaining biodiversity and determines the outcome of intense interspecific competition.

Solution:

(a) Gause's principle states that two species cannot occupy the exact same niche in the same habitat indefinitely if they are competing for the same limiting resources.

(b) Because one species will invariably be slightly more efficient at acquiring or using those resources, it will have a reproductive advantage.

(c) Over time, the competitively superior species will increase in population size, while the competitively inferior species will decline.

(d) This process eventually leads to the elimination of the inferior competitor from that specific habitat or forces it to undergo an evolutionary shift (niche partitioning).

(e) This principle assumes that the environment remains stable and that resources remain limited.

(f) Thus, the core of the principle is that closely related species competing for the same resource cannot coexist indefinitely, leading to the elimination of the weaker competitor.

Final Answer: Two closely related species competing for the same resources cannot coexist indefinitely and the competitively inferior one will be eliminated eventually.

Answer: (C)

Go Back to Question 27

Q28.

Solution

Concept:

The regulation of respiration in humans involves both chemical and neural mechanisms. While the respiratory center in the medulla oblongata controls the rhythm, certain protective reflexes ensure that the mechanical limits of the lungs are not exceeded. The Hering-Breuer reflex is one such vital neural mechanism.

Solution:

(a) Within the walls of the bronchi and bronchioles, there are specialized sensory receptors known as stretch receptors.

(b) As the lungs inflate during inspiration, these stretch receptors are activated by the physical expansion of the lung tissue.

(c) Once the lungs reach a certain threshold of inflation, these receptors send inhibitory nerve impulses via the vagus nerve to the inspiratory center in the medulla.

(d) This signal stops the inspiration process and initiates expiration, thereby preventing the lungs from over-inflating and potentially sustaining tissue damage.

(e) This reflex is more prominent in newborn infants and during strenuous physical activity in adults when tidal volumes are significantly increased.

(f) Since its primary function is mechanical protection against excessive expansion, it is fundamentally a mechanism to prevent over-inflation.

Final Answer: Preventing the over-inflation of the lungs.

Answer: (B)

Go Back to Question 28

Q29.

Solution

Concept:

The chemical composition of DNA is governed by specific pairing rules discovered by Erwin Chargaff. In any double-stranded DNA molecule, the purines and pyrimidines exist in a 1:1 ratio. This means the percentage of adenine equals thymine, and the percentage of guanine equals cytosine. These ratios allow for the calculation of the entire base composition of a genome from a single known value.

Solution:

(a) According to Chargaff's rules, the concentration of Cytosine (C) is equal to the concentration of Guanine (G).

(b) If Cytosine is 20

(c) The total percentage of all four nitrogenous bases (A + T + G + C) must equal 100

(d) Subtracting the C + G portion from the total gives the percentage allocated to Adenine and Thymine: 100

(e) Since Adenine (A) and Thymine (T) also pair together in equal amounts, we divide this remaining percentage by two to find the value for each.

(f) Calculation: 60% / 2 = 30%.

(g) Therefore, if a DNA segment has 20% Cytosine, it must contain 30% Adenine to satisfy the rules of double-stranded base pairing.

Final Answer: 30%.

Answer: (C)

Go Back to Question 29

Q30.

Solution

Concept:

Intrauterine Devices (IUDs) are a highly effective form of long-term reversible contraception. They are inserted into the uterus by medical professionals and work through various biological mechanisms. IUDs are classified into three categories: non-medicated, copper-releasing, and hormone-releasing, each having a different primary mode of action.

Solution:

(a) Non-medicated IUDs were among the first types developed. Their primary function is to act as a foreign body in the uterus, which triggers an inflammatory response.

(b) This local inflammatory environment increases the phagocytosis of sperm within the uterus, preventing fertilization.

(c) The classic and most well-known example of a non-medicated IUD is the Lippes loop, which is a double-S-shaped plastic device.

(d) In contrast, CuT and Multiload 375 are copper-releasing IUDs. They release copper ions that suppress sperm motility and their fertilizing capacity.

(e) Progestasert is a hormone-releasing IUD that makes the cervix hostile to sperm and alters the endometrium to prevent implantation.

(f) Therefore, among the choices provided, the Lippes loop is the only one categorized as a non-medicated device.

Final Answer: Lippes loop.

Answer: (A)

Go Back to Question 30

Q31.

Solution

Concept:

The Lock and Key hypothesis was first proposed by Emil Fischer in 1894 to explain the high specificity observed in enzymatic reactions. This model suggests that the enzyme and its substrate possess specific, rigid shapes that allow them to fit together perfectly, much like a mechanical lock and its corresponding key. This interaction is the foundation for lowering activation energy during chemical reactions.

Solution:

(a) According to this model, every enzyme has a specifically shaped region known as the active site.

(b) The substrate molecule has a geometric shape that is complementary to the active site of the enzyme.

(c) When the substrate collides with the enzyme in the correct orientation, they bind to form an enzyme-substrate complex.

(d) This binding is highly specific; only a substrate with the exact matching shape can "unlock" the enzymatic reaction.

(e) Unlike the later proposed Induced Fit hypothesis, which suggests the active site is flexible, the Lock and Key model emphasizes the rigidity and pre-formed complementarity of the structures.

(f) Once the reaction is complete, the products are released, and the enzyme remains unchanged and ready for another cycle, which disproves the idea that enzymes are consumed in the process.

Final Answer: The enzyme and substrate have complementary geometric shapes.

Answer: (C)

Go Back to Question 31

Q32.

Solution

Concept:

Ecosystem productivity refers to the rate at which radiant energy is converted to organic substances by photosynthetic and chemosynthetic autotrophs. This is measured as the weight of organic matter produced per unit area per unit time. Understanding the distinction between gross and net productivity is essential for calculating energy flow through food webs.

Solution:

(a) The total amount of solar energy captured and converted into chemical energy (organic matter) by green plants during photosynthesis is called Gross Primary Productivity (GPP).

(b) However, plants do not store all of this energy; they consume a significant portion of it for their own metabolic needs and maintenance through the process of cellular respiration (R).

(c) The organic matter that remains after accounting for these respiratory losses is known as Net Primary Productivity (NPP). This is the energy available to heterotrophs like herbivores and decomposers.

(d) Secondary productivity, on the other hand, refers to the rate of formation of new organic matter by consumers, not producers.

(e) Therefore, the specific term for the total rate of production of organic matter during photosynthesis, without subtracting respiration, is Gross Primary Productivity.

Final Answer: Gross Primary Productivity.

Answer: (B)

Go Back to Question 32

Q33.

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. Pioneer species are the first organisms to colonize these harsh environments.

Solution:

(a) On bare rocks (a condition known as xerarch succession), the environment is extremely dry and lacks any organic soil.

(b) Lichens are uniquely adapted to serve as pioneer species in these conditions because they are a symbiotic association between a fungus and an alga or cyanobacteria.

(c) The fungal component provides a grip on the rock and secretes organic acids that chemically weather the rock surface into smaller mineral particles.

(d) This weathering process, combined with the gradual accumulation of dead lichen tissue, initiates the formation of primitive soil.

(e) Once a thin layer of soil is established, other organisms like mosses can colonize the area, followed by ferns and eventually larger plants.

(f) Therefore, lichens are the primary organisms that initiate the conversion of bare rock into a habitable substrate.

Final Answer: Lichens.

Answer: (B)

Go Back to Question 33

Q34.

Solution

Concept:

The human brain is divided into the forebrain, midbrain, and hindbrain, each with specialized centers for processing information and controlling bodily functions. The hindbrain is particularly vital for regulating autonomic functions and physical coordination. The cerebellum, often called the "little brain," is a major component of the hindbrain.

Solution:

(a) The cerebellum is located under the occipital lobes of the cerebrum and has a very convoluted surface to provide additional space for many more neurons.

(b) Its primary function is the coordination of voluntary movements, balance, and posture.

(c) It receives sensory information from the inner ear (vestibular system), visual system, and proprioceptors in the muscles and joints.

(d) It integrates this information to fine-tune motor activity, ensuring smooth and precise movements rather than jerky, uncoordinated ones.

(e) While the cerebrum handles higher-order thinking and the medulla regulates vital functions like breathing, the cerebellum specifically manages the equilibrium and posture of the body.

(f) Alcohol consumption often affects the cerebellum first, which is why intoxicated individuals struggle with balance and walking in a straight line.

Final Answer: Cerebellum.

Answer: (B)

Go Back to Question 34

Q35.

Solution

Concept:

Decomposition is a fundamental ecological process that recycles nutrients back into the soil. It is not a single-step event but a sequence of physical and chemical transformations. Detritus, which consists of dead plant remains and animal wastes, must be broken down physically before microbial enzymes can efficiently act upon it.

Solution:

(a) Fragmentation is the first physical stage of decomposition. It is carried out by detritivores, such as earthworms, termites, and millipedes.

(b) These organisms consume the detritus and break it down into much smaller particles within their digestive tracts.

(c) This process significantly increases the surface area of the organic matter, making it more accessible to fungal and bacterial decomposers.

(d) Catabolism is the next stage, where bacterial and fungal enzymes degrade the small particles into simple inorganic substances.

(e) Leaching is the movement of water-soluble nutrients into the lower soil horizons.

(f) Humification and mineralization are the final stages involving the formation of humus and the release of minerals. Since the question specifically asks about the breakdown into smaller particles by earthworms, the correct term is fragmentation.

Final Answer: Fragmentation.

Answer: (D)

Go Back to Question 35

Q36.

Solution

Concept:

The human heart is equipped with specialized valves that ensure a unidirectional flow of blood, preventing any regurgitation or backflow during the cardiac cycle. These valves open and close in response to pressure changes within the heart chambers. Understanding the specific location of each valve is fundamental to cardiovascular physiology and identifying anatomical landmarks in medical diagrams.

Solution:

(a) The heart is divided into right and left halves. The right side handles deoxygenated blood, while the left side handles oxygenated blood.

(b) The valve located between the right atrium and the right ventricle is the tricuspid valve, so named because it consists of three muscular flaps or cusps.

(c) During ventricular contraction (systole), the pressure in the right ventricle increases, forcing the tricuspid valve to close. This closure prevents blood from being pushed back into the right atrium, ensuring it travels forward into the pulmonary artery.

(d) The mitral valve (or bicuspid valve) is located on the left side of the heart between the left atrium and left ventricle.

(e) The aortic and pulmonary valves are semilunar valves located at the exits of the ventricles.

(f) Therefore, the structure labeled 'X' in a diagram representing the right-side atrioventricular junction is the Tricuspid Valve.

Final Answer: Tricuspid Valve.

Answer: (B)

Go Back to Question 36

Q37.

Solution

Concept:

Genetics involves various patterns of inheritance that deviate from simple Mendelian dominance. These terms describe how alleles interact and how they influence the phenotype of an organism. Precise definitions of these interactions are essential for solving complex genetic problems involving multiple traits or non-traditional inheritance patterns.

Solution:

(a) Pleiotropy occurs when a single gene influences multiple, seemingly unrelated phenotypic traits. For example, the gene for sickle cell anemia affects hemoglobin shape but also provides resistance to malaria.

(b) Polygenic inheritance is the opposite of pleiotropy; it occurs when one trait (like human skin color or height) is controlled by the cumulative effect of multiple different genes.

(c) Codominance is a relationship between two versions of a gene. In this case, neither allele is recessive and the phenotypes of both alleles are expressed equally in the heterozygote, such as in AB blood groups.

(d) Epistasis is a phenomenon where the effect of one gene is dependent on the presence of one or more 'modifier genes'. Essentially, one gene masks or interferes with the phenotypic expression of another gene at a different locus.

(e) Matching the definitions: (i) Pleiotropy matches (b), (ii) Polygenic inheritance matches (a), (iii) Epistasis matches (d), and (iv) Codominance matches (c).

Final Answer: (i)-(b), (ii)-(a), (iii)-(d), (iv)-(c).

Answer: (A)

Go Back to Question 37

Q38.

Solution

Concept:

DNA fingerprinting is a forensic technique used to identify individuals by analyzing specific regions of their DNA that are highly variable. This process relies on identifying patterns in non-coding DNA sequences. The methodology involves several steps, including DNA isolation, digestion, separation, and hybridization with specific markers.

Solution:

(a) The highly variable regions used in DNA fingerprinting are called Variable Number Tandem Repeats (VNTRs). These are short nucleotide sequences that are organized as tandem repeats.

(b) During the hybridization step of the Southern blot procedure, radiolabeled VNTR sequences are used as probes to bind to their complementary sequences on the DNA sample.

(c) To reach the hybridization stage, the DNA must first be cut into fragments by restriction enzymes and then separated according to their size.

(d) The standard laboratory technique used for this separation is gel electrophoresis, where DNA fragments move through an agarose gel under the influence of an electric field.

(e) VNTRs provide the specificity for the 'fingerprint', while gel electrophoresis provides the physical separation necessary to visualize the unique banding pattern.

(f) Other options like PCR are used for amplification, but not as the primary probe itself in the classical sense described.

Final Answer: VNTRs, Gel electrophoresis.

Answer: (A)

Go Back to Question 38

Q39.

Solution

Concept:

The production of red blood cells (erythrocytes) is a tightly regulated physiological process known as erythropoiesis. This process ensures that the body maintains an adequate supply of oxygen-carrying cells. The regulation is primarily hormonal and involves a feedback loop that responds to oxygen levels in the body tissues.

Solution:

(a) Erythropoietin (EPO) is a glycoprotein hormone that serves as the primary stimulus for erythropoiesis. It acts on the bone marrow to stimulate the proliferation and differentiation of red blood cell precursors.

(b) Although the liver produces a small amount of this hormone, approximately 90

(c) The kidneys act as sensors; when they detect low oxygen levels in the blood (hypoxia), they increase the synthesis and release of erythropoietin.

(d) Adrenaline is involved in the fight-or-flight response, thyroxine regulates basal metabolic rate, and insulin manages blood glucose levels.

(e) None of these other hormones have the primary role of stimulating RBC production. Therefore, the hormone is Erythropoietin and its primary source is the Kidney.

Final Answer: Erythropoietin, Kidney.

Answer: (A)

Go Back to Question 39

Q40.

Solution

Concept:

C4 plants have evolved a specialized internal leaf structure known as Kranz anatomy to adapt to hot and dry environments. This anatomy involves a specific arrangement of cells around the vascular bundles (veins), which allows the plant to concentrate CO2 and minimize the wasteful process of photorespiration.

Solution:

(a) In C4 plants, there are two distinct types of photosynthetic cells: mesophyll cells and bundle sheath cells.

(b) The bundle sheath cells are large, thick-walled parenchyma cells that form a protective 'wreath' or circle around the vascular bundles (xylem and phloem).

(c) These cells are characterized by having a large number of chloroplasts, thick walls impervious to gas exchange, and no intercellular spaces.

(d) Their primary role is to host the Calvin cycle (C3 pathway) in an environment with high CO2 concentrations, which are actively pumped in from the surrounding mesophyll cells.

(e) Spongy and palisade mesophyll are the typical photosynthetic tissues found in C3 plants, but they do not form the specialized 'Kranz' bundles.

(f) Thus, the cells specifically surrounding the vascular bundles in C4 plants are the bundle sheath cells.

Final Answer: Bundle sheath cells.

Answer: (C)

Go Back to Question 40

Q41.

Solution

Concept:

The stability and structure of the DNA double helix are maintained by two primary forces: the phosphodiester bonds that form the sugar-phosphate backbone and the hydrogen bonds between complementary nitrogenous bases. According to the base-pairing rules established by Watson and Crick, a purine always pairs with a pyrimidine to maintain a constant distance between the two strands.

Solution:

(a) The two strands of DNA are antiparallel and are held together by hydrogen bonds, which are relatively weak electrostatic attractions that allow the strands to be "unzipped" during replication and transcription.

(b) Adenine (A) always pairs with Thymine (T). This pairing is stabilized by the formation of two hydrogen bonds.

(c) Guanine (G) always pairs with Cytosine (C). Because of the specific arrangement of functional groups (carbonyl and amino groups) on these molecules, they form three hydrogen bonds.

(d) This difference in the number of hydrogen bonds means that G-C rich regions of DNA are more thermally stable and require more energy (higher temperatures) to denature or melt compared to A-T rich regions.

(e) Since the question specifically asks for the number of bonds between Guanine and Cytosine, the correct answer is three.

Final Answer: Three.

Answer: (B)

Go Back to Question 41

Q42.

Solution

Concept:

International environmental agreements are designed to address global ecological crises through collective action. The Montreal Protocol is widely regarded as one of the most successful environmental treaties ever implemented. It was specifically created to address the thinning of the ozone layer in the stratosphere, which protects life on Earth from harmful ultraviolet (UV) radiation.

Solution:

(a) In the mid-1980s, scientists discovered a significant "hole" in the ozone layer over Antarctica, primarily caused by man-made chemicals.

(b) The Montreal Protocol on Substances that Deplete the Ozone Layer was signed in 1987 (and became effective in 1989) to phase out the production and consumption of ozone-depleting substances (ODS).

(c) The primary targets of this protocol were Chlorofluorocarbons (CFCs), which were commonly used in refrigeration, air conditioning, and aerosol propellants.

(d) While the Kyoto Protocol and the Paris Agreement focus on Greenhouse gases to combat climate change, the Montreal Protocol remains the specific instrument for ozone protection.

(e) Therefore, the protocol was signed to control the emission of substances that specifically degrade the stratospheric ozone.

Final Answer: Ozone depleting substances.

Answer: (B)

Go Back to Question 42

Q43.

Solution

Concept:

The Polymerase Chain Reaction (PCR) is a revolutionary technique in molecular biology used to amplify a specific segment of DNA into millions of copies. The process relies on thermal cycling, which involves exposing the reaction mixture to repeated cycles of heating and cooling. Each cycle consists of three distinct, temperature-dependent steps.

Solution:

(a) The first step is Denaturation, which occurs at a high temperature (around 94-96 degrees Celsius). This heat breaks the hydrogen bonds between the two DNA strands, separating them into single strands to serve as templates.

(b) The second step is Annealing, which occurs at a lower temperature (usually 50-65 degrees Celsius). This allows DNA primers to bind (anneal) to their complementary sequences on the single-stranded template DNA.

(c) The third step is Extension (or Elongation), typically occurring at 72 degrees Celsius. During this phase, a thermostable DNA polymerase (like Taq polymerase) adds dNTPs to the primers, synthesizing a new DNA strand complementary to the template.

(d) This sequence must be followed exactly: first separate the strands, then attach the primers, and finally extend the new chain.

(e) Thus, the correct sequence is Denaturation, followed by Annealing, followed by Extension.

Final Answer: Denaturation → Annealing → Extension.

Answer: (B)

Go Back to Question 43

Q44.

Solution

Concept:

Chromosomal disorders in humans often result from non-disjunction during meiosis, leading to an abnormal number of chromosomes (aneuploidy). These conditions are characterized by specific physical and mental developmental challenges. Trisomy refers to the presence of three copies of a particular chromosome instead of the normal pair.

Solution:

(a) Down's syndrome is the most common autosomal chromosomal disorder in humans. It was first described by Langdon Down in 1866.

(b) It is caused by the trisomy of the 21st chromosome, meaning the individual has 47 chromosomes in total (45 autosomes + XX or XY).

(c) Symptoms include a flat facial profile, a protruding furrowed tongue, a broad palm with a characteristic palmar crease, and physical and mental retardation.

(d) Klinefelter's syndrome involves an extra X chromosome in males (47, XXY). Turner's syndrome involves the absence of one X chromosome in females (45, X0). Patau syndrome is the trisomy of chromosome 13.

(e) Therefore, the specific syndrome associated with an extra copy of chromosome 21 is Down's syndrome.

Final Answer: Down's syndrome.

Answer: (C)

Go Back to Question 44

Q45.

Solution

Concept:

Spermatogenesis is the process of sperm production in the male testes, regulated by the hypothalamic-pituitary-gonadal axis. The final stage of this process is known as spermiogenesis, where non-motile, circular spermatids are transformed into highly specialized, motile spermatozoa. This transformation requires specific hormonal stimulation.

Solution:

(a) The process of spermatogenesis is initiated at puberty due to the secretion of Gonadotropin Releasing Hormone (GnRH).

(b) GnRH stimulates the anterior pituitary to release two gonadotropins: Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH).

(c) While LH acts on Leydig cells to produce testosterone, FSH acts directly on the Sertoli cells.

(d) FSH stimulation of Sertoli cells leads to the secretion of factors that are essential for the process of spermiogenesis (the maturation of spermatids into mature sperms).

(e) Therefore, while several hormones are involved in the overall production of sperm, FSH is the specific hormone that triggers the final maturation phase known as spermiogenesis.

Final Answer: FSH.

Answer: (A)

Go Back to Question 45

Q46.

Solution

Concept:

Recombinant DNA technology relies on a variety of enzymes to manipulate genetic material. After DNA has been cut into specific fragments by restriction endonucleases, these fragments must be physically linked to a vector (like a plasmid) to create a recombinant DNA molecule. This process of joining is a fundamental step in gene cloning and genetic engineering.

Solution:

(a) When DNA is cut, the phosphate-sugar backbone is broken. To repair this or to join two different DNA fragments together, a covalent bond must be reformed between the 3' hydroxyl group of one nucleotide and the 5' phosphate group of another.

(b) The enzyme responsible for catalyzing the formation of this phosphodiester bond is DNA ligase. It effectively "glues" the DNA strands back together.

(c) DNA polymerase is used for synthesizing new DNA strands by adding nucleotides.

(d) Helicase is responsible for unwinding the DNA double helix during replication, and primase creates the RNA primer necessary for DNA polymerase to start working.

(e) Therefore, in the context of joining DNA "bits" or fragments, DNA ligase is the specific molecular tool required.

Final Answer: DNA ligase.

Answer: (B)

Go Back to Question 46

Q47.

Solution

Concept:

Polysaccharides are long chains of monosaccharides linked by glycosidic bonds. They serve two primary functions in nature: energy storage (like starch and glycogen) and structural support. The composition of cell walls varies significantly across different kingdoms of life, and these differences are often used as a basis for biological classification.

Solution:

(a) Fungi possess a rigid cell wall that protects the cell and maintains its shape. Unlike plants, which use cellulose as their primary structural polysaccharide, fungi use a unique nitrogen-containing polysaccharide.

(b) This substance is called chitin. Chitin is a polymer of N-acetylglucosamine.

(c) Chitin is also found in the exoskeletons of arthropods, such as insects and crustaceans, demonstrating its effectiveness as a durable structural material.

(d) Cellulose is characteristic of green plants and algae.

(e) Glycogen and starch are storage polysaccharides found in animals and plants, respectively, and do not provide structural support in cell walls.

(f) Thus, chitin is the defining structural component of the fungal cell wall.

Final Answer: Chitin.

Answer: (B)

Go Back to Question 47

Q48.

Solution

Concept:

Biomagnification, also known as bioamplification, refers to the increasing concentration of a substance, such as a toxic chemical, in the tissues of tolerant organisms at successively higher levels in a food chain. This phenomenon is particularly dangerous with substances that are lipophilic (fat-soluble) and cannot be easily metabolized or excreted by organisms.

Solution:

(a) When a non-biodegradable toxicant like DDT or mercury enters a food chain, it is first absorbed by producers (phytoplankton or plants).

(b) Because the organism cannot excrete the toxin, it remains in its body. When a primary consumer eats many of these producers, it accumulates the total toxin load of all the organisms it consumed.

(c) This process repeats at every trophic level. As the energy decreases up the pyramid, the concentration of the toxin per unit of biomass increases significantly.

(d) By the time the toxin reaches top predators (like eagles or humans), the concentration can be millions of times higher than it was in the water or soil.

(e) Eutrophication refers to nutrient enrichment in water bodies, while bioaccumulation is the increase of a toxin within a single organism over time. The increase across trophic levels is specifically biomagnification.

Final Answer: Biomagnification.

Answer: (B)

Go Back to Question 48

Q49.

Solution

Concept:

Muscle contraction is explained by the sliding filament theory, which describes how actin and myosin filaments slide past each other to shorten the muscle. To understand this, one must look at the microscopic organization of the myofibril, which is divided into repeating structural units. These units are the smallest components capable of performing the contraction process.

Solution:

(a) A myofibril is composed of dark bands (A-bands) and light bands (I-bands). In the center of each I-band is a dense line called the Z-line.

(b) The portion of a myofibril located between two successive Z-lines is defined as the sarcomere.

(c) The sarcomere contains the entire A-band and half of two adjacent I-bands. It is considered the functional unit of contraction because the shortening of individual sarcomeres leads to the shortening of the entire muscle fiber.

(d) During contraction, the Z-lines move closer together, decreasing the length of the sarcomere.

(e) A fascicle is a bundle of muscle fibers, and sarcoplasm is the cytoplasm of a muscle cell; neither is a functional unit of contraction.

(f) Therefore, the sarcomere is the correct anatomical and functional designation.

Final Answer: Sarcomere.

Answer: (B)

Go Back to Question 49

Q50.

Solution

Concept:

Biodiversity conservation strategies are broadly categorized into two types: in-situ and ex-situ. In-situ conservation involves protecting species within their natural habitats, where evolutionary processes continue. Ex-situ conservation involves removing organisms from their natural, often threatened, habitats and placing them under human care to ensure their survival.

Solution:

(a) In-situ conservation examples include National Parks, Biosphere Reserves, and Wildlife Sanctuaries. In these areas, the entire ecosystem is protected to conserve the species within it.

(b) Ex-situ conservation involves "off-site" protection. Botanical gardens, Zoos, Wildlife Safari Parks, and Seed Banks are classic examples where specific species are maintained in artificial or controlled environments.

(c) National Parks are strictly protected areas where the government preserves the flora, fauna, and landscape in its natural state. Because the conservation happens "on-site," it is the primary example of in-situ conservation.

(d) Wildlife Safari Parks might seem natural, but they are often enclosed areas where animals are kept in a semi-captive state for protection and public viewing, making them ex-situ.

(e) Therefore, among the options provided, National Parks is the only one that does NOT belong to the ex-situ category.

Final Answer: National Parks.

Answer: (C)

Go Back to Question 50

Q51.

Solution

Concept:

Postural deformities are deviations from the normal alignment of the skeletal system, often studied in both Biology and Physical Education. The human spine has natural curves (cervical, thoracic, lumbar), but abnormal curvatures can lead to health complications. These deformities are generally classified based on the direction of the curvature: forward, backward, or lateral.

Solution:

(a) The spine typically appears straight when viewed from the back. Scoliosis is a condition where the spine develops an abnormal lateral or "S" or "C" shaped curve.

(b) This lateral curvature can cause the shoulders to be uneven or the waist to appear tilted. It is often diagnosed during adolescence when rapid growth occurs.

(c) In contrast, Kyphosis refers to an exaggerated forward rounding of the upper back (thoracic region), commonly called a "hunchback."

(d) Lordosis refers to an increased inward curve of the lower back (lumbar region), often called "swayback."

(e) Osteoporosis is a bone disease characterized by decreased bone density and is not a curvature deformity itself, though it can lead to Kyphosis due to vertebral fractures.

(f) Therefore, based on the description of lateral curvature shown in the image, the condition is definitively identified as Scoliosis.

Final Answer: Scoliosis.

Answer: (C)

Go Back to Question 51

Q52.

Solution

Concept:

The human forebrain contains several critical structures involved in processing information. The diencephalon, located between the cerebral hemispheres and the midbrain, contains the thalamus and hypothalamus. The thalamus acts as a sophisticated gatekeeper or relay station for the central nervous system, filtering information before it reaches higher consciousness.

Solution:

(a) Almost all sensory information that is destined for the cerebral cortex first stops at the thalamus. It acts as a switchboard, receiving impulses from the eyes, ears, and skin.

(b) Once the signals reach the thalamus, they are sorted and "relayed" to the appropriate specific sensory areas of the cerebral cortex for interpretation.

(c) A notable exception to this rule is the sense of smell (olfaction). Olfactory pathways bypass the thalamus and travel directly to the olfactory bulb and cortex, which is a primitive trait in vertebrate evolution.

(d) The hypothalamus is primarily involved in homeostasis and endocrine control, while the corpus callosum connects the two cerebral hemispheres.

(e) The hippocampus is vital for memory formation.

(f) Because the question specifies the relay station function for sensory impulses excluding smell, the thalamus is the only correct anatomical choice.

Final Answer: Thalamus.

Answer: (B)

Go Back to Question 52

Q53.

Solution

Concept:

Oogenesis is the process of formation of a mature female gamete (ovum). Unlike spermatogenesis, which is continuous, oogenesis is a discontinuous process that begins before birth. The meiotic divisions in oogenesis are highly asymmetrical, ensuring that one large cell retains most of the cytoplasm and nutrients needed for a potential embryo.

Solution:

(a) The primary oocyte (diploid) undergoes the first meiotic division (Meiosis I). This division is unequal.

(b) The result of Meiosis I is the formation of two haploid cells of very different sizes: a large secondary oocyte and a tiny cell known as the first polar body.

(c) The first polar body contains very little cytoplasm and serves primarily as a "dumping ground" for the extra set of chromosomes.

(d) Meiosis I is completed just prior to ovulation under the influence of the LH surge.

(e) The secondary oocyte then begins Meiosis II but remains arrested in metaphase until fertilization occurs.

(f) If fertilization happens, Meiosis II is completed, producing a second polar body and the mature ootid (ovum).

(g) Thus, the first polar body specifically marks the conclusion of the first reductional division, which is Meiosis I.

Final Answer: Meiosis I.

Answer: (B)

Go Back to Question 53

Q54.

Solution

Concept:

Respiratory volumes and capacities are measurable parameters used to assess lung function. These volumes represent the quantity of air moved into or out of the lungs under different conditions. One specific volume is vital for preventing the total collapse of the lungs and ensuring continuous gas exchange even between breaths.

Solution:

(a) Tidal Volume is the air inspired or expired during normal, relaxed breathing. Vital Capacity is the maximum air a person can breathe out after a forced inspiration.

(b) Residual Volume (RV) is the volume of air remaining in the lungs even after the most forceful possible expiration.

(c) It is impossible to completely empty the lungs of air because the thoracic cage and the surfactant in the alveoli prevent the airways from collapsing entirely.

(d) This residual air is crucial because it allows for the continuous exchange of oxygen and carbon dioxide into the blood, even during the pause between expiration and the next inspiration.

(e) Because RV cannot be exhaled, it cannot be measured directly using simple spirometry and must be calculated using gas dilution techniques.

(f) Therefore, the air left behind after a maximum expiratory effort is correctly defined as the Residual Volume.

Final Answer: Residual Volume.

Answer: (B)

Go Back to Question 54

Q55.

Solution

Concept:

The B-DNA model, proposed by Watson and Crick, describes the physical dimensions of the double helix. These dimensions are remarkably consistent and are dictated by the chemical structure of the nucleotides and the hydrogen bonding between the nitrogenous bases. Understanding these measurements is key to calculating the length of DNA in a cell.

Solution:

(a) The double helix of DNA has a diameter of 2 nm.

(b) The pitch of the helix (the length of one complete turn) is 3.4 nm.

(c) In each complete turn of the B-DNA helix, there are approximately 10 base pairs.

(d) To find the distance between two adjacent (consecutive) base pairs, we divide the total length of one turn by the number of base pairs in that turn.

(e) Calculation: 3.4 nm/10 = 0.34 nm.

(f) This can also be expressed as 3.4 Angstroms (1 nm = 10 Angstroms).

(g) This specific spacing ensures that the DNA molecule is compact yet allows for the stable stacking of nitrogenous bases, which contributes to the overall structural integrity of the genetic material.

Final Answer: 0.34 nm.

Answer: (B)

Go Back to Question 55

Q56.

Solution

Concept:

Adenosine deaminase (ADA) is an enzyme essential for the metabolic breakdown of purine nucleosides. In humans, this enzyme plays a pivotal role in the development and maintenance of the immune system, particularly the maturation and function of T-lymphocytes. ADA deficiency is a primary cause of Autosomal Recessive Severe Combined Immunodeficiency (SCID).

Solution:

(a) The absence of the ADA enzyme leads to the accumulation of deoxyadenosine and its derivatives, which are toxic to immature lymphocytes.

(b) Consequently, the body fails to produce functional T-cells and B-cells, leaving the individual with no effective defense against pathogens.

(c) This condition was the first to be treated with human gene therapy in 1990, where functional ADA genes were introduced into the patient's lymphocytes.

(d) Because the primary pathology involves the total failure of the adaptive immune response, it is strictly a disorder of the immune system.

(e) It does not directly affect the mechanical aspects of the respiratory or circulatory systems, although patients often succumb to infections in those systems due to their immunocompromised state.

Final Answer: Immune system.

Answer: (C)

Go Back to Question 56

Q57.

Solution

Concept:

The human heart is myogenic, meaning the impulse for contraction originates within the muscular tissue itself rather than from external nerve stimulation. This is made possible by a specialized excitatory and conductive system consisting of nodal tissues. The component that initiates the rhythm is known as the pacemaker.

Solution:

(a) The Sino-atrial (SA) node is a small mass of specialized cardiac muscle fibers located in the upper wall of the right atrium.

(b) It has the highest rate of spontaneous depolarization (autorhythmicity) among all the components of the conduction system.

(c) Because it generates action potentials at a frequency of 70 to 75 per minute, it sets the fundamental pace or rhythm for the entire heart.

(d) The Atrioventricular (AV) node is considered the "pace-setter" as it receives the impulse from the SA node and delays it slightly before passing it to the ventricles.

(e) The Bundle of His and Purkinje fibers are involved in the rapid distribution of the impulse throughout the ventricular walls.

(f) Therefore, the SA node is the primary natural pacemaker that initiates the heartbeat.

Final Answer: SA Node.

Answer: (C)

Go Back to Question 57

Q58.

Solution

Concept:

Population ecology defines various types of interspecific interactions based on the benefit or harm caused to the interacting species. These interactions are denoted by symbols: (+) for benefit, (-) for harm, and (0) for no effect. Understanding these relationships is key to predicting community dynamics and species survival.

Solution:

(a) Amensalism is an interaction where one species is harmed, inhibited, or killed, while the other species remains completely unaffected and derives no benefit.

(b) A classic example is the production of antibiotics by certain fungi (like Penicillium), which inhibits the growth of bacteria. The fungus does not gain nutrients from the bacteria; the bacteria are simply harmed.

(c) Parasitism involves one species benefiting (+) while the other is harmed (-).

(d) Commensalism involves one species benefiting (+) while the other is unaffected (0).

(e) Mutualism involves both species benefiting (+, +).

(f) Since the question describes a (-, 0) relationship, it is definitively identified as amensalism.

Final Answer: Amensalism.

Answer: (B)

Go Back to Question 58

Q59.

Solution

Concept:

The Central Dogma of molecular biology, proposed by Francis Crick, outlines the unidirectional flow of genetic information within a biological system. It describes how the code stored in DNA is eventually expressed as functional proteins through two main intermediary processes.

Solution:

(a) The first step in expressing a gene is the copying of the DNA sequence into a complementary RNA sequence, specifically messenger RNA (mRNA).

(b) This process is called transcription. It is catalyzed by the enzyme RNA polymerase, which reads the DNA template and assembles the RNA strand.

(c) Translation is the subsequent step where the mRNA sequence is decoded by ribosomes to synthesize a specific protein.

(d) Replication is the process of copying DNA to produce more DNA, which occurs before cell division.

(e) Transformation is the genetic alteration of a cell resulting from the direct uptake and incorporation of exogenous genetic material.

(f) Therefore, the synthesis of RNA from a DNA template is correctly termed transcription.

Final Answer: Transcription.

Answer: (C)

Go Back to Question 59

Q60.

Solution

Concept:

Plant hormones, or phytohormones, regulate almost every aspect of a plant's life cycle. Apical dominance is a physiological phenomenon where the main, central stem of the plant is dominant over the side (lateral) stems. This allows the plant to grow taller and compete more effectively for sunlight in crowded environments.

Solution:

(a) Auxins are produced in the shoot apical meristem (the tip of the stem).

(b) As auxin moves downward through the plant, it inhibits the growth of axillary (lateral) buds, preventing them from developing into branches.

(c) If the apical bud is removed (decapitation), the source of auxin is eliminated, and the lateral buds begin to grow, which is why pruning makes plants "bushier."

(d) Cytokinins act antagonistically to auxins and promote the growth of lateral buds.

(e) Gibberellins are primarily involved in internodal elongation, and Abscisic acid is a growth inhibitor.

(f) Because the phenomenon of apical dominance is directly maintained by the concentration of auxin at the shoot tip, it is the hormone responsible.

Final Answer: Auxin.

Answer: (C)

Go Back to Question 60

Q61.

Solution

Concept:

Endocrine disorders often arise from the hypo-secretion or hyper-secretion of specific hormones. Diabetes Insipidus is a condition characterized by extreme thirst and the excretion of large amounts of highly diluted urine. Although it shares a name with Diabetes Mellitus, the underlying hormonal mechanism and the organ systems involved are entirely different. This condition relates specifically to the body's ability to conserve water.

Solution:

(a) The posterior pituitary gland releases a hormone called Antidiuretic Hormone (ADH), also known as Vasopressin. This hormone is synthesized in the hypothalamus.

(b) The primary role of ADH is to act on the distal convoluted tubules and collecting ducts of the nephrons in the kidney to increase their permeability to water, thereby promoting water reabsorption back into the blood.

(c) When there is a deficiency of ADH, or when the kidneys fail to respond to it, water is not reabsorbed properly. This leads to the production of massive quantities of dilute urine, a condition known as polyuria.

(d) This loss of fluid causes intense thirst (polydipsia) as the body attempts to maintain hydration.

(e) Insulin and Glucagon are pancreatic hormones involved in glucose metabolism; their dysfunction leads to Diabetes Mellitus. Oxytocin is involved in childbirth and milk ejection.

(f) Therefore, the deficiency of ADH (Vasopressin) is the direct cause of the inability to concentrate urine seen in Diabetes Insipidus.

Final Answer: ADH (Vasopressin).

Answer: (C)

Go Back to Question 61

Q62.

Solution

Concept:

The human respiratory system is designed to facilitate the exchange of gases between the external environment and the internal circulatory system. This process is divided into a conducting part and a respiratory part. The exchange itself is a passive process that relies on the physical properties of gases and the structural characteristics of the respiratory membrane.

Solution:

(a) The conducting part consists of the nose, pharynx, larynx, trachea, and bronchi, which transport and filter air. However, gas exchange does not occur in these regions.

(b) The actual site of diffusion for oxygen and carbon dioxide is the Alveoli and their associated ducts. The alveoli are thin-walled, vascularized bag-like structures that provide a massive surface area for gas exchange.

(c) Diffusion occurs across the respiratory membrane, which is composed of the alveolar epithelium, the capillary endothelium, and the thin basement membrane between them.

(d) This movement of gases is entirely passive and is driven by a partial pressure gradient. A gas will naturally move from an area where its partial pressure is higher to an area where its partial pressure is lower.

(e) For example, oxygen moves from the alveoli (higher partial pressure) into the blood (lower partial pressure), while carbon dioxide moves in the opposite direction.

(f) Temperature and volume may affect the rate, but the fundamental driving force is the pressure gradient.

Final Answer: Alveoli, Pressure.

Answer: (A)

Go Back to Question 62

Q63.

Solution

Concept:

The human skin is not just a protective barrier but a complex organ with several metabolic functions. One of its most critical roles is the production of Vitamin D, which is essential for bone health, calcium absorption, and immune function. This process is a unique example of the body synthesizing a vital nutrient through interaction with the external environment.

Solution:

(a) The skin contains a precursor molecule called 7-dehydrocholesterol. When the skin is exposed to sunlight, this molecule undergoes a chemical transformation.

(b) Specifically, it is the Ultraviolet B (UVB) radiation from the sun that provides the energy necessary to convert 7-dehydrocholesterol into Cholecalciferol, which is Vitamin D3.

(c) This Vitamin D3 then enters the bloodstream and is transported to the liver and subsequently the kidneys, where it is converted into its active form, calcitriol.

(d) Without adequate exposure to ultraviolet radiation, the body cannot produce sufficient Vitamin D, which can lead to conditions like rickets in children or osteomalacia in adults.

(e) Infrared radiation provides heat, and gamma or visible light does not have the specific energy level required to trigger this particular biosynthetic pathway in the epidermal cells.

(f) Therefore, the skin serves as the primary site for this synthesis under the specific influence of UV radiation.

Final Answer: Skin, Ultraviolet.

Answer: (B)

Go Back to Question 63

Q64.

Solution

Concept:

The placenta is a unique, temporary organ that forms during pregnancy. It is an intimate connection between the mother and the developing fetus, formed by both maternal and fetal tissues. It serves multiple physiological roles, acting as a lung, a digestive system, a kidney, and an endocrine gland for the embryo during its intrauterine life.

Solution:

(a) Statement 1 asserts that the placenta acts as an endocrine tissue. This is correct. The placenta secretes several essential hormones, including Human Chorionic Gonadotropin (hCG), Human Placental Lactogen (hPL), Estrogens, and Progestogens. hCG is particularly important as it maintains the corpus luteum in the early stages of pregnancy.

(b) Statement 2 asserts that it facilitates the supply of oxygen and nutrients. This is also correct. The placenta allows for the diffusion of oxygen, glucose, amino acids, and other essential nutrients from the maternal blood into the fetal blood.

(c) Additionally, the placenta is responsible for the removal of carbon dioxide and other excretory or waste materials produced by the fetus.

(d) The exchange occurs across the placental membrane, ensuring that the maternal and fetal blood supplies remain separate while allowing for efficient transport.

(e) Since both statements accurately reflect the primary biological functions of the placenta, the third option is the correct choice.

Final Answer: Both Statement 1 and Statement 2 are true.

Answer: (C)

Go Back to Question 64

Q65.

Solution

Concept:

Biotechnology utilizes various molecular tools to manipulate DNA for research, medicine, and agriculture. Two of the most important tools are vectors and restriction enzymes. Vectors serve as vehicles to carry foreign DNA into a host cell, while restriction enzymes act as the "scissors" to cut DNA at specific, predictable locations.

Solution:

(a) Statement 1 discusses pBR322. While pBR322 is indeed a widely used cloning vector in E. coli, it is not a natural vector. It is a plasmid that was genetically engineered in a laboratory to include specific antibiotic resistance genes (ampicillin and tetracycline) and a versatile origin of replication.

(b) Statement 2 discusses restriction enzymes. Many restriction endonucleases cut the two strands of DNA at slightly different positions, leaving short, single-stranded overhanging sequences.

(c) These overhangs are called "sticky ends." They are highly useful because they can form hydrogen bonds with their complementary counterparts on another DNA fragment, significantly increasing the efficiency of the enzyme DNA ligase during the ligation process.

(d) Some restriction enzymes produce "blunt ends," but the production of sticky ends is a key feature mentioned in the statement that facilitates ligation.

(e) Since Statement 1 contains a factual error (calling it natural) and Statement 2 is correct, the second option is the right answer.

Final Answer: Only Statement 2 is true.

Answer: (B)

Go Back to Question 65

Q66.

Solution

Concept:

Population attributes are measurable characteristics that describe a group of organisms of the same species living in a specific geographical area. While individuals have births and deaths, a population has birth rates and death rates. One of the most fundamental attributes is the size of the population relative to the space it occupies, which determines the intensity of competition and the availability of resources.

Solution:

(a) Population density refers to the size of a population in relation to a specific unit of area (for terrestrial organisms) or volume (for aquatic organisms).

(b) It is a dynamic variable that changes based on four primary factors: natality (birth rate), mortality (death rate), immigration (entry of individuals), and emigration (exit of individuals).

(c) Natality is the number of births in a population during a given period.

(d) Mortality is the number of deaths in the population during a given period.

(e) Vital index is a ratio used to measure the growth of a population, calculated as (Natality / Mortality) x 100.

(f) Since the question asks for the sum total of individuals per unit area or volume, it is the definition of population density.

Final Answer: Population Density.

Answer: (C)

Go Back to Question 66

Q67.

Solution

Concept:

The human immune system uses different strategies to identify and eliminate foreign threats. These are broadly categorized into humoral (antibody-mediated) and cell-mediated immunity. When a foreign organ is transplanted, the body's immune system recognizes the surface markers (MHC/HLA) of the donor organ as "non-self," triggering a defensive response that can lead to graft rejection.

Solution:

(a) Cell-mediated immunity (CMI) is primarily mediated by T-lymphocytes. Unlike B-cells, which produce antibodies that circulate in the blood (humoral), T-cells interact directly with foreign or infected cells.

(b) Specifically, Cytotoxic T-cells (CD8+) recognize foreign antigens on the surface of the transplanted organ's cells.

(c) Upon recognition, these T-cells release perforins and granzymes that cause the foreign cells to undergo apoptosis or lysis, leading to the failure of the transplant.

(d) This is why tissue matching and blood group matching are essential before any graft or transplant, and why patients must often take immunosuppressants for the rest of their lives.

(e) Humoral immunity is more effective against free-floating bacteria and viruses, while innate immunity is the non-specific first line of defense.

(f) Therefore, the specific branch of the immune system responsible for recognizing and attacking a transplanted tissue is cell-mediated immunity.

Final Answer: Cell-mediated immunity.

Answer: (B)

Go Back to Question 67

Q68.

Solution

Concept:

Mendelian genetics established the basic laws of inheritance through the study of pea plants. A dihybrid cross is a breeding experiment between P-generation organisms that differ in two observed traits. For example, crossing a plant with round yellow seeds (RRYY) with a plant with wrinkled green seeds (rryy). The F2 generation reveals how these traits assort independently.

Solution:

(a) In the F1 generation of a dihybrid cross, all offspring are dihybrids (RrYy) and show the dominant phenotypes.

(b) When the F1 generation is self-pollinated, the Law of Independent Assortment states that the alleles for seed shape assort independently of the alleles for seed color.

(c) This results in four different types of gametes (RY, Ry, rY, ry) produced by each parent.

(d) Using a Punnett square to represent the 16 possible combinations, we find four distinct phenotypic categories: Parental dominant (9), Recombinant 1 (3), Recombinant 2 (3), and Parental recessive (1).

(e) The 3:1 ratio is characteristic of a monohypbrid cross. The 1:2:1 ratio is the genotypic ratio of a monohybrid cross. The 1:1:1:1 ratio is the result of a dihybrid test cross.

(f) Therefore, the classic Mendelian phenotypic ratio for a dihybrid cross in the F2 generation is 9:3:3:1.

Final Answer: 9 : 3 : 3 : 1.

Answer: (C)

Go Back to Question 68

Q69.

Solution

Concept:

The genetic code is the set of rules by which information encoded in genetic material is translated into proteins by living cells. It consists of codons, which are sequences of three nucleotides. While 61 codons specify particular amino acids, three specific codons do not code for any amino acid and instead act as biological punctuation marks to end the translation process.

Solution:

(a) Translation begins at the start codon, which is almost always AUG (coding for Methionine).

(b) As the ribosome moves along the mRNA, it adds amino acids according to the sequence of codons until it encounters a termination signal.

(c) There are three stop codons, also known as nonsense codons: UAA (Ochre), UAG (Amber), and UGA (Opal).

(d) When a ribosome reaches one of these codons, no corresponding tRNA molecule with an anticodon can bind to it.

(e) Instead, release factors bind to the ribosome, causing the newly synthesized polypeptide chain to be released and the ribosomal subunits to dissociate.

(f) Among the options provided, UAA is one of the three universal stop codons. GGG and CCC are regular codons coding for Glycine and Proline, respectively.

Final Answer: UAA.

Answer: (B)

Go Back to Question 69

Q70.

Solution

Concept:

The nitrogen cycle is a biogeochemical process by which nitrogen is converted into various chemical forms as it circulates among atmospheric, terrestrial, and marine ecosystems. Since most plants cannot absorb atmospheric nitrogen (N_2) directly, they rely on soil bacteria to convert nitrogenous compounds into forms like nitrates, which are easily assimilated by roots.

Solution:

(a) Nitrification is a two-step biological process of oxidation. First, ammonia (NH_3) or ammonium (NH_4^+) is converted into nitrites (NO_2^-) by bacteria such as Nitrosomonas and Nitrococcus.

(b) Second, the nitrites are further oxidized into nitrates (NO_3^-) by bacteria like Nitrobacter.

(c) These nitrates are the primary form of nitrogen taken up by plants from the soil.

(d) Nitrogen fixation is the conversion of atmospheric N_2 gas into ammonia.

(e) Ammonification is the process where decomposers break down organic nitrogen from dead organisms into ammonia.

(f) Denitrification is the opposite of nitrification, where nitrates are reduced back into nitrogen gas by bacteria like Pseudomonas, returning it to the atmosphere.

(g) Since the question specifically describes the conversion of ammonia to nitrates, the process is nitrification.

Final Answer: Nitrification.

Answer: (B)

Go Back to Question 70

Q71.

Solution

Concept:

The human eye is a highly specialized photo-sensory organ that converts light energy into nerve impulses. It is composed of three distinct layers: the outer fibrous tunic (sclera and cornea), the middle vascular tunic (choroid, ciliary body, and iris), and the innermost neural layer. This inner layer is responsible for the actual detection of light and the initiation of visual signals.

Solution:

(a) The Retina is the innermost layer of the eye. It contains several layers of cells, including the photoreceptor cells, bipolar cells, and ganglion cells.

(b) The photoreceptor cells are of two types: rods and cones. Rods are responsible for twilight or scotopic vision and are very sensitive to low light levels, whereas cones are responsible for daylight or photopic vision and color perception.

(c) These receptors contain light-sensitive proteins (photopigments) that undergo chemical changes when struck by light, triggering a neural signal.

(d) The Sclera is the white, tough outer layer that maintains the shape of the eye, and the Cornea is the transparent front part that refracts light.

(e) The Choroid is the pigmented vascular layer that prevents light reflection within the eye and provides nourishment.

(f) Therefore, the specific anatomical site containing the sensory receptors for vision is the Retina.

Final Answer: Retina.

Answer: (C)

Go Back to Question 71

Q72.

Solution

Concept:

The menstrual cycle is regulated by a complex interplay of hormones from the hypothalamus, pituitary gland, and ovaries. After ovulation occurs, the remains of the ruptured Graafian follicle undergo a transformation into a temporary endocrine structure. The maintenance of the uterine lining for a potential pregnancy depends entirely on the secretions from this structure.

Solution:

(a) Following the release of the ovum (ovulation) due to the LH surge, the empty Graafian follicle transforms into the Corpus Luteum under the influence of Luteinizing Hormone.

(b) The primary and essential function of the Corpus Luteum is to secrete large amounts of Progesterone.

(c) Progesterone is critical for the maintenance of the endometrium (the inner lining of the uterus), making it thick, vascular, and secretory to support the implantation of a fertilized egg.

(d) If fertilization does not occur, the Corpus Luteum degenerates into a white scar called the Corpus Albicans, leading to a drop in progesterone levels and the initiation of menstruation.

(e) While it also secretes some estrogen, its defining and most significant role is progesterone production. It does not stimulate ovulation; rather, it is a product of it.

Final Answer: To produce Progesterone.

Answer: (B)

Go Back to Question 72

Q73.

Solution

Concept:

Genetic engineering in plants often requires a vector capable of integrating foreign DNA into the host genome. One of the most effective natural systems for this involves a soil-dwelling bacterium. This bacterium has the innate ability to transfer a specific piece of its DNA into plant cells, which then incorporates into the plant's chromosomes.

Solution:

(a) Agrobacterium tumefaciens is a gram-negative soil bacterium known as a "natural genetic engineer" of plants.

(b) It contains a large plasmid called the Ti-plasmid (Tumor-inducing plasmid). In nature, a segment of this plasmid called T-DNA is transferred into plant cells, causing them to form galls or tumors.

(c) Scientists have modified this system by "disarming" the Ti-plasmid—removing the tumor-causing genes and replacing them with desired genes for crop improvement.

(d) Bacillus thuringiensis is used for its Bt-toxin genes, and Escherichia coli is a common host for bacterial cloning, but they do not naturally possess the Ti-plasmid system.

(e) Thermus aquaticus is the source of Taq polymerase used in PCR.

(f) Therefore, the Ti-plasmid is specifically derived from Agrobacterium tumefaciens.

Final Answer: Agrobacterium tumefaciens.

Answer: (B)

Go Back to Question 73

Q74.

Solution

Concept:

The cardiac cycle produces distinct heart sounds that can be heard through a stethoscope. These sounds are not caused by the contraction of the heart muscle itself, but by the mechanical vibrations produced when the heart valves snap shut. These sounds provide critical diagnostic information about the health and function of the cardiac valves.

Solution:

(a) The first heart sound, often described as 'Lubb', is a low-pitched, relatively long-duration sound.

(b) It is produced during the beginning of ventricular systole (contraction). As the ventricles begin to contract, the pressure inside them rises sharply.

(c) This sudden increase in pressure forces the Atrioventricular (AV) valves—the tricuspid and bicuspid (mitral) valves—to close simultaneously to prevent the backflow of blood into the atria.

(d) The second heart sound, 'Dupp', is higher-pitched and shorter. It is produced at the beginning of ventricular diastole when the semilunar valves (aortic and pulmonary) close.

(e) Since the question specifically asks about the 'Lubb' sound, it corresponds to the closure of the AV valves.

Final Answer: AV valves (Tricuspid and Bicuspid).

Answer: (B)

Go Back to Question 74

Q75.

Solution

Concept:

Evolutionary biology identifies various types of evidence for common descent, including homologous, analogous, and vestigial structures. Vestigial organs are anatomical features that have no current function in an organism but were functional in its ancestors. These structures serve as "evolutionary leftovers" that provide clues about the organism's history.

Solution:

(a) A vestigial organ is one that has become reduced in size and function over millions of years of evolution.

(b) In humans, the vermiform appendix is a classic example. In our herbivorous ancestors, it was a large, functional organ used for the digestion of cellulose. In modern humans, it is small and serves no essential digestive purpose.

(c) Other examples in humans include the coccyx (tailbone), the nictitating membrane (plica semilunaris) in the eye, and the wisdom teeth.

(d) The heart, pancreas, and gall bladder are all vital, fully functional organs essential for survival; therefore, they cannot be considered vestigial.

(e) Consequently, the vermiform appendix is the correct choice from the provided list.

Final Answer: Vermiform Appendix.

Answer: (B)

Go Back to Question 75

Q76.

Solution

Concept:

The immune system is organized into specialized organs where lymphocytes are produced, matured, and activated. These are categorized into primary and secondary lymphoid organs. Primary lymphoid organs are the sites of lymphopoiesis, where stem cells divide and differentiate into T-cells and B-cells, gaining their specific antigen receptors before they ever encounter a pathogen.

Solution:

(a) The two primary lymphoid organs in the human body are the Bone Marrow and the Thymus.

(b) All blood cells, including B-lymphocytes and T-lymphocytes, are initially produced in the Bone Marrow. B-lymphocytes also complete their maturation process within the bone marrow.

(c) T-lymphocytes, however, migrate from the bone marrow to the Thymus, a lobed organ located near the heart, to undergo maturation and "education" to distinguish self from non-self.

(d) Secondary lymphoid organs, such as the spleen, lymph nodes, tonsils, and Peyer's patches, are the sites where mature lymphocytes migrate to interact with antigens and undergo clonal expansion.

(e) Therefore, the specific sites for the differentiation of immature lymphocytes into antigen-sensitive ones are the bone marrow and the thymus.

Final Answer: Bone marrow, Thymus.

Answer: (B)

Go Back to Question 76

Q77.

Solution

Concept:

The Lac Operon is a classic model of prokaryotic gene regulation proposed by Jacob and Monod. It consists of a set of structural genes and regulatory elements that control the metabolism of lactose in E. coli. The system operates on the principle of negative feedback, where the presence or absence of a substrate determines whether the genes are transcribed.

Solution:

(a) The Lac Operon contains one regulatory gene called the 'i' gene (inhibitor). This gene is expressed constitutively and codes for the Repressor protein.

(b) In the absence of lactose, the repressor binds to the operator region, physically blocking RNA polymerase from transcribing the structural genes.

(c) There are three structural genes: z, y, and a.

(d) The 'z' gene codes for the enzyme Beta-galactosidase, which is responsible for the hydrolysis of lactose into glucose and galactose.

(e) The 'y' gene codes for Permease, which increases the cell's permeability to beta-galactosides, and the 'a' gene codes for Transacetylase.

(f) Thus, the 'i' gene produces the repressor and the 'z' gene produces beta-galactosidase.

Final Answer: Repressor, Beta-galactosidase.

Answer: (B)

Go Back to Question 77

Q78.

Solution

Concept:

Respiratory disorders can be obstructive, restrictive, or environmental in nature. Each condition has a distinct underlying pathology that affects the efficiency of ventilation or gas exchange. Proper diagnosis depends on identifying whether the issue lies in the airway diameter, the integrity of the alveolar surface, or the presence of chronic inflammation.

Solution:

(a) Asthma is an allergic reaction characterized by the spasm of the smooth muscles in the bronchial walls, leading to wheezing and difficulty breathing. This matches (d).

(b) Emphysema is a chronic condition, often caused by cigarette smoking, where the alveolar walls are damaged and lose their elasticity, significantly reducing the surface area for gas exchange. This matches (a).

(c) Occupational Respiratory Disorders, such as silicosis or asbestosis, occur due to long-term inhalation of dust in industries. This leads to the proliferation of fibrous tissues (fibrosis), causing serious lung damage. This matches (c).

(d) Bronchitis is the inflammation of the lining of the bronchial tubes, which carry air to and from the lungs. This matches (b).

(e) Matching the pairs: (i)-(d), (ii)-(a), (iii)-(c), (iv)-(b).

Final Answer: (i)-(d), (ii)-(a), (iii)-(c), (iv)-(b).

Answer: (A)

Go Back to Question 78

Q79.

Solution

Concept:

Antibodies, also known as immunoglobulins (Ig), are large, Y-shaped glycoproteins produced by B-cells. They are highly specific and recognize particular molecular patterns on pathogens. The structure of an antibody is designed to provide both high-affinity binding to an antigen and the ability to trigger various effector functions of the immune system.

Solution:

(a) A typical antibody molecule consists of four polypeptide chains: two identical heavy (H) chains and two identical light (L) chains. This is why it is represented as H2L2.

(b) These four chains are held together by inter-chain disulfide bonds, which are covalent bonds, not just ionic bonds.

(c) Each antibody has two identical antigen-binding sites. These sites are located at the tips of the 'Y' and are formed by the variable regions of both the heavy and light chains working together.

(d) Statement A is wrong because it has two heavy and two light chains. Statement B is wrong because the heavy chain also contributes to the binding site. Statement D is wrong because the bonds are disulfide.

(e) Statement C is the only correct one, as antibodies are indeed glycoproteins and follow the H2L2 structural formula.

Final Answer: It is a glycoprotein represented as H2L2.

Answer: (C)

Go Back to Question 79

Q80.

Solution

Concept:

The greenhouse effect is a natural process that warms the Earth's surface. When the Sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases. However, human activities have increased the concentration of these gases, leading to an enhanced greenhouse effect known as global warming.

Solution:

(a) Global warming is caused by the accumulation of greenhouse gases that trap infrared radiation (heat) in the atmosphere.

(b) The major gases responsible for this effect are Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), and Chlorofluorocarbons (CFCs). CO_2 contributes roughly 60

(c) Statement A is a common misconception; ozone depletion primarily allows more UV radiation to reach the earth, while global warming is about heat trapping.

(d) Statement C is incorrect because global warming by definition increases the average temperature.

(e) Statement D is incorrect because the rising temperatures cause polar ice to melt and thermal expansion of seawater, leading to rising sea levels.

(f) Therefore, statement B is the only scientifically accurate description of the primary drivers of global warming.

Final Answer: Carbon dioxide and Methane are the major greenhouse gases.

Answer: (B)

Go Back to Question 80

Q81.

Solution

Concept:

Inbreeding involves the mating of more closely related individuals within the same breed for 4 to 6 generations. While this strategy is used to increase homozygosity and evolve pure lines, it often leads to a biological phenomenon where the fitness of the population significantly declines. This is primarily due to the expression of harmful recessive alleles that become homozygous through the inbreeding process.

Solution:

(a) Continuous inbreeding, especially close inbreeding, usually reduces fertility and even productivity in animals and plants.

(b) This specific reduction in biological fitness and yield is termed Inbreeding Depression.

(c) The genetic basis for this is that inbreeding increases the chances of offspring inheriting two copies of a deleterious recessive gene from a common ancestor.

(d) To overcome this problem, the selected animals should be mated with unrelated superior animals of the same breed. This is known as outcrossing, which usually restores fertility and yield.

(e) Cross-breeding involves different breeds, whereas inbreeding depression is an intra-breed phenomenon.

(f) Therefore, the term refers specifically to the loss of vigor and reproductive ability due to sustained close mating.

Final Answer: Reduced fertility and productivity due to continued close inbreeding.

Answer: (B)

Go Back to Question 81

Q82.

Solution

Concept:

Ethnobotany and pharmacognosy study the medicinal properties of plants. Many modern drugs are derived from plant secondary metabolites. These compounds often serve as defense mechanisms for the plant but have therapeutic effects in humans, such as regulating blood pressure, treating malaria, or acting as analgesics.

Solution:

(a) Reserpine is an alkaloid that was traditionally used to treat snakebites and insanity, but in modern medicine, it is primarily used as an antipsychotic and antihypertensive drug to control high blood pressure.

(b) This drug is extracted from the dried roots of the plant Rauwolfia serpentina, commonly known as Sarpagandha.

(c) Papaver somniferum is the source of opium and morphine (analgesics).

(d) Cannabis sativa is the source of cannabinoids (marijuana/hashish).

(e) Atropa belladonna is the source of atropine, which affects the autonomic nervous system.

(f) Given the specific chemical 'Reserpine', Rauwolfia serpentina is the unique biological source.

Final Answer: Rauwolfia serpentina.

Answer: (B)

Go Back to Question 82

Q83.

Solution

Concept:

Fertilization in flowering plants is a complex event discovered by Nawaschin. It involves the fusion of two separate sets of nuclei, ensuring the development of both the future plant (embryo) and its food supply (endosperm). This "double" event is a major evolutionary advancement that characterizes the most dominant group of land plants today.

Solution:

(a) In Angiosperms (flowering plants), the pollen tube carries two male gametes into the embryo sac.

(b) The first male gamete fuses with the egg cell (syngamy) to form a diploid zygote ($2n$), which eventually develops into the embryo.

(c) The second male gamete fuses with the two polar nuclei (or the secondary nucleus) in the center of the embryo sac. This is called triple fusion because three haploid nuclei join to form a triploid primary endosperm nucleus (PEN).

(d) Since two types of fusions (syngamy and triple fusion) take place in the same embryo sac, the phenomenon is called Double Fertilization.

(e) Algae, Bryophytes, and Pteridophytes do not exhibit this process; they typically have simpler fertilization mechanisms involving water.

(f) Thus, double fertilization is a defining taxonomic character of Angiosperms.

Final Answer: Angiosperms.

Answer: (D)

Go Back to Question 83

Q84.

Solution

Concept:

The female reproductive cycle, or menstrual cycle, is a series of rhythmic changes in the ovary and the uterus. It is divided into phases based on the status of the uterine lining and the development of the ovarian follicles. Understanding the sequence of these phases is vital for grasping reproductive endocrinology.

Solution:

(a) The cycle begins with the Menstrual Phase (days 1-5), where the endometrial lining is shed if fertilization has not occurred.

(b) Immediately following menstruation, the Follicular Phase (also called the Proliferative Phase) begins. During this time, primary follicles in the ovary grow to become fully mature Graafian follicles.

(c) Simultaneously, the endometrium of the uterus regenerates through proliferation, stimulated by rising levels of estrogen.

(d) The Ovulatory Phase occurs around day 14, followed by the Luteal Phase (Secretory Phase), where the corpus luteum secretes progesterone.

(e) Since the question asks for the phase that directly follows the menstrual phase, the answer is the follicular phase.

Final Answer: Follicular phase.

Answer: (B)

Go Back to Question 84

Q85.

Solution

Concept:

Decomposition is the process of breaking down complex organic matter into inorganic substances like carbon dioxide, water, and nutrients. It is a critical part of the nutrient cycle in any ecosystem. One specific physical process within this cycle involves the movement of chemical components through the soil profile due to the action of water.

Solution:

(a) Decomposition involves several steps: fragmentation, leaching, catabolism, humification, and mineralization.

(b) Leaching is the process where water-soluble inorganic nutrients and minerals dissolve in percolating water (rain or irrigation).

(c) These dissolved substances move downward into the lower layers of the soil horizon.

(d) Once they reach the deeper layers, they often become precipitated as unavailable salts, effectively being removed from the immediate reach of plant roots in the topsoil.

(e) Fragmentation is done by detritivores (like earthworms), and humification is the formation of humus.

(f) Therefore, the downward movement of soluble nutrients is specifically defined as leaching.

Final Answer: Water-soluble inorganic nutrients going down into the soil horizon.

Answer: (B)

Go Back to Question 85

Q86.

Solution

Concept:

Nucleic acids like DNA and RNA are polymers of nucleotides. A nucleotide itself is a complex molecule consisting of three distinct chemical components. Understanding the difference between a nucleoside and a nucleotide is fundamental to molecular biology, as it distinguishes between the basic base-sugar unit and the energized, phosphate-bearing version that builds the genetic chain.

Solution:

(a) A nucleoside is formed when a nitrogenous base (either a purine or a pyrimidine) is linked to a five-carbon pentose sugar (ribose in RNA or deoxyribose in DNA) via an N-glycosidic linkage.

(b) A nucleotide is formed when a phosphate group is subsequently attached to the 5' hydroxyl group of the nucleoside's sugar through a phosphoester linkage.

(c) Therefore, the formula can be summarized as: Nucleoside + Phosphate Group = Nucleotide.

(d) Because the question specifically asks for what is NOT a component of a nucleoside, we look for the element that is added to turn a nucleoside into a nucleotide.

(e) While the pentose sugar and nitrogenous base are the two core components of a nucleoside, the phosphate group is the third component that is absent in a nucleoside but present in a nucleotide.

Final Answer: Phosphate group.

Answer: (C)

Go Back to Question 86

Q87.

Solution

Concept:

The central dogma of molecular biology traditionally describes the flow of genetic information from DNA to RNA to Protein. However, certain viruses, specifically retroviruses like HIV, possess a unique enzyme that allows them to reverse this flow. This process is essential for these viruses to integrate their genetic material into the host's genome.

Solution:

(a) Transcription is the synthesis of RNA from a DNA template using RNA polymerase.

(b) Reverse Transcriptase is an RNA-dependent DNA polymerase. As the name suggests, it performs the reverse of the standard transcription process.

(c) It uses a single-stranded RNA molecule as a template to synthesize a complementary DNA (cDNA) strand.

(d) This discovery by Temin and Baltimore challenged the original rigid view of the central dogma and explained how RNA viruses could persist in DNA-based organisms.

(e) DNA from DNA is synthesized by DNA polymerase (replication), and protein from RNA is synthesized by ribosomes (translation).

(f) Therefore, the specific function of reverse transcriptase is the synthesis of DNA from an RNA template.

Final Answer: DNA from RNA.

Answer: (B)

Go Back to Question 87

Q88.

Solution

Concept:

The immune system is designed to distinguish between "self" and "non-self" molecules. In a healthy individual, the body does not attack its own tissues. However, in certain conditions, the immune system loses this ability and begins to produce antibodies or activate T-cells against the body's own healthy cells and organs. These conditions are categorized as autoimmune diseases.

Solution:

(a) Rheumatoid arthritis is a classic autoimmune disorder where the immune system attacks the synovial membranes of the joints, leading to chronic inflammation, pain, and eventual joint deformity.

(b) AIDS (Acquired Immunodeficiency Syndrome) is caused by the HIV virus and results in the destruction of the immune system, but it is an infectious disease, not an autoimmune one.

(c) Cancer is the result of uncontrolled cell division, and Malaria is a protozoan infection transmitted by mosquitoes.

(d) In autoimmune diseases like Myasthenia Gravis, Multiple Sclerosis, or Rheumatoid arthritis, the primary pathology is the body's self-destructive immune response.

(e) Since the question asks for an example of this self-attacking phenomenon, Rheumatoid arthritis is the correct medical choice.

Final Answer: Rheumatoid arthritis.

Answer: (B)

Go Back to Question 88

Q89.

Solution

Concept:

Amniocentesis is a prenatal diagnostic procedure where a small amount of amniotic fluid, which contains fetal cells, is extracted from the uterus. While it was originally developed for medical diagnostics, its potential for misuse in gender-biased sex selection led to strict legal regulations. Understanding the legal and ethical boundaries of this technique is a significant part of reproductive health education.

Solution:

(a) The primary and legal purpose of amniocentesis is to analyze the chromosomal pattern of the fetal cells to detect genetic disorders.

(b) It is used to identify conditions such as Down's syndrome, Turner's syndrome, and various metabolic disorders like hemophilia or sickle cell anemia.

(c) In many countries, including India, the use of amniocentesis for determining the sex of the fetus is strictly prohibited by law to prevent female feticide.

(d) While the procedure can technically reveal the sex, doing so is an illegal application of the technology.

(e) It is not a method used to induce abortion, though the results might lead to a medical recommendation for termination if severe abnormalities are found.

(f) Thus, the legally sanctioned use of the technique is for detecting chromosomal and genetic health issues in the fetus.

Final Answer: Detecting chromosomal abnormalities in the fetus.

Answer: (B)

Go Back to Question 89

Q90.

Solution

Concept:

Energy flow is one of the most important functional aspects of an ecosystem. Unlike nutrients (like carbon, nitrogen, and phosphorus), which circulate in cycles within an ecosystem, energy enters the system from an external source (the sun) and is gradually dissipated as it moves through the food chain. This creates a specific directionality in the movement of energy.

Solution:

(a) Energy enters the ecosystem through producers (green plants) who capture solar energy via photosynthesis.

(b) This energy is then transferred to primary consumers (herbivores), then to secondary consumers (carnivores), and so on.

(c) At every trophic level, a significant amount of energy (approximately 90 percent) is lost as heat due to metabolic activities and respiration.

(d) Once energy is lost as heat to the atmosphere, it cannot be recaptured by the producers to be reused in the food chain.

(e) This means energy cannot "cycle" back from consumers to producers. It moves in a straight line from a lower trophic level to a higher trophic level.

(f) Because the flow does not return to the start and does not move in multiple directions simultaneously, it is described as unidirectional.

Final Answer: Unidirectional.

Answer: (C)

Go Back to Question 90

Q91.

Solution

Concept:

Cell biology identifies various organelles within the eukaryotic cell, each performing specialized tasks necessary for life. The mitochondria are double-membrane-bound structures found in the cytoplasm of nearly all eukaryotic cells. Their primary role is to convert the chemical energy stored in food into a form that the cell can easily use to power its various biological processes.

Solution:

(a) Mitochondria are often called the powerhouses of the cell because they are the primary sites of aerobic respiration.

(b) Within their inner membrane, which is folded into structures called cristae, the biochemical reactions of the Krebs cycle and the Electron Transport Chain take place.

(c) These processes generate Adenosine Triphosphate (ATP), which serves as the universal energy currency of the cell.

(d) Cells that require significant amounts of energy, such as muscle cells or liver cells, contain a much higher number of mitochondria compared to less active cells.

(e) Ribosomes are responsible for protein synthesis, the Golgi apparatus for packaging and secretion, and lysosomes for waste digestion.

(f) Therefore, because of its unique role in the large-scale production of ATP, the mitochondrion is the only organelle designated as the powerhouse.

Final Answer: Mitochondria.

Answer: (C)

Go Back to Question 91

Q92.

Solution

Concept:

Population growth models describe how the number of individuals in a population increases over time under different environmental conditions. The two primary models are exponential growth and logistic growth. The shape of the resulting growth curve provides immediate insight into whether the environment has unlimited resources or a specific carrying capacity.

Solution:

(a) Exponential growth occurs only when resources are unlimited, resulting in a J-shaped curve. This is rarely seen in nature for extended periods.

(b) In most natural habitats, resources like food and space are limited. This leads to competition between individuals, and only the fittest survive and reproduce.

(c) A population growing in such an environment initially shows a lag phase, followed by phases of acceleration and deceleration, and finally reaches an asymptote.

(d) This type of growth is called logistic growth, or Verhulst-Pearl Logistic Growth.

(e) When plotted over time, this pattern produces a characteristic S-shaped or sigmoid curve.

(f) The point where the curve flattens out represents the carrying capacity (K), which is the maximum population size the environment can sustain.

Final Answer: S-shaped (Sigmoid).

Answer: (B)

Go Back to Question 92

Q93.

Solution

Concept:

The ABO blood group system is classified based on the presence or absence of specific antigens on the surface of red blood cells and antibodies in the plasma. During a blood transfusion, the donor's antigens must not react with the recipient's antibodies. One specific blood group is unique because its red blood cells lack both A and B antigens, making them "invisible" to the recipient's immune system.

Solution:

(a) Blood group O individuals do not have A or B antigens on their red blood cells. Therefore, their blood can be given to people with any ABO blood type without triggering an immune reaction.

(b) Furthermore, the Rh factor must be considered. Rh-negative blood does not have the Rh antigen.

(c) Consequently, O-negative blood is the true universal donor group because it lacks A, B, and Rh antigens, minimizing the risk of a hemolytic transfusion reaction in any recipient.

(d) Conversely, AB-positive individuals are known as universal recipients because their plasma lacks antibodies against A, B, and Rh antigens.

(e) While O-positive is common, O-negative is the preferred group in emergency situations where the recipient's blood type is unknown.

(f) Thus, O-negative is the correct designation for a universal donor.

Final Answer: O negative.

Answer: (B)

Go Back to Question 93

Q94.

Solution

Concept:

Diagnostic tests in medicine are often named after the scientists who developed them. These tests detect specific antibodies or antigens associated with a pathogen. For enteric fevers, which are systemic infections caused by consuming contaminated food or water, a specific serological test is used to confirm the presence of the causative bacteria.

Solution:

(a) Typhoid fever is a bacterial infection caused by Salmonella typhi. It is characterized by high fever, weakness, stomach pain, and headache.

(b) The Widal test is a clinical tool used to diagnose typhoid. It works by measuring the agglutination (clumping) of the patient's serum when mixed with specific antigens of Salmonella.

(c) A positive result indicates that the patient has developed antibodies against the O and H antigens of the bacteria.

(d) While newer tests like the Typhidot are also used, the Widal test remains a standard diagnostic method in many clinical settings.

(e) Pneumonia is typically diagnosed via chest X-ray or sputum culture, and Tuberculosis is diagnosed via the Mantoux skin test or sputum smear.

(f) Therefore, the Widal test is specifically and exclusively used for the diagnosis of typhoid fever.

Final Answer: Typhoid.

Answer: (A)

Go Back to Question 94

Q95.

Solution

Concept:

The Human Genome Project (HGP) was a massive international research effort to determine the DNA sequence of the entire human genome. One of the significant findings was the variation in size and gene density among different chromosomes. The chromosomes are numbered based on their size, with a few exceptions that were clarified during the final sequencing phases.

Solution:

(a) In humans, the genome is spread across 23 pairs of chromosomes. Chromosome 1 is the largest, containing the most genes (2,968).

(b) The Y chromosome, which is one of the two sex chromosomes in males, is the smallest human chromosome.

(c) It contains the fewest number of genes, with only about 231 genes identified during the HGP.

(d) Although Chromosome 21 was long thought to be the smallest, the HGP confirmed that the Y chromosome is physically the shortest and contains the least genetic information.

(e) Chromosome X is significantly larger than the Y chromosome and carries many essential genes unrelated to sex determination.

(f) Thus, the final data from the Human Genome Project identified the Y chromosome as the smallest in the human karyotype.

Final Answer: Chromosome Y.

Answer: (C)

Go Back to Question 95

Q96.

Solution

Concept:

The process of childbirth, or parturition, is regulated by a complex neuroendocrine mechanism involving signals from both the mother and the fetus. Several hormones work in tandem to prepare the birth canal and facilitate the expulsion of the baby. One particular hormone is responsible for increasing the flexibility of the pelvic joints.

Solution:

(a) Relaxin is a protein hormone that plays a crucial role in the later stages of pregnancy.

(b) In humans, it is secreted primarily by the corpus luteum in the ovary and later by the placenta.

(c) Its primary function is to relax the pubic symphysis (the joint between the pubic bones) and the various ligaments of the pelvic region.

(d) This relaxation increases the diameter of the birth canal, making it easier for the fetus to pass through during labor.

(e) It also helps in dilating the cervix. While the uterus is the site of Relaxin's action, and the pituitary releases Oxytocin for contractions, the ovary is the primary source of Relaxin.

(f) Therefore, based on its site of secretion during the late pregnancy phase, the ovary is the correct answer.

Final Answer: Ovary.

Answer: (B)

Go Back to Question 96

Q97.

Solution

Concept:

Greenhouse gases are atmospheric gases that absorb and emit radiant energy within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. While some of these gases occur naturally, human industrial and agricultural activities have significantly increased their concentrations, leading to climate change.

Solution:

(a) The most abundant gases in the Earth's atmosphere are Nitrogen and Oxygen, but neither of these are greenhouse gases because they do not absorb infrared radiation.

(b) Methane (CH_4) is a very potent greenhouse gas. Although its concentration is lower than carbon dioxide, its global warming potential is many times higher over a 100-year period.

(c) Major sources of methane include rice paddies, the digestive processes of ruminant livestock (like cows), marshes, and the extraction of fossil fuels.

(d) Argon is an inert noble gas and does not contribute to the greenhouse effect.

(e) Other important greenhouse gases include water vapor, carbon dioxide, nitrous oxide, and ozone.

(f) Among the choices provided, methane is the only gas that fits the criteria of being a greenhouse gas responsible for trapping heat in the atmosphere.

Final Answer: Methane.

Answer: (C)

Go Back to Question 97

Q98.

Solution

Concept:

Microbes play a vital role in the industrial production of chemicals, enzymes, and bioactive molecules. Bioactive molecules are substances that have a direct effect on living tissues or systems. One such group of molecules is the statins, which have revolutionized the treatment of cardiovascular diseases by managing cholesterol levels.

Solution:

(a) Statins act as competitive inhibitors of the enzyme HMG-CoA reductase, which is the rate-limiting enzyme in the internal synthesis of cholesterol in the liver.

(b) By inhibiting this enzyme, statins effectively lower the level of low-density lipoprotein (LDL) or "bad" cholesterol in the blood.

(c) The first commercial statins were derived from a specific microorganism called Monascus purpureus.

(d) Monascus purpureus is a species of yeast, which is a unicellular fungus.

(e) This is a classic example of using fungal secondary metabolites for human pharmaceutical benefit, similar to the production of antibiotics.

(f) Bacteria and algae produce many other useful substances, but they are not the biological source used for the production of statins.

Final Answer: Yeast (Monascus purpureus).

Answer: (B)

Go Back to Question 98

Q99.

Solution

Concept:

Cranial nerves are the nerves that emerge directly from the brain and brainstem. In humans, there are twelve pairs of cranial nerves, each serving specific sensory or motor functions, mostly in the head and neck region. However, one specific nerve is unique because it extends far beyond the head and neck to innervate thoracic and abdominal organs.

Solution:

(a) The Vagus nerve is the tenth cranial nerve (CNX). Its name is derived from the Latin word for "wandering," which describes its extensive path through the body.

(b) It is the longest cranial nerve and contains both sensory and motor fibers.

(c) After leaving the brainstem, it travels down the neck and enters the thorax, providing nerve supply to the heart and lungs.

(d) It then continues through the diaphragm into the abdominal cavity, where it innervates the digestive tract (stomach and intestines), liver, and kidneys.

(e) It is a key component of the parasympathetic nervous system, regulating heart rate and digestion.

(f) The optic, facial, and trigeminal nerves are restricted to the head and neck regions. Thus, the Vagus nerve is the longest and most widely distributed.

Final Answer: Vagus nerve.

Answer: (C)

Go Back to Question 99

Q100.

Solution

Concept:

The theory of biological evolution explains how living organisms have changed over time through processes like natural selection. The mid-19th century saw the publication of a groundbreaking work that provided a comprehensive mechanism for these changes, forever altering our understanding of the natural world and the origin of species.

Solution:

(a) Charles Darwin was an English naturalist who proposed that all species of life have descended over time from common ancestors.

(b) His landmark book, titled "On the Origin of Species by Means of Natural Selection," was published in 1859.

(c) In this book, he introduced the concept of natural selection as the primary mechanism for evolution, where individuals with favorable traits are more likely to survive and reproduce.

(d) Jean-Baptiste Lamarck is known for his earlier theory of "inheritance of acquired characteristics," which was later largely discredited.

(e) Hugo de Vries proposed the mutation theory of evolution, and Gregor Mendel established the laws of inheritance, though Darwin was unaware of Mendel's work at the time.

(f) Darwin's work remains the foundational text for modern evolutionary biology.

Final Answer: Charles Darwin.

Answer: (B)

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Answer Key

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