NEET-UG Biology Sample Paper-13

Duration: 1 Hour **Maximum Marks: 360**

Instructions

- This paper contains a total of **90** Multiple Choice Questions.
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Q1. Which of the following combinations of characters is universally true for all members of the Kingdom Monera, distinguishing them from all other kingdoms in Whittaker's five-kingdom classification?

(A) Presence of a cell wall made of cellulose and nuclear membrane.

(B) Absence of membrane-bound organelles and presence of 70S ribosomes.

(C) Autotrophic mode of nutrition and filamentous body organization.

(D) Ability to fix atmospheric nitrogen and presence of histones in DNA.

Q2. A taxonomist discovers a new organism that is multicellular, has a cell wall made of chitin, and exhibits saprophytic nutrition. In which taxonomic category would this organism be most appropriately placed alongside others sharing the same cell wall composition?

(A) Division - Spermatophyta

(B) Kingdom - Fungi

(C) Phylum - Arthropoda

(D) Class - Ascomycetes

Q3. In the taxonomic hierarchy, as one moves from Species to Kingdom, which of the following trends is observed regarding the number of shared characteristics and the specificity of the group?

(A) Shared characteristics increase; specificity increases.

(B) Shared characteristics decrease; specificity decreases.

(C) Shared characteristics increase; specificity decreases.

(D) Shared characteristics decrease; specificity increases.

Q4. An organism is found to have a diploblastic body, radial symmetry, and specialized cells called cnidocytes. Identify the level of organization and the symmetry exhibited by its larval stage if it belongs to Phylum Ctenophora.

(A) Tissue level; Bilateral symmetry

(B) Organ level; Radial symmetry

(C) Cellular level; Asymmetry

(D) Tissue level; Radial symmetry

Q5. Match the following organisms with their respective taxonomic categories: (i) Housefly - Musca (ii) Wheat - Triticum (iii) Tiger - Panthera (iv) Potato - Solanum Which of the following represents the correct level of 'Genus' for all?

(A) i, ii, iii, and iv

(B) i and iii only

(C) ii and iv only

(D) i, ii, and iii only

Q6. Identify the correct sequence of taxonomic categories in descending order for the classification of Mango (Mangifera indica):

(A) Angiospermae → Dicotyledonae → Sapindales → Anacardiaceae

(B) Dicotyledonae → Sapindales → Anacardiaceae → Angiospermae

(C) Sapindales → Anacardiaceae → Dicotyledonae → Mangifera

(D) Angiospermae → Sapindales → Anacardiaceae → Dicotyledonae

Q7. Which of the following is an exclusive characteristic of living beings that does not show any exception?

(A) Increase in mass from inside.

(B) Perception of events in the environment and their memory.

(C) Isolated metabolic reactions in-vitro.

(D) Increase in mass by accumulation of material on the surface.

Q8. In a taxonomic study of the family Solanaceae, which of the following floral features is most critical for distinguishing it from Liliaceae?

(A) Superior ovary and axile placentation.

(B) Epipetalous stamens and valvate aestivation.

(C) Presence of perianth and tricarpellary gynoecium.

(D) Gamosepalous calyx and persistent sepal.

Q9. The vascular bundle in a dicot stem is described as conjoint, collateral, and open. What does the term 'open' specifically imply in this anatomical context?

(A) The presence of cambium between xylem and phloem for secondary growth.

(B) The absence of a bundle sheath around the vascular tissue.

(C) The arrangement of protoxylem towards the center (endarch).

(D) The ability of the stem to transport water without any regulation.

Q10. Bulliform cells are specialized epidermal cells found in certain grasses. Which of the following best describes their physiological role during water stress?

(A) They become turgid to increase the surface area for transpiration.

(B) They lose turgidity, causing the leaves to curl inward to minimize water loss.

(C) They store excess water to be used during prolonged dry periods.

(D) They secrete a waxy substance to block the stomatal openings.

Q11. In the anatomy of a dorsiventral leaf, the position of the protoxylem in the midrib vascular bundle is:

(A) Towards the abaxial epidermis.

(B) Towards the adaxial epidermis.

(C) In the center of the phloem.

(D) Distributed randomly throughout the bundle.

Q12. Which of the following tissues provides maximum mechanical strength to the petiole of a young dicot leaf while allowing it to bend in the wind without breaking?

(A) Sclerenchyma

(B) Collenchyma

(C) Parenchyma

(D) Xylem vessels

Q13. In a longitudinal section of the shoot apex, the 'tunica-corpus' theory explains the organization of the meristem. The 'tunica' layer primarily undergoes which type of cell division?

(A) Periclinal divisions only.

(B) Anticlinal divisions only.

(C) Both periclinal and anticlinal divisions.

(D) Meiotic divisions.

Q14. The epithelial tissue that lines the inner surface of fallopian tubes and bronchioles is specialized to move particles or mucus in a specific direction. Identify the tissue type:

(A) Squamous epithelium

(B) Cuboidal epithelium

(C) Ciliated epithelium

(D) Glandular epithelium

Q15. Tight junctions, adhering junctions, and gap junctions are specialized structures found in animal tissues. Which of them is responsible for facilitating rapid ion transfer between adjacent cells?

(A) Tight junctions

(B) Adhering junctions

(C) Gap junctions

(D) Desmosomes

Q16. A researcher observes a cell organelle that contains its own circular DNA and 70S ribosomes but lacks a double membrane. However, the question specifically refers to an organelle that is responsible for the synthesis of lipids and steroidal hormones in animal cells. Identify the organelle:

(A) Rough Endoplasmic Reticulum

(B) Smooth Endoplasmic Reticulum

(C) Golgi Apparatus

(D) Mitochondria

Q17. During the metaphase of mitosis, a drug is applied that inhibits the function of motor proteins at the kinetochores. What would be the most likely immediate effect on the chromosomes?

(A) Failure of chromosomes to align at the equatorial plate.

(B) Inability of sister chromatids to separate during anaphase.

(C) Re-formation of the nuclear envelope prematurely.

(D) Inhibition of DNA replication in the S-phase.

Q18. The 'Fluid Mosaic Model' accounts for the lateral movement of proteins within the lipid bilayer. This fluidity is essential for functions like cell growth and secretion. Which component is primarily responsible for maintaining membrane fluidity at low temperatures in animal cells?

(A) Peripheral proteins

(B) Cholesterol

(C) Integral proteins

(D) Saturated fatty acids

(E) Glycoproteins

Q19. Which of the following events occurs during the Diplotene stage of Prophase I, distinguishing it from the Pachytene stage?

(A) Formation of the synaptonemal complex.

(B) Appearance of recombination nodules.

(C) Dissolution of the synaptonemal complex and visibility of Chiasmata.

(D) Terminalisation of chiasmata.

Q20. Identify the correct statement regarding the endomembrane system:

(A) It includes Mitochondria, Chloroplasts, and Peroxisomes because their functions are coordinated.

(B) The Golgi apparatus remains in close association with the ER to receive proteins synthesized by ribosomes.

(C) Lysosomes are formed by the process of packaging in the Endoplasmic Reticulum.

(D) Vacuoles in plant cells occupy 10% of the cell volume and store only water.

Q21. According to the Chemiosmotic Hypothesis of Peter Mitchell, the proton gradient required for ATP synthesis in chloroplasts is established across the:

(A) Inner mitochondrial membrane

(B) Thylakoid membrane

(C) Outer chloroplast membrane

(D) Plasma membrane

Q22. In C_4 plants, the primary CO_2 acceptor and the first stable product are respectively:

(A) RuBP and 3-PGA

(B) PEP and Oxaloacetic acid

(C) PEP and Malic acid

(D) RuBP and Oxaloacetic acid

Q23. Which of the following conditions would lead to the 'Warburg Effect' in plants, significantly reducing the efficiency of photosynthesis?

(A) High CO_2 concentration and low light intensity.

(B) High O_2 concentration and high light intensity/temperature.

(C) Low O_2 concentration and high CO_2 concentration.

(D) Presence of Magnesium and Manganese ions.

Q24. The conversion of Pyruvic acid into Acetyl-CoA in the mitochondrial matrix is a/an:

(A) Oxidative decarboxylation reaction.

(B) Reductive carboxylation reaction.

(C) Hydrolytic cleavage.

(D) Substrate-level phosphorylation.

Q25. During the light reaction of photosynthesis, the movement of electrons from PS II to PS I results in the pumping of protons from the stroma to the:

(A) Intermembrane space

(B) Thylakoid lumen

(C) Matrix

(D) Cytoplasm

Q26. In the Electron Transport System (ETS) of mitochondria, Cytochrome 'c' acts as a mobile carrier for transfer of electrons between:

(A) Complex I and Complex II

(B) Complex II and Complex III

(C) Complex III and Complex IV

(D) Complex IV and ATP synthase

Q27. Identify the phytohormone that acts as a 'stress hormone' and is responsible for the closure of stomata during water deficiency:

(A) Indole-3-acetic acid

(B) Gibberellic acid

(C) Abscisic acid

(D) Zeatin

Q28. In a link reaction, how many molecules of $NADH$ are produced from two molecules of glucose?

(A) 2

(B) 4

(C) 6

(D) 8

Q29. Which of the following minerals is required for the photolysis of water during the light reaction of photosynthesis?

(A) Copper and Zinc

(B) Manganese and Chlorine

(C) Iron and Magnesium

(D) Boron and Molybdenum

Q30. The respiratory quotient (RQ) of tripalmitin (a fat) is approximately:

(A) 1.0

(B) 0.7

(C) 0.9

(D) 1.4

Q31. A person suffers from a condition where their parietal cells in the gastric mucosa are non-functional. Which of the following physiological consequences is most likely to occur in this individual?

(A) Inability to digest fats due to lack of bile activation.

(B) Impaired protein digestion and deficiency of Vitamin B_{12}.

(C) Excessive production of enterokinase in the duodenum.

(D) Rapid emptying of the stomach into the small intestine.

Q32. During the cardiac cycle, the 'Lubb' sound is produced by the closure of the atrioventricular valves. This specific event occurs at the beginning of which phase?

(A) Joint Diastole

(B) Atrial Systole

(C) Ventricular Systole

(D) Ventricular Diastole

Q33. In the human kidney, the counter-current mechanism is primarily responsible for maintaining an increasing osmolarity from the cortex to the inner medulla.

Which part of the nephron is impermeable to water, helping in this concentration gradient?

(A) Descending limb of Loop of Henle

(B) Ascending limb of Loop of Henle

(C) Proximal Convoluted Tubule

(D) Distal Convoluted Tubule

Q34. The 'p-wave' in a standard Electrocardiogram (ECG) represents the electrical excitation of the atria. What would be the clinical significance of an enlarged or peaked P-wave?

(A) Myocardial Infarction

(B) Atrial Hypertrophy or enlargement

(C) Delayed ventricular depolarization

(D) Hyperkalemia

Q35. Identify the hormone that is produced by the hypothalamus but released into the bloodstream by the posterior pituitary gland (neurohypophysis):

(A) Growth Hormone

(B) Prolactin

(C) Vasopressin (ADH)

(D) Luteinizing Hormone

Q36. In the human female reproductive cycle, the 'LH surge' triggers ovulation. This surge is primarily caused by a sudden positive feedback loop initiated by a high concentration of:

(A) Progesterone

(B) Estrogen

(C) Inhibin

(D) FSH

Q37. The morula stage of the human embryo consists of 8 to 16 blastomeres. Where in the female reproductive tract is the morula typically located?

(A) Ovary

(B) Ampulla of the Fallopian tube

(C) Isthmus of the Fallopian tube

(D) Uterine fundus

Q38. Which of the following barriers is present in the 'multilaminate' zona pellucida to prevent polyspermy during fertilization?

(A) Hyaluronidase activity

(B) Cortical reaction and membrane depolarization

(C) Capacitation of the sperm

(D) Formation of the second polar body

Q39. A cross between a red-flowered plant and a white-flowered plant in *Antirrhinum* (Snapdragon) produces all pink-flowered offspring. If these pink flowers are self-pollinated, the phenotypic ratio in the F_2 generation will be:

(A) 3:1 (Red:White)

(B) 1:2:1 (Red:Pink:White)

(C) 9:3:3:1 (Red:Pink:White:Cream)

(D) 1:1 (Red:Pink)

Q40. In a dihybrid cross ($AaBb \times AaBb$), assuming independent assortment and complete dominance, what is the probability of obtaining an offspring with the genotype $AABb$?

(A) $1/16$

(B) 2/16

(C) 4/16

(D) 9/16

Q41. The phenomenon where a single gene can exhibit multiple phenotypic expressions is known as:

(A) Polygenic inheritance

(B) Epistasis

(C) Pleiotropy

(D) Co-dominance

Q42. According to the Lac Operon model in *E. coli*, when lactose is present in the medium, it acts as an inducer by binding to the:

(A) Promoter gene

(B) Operator gene

(C) Repressor protein

(D) Structural gene (lacZ)

Q43. In DNA fingerprinting, the DNA fragments are separated by size using gel electrophoresis. These fragments are then transferred to a synthetic membrane through a process called:

(A) Northern Blotting

(B) Southern Blotting

(C) Western Blotting

(D) Eastern Blotting

Q44. Which of the following nitrogenous bases is a Purine and is found in both DNA and RNA?

(A) Cytosine

(B) Thymine

(C) Uracil

(D) Adenine

Q45. During the process of Translation, the enzyme responsible for the formation of a peptide bond between amino acids is:

(A) DNA Polymerase

(B) RNA Polymerase

(C) Peptidyl transferase

(D) Aminoacyl tRNA synthetase

Q46. In recombinant DNA technology, the term 'Insertional Inactivation' is used to identify recombinant transformants. If a foreign DNA is ligated at the BamHI site of the pBR322 plasmid, the resulting transformants will:

(A) Gain resistance to both ampicillin and tetracycline.

(B) Lose resistance to ampicillin but remain resistant to tetracycline.

(C) Lose resistance to tetracycline but remain resistant to ampicillin.

(D) Grow on a medium containing both ampicillin and tetracycline.

Q47. Which of the following enzymes is used to 'glue' the sticky ends of DNA fragments together by forming a phosphodiester bond?

(A) DNA Polymerase I

(B) Restriction Endonuclease

(C) DNA Ligase

(D) Reverse Transcriptase

Q48. The first clinical gene therapy was given in 1990 to a four-year-old girl with a deficiency of which enzyme?

(A) Adenosine deaminase (ADA)

(B) Tyrosinase

(C) Phenylalanine hydroxylase

(D) Glutamate dehydrogenase

Q49. In the context of 'Bt Cotton', the 'Bt' toxin exists as an inactive protoxin within the bacterium. It gets activated in the gut of the insect pest due to:

(A) Acidic pH of the foregut.

(B) Presence of specialized enzymes in the hemolymph.

(C) Alkaline pH of the midgut.

(D) Mechanical action of the mandibles.

Q50. RNA interference (RNAi) is a method of cellular defense in eukaryotes. It involves silencing of a specific mRNA due to a complementary molecule. Identify the molecule:

(A) Single-stranded DNA

(B) Double-stranded RNA

(C) Single-stranded RNA

(D) Double-stranded DNA

Q51. Which of the following models of population growth is represented by the equation $dN/dt = rN[(K - N)/K]$?

(A) Exponential growth model

(B) Geometric growth model

(C) Logistic growth model

(D) Arithmetic growth model

Q52. In an ecosystem, the rate of production of organic matter during photosynthesis by producers is known as:

(A) Net Primary Productivity (NPP)

(B) Gross Primary Productivity (GPP)

(C) Secondary Productivity

(D) Net Community Productivity

Q53. According to the 'Competitive Exclusion Principle' proposed by Gause, what happens when two species compete for the same limiting resources?

(A) Both species coexist by partitioning resources.

(B) The inferior competitor is eventually eliminated.

(C) Both species undergo character displacement.

(D) Both species increase in population density.

Q54. In the 'Rivet Popper Hypothesis' proposed by Paul Ehrlich, the 'rivets' on the wings of an airplane represent:

(A) Ecosystem services

(B) Rare species

(C) Key species (Keystone species)

(D) All species in the ecosystem

Q55. Which of the following regions of the globe is known as the 'Lungs of the Planet' due to its massive oxygen contribution and biodiversity?

(A) Himalayan Ranges

(B) Amazon Rainforest

(C) Western Ghats

(D) African Savannah

Q56. 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

Q57. In the process of 'Eutrophication', the accelerated aging of a water body is primarily caused by the excessive runoff of which two nutrients?

(A) Carbon and Hydrogen

(B) Nitrogen and Phosphorus

(C) Sulfur and Magnesium

(D) Potassium and Calcium

Q58. The relationship between a sea anemone and a hermit crab, where the crab carries the anemone for protection and the anemone gets fragments of food, is an example of:

(A) Parasitism

(B) Commensalism

(C) Mutualism (Proto-cooperation)

(D) Amensalism

Q59. An inverted pyramid of biomass is typically found in which type of ecosystem?

(A) Grassland ecosystem

(B) Forest ecosystem

(C) Marine/Aquatic ecosystem

(D) Desert ecosystem

Q60. The 'Species-Area Relationship' on a logarithmic scale is represented by a straight line with the equation $\log S = \log C + Z \log A$. What does the parameter 'Z' represent?

(A) Species richness

(B) Regression coefficient (Slope of the line)

(C) Y-intercept

(D) Total Area

Q61. A man with blood group 'A' (whose mother had blood group 'O') marries a woman with blood group 'B' (whose father had blood group 'O'). What is the probability that their first child will have blood group 'O'?

(A) 0%

(B) 25%

(C) 50%

(D) 100%

Q62. In a population at Hardy-Weinberg equilibrium, the frequency of a recessive allele (q) for a certain hereditary trait is 0.2. What is the frequency of the heterozygous individuals in that population?

(A) 0.64

(B) 0.32

(C) 0.04

(D) 0.80

Q63. The 'Theory of Natural Selection' by Darwin explains evolution, but it failed to explain the mechanism of inheritance and the origin of variation. Which scientist provided the 'Mutation Theory' to fill this gap?

(A) Lamarck

(B) Hugo de Vries

(C) Alfred Wallace

(D) Thomas Malthus

Q64. Identify the set of homologous organs from the following options, which indicate divergent evolution:

(A) Wings of a butterfly and wings of a bird.

(B) Flippers of a penguin and flippers of a dolphin.

(C) Thorns of *Bougainvillea* and tendrils of *Cucurbita*.

(D) Eyes of an octopus and eyes of a mammal.

Q65. According to the operon model, the regulator gene 'i' is termed as such because:

(A) It acts as an inducer for the structural genes.

(B) Its product inhibits the transcription of structural genes.

(C) It initiates the process of translation.

(D) It is always inactive in the presence of lactose.

Q66. During DNA replication, the small fragments synthesized on the lagging strand are known as Okazaki fragments. These are synthesized in which direction?

(A) $3' \rightarrow 5'$

(B) $5' \rightarrow 3'$

(C) Both directions simultaneously

(D) Randomly based on primer availability

Q67. A woman is a carrier for Hemophilia (an X-linked recessive disorder) and marries a normal man. What percentage of their sons are expected to be hemophilic?

(A) 0%

(B) 25%

(C) 50%

(D) 100%

Q68. The 'Miller-Urey Experiment' provided evidence for the chemical evolution of life. They used a mixture of gases in a closed flask at 800°C. Which of the following gases was NOT part of their starting mixture?

(A) CH_4

(B) NH_3

(C) O_2

(D) H_2

Q69. In the context of the 'History of Life', the first cellular forms of life appeared on Earth approximately:

(A) 4.5 billion years ago

(B) 3 billion years ago

(C) 2000 million years ago

(D) 500 million years ago

Q70. Which of the following is an example of 'Adaptive Radiation'?

(A) Darwin's Finches in Galapagos Islands

(B) Australian Marsupials

(C) Placental mammals in North America

(D) All of the above

Q71. Meselson and Stahl's experiment proved the semi-conservative nature of DNA replication using which isotope?

(A) ^{32}P

(B) ^{35}S

(C) ^{14}C

(D) ^{15}N

Q72. In a DNA molecule, the ratio of Adenine to Thymine and Guanine to Cytosine is always constant and equals one. This rule is known as:

(A) Griffith's Rule

(B) Chargaff's Rule

(C) Watson and Crick's Rule

(D) Hershey-Chase Rule

Q73. Identify the correct sequence of steps involved in the process of DNA Fingerprinting:

(A) Isolation → Digestion → Electrophoresis → Blotting → Hybridization → Autoradiography

(B) Hybridization → Blotting → Isolation → Digestion → Electrophoresis

(C) Digestion → Isolation → Hybridization → Autoradiography → Blotting

(D) Isolation → Electrophoresis → Digestion → Hybridization → Blotting

Q74. The amino acid sequence is determined by the sequence of bases on mRNA. How many codons code for amino acids in the standard genetic code?

(A) 64

(B) 61

(C) 20

(D) 3

Q75. Sickle cell anemia is caused by a point mutation in the beta-globin chain of hemoglobin. This mutation results in the substitution of:

(A) Valine by Glutamic acid at the 6th position.

(B) Glutamic acid by Valine at the 6th position.

(C) Glycine by Alanine at the 5th position.

(D) Leucine by Valine at the 1st position.

Q76. During DNA replication, the tension created by the unwinding of the double helix is relieved by which enzyme?

(A) DNA Helicase

(B) DNA Topoisomerase (DNA Gyrase)

(C) Single-strand binding proteins (SSBPs)

(D) DNA Polymerase III

Q77. Which of the following is a 'Stop Codon' that signals the termination of polypeptide synthesis during translation?

(A) AUG

(B) UGG

(C) UAG

(D) GUG

Q78. The 'World Summit on Sustainable Development' (2002) was held in Johannesburg, South Africa. What was the primary objective of this summit?

(A) To reduce the use of ozone-depleting substances.

(B) To achieve a significant reduction in the current rate of biodiversity loss.

(C) To promote the use of genetically modified crops in developing nations.

(D) To sign the Kyoto Protocol for carbon emission control.

Q79. In the context of Human Health, 'Malarial parasites' undergo asexual reproduction in which of the following hosts/organs?

(A) Gut of female Anopheles mosquito

(B) Salivary glands of female Anopheles mosquito

(C) Human liver cells and Erythrocytes

(D) Human Spleen only

Q80. Which of the following antibodies is predominantly present in 'Colostrum' (the first milk produced by mothers) and provides passive immunity to the infant?

(A) IgG

(B) IgM

(C) IgE

(D) IgA

Q81. Identify the technique used to produce 'Dolly', the first cloned mammal:

(A) In-vitro fertilization

(B) Somatic Cell Nuclear Transfer (SCNT)

(C) Parthenogenesis

(D) Embryo Splitting

Q82. The 'Human Genome Project' (HGP) revealed that the total number of genes in the human genome is approximately:

(A) 100,000 to 150,000

(B) 20,000 to 25,000

(C) 3,000 to 5,000

(D) 1 million

Q83. In 'PCR' (Polymerase Chain Reaction), the correct sequence of the three main steps is:

(A) Extension → Denaturation → Annealing

(B) Denaturation → Annealing → Extension

(C) Annealing → Extension → Denaturation

(D) Denaturation → Extension → Annealing

Q84. Which part of the human brain is primarily responsible for the regulation of body temperature, hunger, and thirst?

(A) Cerebellum

(B) Thalamus

(C) Hypothalamus

(D) Medulla Oblongata

Q85. The 'Glomerular Filtration Rate' (GFR) in a healthy human individual is approximately:

(A) 125 mL/minute

(B) 180 mL/hour

(C) 5 Liters/minute

(D) 125 mL/day

Q86. Which of the following is an example of an 'Autoimmune Disease' where the body's immune system attacks its own joint tissues?

(A) Osteoarthritis

(B) Rheumatoid Arthritis

(C) Gout

(D) Osteoporosis

Q87. In the 'Double Helix' model of DNA, the two strands are held together by hydrogen bonds between nitrogenous bases. How many hydrogen bonds are formed between Guanine and Cytosine?

(A) Two

(B) Three

(C) Four

(D) One

Q88. A biocontrol agent used to control butterfly caterpillars is:

(A) *Trichoderma*

(B) *Bacillus thuringiensis*

(C) *Dragonflies*

(D) *Aphids*

Q89. The hormone 'Erythropoietin', which stimulates the formation of RBCs, is produced by:

(A) Alpha cells of Pancreas

(B) Juxtaglomerular (JG) cells of the Kidney

(C) Adenohypophysis

(D) Bone marrow itself

Q90. According to the 'Sliding Filament Theory' of muscle contraction, which of the following occurs during the contraction phase?

(A) The A-band shortens.

(B) The I-band shortens and the H-zone disappears.

(C) Actin and Myosin filaments themselves shorten in length.

(D) The Sarcomere length remains constant.

Detailed Solutions

Q1.

Solution

Concept:

Kingdom Monera includes all prokaryotic organisms. The defining characteristic of prokaryotes is the lack of a true nucleus and membrane-bound organelles. Their genetic material is not enclosed by a nuclear envelope. They also possess 70S ribosomes, unlike the 80S ribosomes found in the cytoplasm of eukaryotes.

Solution:

1. Monerans are unicellular prokaryotes. 2. They do not have a nuclear membrane or membrane-bound organelles like mitochondria or Golgi bodies. 3. Their cell wall, if present, is generally made of peptidoglycan, not cellulose which is characteristic of plants. 4. Histones are generally absent in the DNA of Monerans. 5. Therefore, the absence of membrane-bound organelles and the presence of 70S ribosomes is the most accurate distinguishing combination for the whole kingdom.

Final Answer: The correct option is (B).

Answer: (B)

Q2.

Solution

Concept:

Taxonomy uses structural features to classify organisms. A cell wall composed of chitin is a signature characteristic of the Kingdom Fungi.

Solution:

1. Organisms that are multicellular, heterotrophic (saprophytic), and have chitinous cell walls belong to Kingdom Fungi. 2. Spermatophyta (Plants) have cellulose cell walls. 3. Arthropoda (Animals) lack cell walls entirely. 4. While Ascomycetes is a class within Fungi, the question asks for the broad category where it is placed alongside others sharing that specific cell wall composition, which refers to the Kingdom level.

Final Answer: The organism would be placed in Kingdom Fungi.

Answer: (B)

Q3.

Solution

Concept:

The taxonomic hierarchy moves from Species to Kingdom. As we move up the hierarchy, the groups become broader and more inclusive.

Solution:

1. Species is the lowest, most specific level where organisms share the maximum number of common characteristics. 2. As we move towards Kingdom (the highest level), the number of shared characteristics between the organisms in that group decreases. 3. The group becomes less specific and more general as it encompasses a wider variety of life forms. 4. Thus, shared characteristics decrease and specificity decreases.

Final Answer: Shared characteristics decrease; specificity decreases.

Answer: (B)

Q4.

Solution

Concept:

Phylum Ctenophora consists of marine, radially symmetrical, diploblastic organisms with tissue-level organization.

Solution:

1. Ctenophores exhibit tissue level of organization. 2. Adults are radially symmetrical. 3. A key characteristic of Ctenophora and Coelenterata is that their larval stages (like the Cydippid larva) maintain the basic symmetry and level of organization of the phylum. 4. Unlike Echinoderms (which have bilateral larvae), Ctenophores maintain radial symmetry throughout life stages.

Final Answer: Tissue level; Radial symmetry.

Answer: (D)

Q5.

Solution

Concept:

In binomial nomenclature, the first name represents the Genus.

Solution:

1. In Musca domestica, Musca is the Genus. 2. In Triticum aestivum, Triticum is the Genus. 3. In Panthera tigris, Panthera is the Genus. 4. In Solanum tuberosum, Solanum is the Genus. 5. All four listed terms (i, ii, iii, iv) represent the Genus level of their respective organisms.

Final Answer: All represent the Genus level.

Answer: (A)

Q6.

Solution

Concept:

The classification of Mango (*Mangifera indica*) follows the standard taxonomic hierarchy. Mango belongs to the Kingdom Plantae and the Division Angiospermae (flowering plants). Within Angiospermae, it is classified under the Class Dicotyledonae due to the presence of two cotyledons in its seed.

Solution:

1. The Division is **Angiospermae**, which includes all plants that produce flowers and seeds within an ovary. 2. The Class is **Dicotyledonae**, characterized by seeds with two cotyledons and reticulate venation. 3. The Order is **Sapindales**, which is a group of flowering plants including maples and citrus. 4. The Family is **Anacardiaceae**, commonly known as the cashew or sumac family. 5. Following the descending order (Higher to Lower): Division → Class → Order → Family. 6. Therefore, the sequence is: Angiospermae → Dicotyledonae → Sapindales → Anacardiaceae.

Final Answer: The correct sequence is Angiospermae → Dicotyledonae → Sapindales → Anacardiaceae.

Answer: (A)

Q7.

Solution

Concept:

Defining characteristics of life must be present in all living organisms without exception. While growth, reproduction, and metabolism are traits of life, some exhibit exceptions (e.g., mules cannot reproduce, mountains "grow" by accumulation).

Solution:

1. Growth by accumulation of material on the surface (extrinsic growth) is seen in non-living objects like snowballs or mountains. 2. Living organisms exhibit **intrinsic growth**, which is an increase in mass from the inside due to cellular processes. 3. While "perception and memory" (consciousness) is a defining property, "memory" specifically is not proven or required for all life forms (like simple bacteria or plants). 4. Isolated metabolic reactions in-vitro are living reactions but not living things. 5. Therefore, intrinsic growth (increase in mass from inside) is a universal and fundamental characteristic of all living beings.

Final Answer: Increase in mass from inside.

Answer: (A)

Q8.

Solution

Concept:

Solanaceae (Potato family) and Liliaceae (Lily family) are two distinct families. Solanaceae is a dicot family, while Liliaceae is a monocot family. Their floral structures differ significantly in terms of fusion and persistence.

Solution:

1. Both families typically have a superior ovary and axile placentation, so this does not distinguish them effectively. 2. Liliaceae is characterized by a **perianth** (tepals) and a **tricarpellary** gynoecium, which are monocot features. 3. Solanaceae is characterized by a **gamosepalous** calyx (fused sepals) that is often **persistent** (remains attached to the fruit, like in Brinjal or Chilli). 4. Liliaceae usually lacks a distinct calyx and corolla (having a perianth instead). 5. The presence of a gamosepalous calyx and persistent sepal is a hallmark of Solanaceae.

Final Answer: Gamosepalous calyx and persistent sepal.

Answer: (D)

Q9.

Solution

Concept:

In plant anatomy, vascular bundles are classified based on the presence or absence of cambium. Cambium is a lateral meristematic tissue responsible for secondary growth (increase in girth).

Solution:

1. **Conjoint** means xylem and phloem are on the same radius. 2. **Collateral** means phloem is located on the outer side of the xylem. 3. **Open** vascular bundles possess a layer of **intrafascicular cambium** between the primary xylem and primary phloem. 4. This cambium allows the plant to form secondary xylem and phloem later in life. 5. In contrast, "closed" bundles (found in monocots) lack this cambium and cannot undergo secondary growth.

Final Answer: The presence of cambium between xylem and phloem for secondary growth.

Answer: (A)

Q10.

Solution

Concept:

Bulliform cells (or motor cells) are large, bubble-shaped epidermal cells that occur in groups on the upper surface of the leaves of many monocots, particularly grasses.

Solution:

1. These cells are highly sensitive to water availability. 2. When water is abundant, they absorb water, become turgid, and keep the leaf surface exposed. 3. During **water stress** (drought), these cells lose water and become flaccid. 4. This loss of turgidity causes the leaf to **curl or roll inward** to reduce the exposed surface area. 5. This mechanism significantly reduces water loss through transpiration by shielding the stomata from direct sunlight and wind.

Final Answer: They lose turgidity, causing the leaves to curl inward to minimize water loss.

Answer: (B)

Q11.

Solution

Concept:

In a dorsiventral (dicot) leaf, the vascular bundles are located within the veins and the midrib. The orientation of the xylem and phloem is constant and reflects their origin from the stem's vascular system.

Solution:

1. The vascular bundles in leaves are conjoint and collateral. 2. In the midrib (the central vein), the xylem is always located towards the upper surface, which is technically called the **adaxial epidermis**. 3. The phloem is located towards the lower surface, known as the **abaxial epidermis**. 4. Specifically, within the xylem tissue, the **protoxylem** (the first-formed xylem) is directed towards the adaxial side, while the metaxylem is directed towards the abaxial side. 5. This arrangement is crucial for the efficient transport of water from the stem into the leaf blade.

Final Answer: Towards the adaxial epidermis.

Answer: (B)

Q12.

Solution

Concept:

Plants utilize different simple permanent tissues for structural support. Collenchyma and Sclerenchyma are the primary mechanical tissues, but they differ in their properties and locations.

Solution:

1. **Collenchyma** consists of living cells with pectin depositions at the corners. It provides mechanical support along with **flexibility** (tensile strength). 2. It is typically found in the petiole of leaves and young stems of dicots. 3. This tissue allows the plant part to bend easily without breaking under wind pressure. 4. **Sclerenchyma** consists of dead cells with lignin and provides extreme rigidity, but it lacks the flexibility required for a moving petiole. 5. **Parenchyma** is primarily for storage and photosynthesis, and **Xylem** is for conduction. 6. Therefore, Collenchyma is the specific tissue responsible for this combination of strength and elasticity.

Final Answer: Collenchyma.

Answer: (B)

Q13.

Solution

Concept:

The Tunica-Corpus theory, proposed by Schmidt, describes the organization of the vegetative shoot apex. It divides the meristem into two distinct regions based on the planes of cell division.

Solution:

1. The **Tunica** consists of one or more peripheral layers of cells. 2. These cells divide almost exclusively in an **anticlinal** plane (perpendicular to the surface). 3. This type of division allows the tunica to increase in surface area, helping it to cover the expanding internal mass of the shoot. 4. The **Corpus** is the inner mass of cells that divide in all planes (anticlinal, periclinal, and oblique) to increase the volume of the shoot. 5. The tunica typically gives rise to the epidermis.

Final Answer: Anticlinal divisions only.

Answer: (B)

Q14.

Solution

Concept:

Epithelial tissues are classified by cell shape and specialized surface modifications. Cilia are hair-like projections on the free surface of certain epithelial cells.

Solution:

1. **Ciliated epithelium** consists of columnar or cuboidal cells that possess cilia. 2. The function of these cilia is to move particles, fluids, or mucus in a specific, coordinated direction over the epithelial surface. 3. In the **fallopian tubes**, the cilia help move the ovum (egg) toward the uterus. 4. In the **bronchioles** of the respiratory tract, they push mucus and trapped dust particles upward toward the pharynx to be cleared. 5. Squamous, cuboidal, and glandular epithelia lack these rhythmic, moving hair-like structures.

Final Answer: Ciliated epithelium.

Answer: (C)

Q15.

Solution

Concept:

Cell junctions are specialized structures that provide contact between neighboring cells in animal tissues. They serve various functions ranging from sealing to communication.

Solution:

1. **Tight junctions** help to stop substances from leaking across a tissue. 2. **Adhering junctions** (including desmosomes) perform cementing to keep neighboring cells together mechanically. 3. **Gap junctions** are specialized communication channels. 4. They facilitate the transfer of ions, small molecules, and sometimes big molecules between adjacent cells by connecting the cytoplasm of the two cells. 5. This allows for rapid electrical or chemical signaling, which is essential in tissues like cardiac muscle.

Final Answer: Gap junctions.

Answer: (C)

Q16.

Solution

Concept:

The Endoplasmic Reticulum (ER) is divided into Rough ER (RER) and Smooth ER (SER). While RER is involved in protein synthesis due to ribosomes, the SER lacks ribosomes and performs lipid metabolism.

Solution:

1. The question asks for the organelle responsible for lipid and steroidal hormone synthesis. 2. The **Smooth Endoplasmic Reticulum (SER)** is the major site for synthesis of lipids. In animal cells, lipid-like steroidal hormones (e.g., estrogen, testosterone) are synthesized in the SER. 3. Although mitochondria have circular DNA and 70S ribosomes, their primary function is ATP production, not the primary synthesis of these hormones. 4. RER is involved in protein secretion. 5. Golgi apparatus is involved in packaging and modification.

Final Answer: The correct option is (B).

Answer: (B)

Q17.

Solution

Concept:

During mitosis, motor proteins (like dynein and kinesin) at the kinetochores are responsible for pulling sister chromatids toward opposite poles along the spindle fibers.

Solution:

1. If motor proteins are inhibited at the metaphase-anaphase transition, the force required to pull chromatids apart will be absent. 2. In **Anaphase**, the centromeres split, and sister chromatids must migrate to the poles. 3. Without functional motor proteins, the sister chromatids will fail to separate and move. 4. While spindle fibers attach during metaphase, the "movement" or "separation" is the dynamic process hindered here.

Final Answer: Inability of sister chromatids to separate during anaphase.

Answer: (B)

Q18.

Solution

Concept:

Membrane fluidity is vital for cell function. Temperature changes can affect the packing of phospholipids.

Solution:

1. **Cholesterol** acts as a "temperature buffer" or "fluidity buffer" for the cell membrane. 2. At high temperatures, it restrains the movement of phospholipids, preventing the membrane from becoming too fluid. 3. At low temperatures, it prevents the phospholipids from packing too tightly together (crystallizing), thereby maintaining fluidity. 4. Saturated fatty acids actually decrease fluidity because they pack tightly.

Final Answer: Cholesterol.

Answer: (B)

Q19.

Solution

Concept:

Prophase I of Meiosis I is divided into five substages: Leptotene, Zygotene, Pachytene, Diplotene, and Diakinesis.

Solution:

1. Crossing over and recombination nodules appear in **Pachytene**. 2. In **Diplotene**, the synaptonemal complex (which held homologous chromosomes together) dissolves. 3. The homologous chromosomes begin to separate except at the sites of crossing over. 4. These X-shaped points of attachment are called **Chiasmata**, and they become visible for the first time in Diplotene. 5. Terminalisation occurs in the next stage, Diakinesis.

Final Answer: Dissolution of the synaptonemal complex and visibility of Chiasmata.

Answer: (C)

Q20.

Solution

Concept:

The endomembrane system includes those organelles whose functions are coordinated.

Solution:

1. The endomembrane system includes: Endoplasmic Reticulum (ER), Golgi complex, Lysosomes, and Vacuoles. 2. Mitochondria, Chloroplasts, and Peroxisomes are **not** part of this system because their functions are not coordinated with the others. 3. The Golgi apparatus receives materials (proteins) from the ER; thus, they are in close physical and functional association. 4. Lysosomes are formed by the Golgi apparatus, not the ER directly. 5. Vacuoles in plants can occupy up to 90% of the volume.

Final Answer: The Golgi apparatus remains in close association with the ER.

Answer: (B)

Q21.

Solution

Concept:

The Chemiosmotic Hypothesis explains the mechanism of ATP synthesis in both chloroplasts and mitochondria. It relies on the creation of a proton (H^+) gradient across a membrane.

Solution:

1. In chloroplasts, during the light-dependent reactions of photosynthesis, protons are accumulated within the lumen of the thylakoids. 2. This creates a high concentration of protons inside the lumen compared to the stroma. 3. The **Thylakoid membrane** is the site where the Electron Transport Chain (ETC) is located and where the gradient is established. 4. The breakdown of this gradient through the $F_0 - F_1$ ATPase complex provides the energy necessary to catalyze the formation of ATP from ADP and inorganic phosphate. 5. In contrast, in mitochondria, the gradient is established across the inner mitochondrial membrane.

Final Answer: The proton gradient is established across the Thylakoid membrane.

Answer: (B)

Q22.

Solution

Concept:

C_4 plants have evolved a specialized mechanism to concentrate CO_2 around the enzyme RuBisCO to minimize photorespiration. This involves two types of cells: mesophyll cells and bundle sheath cells.

Solution:

1. In the mesophyll cells of C_4 plants, the primary CO_2 acceptor is a 3-carbon molecule called **Phosphoenolpyruvate (PEP)**. 2. This reaction is catalyzed by the enzyme PEP carboxylase (PEPcase). 3. The first stable product formed is a 4-carbon acid called **Oxaloacetic acid (OAA)**. 4. OAA is then converted into other 4-carbon acids like Malic acid or Aspartic acid to be transported to the bundle sheath cells. 5. Therefore, PEP is the acceptor and OAA is the first stable product.

Final Answer: PEP and Oxaloacetic acid.

Answer: (B)

Q23.

Solution

Concept:

The Warburg Effect in plant physiology (distinct from the cancer-related term) refers to the inhibition of photosynthesis by high oxygen levels.

Solution:

1. RuBisCO is an enzyme that can act as both a carboxylase and an oxygenase. 2. When the concentration of O_2 is high and CO_2 is low, RuBisCO binds with O_2 instead of CO_2. 3. This initiates a process called **Photorespiration** (C_2 cycle), where CO_2 is actually released and ATP/NADPH are consumed without producing sugar. 4. High light intensity and high temperatures further favor the oxygenase activity of RuBisCO. 5. This drastically reduces the net photosynthetic yield.

Final Answer: High O_2 concentration and high light intensity/temperature.

Answer: (B)

Q24.

Solution

Concept:

After glycolysis in the cytoplasm, pyruvic acid enters the mitochondrial matrix to undergo the "Link Reaction" (or Transition Reaction) before entering the Krebs Cycle.

Solution:

1. Pyruvic acid (3C) is converted into Acetyl-CoA (2C). 2. During this process, one molecule of CO_2 is removed, which is a **decarboxylation** step. 3. Simultaneously, NAD^+ is reduced to $NADH + H^+$, which is an **oxidation** step. 4. Because both oxidation and decarboxylation occur, the reaction is termed **Oxidative decarboxylation**. 5. This reaction is catalyzed by a complex called the Pyruvate Dehydrogenase Complex.

Final Answer: Oxidative decarboxylation reaction.

Answer: (A)

Q25.

Solution

Concept:

The light reaction involves the Z-scheme of electron transport. Protons are moved as electrons pass through the cytochrome b_6f complex.

Solution:

1. As electrons move from Photosystem II (PS II) to Photosystem I (PS I) through the electron transport chain, energy is released. 2. This energy is used to pump protons (H^+) across the thylakoid membrane. 3. Protons are moved from the **Stroma** (low concentration) into the **Thylakoid lumen** (high concentration). 4. Additionally, the photolysis of water occurs on the inner side of the thylakoid membrane, further increasing the proton concentration in the lumen. 5. This establishes the electrochemical gradient used for ATP production.

Final Answer: Thylakoid lumen.

Answer: (B)

Q26.

Solution

Concept:

The Electron Transport System (ETS) consists of several complexes (I to IV) and mobile carriers. Cytochrome c is a small, peripheral membrane protein attached to the outer surface of the inner mitochondrial membrane.

Solution:

1. Complex III is the Cytochrome bc_1 complex, and Complex IV is the Cytochrome c oxidase complex. 2. Cytochrome c is not part of any fixed complex; instead, it is a mobile electron carrier. 3. It receives electrons from Complex III (specifically from Cytochrome c_1) and transfers them to Complex IV. 4. This mobile nature allows it to shuttle electrons efficiently across the membrane surface between these two large, stationary enzyme complexes. 5. Complex I and II both transfer electrons to Ubiquinone, not Cytochrome c.

Final Answer: Complex III and Complex IV.

Answer: (C)

Q27.

Solution

Concept:

Abscisic acid (ABA) is a plant growth inhibitor that plays a crucial role in regulating plant responses to environmental stresses, particularly drought and water scarcity.

Solution:

1. Under conditions of water stress, the roots of the plant produce Abscisic acid which is transported to the leaves. 2. ABA acts on the guard cells of the stomata, causing an efflux of potassium ions and a subsequent loss of turgor pressure. 3. This leads to the rapid **closure of stomata**, reducing water loss through transpiration. 4. Because of this protective role, ABA is widely known as the "stress hormone." 5. Indole-3-acetic acid (Auxin) and Gibberellic acid are growth promoters, while Zeatin is a Cytokinin.

Final Answer: Abscisic acid.

Answer: (C)

Q28.

Solution

Concept:

The link reaction (oxidative decarboxylation of pyruvate) connects glycolysis to the Krebs cycle. It occurs once for every molecule of pyruvate that enters the mitochondria.

Solution:

1. One molecule of glucose produces two molecules of Pyruvic acid through glycolysis. 2. Therefore, for two molecules of glucose, a total of **four** molecules of Pyruvic acid are produced. 3. In the link reaction, each molecule of Pyruvic acid is converted into Acetyl-CoA, producing **one** molecule of $NADH + H^+$ in the process. 4. Since we have four molecules of Pyruvic acid (from two glucose molecules), the total production of $NADH$ is:

$$4 \text{ Pyruvate} \times 1 \text{ NADH/Pyruvate} = 4 \text{ NADH}$$

5. It is essential to double the standard yield of a single glucose molecule.

Final Answer: 4 molecules of NADH.

Answer: (B)

Q29.

Solution

Concept:

Photolysis (water splitting) is the process by which water is oxidized to release electrons, protons, and oxygen during the light-dependent reactions of photosynthesis.

Solution:

1. This process occurs at the Oxygen Evolving Complex (OEC) associated with Photosystem II (PS II). 2. The OEC requires specific inorganic mineral ions as cofactors to function. 3. **Manganese** (Mn^{2+}) is the most critical element, as four manganese atoms form a cluster that facilitates the removal of electrons from water. 4. **Chlorine** (Cl^-) and sometimes Calcium (Ca^{2+}) are also required for the stability and optimal activity of this complex. 5. Magnesium is the central atom of chlorophyll, and Iron is found in cytochromes, but they do not directly catalyze water splitting.

Final Answer: Manganese and Chlorine.

Answer: (B)

Q30.

Solution

Concept:

The Respiratory Quotient (RQ) is the ratio of the volume of CO_2 evolved to the volume of O_2 consumed during respiration. It depends on the type of respiratory substrate being oxidized.

$$RQ = \frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ consumed}}$$

Solution:

1. For carbohydrates (like glucose), the RQ is 1.0 because the amount of CO_2 produced equals the O_2 consumed. 2. For **fats** (like tripalmitin), the molecules are oxygen-poor compared to carbohydrates, so more external oxygen is required for complete oxidation. 3. The balanced equation for tripalmitin oxidation is:

$$2(C_{51}H_{98}O_6) + 145O_2 \rightarrow 102CO_2 + 98H_2O + \text{Energy}$$

4. Calculating the ratio: $RQ = 102/145 \approx 0.7$. 5. Proteins typically have an RQ of around 0.9, and organic acids have an RQ greater than 1.0.

Final Answer: 0.7.

Answer: (B)

Q31.

Solution

Concept: Parietal cells (also called oxyntic cells) are located in the gastric glands of the stomach. They are responsible for secreting two vital substances: Hydrochloric acid (HCl) and Castle's Intrinsic Factor.

Solution: 1. **HCl Secretion:** HCl maintains the acidic pH required for the conversion of inactive pepsinogen into active pepsin. Without HCl, protein digestion is severely impaired. 2. **Intrinsic Factor:** This is essential for the absorption of Vitamin B_{12} in the terminal ileum. 3. Vitamin B_{12} is necessary for erythropoiesis (RBC production). Its deficiency leads to Pernicious Anemia. 4. If parietal cells are non-functional, the stomach environment will not be acidic enough for proteins, and Vitamin B_{12} cannot be absorbed. 5. Bile activation occurs in the duodenum and is related to cholecystokinin, not parietal cells.

Final Answer: Impaired protein digestion and deficiency of Vitamin B_{12}.

Answer: (B)

Q32.

Solution

Concept: The heart sounds are clinical markers of the cardiac cycle. The first heart sound 'Lubb' (S1) is associated with the mechanical closure of the valves to prevent backflow.

Solution: 1. When the ventricles begin to contract (**Ventricular Systole**), the pressure within them rises rapidly. 2. This rising pressure exceeds the pressure in the atria, causing the atrioventricular (AV) valves (Mitral and Tricuspid) to snap shut. 3. The closure of these valves produces the 'Lubb' sound. 4. This ensures that blood is pumped out through the semilunar valves into the arteries rather than leaking back into the atria. 5. The 'Dupp' sound occurs at the start of ventricular diastole due to the closure of semilunar valves.

Final Answer: Ventricular Systole.

Answer: (C)

Q33.

Solution

Concept: The Loop of Henle is essential for the concentration of urine. Its descending and ascending limbs have distinct permeability properties for water and electrolytes.

Solution: 1. The **Descending limb** of the Loop of Henle is permeable to water but almost impermeable to electrolytes. 2. The **Ascending limb** is the opposite: it is **impermeable to water** but allows active or passive transport of electrolytes (Na^+, Cl^-). 3. As the filtrate moves up the ascending limb, solutes are removed while water stays behind, making the filtrate dilute and the medullary interstitium concentrated (hypertonic). 4. This impermeability to water in the ascending limb is a key requirement for the counter-current multiplier system to work.

Final Answer: Ascending limb of Loop of Henle.

Answer: (B)

Q34.

Solution

Concept: The P-wave represents the depolarization of the atria, which precedes atrial contraction. Its shape and size reflect the health and mass of the atrial tissue.

Solution: 1. A normal P-wave is small and rounded. 2. If the P-wave becomes abnormally tall (peaked) or wide (enlarged), it indicates that the electrical impulse is traveling through a larger-than-normal muscle mass. 3. This is a common indicator of **Atrial Hypertrophy** (enlargement of the atria), often caused by valve problems or pulmonary hypertension. 4. Myocardial infarction is typically associated with ST-segment changes or pathological Q-waves, not primarily P-wave changes.

Final Answer: Atrial Hypertrophy or enlargement.

Answer: (B)

Q35.

Solution

Concept: The posterior pituitary gland (neurohypophysis) does not synthesize hormones. It acts as a storage and release site for hormones produced by the hypothalamus.

Solution: 1. The hypothalamus contains supraoptic and paraventricular nuclei that synthesize **Vasopressin** (Antidiuretic Hormone) and Oxytocin. 2. These hormones travel down the axons of the hypothalamic-hypophyseal tract to the posterior pituitary. 3. Upon receiving a signal, the posterior pituitary releases them into the blood. 4. In contrast, Growth Hormone, Prolactin, and LH are synthesized and released by the anterior pituitary (adenohypophysis).

Final Answer: Vasopressin (ADH).

Answer: (C)

Q36.

Solution

Concept:

The menstrual cycle is regulated by a complex interplay of hormones from the hypothalamus (GnRH), anterior pituitary (FSH and LH), and ovaries (Estrogen and Progesterone). Ovulation is the pivotal event occurring mid-cycle.

Solution:

1. During the follicular phase, growing follicles secrete increasing amounts of **Estrogen**. 2. Initially, low levels of estrogen exert negative feedback on the pituitary. However, as the dominant follicle matures, estrogen levels rise significantly. 3. Once estrogen reaches a specific high threshold and remains there for about 48 hours, it switches from negative feedback to **positive feedback**. 4. This extreme high level of estrogen triggers the anterior pituitary to release a massive amount of Luteinizing Hormone, known as the **LH surge**. 5. This surge is the direct trigger for the rupture of the Graafian follicle and the release of the secondary oocyte (ovulation).

Final Answer: High concentration of Estrogen.

Answer: (B)

Q37.

Solution

Concept:

After fertilization in the ampulla of the fallopian tube, the zygote undergoes rapid mitotic divisions called cleavage. As it divides, it simultaneously moves toward the uterus.

Solution:

1. The first cleavage occurs about 30 hours after fertilization. 2. By the time the embryo reaches the 8 to 16-cell stage, it is called a **Morula** (resembling a mulberry). 3. This stage typically occurs about 3 days after fertilization. 4. During this time, the embryo is still traveling through the narrow part of the fallopian tube called the **Isthmus**. 5. By day 4 or 5, it enters the uterus as a blastocyst. Therefore, the morula is characteristic of the transit through the isthmus.

Final Answer: Isthmus of the Fallopian tube.

Answer: (C)

Q38.

Solution

Concept:

Polyspermy (the entry of more than one sperm into the egg) would result in a non-viable polyploid embryo. The egg has two primary mechanisms to prevent this: the "fast block" and the "slow block."

Solution:

1. When a sperm contacts the egg membrane, it triggers a **cortical reaction**. 2. Cortical granules located just beneath the egg's plasma membrane fuse with the membrane and release their contents (enzymes) into the space between the membrane and the zona pellucida. 3. These enzymes harden the zona pellucida and destroy sperm receptors (ZP3). 4. Simultaneously, a rapid **depolarization of the egg membrane** occurs (fast block). 5. Together, these changes ensure that once one sperm has entered, no other sperm can bind or penetrate, effectively blocking polyspermy.

Final Answer: Cortical reaction and membrane depolarization.

Answer: (B)

Q39.

Solution

Concept:

Incomplete dominance is a genetic phenomenon where the heterozygous phenotype is an intermediate blend of the two homozygous phenotypes, rather than one being completely dominant over the other.

Solution:

1. In *Antirrhinum*, Red flowers are RR and White flowers are rr. 2. The F_1 generation offspring are Rr, which appear **Pink**. 3. When Rr (Pink) is self-pollinated ($Rr \times Rr$): - $1/4$ are RR (Red) - $2/4$ (or $1/2$) are Rr (Pink) - $1/4$ are rr (White) 4. This results in a phenotypic ratio of **1:2:1**. 5. Notably, in incomplete dominance, the genotypic and phenotypic ratios are identical.

Final Answer: 1:2:1 (Red:Pink:White).

Answer: (B)

Q40.

Solution

Concept:

In a Mendelian dihybrid cross, we use the product rule of probability. We can look at each gene locus independently and then multiply the probabilities.

Solution:

1. For the cross $Aa \times Aa$, the probability of getting AA is $1/4$. 2. For the cross $Bb \times Bb$, the probability of getting Bb is $2/4$ (or $1/2$). 3. To find the probability of the combined genotype $AABb$, we multiply the individual probabilities:

$$P(AA) \times P(Bb) = \frac{1}{4} \times \frac{2}{4} = \frac{2}{16}$$

4. Alternatively, using a 16-square Punnett square, you would find exactly 2 squares out of 16 containing the $AABb$ genotype.

Final Answer: $2/16$.

Answer: (B)

Q41.

Solution

Concept:

Pleiotropy is a genetic condition where a single gene or a single locus influences multiple, seemingly unrelated phenotypic traits. This is often due to the gene product being involved in a metabolic pathway that affects various physiological processes.

Solution:

1. In **Polygenic inheritance**, multiple genes control a single trait (e.g., human skin color). 2. In **Pleiotropy**, a single gene mutation has multiple clinical or physical manifestations. 3. A classic example is **Phenylketonuria (PKU)**. A mutation in the gene that codes for the enzyme phenylalanine hydroxylase results in mental retardation, as well as reduced hair and skin pigmentation. 4. Another example is Sickle Cell Anemia, where a single mutation in the hemoglobin gene affects the shape of RBCs, blood flow, and organ function. 5. Epistasis involves one gene masking the expression of another, and Co-dominance is when both alleles are expressed equally.

Final Answer: Pleiotropy.

Answer: (C)

Q42.

Solution

Concept:

The Lac Operon is a classic model of gene regulation in prokaryotes. It consists of structural genes, a promoter, an operator, and a regulatory gene (*i* gene).

Solution:

1. The regulatory gene (*i* gene) constitutively synthesizes a **repressor protein**. 2. In the absence of an inducer, the repressor binds to the **operator gene**, preventing RNA polymerase from transcribing the structural genes. 3. When **lactose** (the inducer) is present, it enters the cell and binds to the repressor protein. 4. This binding changes the conformation of the repressor, making it unable to bind to the operator. 5. Consequently, the operator is "switched on," allowing RNA polymerase to move forward and transcribe the genes required for lactose metabolism.

Final Answer: Repressor protein.

Answer: (C)

Q43.

Solution

Concept:

DNA fingerprinting involves several steps: isolation, digestion by restriction enzymes, separation by electrophoresis, and transferring.

Solution:

1. After DNA fragments are separated based on size using gel electrophoresis, they are in a fragile gel. 2. To perform hybridization with probes, the DNA must be transferred to a stable solid support, such as a nitrocellulose or nylon membrane. 3. This transfer process of DNA from a gel to a membrane is called **Southern Blotting** (named after E.M. Southern). 4. Northern Blotting is used for RNA, and Western Blotting is used for proteins. 5. Eastern Blotting is a specialized technique for post-translational modifications of proteins.

Final Answer: Southern Blotting.

Answer: (B)

Q44.

Solution

Concept:

Nitrogenous bases are divided into two categories: Purines (double-ring structure) and Pyrimidines (single-ring structure).

Solution:

1. The **Purines** are **Adenine (A)** and **Guanine (G)**. 2. The **Pyrimidines** are **Cytosine (C)**, **Thymine (T)**, and **Uracil (U)**. 3. Cytosine is found in both DNA and RNA. 4. Thymine is found strictly in DNA, while Uracil is found strictly in RNA. 5. Adenine (a Purine) is a fundamental component of both DNA and RNA genetic codes. 6. Therefore, Adenine fits the criteria of being a purine present in both nucleic acids.

Final Answer: Adenine.

Answer: (D)

Q45.

Solution

Concept:

Translation is the synthesis of a polypeptide chain (protein) from an mRNA template. This occurs on the ribosome.

Solution:

1. During the elongation phase of translation, amino acids are brought to the ribosome by tRNA molecules. 2. A peptide bond must be formed between the carboxyl group of the amino acid at the P-site and the amino group of the amino acid at the A-site. 3. The enzyme that catalyzes this reaction is **Peptidyl transferase**. 4. In bacteria, this enzymatic activity is actually performed by the 23S rRNA of the large ribosomal subunit, making it a "ribozyme." 5. Aminoacyl tRNA synthetase is responsible for "charging" the tRNA with its specific amino acid before it reaches the ribosome.

Final Answer: Peptidyl transferase.

Answer: (C)

Q46.

Solution

Concept: The plasmid pBR322 has two antibiotic resistance genes: amp^R (ampicillin resistance) and tet^R (tetracycline resistance). The BamHI restriction site is located within the tet^R gene sequence.

Solution: 1. When a foreign DNA fragment is inserted into the BamHI site, it disrupts the continuity of the tet^R gene. 2. This process is called **Insertional Inactivation**. As a result, the plasmid loses its ability to confer resistance to tetracycline. 3. However, the amp^R gene remains intact because no DNA was inserted into its sequence. 4. Therefore, the recombinant transformants will be able to grow on a medium containing ampicillin (because they are still resistant) but will fail to grow on a medium containing tetracycline. 5. This differential growth is used to select recombinants from non-recombinants.

Final Answer: Lose resistance to tetracycline but remain resistant to ampicillin.

Answer: (C)

Q47.

Solution

Concept: DNA Ligase is an essential enzyme in molecular biology and DNA replication. It acts as the "molecular glue" that facilitates the joining of DNA strands together.

Solution: 1. Restriction endonucleases cut DNA at specific sites, often leaving single-stranded overhanging ends called "sticky ends." 2. When two DNA fragments with complementary sticky ends come together, they form hydrogen bonds between their bases. 3. **DNA Ligase** then catalyzes the formation of a covalent **phosphodiester bond** between the 3'-hydroxyl end of one nucleotide and the 5'-phosphate end of the adjacent nucleotide. 4. This completes the sugar-phosphate backbone, resulting in a continuous double-stranded DNA molecule. 5. Reverse transcriptase is for RNA-to-DNA conversion, and Polymerase is for adding new nucleotides to a growing chain.

Final Answer: DNA Ligase.

Answer: (C)

Q48.

Solution

Concept: Gene therapy is a technique that uses genes to treat or prevent disease by inserting a functional gene into a patient's cells to replace a defective one.

Solution: 1. In 1990, the first clinical gene therapy trial was conducted on a girl suffering from Severe Combined Immunodeficiency (SCID). 2. SCID is caused by a genetic defect in the gene coding for the enzyme **Adenosine deaminase (ADA)**. 3. This enzyme is crucial for the proper functioning of the immune system; its absence leads to the accumulation of toxic metabolites that destroy T-lymphocytes. 4. The treatment involved extracting the patient's lymphocytes, inserting a functional ADA cDNA using a retroviral vector, and re-infusing the cells back into the patient.

Final Answer: Adenosine deaminase (ADA).

Answer: (A)

Q49.

Solution

Concept: The soil bacterium *Bacillus thuringiensis* (Bt) produces crystalline protein inclusions (Cry proteins) that have insecticidal properties. These proteins are harmless to the bacterium itself.

Solution: 1. The Bt protein exists as an inactive **protoxin** crystal. 2. When an insect (such as a bollworm) ingests the cotton plant tissue containing this protoxin, the crystal enters the insect's gut. 3. In the **midgut** of the insect, the environment is highly **alkaline**. 4. This alkaline pH solubilizes the crystals and triggers the proteolytic cleavage of the protoxin into its active, toxic form. 5. The active toxin then binds to the surface of midgut epithelial cells, creating pores that cause cell swelling and lysis, eventually leading to the death of the insect.

Final Answer: Alkaline pH of the midgut.

Answer: (C)

Q50.

Solution

Concept: RNA interference (RNAi) is a biological process in which RNA molecules inhibit gene expression or translation by neutralizing targeted mRNA molecules.

Solution: 1. The process is initiated by the presence of **double-stranded RNA (dsRNA)**. 2. This dsRNA is processed into small interfering RNAs (siRNAs) by an enzyme called Dicer. 3. One strand of the siRNA is incorporated into a protein complex called RISC (RNA-induced silencing complex). 4. The RISC then uses this strand as a template to find and bind to a complementary mRNA molecule produced by the cell or a virus. 5. Once bound, the mRNA is cleaved or degraded, preventing it from being translated into a protein. This "silences" the gene.

Final Answer: Double-stranded RNA.

Answer: (B)

Q51.

Solution

Concept:

Population growth models describe how the size of a population changes over time. The logistic growth model is more realistic than the exponential model because it accounts for limited resources and carrying capacity.

Solution:

1. The equation $dN/dt = rN[(K - N)/K]$ is the differential form of the **Verhulst-Pearl Logistic Growth** equation. 2. In this equation: - N is the population density at time t. - r is the intrinsic rate of natural increase. - K is the **Carrying Capacity**, which is the maximum population size that a particular environment can sustain. 3. The term $(K - N)/K$ represents the environmental resistance or the portion of the resources still available for growth. 4. When N is very small, growth is nearly exponential, but as N approaches K, the growth rate slows down and eventually becomes zero, resulting in a sigmoid (S-shaped) curve.

Final Answer: Logistic growth model.

Answer: (C)

Q52.

Solution

Concept:

Ecosystem productivity refers to the rate at which solar energy is captured and converted into organic compounds by the community of organisms.

Solution:

1. **Gross Primary Productivity (GPP)** is the total rate at which organic matter is created by producers (green plants) during photosynthesis. 2. However, plants must use some of this organic matter for their own respiration to survive and grow. 3. **Net Primary Productivity (NPP)** is the GPP minus the energy lost through plant respiration ($NPP = GPP - R$). 4. NPP represents the actual biomass available for consumption by heterotrophs (herbivores and decomposers). 5. Secondary productivity refers to the rate of formation of new organic matter by consumers.

Final Answer: Gross Primary Productivity (GPP).

Answer: (B)

Q53.

Solution

Concept:

Gause's Competitive Exclusion Principle is a fundamental rule in ecology regarding niche overlap and competition between species for the same resources.

Solution:

1. The principle states that two species competing for the **same limiting resources** cannot coexist indefinitely in the same niche. 2. If resources are limited, the species that utilizes the resources more efficiently will have a reproductive advantage. 3. Consequently, the competitively **inferior competitor will eventually be eliminated** or excluded from the habitat. 4. While "resource partitioning" is a way species *avoid* exclusion in nature, Gause's specific principle predicts the elimination of the weaker species under constant competition.

Final Answer: The inferior competitor is eventually eliminated.

Answer: (B)

Q54.

Solution

Concept:

The Rivet Popper Hypothesis is an analogy used to explain the importance of biodiversity and the impact of species extinction on ecosystem stability.

Solution:

1. Paul Ehrlich compared an ecosystem to an airplane and the individual species to the **rivets** holding the plane together. 2. If every passenger starts popping rivets (species extinction), the plane might not crash immediately. 3. However, the loss of "rivets on the wings" — which represent **Key species (Keystone species)** that drive major ecosystem functions — would cause immediate and catastrophic failure of the flight (ecosystem collapse). 4. While every "rivet" represents a species, the specific analogy highlights how certain species are more critical to structural integrity than others.

Final Answer: Key species (Keystone species).

Answer: (C)

Answer: (C)

Q55.

Solution

Concept:

Certain regions of the world harbor exceptionally high levels of biodiversity and contribute significantly to global oxygen and carbon cycles.

Solution:

1. The **Amazon Rainforest** in South America is the largest tropical rainforest on Earth. 2. It is estimated to produce about 20% of the world's total oxygen through photosynthesis. 3. Because of this massive oxygen production and its role in sequestering carbon dioxide, it is colloquially referred to as the "**Lungs of the Planet**." 4. It also houses millions of species, many of which are still undiscovered by science. 5. The Western Ghats and Himalayas are biodiversity hotspots, but they do not match the scale of the Amazon's atmospheric contribution.

Final Answer: Amazon Rainforest.

Answer: (B)

Q56.

Solution

Concept:

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

Solution:

1. The ozone layer in the stratosphere protects the Earth from harmful ultraviolet (UV) radiation. 2. In the 1970s and 80s, it was discovered that certain man-made chemicals, particularly **Chlorofluorocarbons (CFCs)**, were breaking down ozone molecules. 3. The **Montreal Protocol** was signed in 1987 (and became effective in 1989) as a global agreement to regulate and phase out the consumption and production of these **Ozone-depleting substances (ODS)**. 4. It is considered one of the most successful environmental treaties, as it has led to the gradual recovery of the Antarctic ozone hole. 5. Greenhouse gases are primarily addressed by the Kyoto Protocol and the Paris Agreement.

Final Answer: Ozone-depleting substances.

Answer: (B)

Q57.

Solution

Concept:

Eutrophication is the natural or artificial enrichment of a body of water with nutrients, which leads to excessive growth of algae and depletion of dissolved oxygen.

Solution:

1. In young lakes, the water is cold and clear, supporting little life. Over time, streams draining into the lake introduce nutrients. 2. The two most critical limiting nutrients in aquatic ecosystems are **Nitrogen and Phosphorus**. 3. Runoff from agricultural fields (containing fertilizers) and sewage discharge significantly increases the concentration of these nutrients in the water. 4. This "nutrient over-enrichment" triggers an **Algal Bloom** (explosive growth of algae). 5. As the algae die and decompose, oxygen is consumed by decomposers, leading to the death of fish and other aquatic organisms, effectively "aging" the lake prematurely.

Final Answer: Nitrogen and Phosphorus.

Answer: (B)

Q58.

Solution

Concept:

Species interactions can be beneficial, harmful, or neutral. Proto-cooperation (a type of mutualism) is an interaction where both species benefit, but the association is not obligatory for survival.

Solution:

1. The sea anemone has stinging cells (nematocysts) that provide protection from predators. 2. The hermit crab often attaches the sea anemone to its shell. The crab gains a "living shield" against predators like octopuses. 3. The sea anemone benefits by being carried to new feeding grounds by the mobile crab and by scavenging fragments of food left over by the crab's messy eating. 4. Since both organisms benefit (+, +) but can survive without each other, this is a form of **Mutualism** (specifically non-obligatory **Proto-cooperation**). 5. Commensalism involves one benefiting while the other is unaffected (+, 0), which is not the case here as the crab also benefits.

Final Answer: Mutualism (Proto-cooperation).

Answer: (C)

Q59.

Solution

Concept:

Ecological pyramids represent the relationship between different trophic levels. While the pyramid of energy is always upright, the pyramid of biomass can be inverted in specific environments.

Solution:

1. In a **Marine/Aquatic ecosystem**, the producers are tiny phytoplanktons. 2. Although they have a high rate of reproduction and turnover, their standing crop (biomass) at any single point in time is very small. 3. The consumers (zooplankton and small fish) that feed on them have a much larger individual size and longer lifespans, resulting in a higher total biomass at that moment. 4. Similarly, large predatory fish at the top have an even greater total biomass than the primary producers. 5. This creates an **Inverted Pyramid of Biomass**, where the base (producers) is much narrower than the higher trophic levels.

Final Answer: Marine/Aquatic ecosystem.

Answer: (C)

Q60.

Solution

Concept:

Alexander von Humboldt observed that within a region, species richness increases with increasing explored area, but only up to a certain limit.

Solution:

1. On a logarithmic scale, the species-area relationship is a straight line described by the equation: $\log S = \log C + Z \log A$. 2. In this equation: - S = Species richness - A = Area - C = Y-intercept - Z = **Slope of the line (Regression coefficient)**. 3. Ecologists have found that the value of Z usually ranges from 0.1 to 0.2 regardless of the taxonomic group or region. 4. However, for very large areas like entire continents, the slope of the line is much steeper (Z values in the range of 0.6 to 1.2), indicating a more rapid increase in species richness with area.

Final Answer: Regression coefficient (Slope of the line).

Answer: (B)

Q61.

Solution

Concept: Human blood groups are determined by the I gene, which has three alleles: I^A, I^B, and i. I^A and I^B are dominant over i, while I^A and I^B are co-dominant.

Solution: 1. **The Man:** He has blood group 'A'. Since his mother had blood group 'O' (ii), he must have inherited one 'i' allele from her. Therefore, his genotype is I^Ai. 2. **The Woman:** She has blood group 'B'. Since her father had blood group 'O' (ii), she must have inherited one 'i' allele from him. Therefore, her genotype is I^Bi. 3. **The Cross:** $I^Ai \times I^Bi$. 4. The possible genotypes of the children are: - I^AI^B (Blood Group AB) - I^Ai (Blood Group A) - I^Bi (Blood Group B) - ii (Blood Group O) 5. Out of the 4 possible combinations, only 1 results in blood group 'O'. 6. Probability = $1/4 \times 100 = 25\%$.

Final Answer: 25%.

Answer: (B)

Q62.

Solution

Concept: The Hardy-Weinberg principle uses the equation $p^2 + 2pq + q^2 = 1$, where p is the frequency of the dominant allele and q is the frequency of the recessive allele.

Solution: 1. Given: Frequency of recessive allele (q) = 0.2. 2. We know that $p + q = 1$. 3. Therefore, $p = 1 - 0.2 = 0.8$. 4. The frequency of heterozygous individuals in the population is represented by the term $2pq$. 5. Calculation: $2 \times (0.8) \times (0.2) = 0.32$. 6. Thus, 32% of the population is heterozygous for this trait.

Final Answer: 0.32.

Answer: (B)

Q63.

Solution

Concept: While Darwin proposed that evolution occurs via gradual variations, Hugo de Vries observed large, sudden changes in the evening primrose (*Oenothera lamarckiana*).

Solution: 1. **Hugo de Vries** proposed the **Mutation Theory** of evolution in the early 20th century. 2. He believed that mutations are the raw material for evolution and that they occur randomly and suddenly. 3. He coined the term **Saltation** to describe a single-step large mutation that leads to speciation. 4. This contrasted with Darwin's view of small, directional variations. 5. Lamarck proposed the theory of inheritance of acquired characters, and Wallace independently arrived at natural selection.

Final Answer: Hugo de Vries.

Answer: (B)

Q64.

Solution

Concept: Homologous organs are those that share a common anatomical origin but perform different functions (divergent evolution). Analogous organs have different origins but perform similar functions (convergent evolution).

Solution: 1. **Thorns of *Bougainvillea* and tendrils of *Cucurbita*** both arise from the axillary bud position. 2. Because they share the same developmental origin, they are **homologous**. Their different functions (protection vs. climbing) represent **divergent evolution**. 3. Wings of birds and butterflies are analogous (different structure, same function). 4. Flippers of penguins (bird) and dolphins (mammal) are analogous. 5. Eyes of octopus and mammals have different retinal orientations, making them analogous.

Final Answer: Thorns of *Bougainvillea* and tendrils of *Cucurbita*.

Answer: (C)

Q65.

Solution

Concept: The Lac Operon regulation depends on the 'i' gene, which stands for the word 'inhibitor', not 'inducer'.

Solution: 1. The **i gene** is the regulatory gene of the operon. 2. It codes for a **repressor protein**. 3. The function of this repressor protein is to bind to the operator region and **inhibit** RNA polymerase from transcribing the structural genes (z, y, a). 4. Therefore, it acts as an inhibitor of the system under normal conditions (in the absence of lactose). 5. When lactose is present, it binds to the repressor and inactivates it, allowing transcription to proceed.

Final Answer: Its product inhibits the transcription of structural genes.

Answer: (B)

Q66.

Solution

Concept:

DNA replication is semi-discontinuous. While the leading strand is synthesized continuously, the lagging strand is synthesized in short stretches called Okazaki fragments because DNA polymerase can only add nucleotides in one specific direction.

Solution:

1. DNA polymerase enzyme acts on a single-stranded template and catalyzes the polymerization of deoxynucleotides. 2. A strict biochemical constraint of DNA polymerase is that it can only add new nucleotides to the 3'-OH end of a growing strand. 3. Therefore, DNA synthesis always proceeds in the **5′ → 3′ direction**. 4. On the lagging strand (5′ → 3′ template), the replication fork moves away from the direction of synthesis, requiring the machinery to restart periodically with new primers. 5. Even though these fragments (Okazaki fragments) are discontinuous, each individual fragment is synthesized in the standard 5′ → 3′ direction.

Final Answer: 5′ → 3′.

Answer: (B)

Q67.

Solution

Concept:

Hemophilia is an X-linked recessive disorder. This means the gene is located on the X chromosome, and the disease manifests in females only if both X chromosomes carry the mutation, whereas in males, a single mutated X chromosome causes the disease.

Solution:

1. **The Mother:** She is a carrier, so her genotype is X^HX^h (where X^h is the hemophilic allele). 2. **The Father:** He is normal, so his genotype is X^HY. 3. **The Offspring Analysis:** - Daughters: X^HX^H (Normal) and X^HX^h (Carrier). - Sons: X^HY (Normal) and X^hY (Hemophilic). 4. The question specifically asks for the percentage of **their sons** who are hemophilic. 5. Out of the total possible sons (X^HY and X^hY), 1 out of 2 is affected. 6. Probability among sons = $1/2 \times 100 = 50\%$.

Final Answer: 50%.

Answer: (C)

Q68.

Solution

Concept:

The Miller-Urey experiment (1953) simulated the conditions thought to exist on the primitive Earth to test the hypothesis of chemical evolution (abiogenesis).

Solution:

1. The early atmosphere of Earth was a **reducing atmosphere**, meaning it lacked free molecular oxygen (O_2). 2. Miller and Urey created a closed system containing water vapor (H_2O), methane (CH_4), ammonia (NH_3), and hydrogen gas (H_2). 3. They used electric discharges (sparks) to represent lightning and maintained a high temperature. 4. **Oxygen (O_2)** was strictly absent; if oxygen had been present, the organic molecules formed (like amino acids) would have been oxidized and destroyed. 5. The appearance of free oxygen in the atmosphere occurred much later due to the evolution of photosynthetic cyanobacteria.

Final Answer: O_2.

Answer: (C)

Q69.

Solution

Concept:

The timeline of the history of Earth shows a progression from the formation of the planet to the emergence of complex life.

Solution:

1. Earth was formed approximately 4.5 billion years ago. 2. The first signs of life (non-cellular macromolecules like RNA and proteins) originated about 4 billion years ago. 3. The **first cellular forms of life** (primitive single-celled organisms) are estimated to have appeared around **3 billion years ago** (or 3000 million years ago). 4. These were likely anaerobic heterotrophs. 5. Significant diversification and the rise of multicellularity occurred much later, around 500-600 million years ago (Cambrian explosion).

Final Answer: 3 billion years ago.

Answer: (B)

Q70.

Solution

Concept:

Adaptive radiation is the process in which organisms diversify rapidly from an ancestral species into a multitude of new forms, particularly when a change in the environment makes new resources available or creates new challenges.

Solution:

1. **Darwin's Finches:** From an original seed-eating ancestor on the mainland, different species evolved on different islands of the Galapagos with beaks adapted for seeds, insects, or nectar. 2. **Australian Marsupials:** A variety of marsupials (kangaroos, koalas, sugar gliders) evolved from a single ancestral stock within the isolated Australian continent. 3. **Placental Mammals:** Similar to marsupials, placental mammals in North America underwent radiation to fill various ecological niches (e.g., flying, swimming, running). 4. All three examples illustrate the phenomenon where different species radiate from a common point to different geographical areas/niches.

Final Answer: All of the above.

Answer: (D)

Q71.

Solution

Concept: Meselson and Stahl (1958) provided the experimental proof for the semi-conservative replication of DNA using the bacterium *E. coli*.

Solution: 1. They grew *E. coli* in a medium containing $^{15}NH_4Cl$ (^{15}N is a heavy isotope of nitrogen, not radioactive). 2. ^{15}N was incorporated into the newly synthesized DNA. 3. They then transferred the cells into a medium with normal $^{14}NH_4Cl$. 4. By using cesium chloride (CsCl) density gradient centrifugation, they could distinguish between "heavy" (^{15}N), "light" (^{14}N), and "hybrid" ($^{14}N - ^{15}N$) DNA. 5. After one generation, the DNA was entirely hybrid, proving that one strand is parental and one is new.

Final Answer: ^{15}N.

Answer: (D)

Q72.

Solution

Concept: Erwin Chargaff formulated important rules regarding the base composition of DNA, which were crucial for Watson and Crick to develop their double helix model.

Solution: 1. **Chargaff's Rule** states that in a double-stranded DNA molecule, the amount of Purines equals the amount of Pyrimidines ($A + G = T + C$). 2. Specifically, the molar ratio of Adenine to Thymine is 1 ($A/T = 1$), and the ratio of Guanine to Cytosine is 1 ($G/C = 1$). 3. This is because A always pairs with T and G always pairs with C. 4. Griffith's work was on transformation; Hershey-Chase proved DNA is the genetic material.

Final Answer: Chargaff's Rule.

Answer: (B)

Q73.

Solution

Concept: DNA Fingerprinting (DNA Profiling) follows a specific laboratory workflow to identify unique Variable Number Tandem Repeats (VNTRs).

Solution: 1. **Isolation:** Extracting DNA from the sample (blood, hair, etc.). 2. **Digestion:** Cutting DNA into fragments using restriction endonucleases. 3. **Electrophoresis:** Separating fragments by size on an agarose gel. 4. **Blotting (Southern Blotting):** Transferring fragments to a nylon membrane. 5. **Hybridization:** Using labeled VNTR probes to bind to specific sequences. 6. **Autoradiography:** Detecting the labeled fragments using X-ray film to visualize the "barcode."

Final Answer: Isolation $\rightarrow$ Digestion $\rightarrow$ Electrophoresis $\rightarrow$ Blotting $\rightarrow$ Hybridization $\rightarrow$ Autoradiography.

Answer: (A)

Q74.

Solution

Concept: The genetic code is a triplet code, meaning three bases (a codon) specify one amino acid.

Solution: 1. There are 4 possible bases (A, U, G, C). In a triplet code, there are $4^3 = 64$ possible codons. 2. Out of these 64 codons, **61 codons** code for amino acids. 3. The remaining **3 codons** (UAA, UAG, UGA) are "Stop Codons" (Nonsense codons) that do not code for any amino acid and instead signal the end of translation. 4. AUG acts as a dual-purpose codon: it codes for Methionine and serves as the "Start Codon."

Final Answer: 61.

Answer: (B)

Q75.

Solution

Concept: Sickle cell anemia is a classic example of a point mutation leading to a qualitative defect in hemoglobin.

Solution: 1. A single base substitution occurs in the gene coding for the beta-globin chain. 2. The codon **GAG** (which codes for Glutamic acid) is mutated to **GUG** (which codes for Valine). 3. This occurs at the **6th position** of the beta-globin chain. 4. Under low oxygen tension, this mutant hemoglobin undergoes polymerization, causing the RBCs to change from biconcave discs to sickle shapes.

Final Answer: Glutamic acid by Valine at the 6th position.

Answer: (B)

Q76.

Solution

Concept: During replication, as Helicase unwinds the DNA, it creates "supercoils" or physical tension ahead of the replication fork.

Solution: 1. **DNA Topoisomerase** (in prokaryotes, specifically **DNA Gyrase**) cuts and rejoins the DNA strands. 2. This action releases the torsional strain (tension) created by the unwinding process. 3. Without Topoisomerase, the DNA would become too tightly wound for replication to continue. 4. Helicase does the actual unwinding; SSBPs prevent the strands from re-annealing.

Final Answer: DNA Topoisomerase (DNA Gyrase).

Answer: (B)

Q77.

Solution

Concept: Stop codons are essential for ending the protein synthesis process at the correct length.

Solution: 1. There are three stop codons: **UAA** (Ochre), **UAG** (Amber), and **UGA** (Opal). 2. Among the options, **UAG** is a stop codon. 3. AUG and GUG are start codons (GUG only occasionally in prokaryotes). 4. UGG codes for the amino acid Tryptophan.

Final Answer: UAG.

Answer: (C)

Q78.

Solution

Concept: Global environmental summits are organized to address the loss of biological diversity and ensure the sustainable use of its components.

Solution: 1. The Earth Summit (Rio, 1992) was the first major conference on biodiversity. 2. The **World Summit on Sustainable Development (Johannesburg, 2002)** followed this. 3. In this summit, 190 countries pledged their commitment to achieve, by 2010, a **significant reduction in the current rate of biodiversity loss** at global, regional, and local levels.

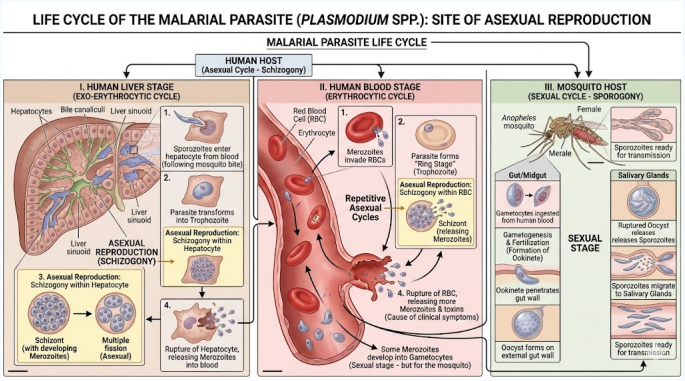
Final Answer: To achieve a significant reduction in the current rate of biodiversity loss.

Answer: (B)

Q79.

Solution

Concept: The life cycle of *Plasmodium* (Malaria parasite) requires two hosts: humans (primary/intermediate) and female *Anopheles* mosquitoes (vector/definitive).



Solution: 1. **Asexual reproduction** (Schizogony) occurs in the human host, specifically in the **liver cells (hepatocytes)** and **red blood cells (erythrocytes)**. 2. Sexual reproduction occurs in the gut of the mosquito. 3. The infective stage (sporozoites) is stored in the salivary glands of the mosquito.

Final Answer: Human liver cells and Erythrocytes.

Answer: (C)

Q80.

Solution

Concept: Passive immunity is the transfer of ready-made antibodies from one individual to another.

Solution: 1. **Colostrum**, the yellowish fluid secreted by the mother during the initial days of lactation, is rich in antibodies. 2. It contains abundant **IgA** antibodies. 3. These antibodies are essential to protect the newborn infant against various pathogens until their own immune system matures. 4. IgG is the only antibody that can cross the placenta.

Final Answer: IgA.

Answer: (D)

Q81.

Solution

Concept: Cloning involves creating a genetically identical copy of a multicellular organism.

Solution: 1. Dolly the sheep was created using **Somatic Cell Nuclear Transfer (SCNT)**. 2. The nucleus of an adult mammary gland cell (somatic cell) was transferred into an enucleated egg cell. 3. The resulting embryo was then implanted into a surrogate mother. 4. This proved that specialized adult cells could be "reprogrammed" back into an embryonic state.

Final Answer: Somatic Cell Nuclear Transfer (SCNT).

Answer: (B)

Q82.

Solution

Concept: The HGP was an international research effort to determine the sequence of the human genome and identify its genes.

Solution: 1. Before the HGP, scientists estimated humans had up to 100,000 genes. 2. The HGP concluded that the human genome contains approximately **20,000 to 25,000 genes**. 3. It also found that the average gene consists of 3000 bases and that 99.9

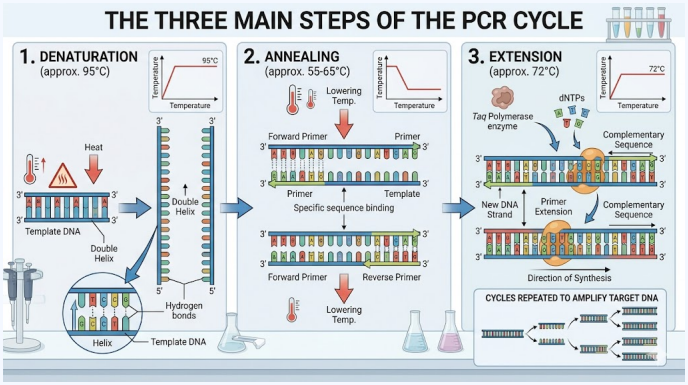
Final Answer: 20,000 to 25,000.

Answer: (B)

Q83.

Solution

Concept: PCR is a technique used to amplify small segments of DNA. It relies on thermal cycling.



Solution: 1. **Denaturation:** High temperature (94°C) to separate the DNA strands. 2. **Annealing:** Lower temperature (50 – 60°C) to allow primers to bind to complementary sequences. 3. **Extension:** Optimal temperature (72°C) for Taq polymerase to add dNTPs and synthesize new strands.

Final Answer: Denaturation → Annealing → Extension.

Answer: (B)

Q84.

Solution

Concept: The hypothalamus is a small but vital part of the forebrain that acts as a control center for many homeostatic functions.

Solution: 1. The **Hypothalamus** contains several centers which control **body temperature**, urge for eating (**hunger**), and drinking (**thirst**). 2. It also secretes hypothalamic hormones which regulate the pituitary gland. 3. The cerebellum is for balance; the medulla is for respiration and cardiovascular reflexes.

Final Answer: Hypothalamus.

Answer: (C)

Q85.

Solution

Concept: The GFR is the volume of filtrate formed by the kidneys per minute.

Solution: 1. In a healthy adult, the GFR is approximately **125 mL/minute**. 2. This amounts to about **180 Liters per day**. 3. However, 99

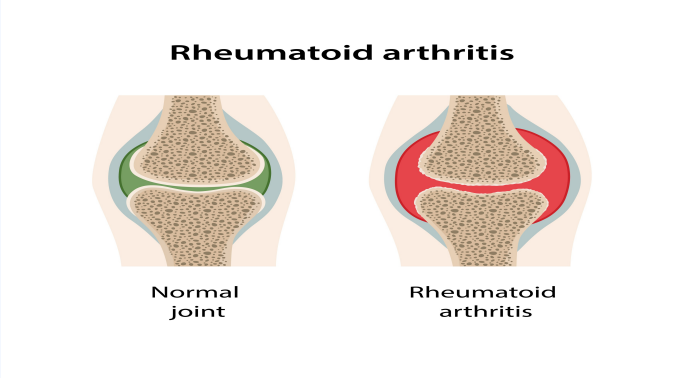
Final Answer: 125 mL/minute.

Answer: (A)

Q86.

Solution

Concept: Rheumatoid arthritis is a systemic autoimmune disease characterized by inflammation of the joints.



Solution: 1. In **Rheumatoid Arthritis**, the body's immune system fails to recognize the synovial membrane of the joints as "self" and attacks it. 2. This leads to chronic inflammation and joint destruction. 3. Gout is due to uric acid; Osteoporosis is due to low bone mass.

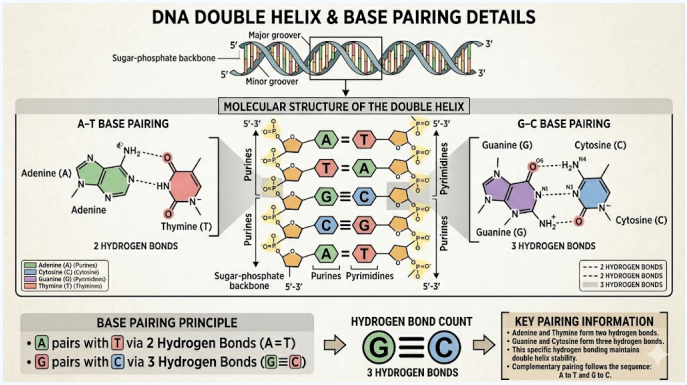
Final Answer: Rheumatoid Arthritis.

Answer: (B)

Q87.

Solution

Concept: Hydrogen bonds between complementary base pairs stabilize the DNA double helix.



Solution: 1. A pairs with T via two hydrogen bonds. 2. **G pairs with C via three hydrogen bonds**. 3. This higher number of bonds makes G-C rich regions of DNA more resistant to thermal denaturation.

Final Answer: Three.

Answer: (B)

Q88.

Solution

Concept: Biocontrol refers to the use of biological methods for controlling plant diseases and pests.

Solution: 1. ***Bacillus thuringiensis*** (Bt) is used to control butterfly caterpillars. 2. It is available in sachets as dried spores which are mixed with water and sprayed onto vulnerable plants. 3. Once the larvae eat the spores, the toxin is released in their gut and kills them. 4. *Trichoderma* is used against soil-borne pathogens.

Final Answer: *Bacillus thuringiensis*.

Answer: (B)

Q89.

Solution

Concept: Erythropoietin is a hormone that regulates the production of red blood cells.

Solution: 1. When oxygen levels in the blood are low, the **Juxtaglomerular (JG) cells of the kidney** secrete **Erythropoietin**. 2. This hormone stimulates the bone marrow to increase the production of RBCs.

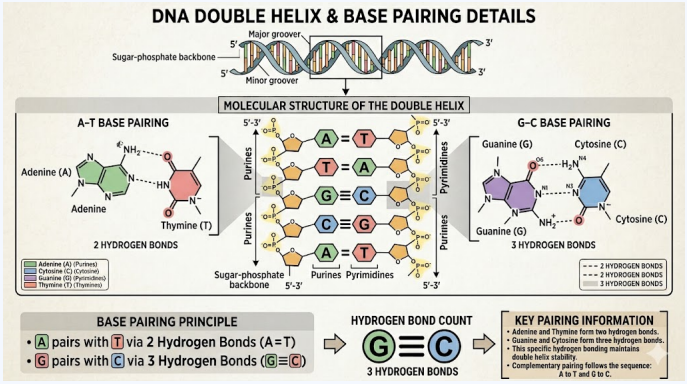
Final Answer: Juxtaglomerular (JG) cells of the Kidney.

Answer: (B)

Q90.

Solution

Concept: The sliding filament theory describes muscle contraction by the movement of thin filaments over thick filaments.



Solution: 1. During contraction, the sarcomere shortens. 2. The **I-band** (containing only thin filaments) decreases in length. 3. The **H-zone** (the central region of the A-band containing only thick filaments) disappears. 4. The **A-band** remains the same length. 5. The filaments themselves do not shorten.

Final Answer: The I-band shortens and the H-zone disappears.

Answer: (B)

Answer Key

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