NEET-UG Biology Sample Paper-7

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. A prokaryotic organism is observed to lack a true nucleus and membrane-bound organelles, but it possesses mesosomes and is capable of fixing atmospheric nitrogen under anaerobic conditions. Based on these characteristics, which of the following correctly identifies the organism and its classification?

(A) Nostoc – Protista

(B) Rhizobium – Monera

(C) Anabaena – Monera

(D) Yeast – Fungi

Q2. In the five-kingdom classification system proposed by Whittaker, certain organisms exhibit both autotrophic and heterotrophic modes of nutrition and possess membrane-bound organelles. Such organisms are most appropriately placed under which kingdom?

(A) Monera

(B) Protista

(C) Fungi

(D) Plantae

Q3. Viruses are often described as obligate intracellular parasites. Which of the following statements best explains this characteristic of viruses in terms of their structure and function?

(A) They lack ribosomes and cannot synthesize proteins independently

(B) They lack both DNA and RNA

(C) They reproduce by binary fission

(D) They are capable of independent metabolism

Q4. Lichens are symbiotic associations between algae and fungi and are widely used as bioindicators. What property makes lichens particularly sensitive to environmental pollution?

(A) They require high oxygen concentration

(B) They cannot tolerate sulfur dioxide pollution

(C) They grow rapidly in polluted environments

(D) They fix atmospheric nitrogen

Q5. Consider the following pairs of organisms and their characteristic storage products or cell wall components. Identify the incorrect pair among them.

(A) Red algae – Floridean starch

(B) Green algae – Cellulose cell wall

(C) Brown algae – Mannitol

(D) Cyanobacteria – Glycogen storage

Q6. Gymnosperms differ significantly from angiosperms in terms of reproductive structures. Which of the following features most accurately distinguishes gymnosperms from angiosperms?

(A) Presence of vascular tissues

(B) Absence of seeds

(C) Presence of naked ovules not enclosed within an ovary

(D) Dominance of gametophytic phase

Q7. Different plant groups exhibit different types of life cycles. Which of the following groups shows a diplontic life cycle in which the diploid phase is dominant?

(A) Bryophytes

(B) Pteridophytes

(C) Gymnosperms

(D) Spirogyra

Q8. Arrange the following plant groups in the correct order of increasing evolutionary advancement based on complexity of structure and reproductive features.

(A) Algae → Bryophytes → Pteridophytes → Gymnosperms → Angiosperms

(B) Bryophytes → Algae → Pteridophytes → Angiosperms → Gymnosperms

(C) Algae → Pteridophytes → Bryophytes → Gymnosperms → Angiosperms

(D) Algae → Bryophytes → Gymnosperms → Pteridophytes → Angiosperms

Q9. In a transverse section of a dicot stem, vascular bundles are arranged in a ring and possess cambium between xylem and phloem. What is the major functional consequence of the presence of cambium in these vascular bundles?

(A) Secondary growth leading to increase in girth

(B) Primary thickening only

(C) Absence of lignification

(D) Reduction in conduction efficiency

Q10. According to the sliding filament theory of muscle contraction, which of the following statements correctly describes the mechanism of contraction at the molecular level?

(A) Actin filaments shorten during contraction

(B) Myosin filaments shorten during contraction

(C) Both actin and myosin filaments shorten

(D) Neither filament shortens, but they slide past each other

Q11. The epithelial tissue lining the small intestine is specialized for absorption. Which structural adaptation makes it highly efficient for this function?

(A) Presence of squamous cells

(B) Presence of cuboidal cells

(C) Presence of columnar cells with microvilli

(D) Stratification of epithelium

Q12. In plant roots, a specialized structure known as Casparian strip is found in a particular tissue layer. What is the location and primary function of this structure?

(A) Cortex – Storage

(B) Endodermis – Regulation of water flow

(C) Pericycle – Lateral root formation

(D) Phloem – Transport of food

Q13. The fluid mosaic model proposed for the structure of the plasma membrane suggests a dynamic arrangement of lipids and proteins. Which of the following statements best describes this model in terms of membrane structure and function?

(A) Proteins are static and embedded in a rigid lipid layer

(B) Lipids form a solid crystalline structure

(C) Proteins are embedded within and move laterally in the lipid bilayer

(D) Membrane is impermeable to all substances

Q14. Certain organelles in eukaryotic cells are involved in detoxification of drugs and harmful metabolic by-products, particularly in liver cells. Which organelle is primarily responsible for this function?

(A) Ribosome

(B) Smooth endoplasmic reticulum

(C) Golgi apparatus

(D) Lysosome

Q15. During the cell cycle, DNA replication must occur precisely once to ensure genetic stability. In which phase of the cell cycle does this replication occur?

(A) G_1 phase

(B) S phase

(C) G_2 phase

(D) M phase

Q16. During mitosis, chromosomes become aligned at the equatorial plane before separation. At which stage does this alignment occur, ensuring equal distribution of genetic material?

(A) Prophase

(B) Metaphase

(C) Anaphase

(D) Telophase

Q17. Prokaryotic cells differ fundamentally from eukaryotic cells in their internal organization. Which of the following structures is absent in prokaryotic cells but present in eukaryotic cells?

(A) Ribosomes

(B) Plasma membrane

(C) Nucleolus

(D) Cytoplasm

Q18. Active transport is a vital cellular process that allows movement of substances against their concentration gradient. Which of the following is essential for active transport to occur?

(A) Diffusion gradient

(B) ATP energy

(C) Osmotic pressure

(D) Carrier proteins only

Q19. DNA replication involves multiple enzymes that ensure accuracy and continuity of the genetic material. Which enzyme is primarily responsible for adding nucleotides to the growing DNA strand?

(A) DNA ligase

(B) DNA polymerase

(C) RNA polymerase

(D) Helicase

Q20. Lysosomes are often referred to as "suicide bags" of the cell. Which of the following best explains this description?

(A) They synthesize proteins

(B) They digest cellular components using hydrolytic enzymes

(C) They store lipids

(D) They generate ATP

Q21. The cytoskeleton plays an important role in maintaining cell structure and facilitating intracellular transport. Which component of the cytoskeleton is directly involved in chromosome movement during cell division?

(A) Microfilaments

(B) Intermediate filaments

(C) Microtubules

(D) Actin fibers

Q22. Phospholipids form the structural basis of biological membranes. What is the key property of phospholipids that enables them to form bilayers in aqueous environments?

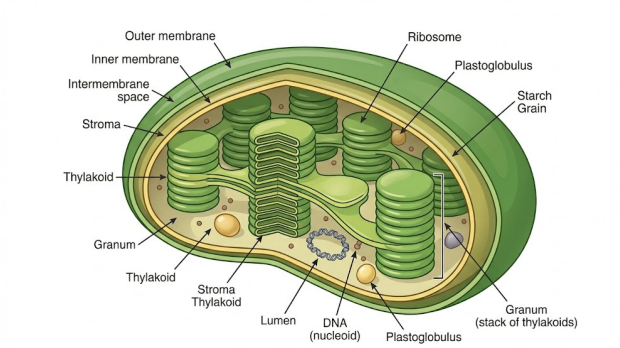
(A) Hydrophilic nature

(B) Hydrophobic nature

(C) Amphipathic nature

(D) Ionic bonding

Q23. The diagram below represents the internal structure of a chloroplast showing grana and stroma. Identify the site where the light-dependent reactions of photosynthesis occur.



(A) Stroma

(B) Grana (thylakoid membranes)

(C) Outer membrane

(D) Intermembrane space

Q24. Water movement in plants occurs through several mechanisms. From root hair cells to xylem vessels, water primarily moves due to which process at the cellular level?

(A) Active transport

(B) Diffusion

(C) Osmosis

(D) Transpiration pull

Q25. Magnesium is considered an essential element for plants. What is its primary role in plant physiology?

(A) Component of ATP

(B) Structural component of cell wall

(C) Central atom in chlorophyll molecule

(D) Electron acceptor

Q26. C_4 plants exhibit higher efficiency in photosynthesis under high temperature and low CO_2 conditions. What is the primary reason for this adaptation?

(A) Increased photorespiration

(B) Absence of RuBisCO

(C) Spatial separation of CO_2 fixation and Calvin cycle

(D) Lack of stomata

Q27. During glycolysis, glucose is broken down into pyruvate with a net gain of ATP molecules. What is the net ATP yield per glucose molecule during glycolysis?

(A) 1

(B) 2

(C) 4

(D) 6

Q28. Plant growth regulators influence various developmental processes. Which hormone is primarily responsible for cell elongation in plants?

(A) Cytokinin

(B) Auxin

(C) Ethylene

(D) Abscisic acid

Q29. In photosynthesis, the splitting of water molecules releases oxygen. Where does this photolysis of water occur within the chloroplast?

(A) Stroma

(B) Thylakoid lumen

(C) Cytoplasm

(D) Mitochondria

Q30. Among the stages of cellular respiration, which process yields the maximum amount of ATP molecules per glucose molecule?

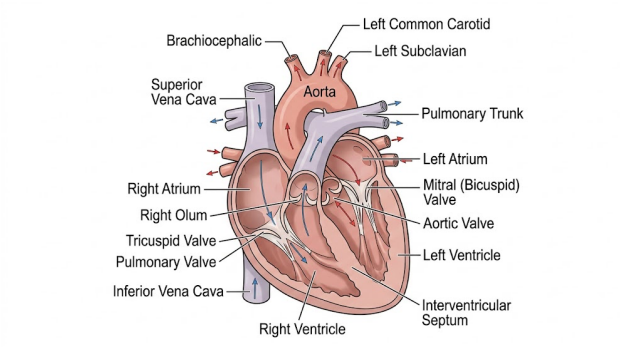
(A) Glycolysis

(B) Krebs cycle

(C) Electron transport chain

(D) Fermentation

Q31. The diagram below represents the human heart showing its chambers and major blood vessels. Identify the chamber that receives oxygenated blood from the lungs.



(A) Right atrium

(B) Right ventricle

(C) Left atrium

(D) Left ventricle

Q32. The human heart has a specialized conduction system to regulate rhythmic contractions. Which structure acts as the natural pacemaker of the heart?

(A) AV node

(B) SA node

(C) Bundle of His

(D) Purkinje fibers

Q33. Digestion of proteins begins in the stomach where specific enzymes are secreted. Which enzyme is responsible for initiating protein digestion?

(A) Amylase

(B) Pepsin

(C) Trypsin

(D) Lipase

Q34. Oxygen transport in human blood is primarily facilitated by a specific protein found in red blood cells. Identify this protein.

(A) Plasma proteins

(B) Hemoglobin

(C) Platelets

(D) Albumin

Q35. The cerebellum is an important part of the human brain. What is its primary function?

(A) Thinking and reasoning

(B) Balance and coordination

(C) Regulation of heartbeat

(D) Hormonal control

Q36. The nephron is the functional unit of the kidney. Which structure within the nephron is responsible for ultrafiltration of blood?

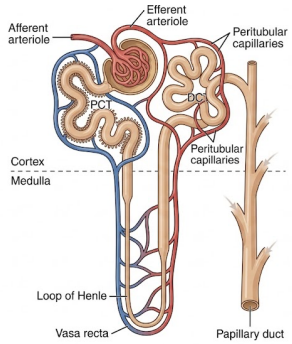
(A) Loop of Henle

(B) Glomerulus

(C) Distal convoluted tubule

(D) Collecting duct

Q37. The diagram below represents a nephron showing different segments. Identify the region where maximum reabsorption of water occurs.



(A) Proximal convoluted tubule

(B) Distal convoluted tubule

(C) Loop of Henle

(D) Collecting duct

Q38. Double fertilization is a unique feature observed in flowering plants. What does this process result in?

(A) Formation of two embryos

(B) Formation of zygote and endosperm

(C) Formation of two seeds

(D) Formation of ovary

Q39. During the menstrual cycle in human females, ovulation is triggered by a sudden increase in which hormone?

(A) FSH

(B) LH

(C) Estrogen

(D) Progesterone

Q40. Mendel's law of segregation explains the separation of alleles during gamete formation. What is the fundamental basis of this law?

(A) Blending inheritance

(B) Independent assortment

(C) Separation of allele pairs

(D) Mutation

Q41. In molecular biology, codons play a crucial role in protein synthesis. Where are codons located?

(A) DNA

(B) mRNA

(C) tRNA

(D) rRNA

Q42. Polygenic inheritance involves multiple genes influencing a single trait. Which of the following traits is an example of polygenic inheritance?

(A) Blood group

(B) Skin colour

(C) Flower colour in pea

(D) Tongue rolling

Q43. PCR is an important technique in biotechnology. What is its primary application?

(A) Protein synthesis

(B) DNA amplification

(C) Gene mutation

(D) Cell division

Q44. In an ecosystem, energy transfer follows a specific pattern. Which statement correctly describes energy flow in an ecosystem?

(A) It is cyclic

(B) It is unidirectional

(C) It is reversible

(D) It is random

Q45. Biomagnification refers to an increase in concentration of toxic substances at successive trophic levels. Which of the following substances is most commonly associated with biomagnification?

(A) Oxygen

(B) Nitrogen

(C) DDT

(D) Carbon dioxide

Q46. Ozone depletion in the stratosphere is primarily caused by which group of compounds released by human activities?

(A) Carbon dioxide

(B) Sulfur dioxide

(C) Chlorofluorocarbons

(D) Nitrogen oxides

Q47. In human males, spermatogenesis is a continuous process that begins at puberty. Which of the following correctly describes the site and regulatory control of spermatogenesis?

(A) Occurs in epididymis and regulated by LH only

(B) Occurs in seminiferous tubules and regulated by FSH and testosterone

(C) Occurs in vas deferens and regulated by estrogen

(D) Occurs in prostate gland and regulated by progesterone

Q48. In flowering plants, the ovule undergoes several structural changes after fertilization. Which part of the ovule ultimately develops into the seed coat?

(A) Nucellus

(B) Integuments

(C) Embryo sac

(D) Micropyle

Q49. During meiosis, genetic recombination increases variation among offspring. At which stage does crossing over between homologous chromosomes occur?

(A) Prophase I

(B) Metaphase I

(C) Anaphase I

(D) Telophase I

Q50. In human females, maintenance of pregnancy is largely dependent on hormonal regulation. Which hormone plays the most crucial role in maintaining the uterine lining during pregnancy?

(A) Estrogen

(B) Progesterone

(C) LH

(D) FSH

Q51. In angiosperms, double fertilization leads to the formation of two distinct structures. Which of the following correctly identifies these products?

(A) Zygote and embryo

(B) Zygote and endosperm

(C) Endosperm and ovule

(D) Embryo and fruit

Q52. Mendel observed that certain traits do not follow simple dominance but show intermediate expression. Which type of inheritance pattern does this represent?

(A) Complete dominance

(B) Incomplete dominance

(C) Codominance

(D) Polygenic inheritance

Q53. In molecular genetics, mutations can arise due to changes in nucleotide sequences. Which type of mutation involves substitution of a single nucleotide base?

(A) Frameshift mutation

(B) Point mutation

(C) Deletion

(D) Duplication

Q54. The genetic code is described as degenerate. What does this imply about codons and amino acids?

(A) One codon codes for multiple amino acids

(B) Multiple codons can code for the same amino acid

(C) Codons are overlapping

(D) Codons are ambiguous

Q55. The Hardy-Weinberg principle applies to populations under specific conditions. Which of the following conditions must be satisfied for genetic equilibrium?

(A) Small population size

(B) Random mating and no mutation

(C) High mutation rate

(D) Natural selection present

Q56. Charles Darwin proposed the theory of natural selection. Which observation best supports this theory?

(A) Organisms acquire traits during lifetime

(B) Only the strongest individuals survive

(C) Individuals with favorable traits reproduce more successfully

(D) Evolution occurs due to sudden mutations only

Q57. Which nitrogenous base is present in DNA but absent in RNA, thereby distinguishing the two nucleic acids structurally?

(A) Adenine

(B) Guanine

(C) Cytosine

(D) Thymine

Q58. During protein synthesis, transfer RNA (tRNA) plays a key role. What is the function of the anticodon present on tRNA?

(A) Codes for amino acids

(B) Recognizes complementary codon on mRNA

(C) Synthesizes proteins

(D) Breaks peptide bonds

Q59. Which enzyme is responsible for transcription, the process by which RNA is synthesized from a DNA template?

(A) DNA polymerase

(B) RNA polymerase

(C) Ligase

(D) Helicase

Q60. In evolution, disruptive selection leads to which of the following outcomes in a population?

(A) Elimination of extreme traits

(B) Favoring of average traits

(C) Favoring of both extreme traits

(D) No change in traits

Q61. Malaria is a major infectious disease in humans. Which organism is responsible for causing malaria in humans?

(A) Virus

(B) Bacteria

(C) Protozoa

(D) Fungus

Q62. Vaccination is an important strategy in disease prevention. What type of immunity does vaccination provide?

(A) Natural passive immunity

(B) Artificial passive immunity

(C) Artificial active immunity

(D) Natural active immunity

Q63. AIDS is a life-threatening condition caused by a specific pathogen that attacks the immune system. Which of the following correctly identifies this pathogen?

(A) Bacteria

(B) Virus

(C) Fungus

(D) Protozoa

Q64. Cirrhosis is a disease associated with damage to a vital organ due to chronic alcohol consumption or infections. Which organ is primarily affected in cirrhosis?

(A) Heart

(B) Liver

(C) Kidney

(D) Lung

Q65. Insulin deficiency or resistance leads to a metabolic disorder characterized by high blood glucose levels. Which disease is associated with this condition?

(A) Hypertension

(B) Diabetes mellitus

(C) Asthma

(D) Cancer

Q66. Polymerase Chain Reaction (PCR) is widely used in molecular biology. What is the primary purpose of this technique?

(A) Protein synthesis

(B) DNA amplification

(C) RNA degradation

(D) Cell division

Q67. Restriction enzymes are essential tools in recombinant DNA technology. What is their primary function?

(A) Synthesizing DNA

(B) Cutting DNA at specific sequences

(C) Joining DNA fragments

(D) Replicating RNA

Q68. In genetic engineering, vectors are used to transfer foreign DNA into host cells. Which of the following is commonly used as a cloning vector?

(A) Ribosome

(B) Plasmid

(C) Lysosome

(D) Mitochondria

Q69. Bt cotton is a genetically modified crop. What characteristic does it possess due to the inserted gene?

(A) Resistance to drought

(B) Resistance to insect pests

(C) Increased yield only

(D) Resistance to viruses

Q70. ELISA is a diagnostic technique widely used in medicine. What is its primary application?

(A) DNA replication

(B) Disease detection

(C) Protein synthesis

(D) Mutation analysis

Q71. In an ecosystem, producers play a fundamental role. Which of the following organisms are classified as producers?

(A) Herbivores

(B) Carnivores

(C) Autotrophs

(D) Decomposers

Q72. Energy flow in an ecosystem follows a definite pattern governed by thermodynamic principles. Which of the following correctly describes this flow?

(A) Cyclic

(B) Unidirectional

(C) Bidirectional

(D) Random

Q73. Biomagnification results in increasing concentration of toxic substances in higher trophic levels. Which of the following substances is a classic example?

(A) Oxygen

(B) Nitrogen

(C) DDT

(D) Carbon dioxide

Q74. Ozone depletion has serious environmental consequences. Which group of chemicals is mainly responsible for this phenomenon?

(A) Carbon dioxide

(B) Sulfur dioxide

(C) Chlorofluorocarbons

(D) Nitrogen compounds

Q75. Food chains represent feeding relationships in an ecosystem. What do they primarily depict?

(A) Water flow

(B) Energy transfer

(C) Mineral cycling

(D) Population density

Q76. Ecological pyramids are graphical representations of trophic levels. Which type of ecological pyramid is always upright?

(A) Pyramid of numbers

(B) Pyramid of biomass

(C) Pyramid of energy

(D) Pyramid of organisms

Q77. Greenhouse gases contribute to global warming by trapping heat in the atmosphere. Which gas contributes the most to this effect?

(A) Oxygen

(B) Nitrogen

(C) Carbon dioxide

(D) Hydrogen

Q78. In human females, the hormone estrogen plays multiple roles during the menstrual cycle. Which of the following functions is primarily associated with estrogen during the proliferative phase?

(A) Maintenance of pregnancy

(B) Thickening of endometrial lining

(C) Triggering milk secretion

(D) Inhibition of ovulation

Q79. During spermiogenesis, spermatids undergo several structural changes to become mature spermatozoa. Which of the following changes occurs during this process?

(A) Increase in cytoplasmic volume

(B) Formation of acrosome and flagellum

(C) Loss of nucleus

(D) Formation of cell wall

Q80. In genetic inheritance, codominance is observed when both alleles express themselves equally. Which of the following is a classical example of codominance in humans?

(A) Height variation

(B) ABO blood group system

(C) Skin colour

(D) Eye colour

Q81. During transcription in eukaryotic cells, RNA undergoes processing before becoming functional mRNA. Which of the following steps is involved in this processing?

(A) DNA replication

(B) Splicing to remove introns

(C) Translation

(D) Protein folding

Q82. In population genetics, gene flow refers to the transfer of genetic material between populations. What is the primary effect of gene flow on genetic variation?

(A) Decreases variation

(B) Increases variation

(C) Eliminates mutations

(D) Stops evolution

Q83. Which of the following enzymes is responsible for joining Okazaki fragments during DNA replication on the lagging strand?

(A) DNA polymerase

(B) DNA ligase

(C) Helicase

(D) Primase

Q84. In biotechnology, recombinant DNA is formed by combining DNA from different sources. Which enzyme is used to join DNA fragments together?

(A) Restriction enzyme

(B) DNA ligase

(C) RNA polymerase

(D) Protease

Q85. Genetically modified organisms (GMOs) are widely used in agriculture. What is the primary advantage of developing GM crops?

(A) Reduced nutritional value

(B) Increased susceptibility to pests

(C) Enhanced resistance to biotic and abiotic stresses

(D) Decreased productivity

Q86. Which of the following ecological interactions benefits both participating species, making it a mutually advantageous relationship?

(A) Parasitism

(B) Commensalism

(C) Mutualism

(D) Predation

Q87. In ecological succession, which stage represents a stable and mature community that remains relatively unchanged over time?

(A) Pioneer stage

(B) Seral stage

(C) Climax community

(D) Transitional stage

Q88. Nitrogen cycle involves several biochemical processes carried out by microorganisms. Which process converts atmospheric nitrogen into ammonia?

(A) Nitrification

(B) Denitrification

(C) Nitrogen fixation

(D) Ammonification

Q89. Eutrophication of water bodies leads to excessive growth of algae and depletion of oxygen. What is the main cause of eutrophication?

(A) Increased oxygen supply

(B) Excess nutrients like nitrates and phosphates

(C) Reduced sunlight

(D) Low temperature

Q90. Which international agreement aims at controlling the emission of ozone-depleting substances to protect the stratospheric ozone layer?

(A) Kyoto Protocol

(B) Paris Agreement

(C) Montreal Protocol

(D) Rio Declaration

Detailed Solutions

Q1.

Solution

Concept: Classification of Prokaryotes (Kingdom Monera) and their metabolic capabilities, such as nitrogen fixation.

Solution: The question describes an organism with the following key characteristics:

- **Prokaryotic:** Lacks a true nucleus and membrane-bound organelles. This places the organism in the Kingdom Monera. This eliminates options (A) Protista and (D) Fungi.
- **Mesosomes:** These are infoldings of the plasma membrane, considered a characteristic feature of prokaryotes in many textbooks.
- **Nitrogen Fixation under Anaerobic Conditions:** The ability to convert atmospheric nitrogen (N_2) into ammonia (NH_3), a process that requires an anaerobic environment as the enzyme responsible, nitrogenase, is sensitive to oxygen.

Now let's evaluate the remaining options:

- **(B) Rhizobium – Monera:** Rhizobium is a bacterium (Kingdom Monera) that lives symbiotically in the root nodules of leguminous plants. It fixes nitrogen, and the nodule provides the necessary anaerobic environment (facilitated by leghemoglobin). This fits the description.
- **(C) Anabaena – Monera:** Anabaena is a type of cyanobacterium (blue-green alga), which also belongs to Kingdom Monera. It is a free-living, filamentous organism capable of both photosynthesis (which produces oxygen) and nitrogen fixation. It performs nitrogen fixation in specialized, thick-walled cells called **heterocysts**, which maintain an anaerobic environment, protecting the nitrogenase enzyme from the oxygen produced in adjacent vegetative cells.

Both Rhizobium and Anabaena fit the general description. However, Anabaena is a classic textbook example of a prokaryote that has structurally and functionally differentiated cells to perform both oxygenic photosynthesis and anaerobic nitrogen fixation. The description fits Anabaena perfectly as a representative prokaryote with these features.

Final Answer : "Anabaena – Monera"

Answer: (C)

Q2.

Solution

Concept: The five-kingdom classification system proposed by R.H. Whittaker, focusing on the defining characteristics of each kingdom, particularly Protista.

Solution: R.H. Whittaker's five-kingdom classification system categorizes organisms based on cell structure (prokaryotic vs. eukaryotic), body organization (unicellular vs. multicellular), and mode of nutrition. The five kingdoms are Monera, Protista, Fungi, Plantae, and Animalia.
Let's analyze the characteristics given in the question:

- **Membrane-bound organelles:** This indicates that the organisms are eukaryotic, which rules out Kingdom **Monera**, as they are prokaryotes and lack these structures.
- **Both autotrophic and heterotrophic modes of nutrition:** This describes organisms that are mixotrophic, or a group that contains both autotrophic and heterotrophic members.

Now let's examine the remaining eukaryotic kingdoms:

- **Protista:** This kingdom is a diverse group of unicellular or simple multicellular eukaryotic organisms. It is defined by what it is not (not an animal, plant, or fungus). It includes autotrophs (e.g., diatoms, dinoflagellates), heterotrophs (e.g., amoeba, paramecium), and organisms that are mixotrophic, exhibiting both modes of nutrition (e.g., Euglena). This kingdom perfectly fits the description.
- **Fungi:** Members of this kingdom are exclusively heterotrophic, obtaining nutrients by absorption (saprophytic or parasitic).
- **Plantae:** Members of this kingdom are primarily multicellular and autotrophic, performing photosynthesis.

Therefore, the organisms described are most appropriately placed in the Kingdom Protista due to their eukaryotic nature and diverse nutritional strategies, including both autotrophy and heterotrophy.
Final Answer : "Protista"

Answer: (B)

Q3.

Solution

Concept: The structure and replication cycle of viruses, explaining their nature as obligate intracellular parasites.

Solution: The term "obligate intracellular parasite" means that the organism (in this case, a virus) absolutely requires a living host cell to replicate. Viruses are acellular and lack the complex machinery required for most life processes. The question asks for the best explanation of this characteristic.
Let's analyze the options:

- **(A) They lack ribosomes and cannot synthesize proteins independently:** Ribosomes are the cellular machinery responsible for protein synthesis (translation). All organisms need to synthesize proteins (e.g., enzymes, structural components) to function and reproduce. Since viruses lack their own ribosomes and other metabolic enzymes, they must hijack the host cell's machinery, including its ribosomes, amino acids, and ATP, to produce new viral proteins and replicate. This dependence is the fundamental reason for their obligate parasitic nature.
- **(B) They lack both DNA and RNA:** This statement is incorrect. A virus has a genome made of nucleic acid, which can be either DNA or RNA, but not both simultaneously.
- **(C) They reproduce by binary fission:** This is the method of reproduction for bacteria and other prokaryotes. Viruses replicate through a process of assembly, where viral components (nucleic acid and proteins) are synthesized separately within the host cell and then assembled into new virus particles (virions).
- **(D) They are capable of independent metabolism:** This is incorrect. Viruses have no metabolic machinery of their own. They are metabolically inert outside of a host cell and rely entirely on the host's metabolic pathways for energy and building blocks.

Therefore, the lack of ribosomes and the inability to synthesize their own proteins is the core reason why viruses must invade a host cell to reproduce.
Final Answer : "They lack ribosomes and cannot synthesize proteins independently"

Answer: (A)

Q4.

Solution

Concept: Lichens as bioindicators of air pollution.

Solution: Lichens are composite organisms arising from a symbiotic relationship between a fungus (the mycobiont) and an alga or cyanobacterium (the phycobiont). They are widely used as bioindicators, which are organisms that can signal changes in the environmental health of an ecosystem.
The property that makes lichens particularly effective bioindicators of air quality is their high sensitivity to atmospheric pollutants.

- Lichens do not have roots; they absorb water, nutrients, and any present pollutants directly from the atmosphere over their entire surface. This makes them highly susceptible to airborne toxins.
- They are particularly sensitive to sulfur dioxide (SO_2), a common industrial pollutant. SO_2 dissolves in water to form sulfurous acid, which damages the algal partner by degrading its chlorophyll. This disrupts photosynthesis and ultimately kills the lichen.
- The presence and abundance of different lichen species can be used to map air quality. In heavily polluted areas, lichens may be completely absent. As air quality improves further away from the pollution source, first crust-like (crustose), then leaf-like (foliose), and finally shrub-like (fruticose) lichens appear, with the latter being the most sensitive.

Analyzing the options:

- (A) They require high oxygen concentration: While they need oxygen for respiration, this is not the specific reason for their sensitivity to pollution.
- (B) They cannot tolerate sulfur dioxide pollution: This is a well-established and primary reason for their use as air quality indicators.
- (C) They grow rapidly in polluted environments: This is the opposite of what happens. They are harmed by pollution.
- (D) They fix atmospheric nitrogen: Only some lichens (with cyanobacterial partners) can do this. It is not related to their sensitivity to pollution.

Thus, their intolerance to SO_2 is the key property.
Final Answer : "They cannot tolerate sulfur dioxide pollution"

Answer: (B)

Q5.

Solution

Concept: Characteristic features (storage products and cell wall components) of different algal groups and cyanobacteria.

Solution: The question asks to identify the incorrect pair among the given options. Let's evaluate each pair:

- **(A) Red algae – Floridean starch:** Red algae (Rhodophyceae) store their food reserves as Floridean starch. This starch is structurally very similar to amylopectin and glycogen. This pairing is **correct**.
- **(B) Green algae – Cellulose cell wall:** Green algae (Chlorophyceae) have a rigid cell wall, the inner layer of which is made of cellulose and the outer layer is made of pectose. The presence of a cellulose cell wall is a key characteristic. This pairing is **correct**.
- **(C) Brown algae – Mannitol:** Brown algae (Phaeophyceae) store food as complex carbohydrates, typically in the form of laminarin or mannitol. Mannitol is a correct example of a storage product in brown algae. This pairing is **correct**.
- **(D) Cyanobacteria – Glycogen storage:** Cyanobacteria (also known as blue-green algae) are prokaryotes. Their primary storage polysaccharide is called **cyanophycean starch**, which is structurally very similar to glycogen (it is a highly branched glucan). While functionally and structurally almost identical to glycogen, the specific term is cyanophycean starch. In the context of a question with other highly specific and accurate pairings, labeling the storage product simply as "glycogen" can be considered an imprecision. However, many sources use the term glycogen-like or even glycogen. If we must choose an incorrect pair, this is the most likely candidate based on a strict terminological distinction. Given that A, B, and C are definitively correct statements of major characteristics, D is the least accurate or most likely intended incorrect option.

Therefore, the pair "Cyanobacteria – Glycogen storage" is considered the incorrect one in this context, likely due to the specific name of the storage product being cyanophycean starch.
Final Answer : "Cyanobacteria – Glycogen storage"

Answer: (D)

Q6.

Solution

Concept: The fundamental differences in the reproductive structures of gymnosperms and angiosperms.

Solution: Gymnosperms and angiosperms are both seed-producing plants (spermatophytes), but they represent two distinct evolutionary lines distinguished primarily by how their seeds are produced. The names themselves provide the key distinction:

- **Gymnosperm** comes from the Greek words *gymnos* (naked) and *sperma* (seed).
- **Angiosperm** comes from the Greek words *angeion* (vessel) and *sperma* (seed).

Let's evaluate the options based on this:

- (A) Presence of vascular tissues: Both gymnosperms and angiosperms possess well-developed vascular tissues (xylem and phloem). This is a shared characteristic, not a distinguishing feature.
- (B) Absence of seeds: This is incorrect. Both groups are defined by the presence of seeds.
- **(C) Presence of naked ovules not enclosed within an ovary:** This is the core difference. In gymnosperms, the ovules (which develop into seeds after fertilization) are exposed on the surface of sporophylls, which are often arranged into cones. They are not enclosed in a protective ovary. In contrast, angiosperms have their ovules enclosed within an ovary, which is part of the flower. After fertilization, the ovary develops into a fruit that protects and helps disperse the seeds.
- (D) Dominance of gametophytic phase: Both gymnosperms and angiosperms have a dominant sporophytic life cycle. The gametophyte is highly reduced in both groups. A dominant gametophyte is characteristic of bryophytes.

Therefore, the presence of naked ovules is the most accurate feature that distinguishes gymnosperms from angiosperms.

Final Answer : "Presence of naked ovules not enclosed within an ovary"

Answer: (C)

Q7.

Solution

Concept: Types of life cycles in plant groups: haplontic, diplontic, and haplodiplontic.

Solution: Plant groups exhibit different life cycles based on the dominance of the haploid (n) gametophytic phase versus the diploid (2n) sporophytic phase.

- **Haplontic life cycle:** The dominant, free-living phase is the haploid gametophyte. The diploid sporophyte is represented only by the zygote. Example: Many algae like *Spirogyra*.
- **Diplontic life cycle:** The dominant, free-living phase is the diploid sporophyte. The haploid gametophyte is highly reduced and dependent on the sporophyte.
- **Haplodiplontic life cycle:** Both gametophyte and sporophyte phases are multicellular, although one may be dominant over the other.

Let's examine the options:

- (A) Bryophytes: They have a haplodiplontic life cycle with a dominant, photosynthetic **gametophyte**. The sporophyte is dependent on the gametophyte.
- (B) Pteridophytes: They have a haplodiplontic life cycle with a dominant, independent **sporophyte**. The gametophyte is small and free-living.
- **(C) Gymnosperms:** They exhibit a diplontic life cycle. The plant body we see (e.g., a pine tree) is the dominant diploid sporophyte. The gametophytes (pollen grain and female gametophyte within the ovule) are microscopic and nutritionally dependent on the sporophyte. Angiosperms also have a diplontic life cycle.
- (D) Spirogyra: This alga exhibits a haplontic life cycle, where the main filamentous body is haploid.

Thus, among the choices given, gymnosperms show a diplontic life cycle where the diploid phase is dominant.

Final Answer : "Gymnosperms"

Answer: (C)

Q8.

Solution

Concept: Major trends in the evolution of the plant kingdom.

Solution: The evolution of plants shows a clear trend of increasing complexity and adaptation to terrestrial life. The major evolutionary advancements occurred in the following sequence:

(a) **Algae:** The simplest plant-like organisms, primarily aquatic. They lack specialized tissues like roots, stems, or leaves, and have simple reproductive structures.

(b) **Bryophytes (Mosses, Liverworts):** The first group to colonize land. They developed a cuticle to prevent water loss but lack true vascular tissue, which limits their size. They are still dependent on water for sexual reproduction. The gametophyte is the dominant generation.

(c) **Pteridophytes (Ferns):** The first plants to develop vascular tissue (xylem and phloem). This allowed them to grow taller and transport water and nutrients efficiently. The sporophyte became the dominant generation. However, they still require water for fertilization.

(d) **Gymnosperms (Conifers):** The next major advancement was the evolution of the seed. The seed protects the embryo and provides it with nutrition, allowing it to survive harsh conditions. They also developed pollen, which eliminated the need for water for fertilization.

(e) **Angiosperms (Flowering Plants):** The most advanced and successful group of plants. They developed flowers, which attract pollinators and make fertilization more efficient. They also developed the fruit, which encloses and protects the seed and aids in its dispersal.

This sequence represents a gradual increase in structural complexity (from simple thallus to differentiated body with vascular tissues) and reproductive efficiency (from spores to seeds, and then to flowers and fruits).
The correct order is: Algae $\rightarrow$ Bryophytes $\rightarrow$ Pteridophytes $\rightarrow$ Gymnosperms $\rightarrow$ Angiosperms.
Final Answer : "Algae $\rightarrow$ Bryophytes $\rightarrow$ Pteridophytes $\rightarrow$ Gymnosperms $\rightarrow$ Angiosperms"

Answer: (A)

Q9.

Solution

Concept: The role of vascular cambium in the secondary growth of dicot stems.

Solution: In dicotyledonous stems, the vascular bundles (containing xylem and phloem) are typically arranged in a ring. These bundles are described as "open" because they contain a layer of meristematic tissue called the **vascular cambium** located between the primary xylem and primary phloem.
The primary function of this cambium is to facilitate **secondary growth**, which is the growth that results in an increase in the thickness or girth of the stem. The process is as follows:

- The cells of the vascular cambium divide.
- Cells produced towards the inside differentiate into **secondary xylem** (wood).
- Cells produced towards the outside differentiate into **secondary phloem** (inner bark).

This continuous addition of new layers of secondary tissues leads to the thickening of the stem, providing mechanical support and increasing transport capacity. This is a characteristic feature of dicots and gymnosperms, but absent in most monocots (which have "closed" vascular bundles without cambium).

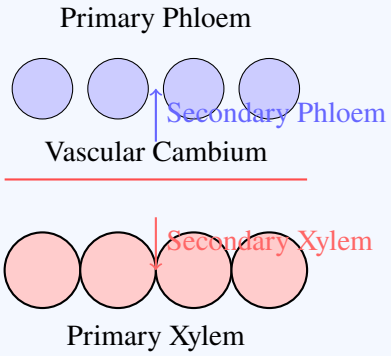


Diagram of cambial activity in an open vascular bundle

Therefore, the major functional consequence of cambium is secondary growth and the resulting increase in girth.
Final Answer : "Secondary growth leading to increase in girth"

Answer: (A)

Q10.

Solution

Concept: The sliding filament theory of muscle contraction.

Solution: The sliding filament theory is the accepted model for explaining muscle contraction at the molecular level. It describes the interaction between two types of protein filaments within a muscle cell's sarcomere: the thin filaments (composed mainly of actin) and the thick filaments (composed of myosin).
The key events are:

(a) A nerve impulse triggers the release of calcium ions (Ca^{2+}) within the muscle fiber.

(b) Calcium ions bind to troponin on the actin filament, causing tropomyosin to shift and expose binding sites for myosin.

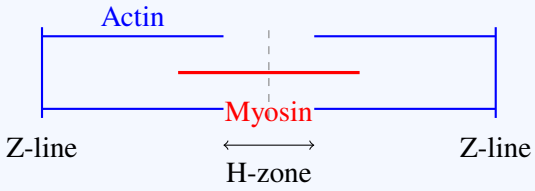
(c) The myosin heads, energized by the hydrolysis of ATP, bind to the exposed sites on the actin filaments, forming cross-bridges.

(d) The myosin heads then perform a "power stroke," pivoting and pulling the actin filaments toward the center of the sarcomere (the M-line).

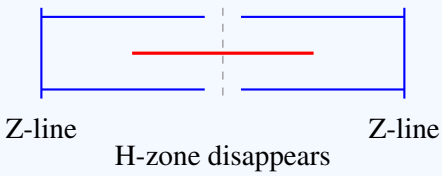
(e) ATP binds to the myosin head, causing it to detach from actin. The cycle can then repeat as long as calcium and ATP are present.

Crucially, during this process, the individual **actin and myosin filaments do not shorten or change in length**.This sliding action pulls the Z-lines closer together, shortening the entire sarcomere, which in turn leads to the contraction of the muscle fiber.

Relaxed Sarcomere



Contracted Sarcomere



Therefore, the correct statement is that neither filament shortens, but they slide past one another.
Final Answer : "Neither filament shortens, but they slide past each other"

Answer: (D)

Q11.

Solution

Concept: Histology of the small intestine and its adaptations for absorption.

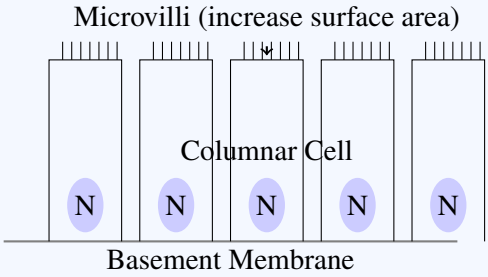
Solution: The primary function of the small intestine is the absorption of nutrients from digested food. To perform this function efficiently, its lining is adapted to have an extremely large surface area. The epithelial tissue plays a crucial role in this adaptation.
The lining of the small intestine is a **simple columnar epithelium**.

- **Columnar cells:** These cells are taller than they are wide, providing a large cytoplasmic volume for metabolic processes involved in absorption and processing of nutrients.
- **Microvilli:** The apical (lumen-facing) surface of these columnar cells is covered with densely packed, microscopic, finger-like projections of the plasma membrane called microvilli. This feature is known as the **brush border**. Microvilli drastically increase the surface area of each cell, maximizing the area available for absorption. They also contain enzymes that complete the final stages of digestion.

Let's analyze the other options:

- (A) Squamous cells are flat and thin, specialized for rapid diffusion (e.g., in the alveoli of the lungs), not absorption.
- (B) Cuboidal cells are cube-shaped and are typically found in secretory ducts and kidney tubules.
- (D) Stratified epithelium consists of multiple layers of cells and its primary function is protection against abrasion (e.g., skin, esophagus), which is not ideal for efficient absorption.

Therefore, the presence of columnar cells with microvilli is the key structural adaptation of the small intestine for absorption.



Final Answer : "Presence of columnar cells with microvilli"

Answer: (C)

Q12.

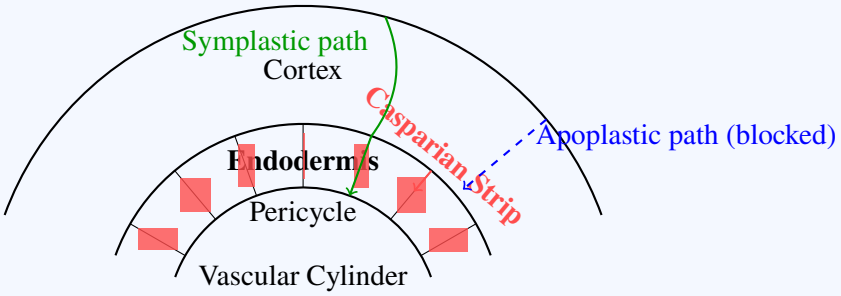
Solution

Concept: The structure and function of the Casparian strip in plant root anatomy.

Solution: In a plant root, water and minerals are absorbed from the soil and must travel through several tissue layers (epidermis, cortex) to reach the central vascular cylinder (stele), where the xylem is located.
Location: The **endodermis** is the innermost layer of the cortex that surrounds the vascular cylinder. The Casparian strip is located within the cell walls of these endodermal cells. Specifically, it is a band of waterproof, waxy material (suberin) impregnated in the radial and transverse walls of the endodermal cells.
Function: Water can move through the cortex via two main pathways:

- **Apoplastic pathway:** Movement through the cell walls and intercellular spaces.
- **Symplastic pathway:** Movement from cell to cell through the cytoplasm, connected by plasmodesmata.

The waterproof Casparian strip completely blocks the apoplastic pathway at the endodermis. This is its primary function. By blocking this "non-living" route, it forces all water and dissolved solutes to pass through the plasma membrane of the endodermal cells (i.e., enter the symplastic pathway) before they can enter the xylem. This allows the cell membrane to act as a selective filter, actively regulating which minerals enter the vascular system and preventing harmful substances from reaching it. This regulation of water and solute flow is crucial for the plant.



Based on this, the correct option is (B), which correctly identifies the location as the endodermis and the primary function as the regulation of water flow.
Final Answer : "Endodermis – Regulation of water flow"

Answer: (B)

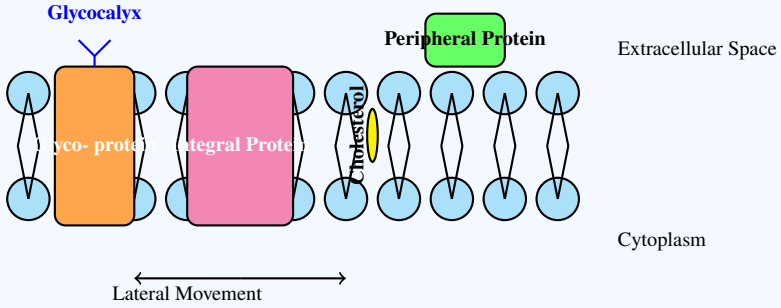
Q13.

Solution

Concept: The fluid mosaic model describes the dynamic nature of the plasma membrane.

Solution: The fluid mosaic model, proposed by Singer and Nicolson in 1972, describes the plasma membrane as a fluid structure with a "mosaic" of various proteins embedded in or attached to a bilayer of phospholipids. The "fluid" part of the model refers to the ability of both lipids and many of the proteins to move laterally within the membrane. This movement is crucial for various cellular functions, including cell signaling, transport, and cell division.

- Option (A) is incorrect because the proteins are not static; they can move.
- Option (B) is incorrect because the lipid bilayer is fluid, not a solid crystalline structure.
- Option (D) is incorrect because the plasma membrane is selectively permeable, allowing certain substances to pass while blocking others.
- Option (C) correctly states that proteins are embedded within the lipid bilayer and can move laterally, which is the core idea of the fluid mosaic model.



Final Answer : "Proteins are embedded within and move laterally in the lipid bilayer"

Answer: (C)

Q14.

Solution

Concept: Specific organelles perform specialized functions within the cell, including detoxification.

Solution: The smooth endoplasmic reticulum (SER) is a network of membranes inside a eukaryotic cell that is involved in several key metabolic processes. One of its primary roles, especially in liver cells (hepatocytes), is the detoxification of harmful substances, including metabolic wastes, drugs, and alcohol. The SER contains a variety of enzymes that chemically modify these toxic compounds, making them more water-soluble so they can be easily flushed from the body.

- **Ribosomes** are responsible for protein synthesis.
- **Golgi apparatus** modifies, sorts, and packages proteins and lipids for secretion or delivery to other organelles.
- **Lysosomes** contain digestive enzymes to break down waste materials, cellular debris, and ingested pathogens.

Therefore, the smooth endoplasmic reticulum is the organelle primarily responsible for detoxification.

Final Answer : "Smooth endoplasmic reticulum"

Answer: (B)

Q15.

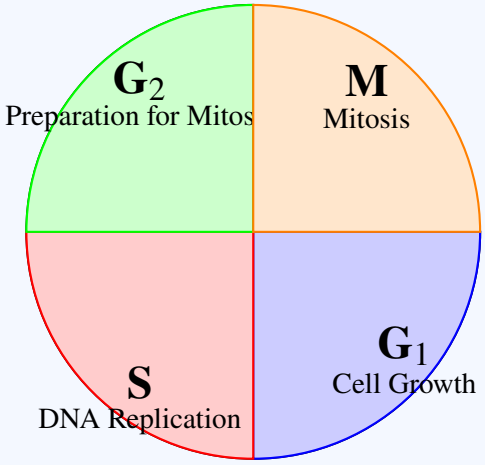
Solution

Concept: The cell cycle consists of distinct phases where key events like growth and DNA replication occur in a regulated sequence.

Solution: The eukaryotic cell cycle is an ordered series of events that leads to cell division and the production of two daughter cells. It is divided into two main stages: Interphase and the M phase. Interphase is further subdivided into three phases:

- **G_1 phase (Gap 1):** The cell grows and carries out its normal metabolic functions. It is a period of intense biochemical activity.
- **S phase (Synthesis):** This is the phase where DNA replication occurs. The cell synthesizes a complete copy of the DNA in its nucleus, resulting in chromosomes that consist of two identical sister chromatids.
- **G_2 phase (Gap 2):** The cell continues to grow and synthesizes proteins and organelles in preparation for cell division.

The **M phase (Mitotic phase)** follows interphase and includes mitosis (nuclear division) and cytokinesis (cytoplasmic division). Thus, DNA replication is specifically confined to the S phase to ensure that each daughter cell receives a full set of genetic material.



Final Answer : "S phase"

Answer: (B)

Q16.

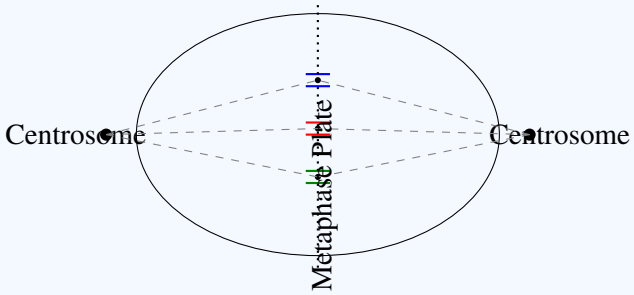
Solution

Concept: Mitosis is a multi-stage process of nuclear division, with each stage defined by the specific arrangement and behavior of chromosomes.

Solution: Mitosis is divided into four main stages: prophase, metaphase, anaphase, and telophase.

- **Prophase:** Chromosomes condense and become visible, the nuclear envelope breaks down, and the spindle fibers begin to form.
- **Metaphase:** The condensed chromosomes, each consisting of two sister chromatids, align along the center of the cell. This imaginary line is called the metaphase plate or the equatorial plane. This alignment is crucial as it ensures that when the sister chromatids separate, each new nucleus will receive one copy of every chromosome.
- **Anaphase:** The sister chromatids are pulled apart by the spindle fibers and move to opposite poles of the cell.
- **Telophase:** The chromosomes arrive at the poles, decondense, and nuclear envelopes re-form around the two new sets of chromosomes.

Therefore, the alignment of chromosomes at the equatorial plane occurs during metaphase.



Final Answer : "Metaphase"

Answer: (B)

Q17.

Solution

Concept: The primary distinction between prokaryotic and eukaryotic cells is the presence of a true nucleus and other membrane-bound organelles in eukaryotes.

Solution: Prokaryotic and eukaryotic cells share some fundamental components, but differ significantly in their internal complexity.

- **Ribosomes:** Present in both prokaryotes and eukaryotes, although they differ in size (70S in prokaryotes, 80S in eukaryotes). They are responsible for protein synthesis.
- **Plasma membrane:** Present in both, acting as a selective barrier enclosing the cell's contents.
- **Cytoplasm:** The jelly-like substance filling the cell is present in both types.
- **Nucleolus:** This is a dense, non-membranous structure found inside the nucleus of eukaryotic cells. Its main function is to synthesize ribosomal RNA (rRNA) and assemble ribosomes. Since prokaryotic cells lack a nucleus, they also lack a nucleolus. Their genetic material (a single circular chromosome) is located in a region of the cytoplasm called the nucleoid.

Therefore, the nucleolus is absent in prokaryotes but present in eukaryotes.
Final Answer : "Nucleolus"

Answer: (C)

Q18.

Solution

Concept: Active transport moves substances against their concentration gradient and requires cellular energy.

Solution: Cellular transport can be passive or active. Passive transport (like diffusion and facilitated diffusion) does not require energy and moves substances down their concentration gradient (from high to low concentration). In contrast, active transport moves substances against their concentration gradient (from low to high concentration). This "uphill" movement requires an input of energy to overcome the electrochemical gradient. The most common source of this energy in the cell is adenosine triphosphate (ATP). The hydrolysis of ATP to ADP and inorganic phosphate releases energy that powers protein pumps (a type of carrier protein) to transport substances across the membrane.

- A diffusion gradient is what active transport works against, not what it requires.
- Osmotic pressure is related to the passive movement of water.
- While carrier proteins are often involved, they cannot function in active transport without an energy source. The defining requirement is energy, typically from ATP.

Final Answer : "ATP energy"

Answer: (B)

Q19.

Solution

Concept: DNA replication is a complex process orchestrated by a suite of specialized enzymes.

Solution: Several key enzymes are involved in DNA replication, each with a specific role:

- **Helicase:** Unwinds the DNA double helix at the replication fork, separating the two parental strands.
- **DNA polymerase:** This is the main synthesizing enzyme. It reads the template strand and adds complementary nucleotides to the 3' end of the new, growing DNA strand. It also has a proofreading function to ensure accuracy.
- **DNA ligase:** Joins fragments of DNA together. On the lagging strand, DNA is synthesized in short pieces called Okazaki fragments. DNA ligase seals the nicks between these fragments to create a continuous strand.
- **RNA polymerase:** This enzyme is primarily involved in transcription, the process of synthesizing an RNA molecule from a DNA template.

Thus, the enzyme primarily responsible for adding nucleotides to the new DNA strand is DNA polymerase.
Final Answer : "DNA polymerase"

Answer: (B)

Q20.

Solution

Concept: Lysosomes are organelles containing hydrolytic enzymes for intracellular digestion.

Solution: Lysosomes are membrane-enclosed organelles that contain a wide array of powerful hydrolytic enzymes, such as proteases, lipases, and nucleases. These enzymes function best at an acidic pH, which is maintained inside the lysosome. The primary function of lysosomes is to digest various materials, including:

- Substances taken into the cell from the outside (endocytosis).
- Worn-out or damaged organelles within the cell itself (a process called autophagy).
- Pathogens like bacteria and viruses.

The term "suicide bags" is a colloquialism that refers to the potential danger these organelles pose to the cell. If the lysosomal membrane were to rupture, it would release its potent digestive enzymes into the cytoplasm, leading to the self-digestion (autolysis) and death of the cell. This controlled cell death is a part of normal development and pathology.

Final Answer : "They digest cellular components using hydrolytic enzymes"

Answer: (B)

Q21.

Solution

Concept: The cytoskeleton is composed of different protein filaments, each with distinct roles in cell structure and movement.

Solution: The cytoskeleton provides structural support to the cell and is involved in various forms of cell movement. It consists of three main types of protein filaments:

- **Microfilaments (or Actin fibers):** These are the thinnest filaments, composed of the protein actin. They are involved in muscle contraction, cell crawling (amoeboid movement), and formation of the cleavage furrow during cytokinesis.
- **Intermediate filaments:** These have a diameter intermediate between the other two. They are very stable and provide mechanical strength to cells, helping them withstand physical stress.
- **Microtubules:** These are the thickest filaments, forming hollow tubes made of the protein tubulin. They play a crucial role in maintaining cell shape, serving as tracks for intracellular transport of organelles, and forming the core of cilia and flagella. Critically, during cell division (mitosis and meiosis), microtubules assemble to form the mitotic spindle. The spindle fibers attach to the chromosomes and are responsible for segregating them into the two daughter cells.

Therefore, microtubules are directly involved in chromosome movement.
Final Answer : "Microtubules"

Answer: (C)

Q22.

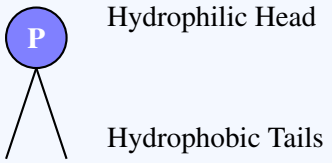
Solution

Concept: The structure of phospholipids, having both hydrophilic and hydrophobic regions, dictates their self-assembly into bilayers in an aqueous environment.

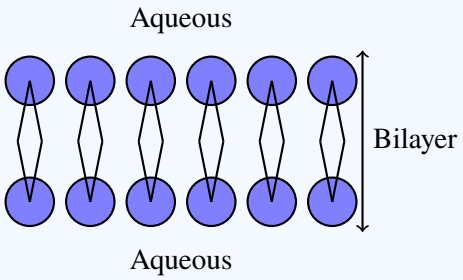
Solution: A phospholipid molecule is composed of a glycerol backbone, two fatty acid tails, and a phosphate-containing head group. This structure gives it a dual character:

- The **phosphate head** is polar and negatively charged, making it hydrophilic ("water-loving").
- The **fatty acid tails** are long hydrocarbon chains that are nonpolar, making them hydrophobic ("water-fearing").

A molecule that possesses both a hydrophilic and a hydrophobic region is described as **amphipathic**. In an aqueous (water-based) environment like the cell's cytoplasm or the extracellular fluid, these amphipathic phospholipids spontaneously arrange themselves to minimize the contact between their hydrophobic tails and water. The most stable arrangement is a bilayer, where the hydrophilic heads face the water on both sides, and the hydrophobic tails are shielded from the water in the interior of the membrane. This amphipathic nature is the fundamental property that allows phospholipids to form the stable yet fluid barrier of biological membranes.



Amphipathic Molecule



Final Answer : "Amphipathic nature"

Answer: (C)

Q23.

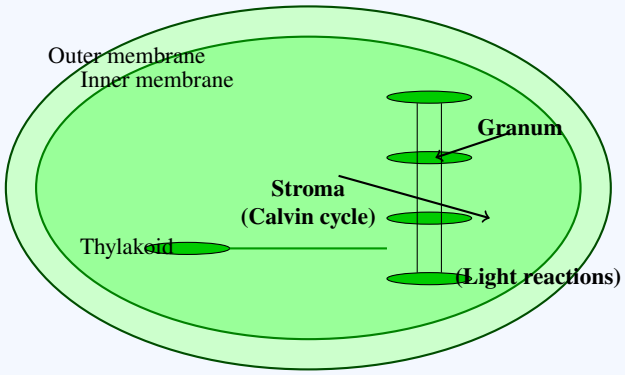
Solution

Concept: Photosynthesis is divided into two main stages, the light-dependent reactions and the light-independent reactions (Calvin cycle), which occur in specific locations within the chloroplast.

Solution: The chloroplast is the site of photosynthesis in plant cells. It has a complex internal structure.

- **Light-dependent reactions:** These reactions capture light energy and convert it into chemical energy in the form of ATP and NADPH. They occur in the thylakoid membranes. The thylakoids are sac-like structures that are often stacked into columns called grana. The pigments that absorb light, like chlorophyll, are embedded in these membranes.
- **Light-independent reactions (Calvin Cycle):** These reactions use the ATP and NADPH produced by the light-dependent reactions to fix carbon dioxide (CO_2) and synthesize glucose. These reactions take place in the stroma, the fluid-filled space surrounding the grana.
- The outer membrane and intermembrane space primarily serve to compartmentalize the chloroplast from the cytoplasm.

Therefore, the grana, which are stacks of thylakoid membranes, are the site of the light-dependent reactions.



Final Answer : "Grana (thylakoid membranes)"

Answer: (B)

Q24.

Solution

Concept: Water moves across semipermeable membranes from an area of higher water potential to an area of lower water potential.

Solution: The movement of water from the soil into root hairs and subsequently across the root cortex to the xylem is a critical process for plant survival.

- **Osmosis** is the net movement of water molecules across a selectively permeable membrane from a region of higher water concentration (higher water potential) to a region of lower water concentration (lower water potential). Soil water typically has a higher water potential than the cytoplasm of root hair cells (due to solutes in the cell). This gradient drives water into the root by osmosis.
- **Active transport** requires energy (ATP) to move substances (usually solutes like ions) against their concentration gradient. While active transport of ions into the root helps create the osmotic gradient, it is not the process by which water itself moves.
- **Diffusion** is the general movement of particles from high to low concentration, but osmosis is the specific term for the diffusion of water across a semipermeable membrane.
- **Transpiration pull** is the large-scale force generated in the leaves by the evaporation of water (transpiration) that pulls the entire column of water up through the xylem. It is the primary driver for long-distance water transport, not the initial cell-to-cell uptake in the root.

Therefore, at the cellular level in the root, water movement is primarily due to osmosis.
Final Answer : "Osmosis"

Answer: (C)

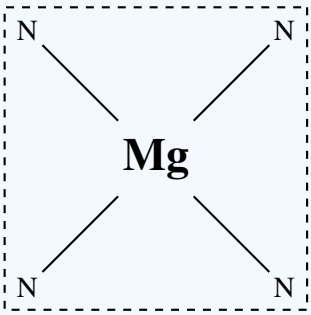
Q25.

Solution

Concept: Essential mineral nutrients have specific structural or metabolic roles in plants.

Solution: Magnesium (Mg) is a vital macronutrient for plants. Its most critical role is as the central atom in the porphyrin ring structure of the chlorophyll molecule. Chlorophyll is the pigment that absorbs light energy for photosynthesis. Without magnesium, chlorophyll cannot be synthesized, leading to a deficiency symptom called chlorosis, where leaves turn yellow due to the lack of green pigment. Magnesium also acts as a cofactor for many enzymes involved in ATP synthesis and other metabolic pathways.

- **Component of ATP:** ATP (adenosine triphosphate) contains adenine, ribose, and three phosphate groups. The key element is phosphorus, not magnesium.
- **Structural component of cell wall:** The primary structural component of the plant cell wall is cellulose. Calcium is also important for forming calcium pectate in the middle lamella.
- **Electron acceptor:** The final electron acceptor in photosynthesis is $NADP^+$.



Porphyrin Ring Structure
(Simplified)

Final Answer : "Central atom in chlorophyll molecule"

Answer: (C)

Q26.

Solution

Concept: C_4 plants have evolved a specialized mechanism to concentrate CO_2 around the enzyme RuBisCO, thereby minimizing photorespiration.

Solution: Photorespiration is a wasteful process where the enzyme RuBisCO binds to O_2 instead of CO_2, especially under hot, dry conditions when stomata close and the CO_2/O_2 ratio inside the leaf drops. C_4 plants have a unique adaptation to overcome this.

- They exhibit **Kranz anatomy**, with two distinct types of photosynthetic cells: mesophyll cells and bundle-sheath cells.
- **Spatial Separation:** The process is divided between these cells.
  (a) In the **mesophyll cells**, the enzyme PEP carboxylase (which has a high affinity for CO_2 and does not bind O_2) initially fixes atmospheric CO_2 into a 4-carbon acid (e.g., malate).
  (b) This 4-carbon acid is then transported to the **bundle-sheath cells**, which surround the vascular bundles.
  (c) Inside the bundle-sheath cells, the 4-carbon acid is decarboxylated, releasing a high concentration of CO_2.
  (d) This concentrated CO_2 is then fixed by RuBisCO in the Calvin cycle, just as in C_3 plants, but under conditions that greatly favor carboxylation over oxygenation (photorespiration).

This CO_2-concentrating mechanism makes C_4 photosynthesis much more efficient than C_3 photosynthesis in high-temperature, high-light, and low-CO_2 environments.
Final Answer : "Spatial separation of CO_2 fixation and Calvin cycle"

Answer: (C)

Q27.

Solution

Concept: Glycolysis is the initial stage of cellular respiration where glucose is partially oxidized, involving an energy investment phase and an energy payoff phase.

Solution: Glycolysis is a sequence of ten enzyme-catalyzed reactions that converts one molecule of glucose (a 6-carbon sugar) into two molecules of pyruvate (a 3-carbon compound). The energy yield can be calculated by looking at the ATP consumed and produced.

- **Energy Investment Phase:** In the initial steps, the cell invests energy to activate the glucose molecule. 2 molecules of ATP are consumed.
  (a) Glucose → Glucose-6-phosphate (1 ATP used)
  (b) Fructose-6-phosphate → Fructose-1,6-bisphosphate (1 ATP used)
- **Energy Payoff Phase:** In the later steps, energy is harvested. 4 molecules of ATP are produced via substrate-level phosphorylation.
  (a) 1,3-bisphosphoglycerate → 3-phosphoglycerate (2 ATP produced, one for each 3-carbon molecule)
  (b) Phosphoenolpyruvate (PEP) → Pyruvate (2 ATP produced)

The **net yield** is the total ATP produced minus the total ATP invested: Net ATP = 4 ATP (produced) - 2 ATP (invested) = **2 ATP**. In addition, 2 molecules of NADH are also produced.
Final Answer : "2"

Answer: (B)

Q28.

Solution

Concept: Plant hormones, or phytohormones, are chemical messengers that regulate plant growth and development.

Solution: Each class of plant hormones has distinct primary functions:

- **Auxin:** This is the key hormone responsible for promoting cell elongation, particularly in stems and coleoptiles. According to the acid growth hypothesis, auxin stimulates proton pumps in the plasma membrane, which lowers the pH in the cell wall. This acidic environment activates enzymes called expansins that loosen the connections between cellulose microfibrils, allowing the cell wall to stretch and the cell to expand under turgor pressure. Auxin is also involved in root formation, fruit development, and apical dominance.
- **Cytokinin:** Primarily promotes cell division (cytokinesis) and differentiation. It often works in conjunction with auxin.
- **Ethylene:** A gaseous hormone that promotes fruit ripening, senescence (aging), and leaf abscission (shedding).
- **Abscisic acid (ABA):** Generally an inhibitory hormone. It promotes seed dormancy, closes stomata during water stress, and inhibits growth.

Therefore, auxin is the hormone primarily responsible for cell elongation.
Final Answer : "Auxin"

Answer: (B)

Q29.

Solution

Concept: During the light-dependent reactions of photosynthesis, water is split (photolysis) to provide electrons for the photosystems and to generate a proton gradient.

Solution: The splitting of water, known as photolysis, is a crucial event that occurs at the beginning of the light-dependent reactions. This process takes place within Photosystem II (PSII), which is located in the thylakoid membranes. Specifically, the reaction occurs on the side of the membrane facing the **thylakoid lumen** (the space inside the thylakoid sac). The reaction is: $2H_2O \rightarrow 4H^+ + 4e^- + O_2$ The products have specific fates:

- **Electrons (e^-):** Replace the electrons that are excited by light energy and lost from the reaction center of PSII.
- **Protons (H^+):** Are released into the thylakoid lumen, contributing to the buildup of a high concentration of protons there. This proton gradient is then used by ATP synthase to produce ATP (chemiosmosis).
- **Oxygen (O_2):** Is a waste product that diffuses out of the chloroplast and eventually out of the leaf.

The stroma is where the Calvin cycle occurs. The cytoplasm and mitochondria are outside the chloroplast and are not involved in this process.

Final Answer : "Thylakoid lumen"

Answer: (B)

Q30.

Solution

Concept: Cellular respiration consists of several stages, with the final stage, oxidative phosphorylation, generating the vast majority of ATP.

Solution: Let's compare the approximate ATP yield from each major stage of aerobic respiration per molecule of glucose:

- **Glycolysis:** Occurs in the cytoplasm. Produces a net gain of **2 ATP** by substrate-level phosphorylation. It also produces 2 NADH.
- **Krebs cycle (including pyruvate oxidation):** Occurs in the mitochondrial matrix. Produces **2 ATP** (or GTP, which is equivalent) by substrate-level phosphorylation. Its main contribution is the production of a large number of electron carriers: 8 NADH and 2 $FADH_2$.
- **Electron transport chain (ETC) and Oxidative Phosphorylation:** Occurs on the inner mitochondrial membrane. This process does not produce ATP directly but uses the energy from the electrons carried by NADH and $FADH_2$ to pump protons, creating a proton-motive force. This force drives ATP synthase, which produces approximately **28-32 ATP**. This is by far the most productive stage.
- **Fermentation:** An anaerobic process that occurs in the cytoplasm. It does not produce any ATP. Its purpose is to regenerate NAD^+ so that glycolysis can continue to produce its small yield of 2 ATP in the absence of oxygen.

Clearly, the electron transport chain is the stage that yields the maximum amount of ATP.
Final Answer : "Electron transport chain"

Answer: (C)

Q31.

Solution

Concept: The human heart is a four-chambered pump. The left side of the heart handles oxygenated blood from the lungs, while the right side handles deoxygenated blood from the body.

Solution: The circulation of blood through the heart follows a specific pathway:

(a) Deoxygenated blood from the body enters the **Right Atrium**.

(b) It passes to the **Right Ventricle**, which pumps it to the lungs.

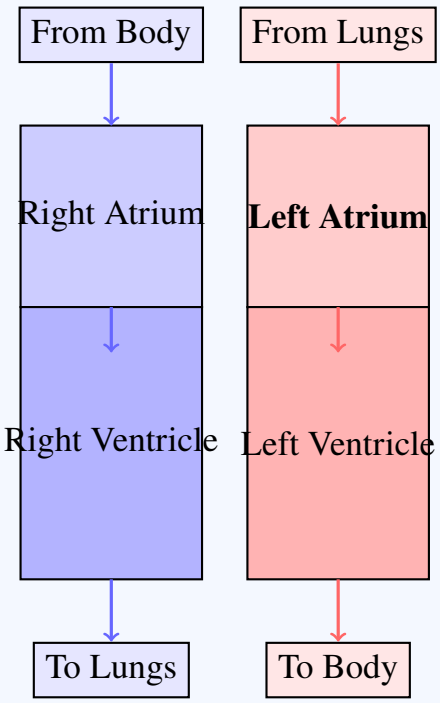
(c) In the lungs, the blood releases CO_2 and picks up oxygen.

(d) This newly **oxygenated** blood returns from the lungs via the pulmonary veins and enters the **Left Atrium**.

(e) From the left atrium, it flows into the **Left Ventricle**.

(f) The powerful left ventricle then pumps the oxygenated blood through the aorta to the rest of the body.

Therefore, the chamber that receives oxygenated blood directly from the lungs is the left atrium.



Final Answer : "Left atrium"

Answer: (C)

Q32.

Solution

Concept: The heart's contractions are initiated and coordinated by a specialized electrical conduction system.

Solution: The rhythmic beating of the heart is controlled by the generation and propagation of electrical impulses. The components of this system, in order of activation, are:

- **Sinoatrial (SA) node:** Located in the upper wall of the right atrium. It has the fastest intrinsic rate of spontaneous depolarization, meaning it generates electrical impulses faster than any other part of the heart. For this reason, it is known as the heart's **natural pacemaker**, setting the normal sinus rhythm (typically 60-100 beats per minute).
- **Atrioventricular (AV) node:** Located at the junction of the atria and ventricles. It receives the impulse from the SA node and delays it slightly to allow the atria to finish contracting before the ventricles are stimulated.
- **Bundle of His:** A bundle of fibers that carries the impulse from the AV node into the interventricular septum.
- **Purkinje fibers:** These fibers spread out from the Bundle of His and conduct the impulse rapidly throughout the ventricular walls, causing a coordinated contraction of the ventricles from the bottom up.

Thus, the SA node is the primary pacemaker.
Final Answer : "SA node"

Answer: (B)

Q33.

Solution

Concept: Chemical digestion involves specific enzymes that break down macromolecules into smaller units at different locations in the digestive tract.

Solution: The digestion of the major macromolecules begins at different points:

- **Carbohydrates:** Digestion begins in the mouth with salivary amylase.
- **Lipids (Fats):** Digestion primarily occurs in the small intestine with pancreatic lipase.
- **Proteins:** Digestion begins in the stomach. The stomach secretes hydrochloric acid (HCl), creating a very acidic environment (pH 1.5-3.5). It also secretes an inactive enzyme precursor called **pepsinogen**. The HCl converts pepsinogen into its active form, **pepsin**. Pepsin is a protease, an enzyme that hydrolyzes proteins into smaller polypeptides.

The other enzymes listed have different roles:

- **Amylase:** Digests starches (carbohydrates).
- **Trypsin:** A protease that works in the alkaline environment of the small intestine to continue protein digestion.
- **Lipase:** Digests fats (lipids).

Therefore, pepsin is the enzyme that initiates protein digestion in the stomach.
Final Answer : "Pepsin"

Answer: (B)

Q34.

Solution

Concept: Oxygen has low solubility in blood plasma, so a specialized transport protein is required to carry sufficient quantities to the body's tissues.

Solution: Oxygen is transported in the blood in two ways:

(a) A small amount (about 1.5%) is dissolved directly in the blood plasma.

(b) The vast majority (about 98.5%) is bound to **hemoglobin**, a protein contained within red blood cells (erythrocytes).

Hemoglobin is a complex protein composed of four polypeptide chains (globins), each with an iron-containing heme group. The iron atom in each heme group can reversibly bind to one molecule of oxygen (O_2). This allows each hemoglobin molecule to carry up to four oxygen molecules. This binding capacity dramatically increases the oxygen-carrying capacity of the blood, ensuring that the metabolic demands of the body's tissues can be met.

- **Plasma proteins** like albumin are involved in maintaining osmotic pressure and transport of other substances, but not oxygen.
- **Platelets** are cell fragments involved in blood clotting.

Final Answer : "Hemoglobin"

Answer: (B)

Q35.

Solution

Concept: The human brain is divided into specialized regions, each responsible for controlling different functions.

Solution: The brain has several major parts with distinct primary functions:

- **Cerebrum:** The largest part of the brain, responsible for higher-order functions like thinking, reasoning, memory, language, and conscious thought.
- **Cerebellum:** Located at the back of the brain, underneath the cerebrum. Its primary role is to coordinate voluntary movements, posture, **balance**, and motor learning. It ensures that movements are smooth, accurate, and timed correctly. Damage to the cerebellum can result in jerky, uncoordinated movements (ataxia).
- **Brainstem (including Medulla Oblongata):** Controls vital autonomic functions such as breathing, heart rate, and blood pressure.
- **Hypothalamus:** Links the nervous system to the endocrine system via the pituitary gland, controlling body temperature, hunger, thirst, and hormonal secretion.

Therefore, the primary function of the cerebellum is balance and coordination of movement.
Final Answer : "Balance and coordination"

Answer: (B)

Q36.

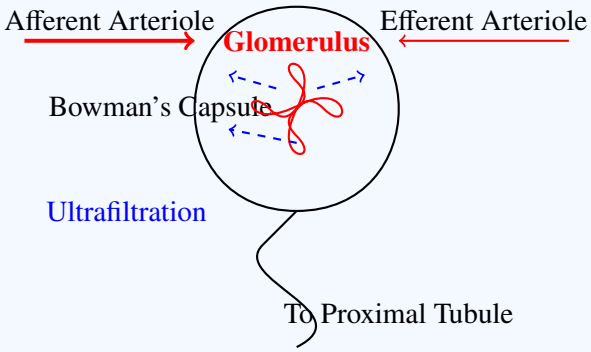
Solution

Concept: Urine formation in the nephron involves three main processes: ultrafiltration, selective reabsorption, and secretion.

Solution: The nephron is the functional unit of the kidney, responsible for filtering blood and producing urine.

- **Ultrafiltration:** This is the first step and occurs in the renal corpuscle, which consists of the glomerulus and Bowman's capsule. The **glomerulus** is a dense network of capillaries under high pressure. This pressure forces water and small solutes (like glucose, salts, amino acids, and urea) from the blood, across the filtration membrane, and into the Bowman's capsule. Larger components like blood cells and proteins are too big to pass through and remain in the blood. The resulting fluid in the Bowman's capsule is called the glomerular filtrate.
- **Selective Reabsorption:** As the filtrate flows through the rest of the nephron (proximal convoluted tubule, **Loop of Henle**, **distal convoluted tubule**), essential substances like glucose, water, and some salts are reabsorbed back into the blood.
- **Secretion:** Waste products and excess ions are actively transported from the blood into the filtrate, primarily in the distal convoluted tubule.
- The **collecting duct** receives filtrate from multiple nephrons and is the site of final water reabsorption under the control of ADH.

Thus, the glomerulus is the specific site of ultrafiltration.



Final Answer : "Glomerulus"

Answer: (B)

Q37.

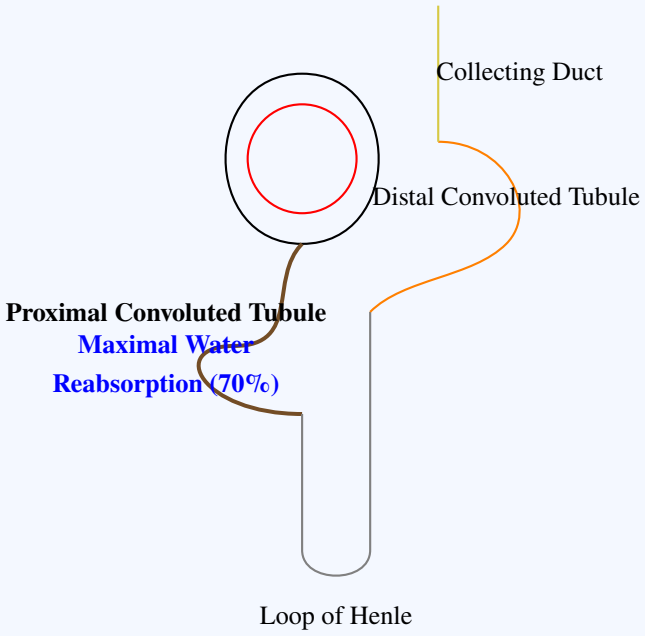
Solution

Concept: The nephron reabsorbs essential substances and water from the glomerular filtrate back into the blood.

Solution: The process of reabsorption occurs along the entire length of the renal tubule, but the extent of reabsorption varies in different segments.

- **Proximal Convoluted Tubule (PCT):** This is the site of maximum reabsorption. Nearly all essential nutrients like glucose and amino acids, and about 65-70% of electrolytes and water are reabsorbed here. The cells of the PCT are lined with microvilli, which greatly increase the surface area for reabsorption. This reabsorption of water is obligatory, meaning it is not under hormonal control but follows the osmotic gradient created by solute reabsorption.
- **Loop of Henle:** The descending limb is permeable to water, while the ascending limb is permeable to salts but not water. This segment is crucial for creating a concentration gradient in the kidney medulla, but the PCT reabsorbs a larger volume of water overall.
- **Distal Convoluted Tubule (DCT):** Conditional reabsorption of water and Na^+ occurs here under the influence of hormones like ADH and aldosterone.
- **Collecting Duct:** Final concentration of urine occurs here, where water is reabsorbed under the influence of ADH.

Therefore, the Proximal Convoluted Tubule is responsible for the maximum reabsorption of water.



Final Answer : "Proximal convoluted tubule"

Answer: (A)

Q38.

Solution

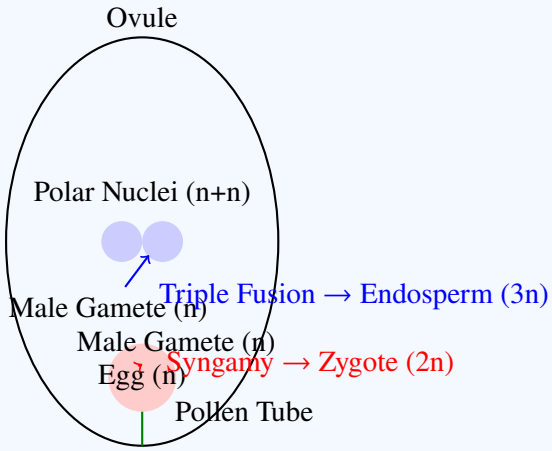
Concept: Double fertilization is a complex reproductive mechanism unique to flowering plants (angiosperms).

Solution: In flowering plants, after pollination, the pollen grain germinates on the stigma and a pollen tube grows down to the ovule. The pollen tube carries two male gametes.

(a) **First Fertilization (Syngamy):** One of the male gametes fuses with the egg cell. This fusion of gametes forms a diploid (2n) **zygote**, which will develop into the embryo.

(b) **Second Fertilization (Triple Fusion):** The other male gamete fuses with the central cell, which contains two polar nuclei. This results in the formation of a triploid (3n) primary endosperm nucleus (PEN). The PEN develops into the **endosperm**, a nutritive tissue that provides food for the developing embryo.

Because two separate fertilization events (syngamy and triple fusion) occur, the process is called double fertilization. It results in the concurrent formation of the embryo (from the zygote) and its food source (the endosperm).



Final Answer : "Formation of zygote and endosperm"

Answer: (B)

Q39.

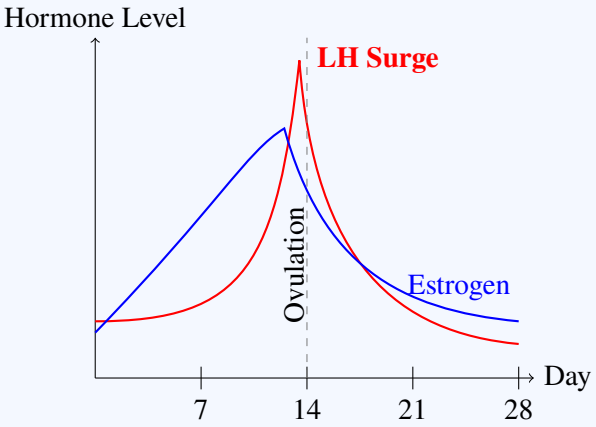
Solution

Concept: The menstrual cycle is regulated by a complex interplay of hormones from the hypothalamus, pituitary gland, and ovaries.

Solution: The menstrual cycle is typically a 28-day cycle involving the development and release of an egg (ovulation) and preparation of the uterus for pregnancy.

- In the first half of the cycle (follicular phase), Follicle-Stimulating Hormone (FSH) stimulates the growth of several ovarian follicles.
- As the dominant follicle grows, it produces increasing amounts of **estrogen**.
- The rising estrogen levels have a positive feedback effect on the pituitary gland. Around day 12-13, when estrogen reaches a peak, it causes the anterior pituitary to release a massive amount of **Luteinizing Hormone (LH)**. This event is known as the "LH surge".
- This LH surge is the direct trigger for ovulation, causing the mature follicle to rupture and release the egg approximately 24-36 hours later.
- After ovulation, the remnant of the follicle becomes the corpus luteum, which produces **progesterone** to maintain the uterine lining.

Therefore, the sudden increase in LH is the direct trigger for ovulation.



Final Answer : “LH”

Answer: (B)

Q40.

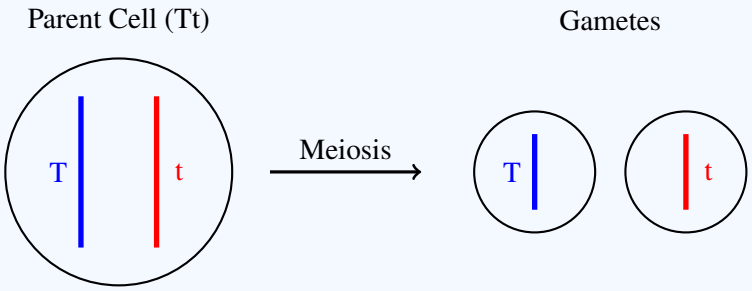
Solution

Concept: Mendel's first law, the Law of Segregation, describes how alleles for a single gene are passed from parents to offspring.

Solution: The Law of Segregation is one of the fundamental principles of heredity discovered by Gregor Mendel. It states that:

- For any given trait, an individual organism has two alleles, one inherited from each parent.
- During gamete formation (meiosis), these two alleles **segregate (separate)** from each other, so that each gamete receives only one of the two alleles.
- This segregation corresponds to the separation of homologous chromosomes during Anaphase I of meiosis, where each chromosome of a homologous pair (and thus the allele it carries) goes to a different daughter cell.

This principle explains why offspring can inherit traits not seen in their parents (in the case of heterozygous parents) and forms the basis for predicting inheritance patterns using Punnett squares. It directly refutes the older idea of "blending inheritance." The Law of Independent Assortment is Mendel's second law, which deals with the inheritance of two different traits simultaneously.



Final Answer : "Separation of allele pairs"

Answer: (C)

Q41.

Solution

Concept: The genetic code is transcribed from DNA to mRNA and then translated into protein, with specific terminology for the information units at each stage.

Solution: The flow of genetic information in a cell is typically from DNA to RNA to protein (the Central Dogma).

- **DNA** stores the master blueprint of genetic information as a sequence of nucleotides.
- **mRNA (messenger RNA)** is a temporary copy of a gene that is synthesized during transcription. The genetic information on mRNA is read in non-overlapping, three-nucleotide units called **codons**. Each codon specifies a particular amino acid (e.g., AUG codes for methionine) or a stop signal.
- **tRNA (transfer RNA)** acts as an adapter molecule. It has a three-nucleotide sequence called an **anticodon** that is complementary to an mRNA codon. It carries the specific amino acid corresponding to that codon to the ribosome.
- **rRNA (ribosomal RNA)** is a structural component of ribosomes, the cellular machinery where translation (protein synthesis) takes place.

Therefore, the codons that are read during translation to determine the amino acid sequence of a protein are located on the mRNA molecule.
Final Answer : "mRNA"

Answer: (B)

Q42.

Solution

Concept: Polygenic inheritance is a pattern of inheritance where a single trait is controlled by the cumulative effect of multiple genes.

Solution: Polygenic traits are distinct from Mendelian traits, which are typically controlled by a single gene. The key feature of polygenic inheritance is that it results in a continuous range of phenotypes rather than distinct categories.

- **Blood group (ABO):** This is an example of multiple alleles (A, B, O) and codominance (A and B are codominant). It is controlled by a single gene, so it is not polygenic.
- **Skin colour:** Human skin colour is a classic example of polygenic inheritance. It is determined by the amount of melanin pigment, which is controlled by several (at least three) different genes. The combination of alleles from these multiple genes results in a continuous spectrum of skin tones from very light to very dark. Other examples include height, weight, and intelligence.
- **Flower colour in pea plants:** As studied by Mendel, this is a simple Mendelian trait controlled by a single gene with dominant and recessive alleles (e.g., purple or white).
- **Tongue rolling:** This is often cited as a simple Mendelian trait, controlled by a single gene, although its genetics are more complex than originally thought. It does not show continuous variation.

Therefore, skin colour is the best example of polygenic inheritance among the options.
Final Answer : "Skin colour"

Answer: (B)

Q43.

Solution

Concept: The Polymerase Chain Reaction (PCR) is a cornerstone technique in molecular biology that allows for the in-vitro replication of DNA.

Solution: The Polymerase Chain Reaction (PCR) is a revolutionary technique that allows scientists to create millions to billions of copies of a specific DNA segment from a very small initial sample. This process is known as **DNA amplification**. The process involves a series of repeated cycles of heating and cooling in a thermal cycler, with key ingredients including the template DNA, DNA polymerase enzyme (usually Taq polymerase), primers, and nucleotides. The three main steps in a PCR cycle are:

(a) **Denaturation:** The mixture is heated to separate the double-stranded DNA into single strands.

(b) **Annealing:** The mixture is cooled to allow short DNA primers to bind (anneal) to the complementary sequences on the single-stranded DNA templates.

(c) **Extension:** The temperature is raised again, and the Taq polymerase enzyme synthesizes new DNA strands by adding nucleotides, starting from the primers.

By repeating this cycle 20-40 times, the target DNA sequence is amplified exponentially. This technique is fundamental to genetic testing, forensics, diagnostics, and research.

Final Answer : "DNA amplification"

Answer: (B)

Q44.

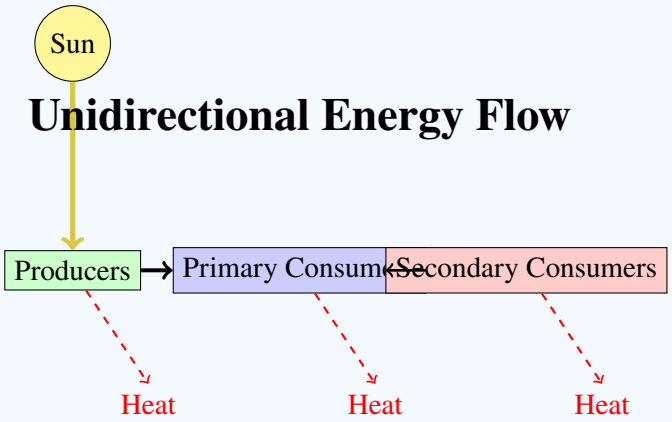
Solution

Concept: Ecosystems are characterized by the flow of energy and the cycling of nutrients. These two processes follow different fundamental principles.

Solution: The flow of energy through an ecosystem is governed by the laws of thermodynamics.

- Energy enters most ecosystems in the form of sunlight.
- Producers (e.g., plants) convert this light energy into chemical energy (glucose) through photosynthesis.
- This chemical energy is then transferred through the food chain as producers are eaten by primary consumers (herbivores), who are then eaten by secondary consumers (carnivores), and so on.
- At each trophic level transfer, a significant portion of energy (around 90%) is lost from the ecosystem as metabolic heat.
- Because of this constant loss, energy does not cycle back to the producers. It flows in one direction only, from the sun, through the trophic levels, and is eventually dissipated. This is why it is called an energy **flow**, not a cycle.

In contrast, chemical nutrients (like carbon, nitrogen, water) are finite and are continuously recycled within the ecosystem. Therefore, energy flow is best described as **unidirectional**.



Final Answer : "It is unidirectional"

Answer: (B)

Q45.

Solution

Concept: Biomagnification describes the accumulation of certain persistent toxins up the food chain.

Solution: Biomagnification, also known as bioamplification, is the process by which the concentration of a contaminant increases as it moves up through the trophic levels of a food chain. For a substance to biomagnify, it must be:

- **Persistent:** Not easily broken down by environmental processes.
- **Fat-soluble:** Stored in the fatty tissues of an organism rather than being excreted.
- **Biologically active and mobile.**

When a small organism consumes a small amount of the toxin, it is stored in its fat. When a larger organism eats many of these smaller organisms, it accumulates the toxins from all of them. This process continues up the food chain, leading to dangerously high concentrations in top predators.

- **DDT** (Dichlorodiphenyltrichloroethane) is a synthetic pesticide that is a classic example of a substance that biomagnifies. It is highly persistent and fat-soluble. Its biomagnification in aquatic and terrestrial food chains famously led to eggshell thinning and reproductive failure in birds of prey like the bald eagle.
- Oxygen, nitrogen, and carbon dioxide are essential substances that are part of natural biogeochemical cycles and are not stored in fatty tissues, so they do not biomagnify.

Final Answer : "DDT"

Answer: (C)

Q46.

Solution

Concept: The stratospheric ozone layer is depleted by catalytic reactions involving halogen radicals released from specific man-made compounds.

Solution: The ozone layer in the stratosphere is crucial for life as it absorbs most of the Sun's harmful ultraviolet (UV-B) radiation. Its depletion is a major environmental concern.

- The primary cause of this depletion is the release of man-made chemicals known as ozone-depleting substances (ODS).
- The most significant and well-known group of ODS is **Chlorofluorocarbons (CFCs)**. These compounds, once widely used in refrigerators, air conditioners, and aerosol sprays, are extremely stable in the lower atmosphere.
- They slowly drift up to the stratosphere, where they are broken down by intense UV radiation. This process releases chlorine (Cl) atoms.
- A single chlorine atom can act as a catalyst to destroy tens of thousands of ozone (O_3) molecules through a chemical cycle before it is removed from the stratosphere. The basic reaction is: $Cl + O_3 \rightarrow ClO + O_2$ $ClO + O \rightarrow Cl + O_2$ Net: $O_3 + O \rightarrow 2O_2$

While other compounds like nitrogen oxides can also affect ozone levels, CFCs have been identified as the main driver of the large-scale ozone depletion observed, particularly the Antarctic ozone hole.

Final Answer : "Chlorofluorocarbons"

Answer: (C)

Q47.

Solution

Concept: Spermatogenesis is the process of sperm cell production, which occurs at a specific site in the male reproductive system and is regulated by hormones.

Solution: Spermatogenesis, the process of producing mature sperm, takes place within the **seminiferous tubules** of the testes. This complex process is under precise hormonal control involving the hypothalamus, pituitary gland, and testes (the HPG axis).

- The pituitary gland secretes two key gonadotropins:
  (a) **Follicle-Stimulating Hormone (FSH):** Acts on the Sertoli cells within the seminiferous tubules. Sertoli cells nourish the developing sperm cells and are essential for spermatogenesis.
  (b) **Luteinizing Hormone (LH):** Acts on the Leydig cells (interstitial cells) located between the seminiferous tubules, stimulating them to produce and secrete **testosterone**.
- **Testosterone** is the primary male sex hormone and is crucial for stimulating and maintaining spermatogenesis.

The other locations mentioned are incorrect: the epididymis is for sperm maturation and storage, the vas deferens is for transport, and the prostate gland produces seminal fluid. Estrogen and progesterone are primarily female hormones. Therefore, spermatogenesis occurs in the seminiferous tubules and is regulated by both FSH and testosterone.

Final Answer : "Occurs in seminiferous tubules and regulated by FSH and testosterone"

Answer: (B)

Q48.

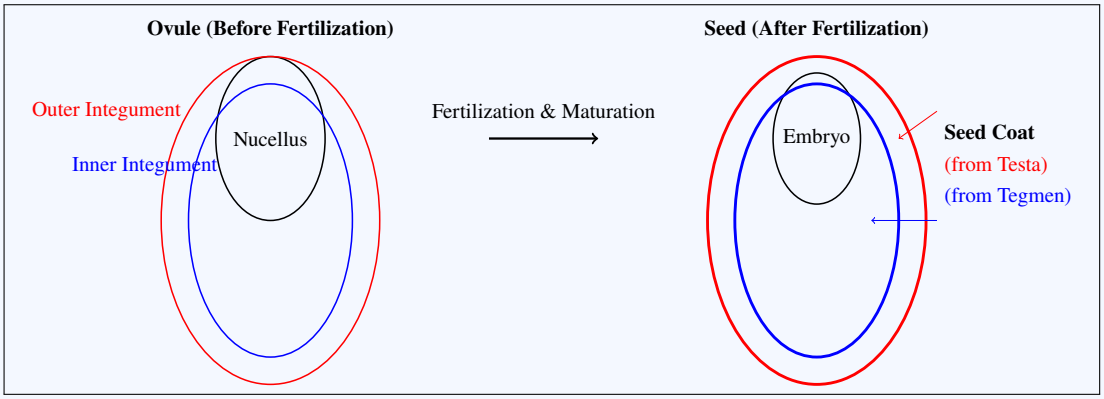
Solution

Concept: After fertilization in angiosperms, the ovule develops into a seed, and its various parts differentiate into specific seed structures.

Solution: An ovule is a complex structure within the plant ovary that contains the female gamete. After fertilization, it matures into a seed.

- The **integuments** are the one or two protective outer layers of the ovule. After fertilization, these layers harden and thicken to become the protective **seed coat**. The outer integument typically forms the tough testa, and the inner integument forms the thinner tegmen.
- The **nucellus** is the tissue within the ovule that surrounds the embryo sac. It often serves as a nutritive tissue and may be consumed by the developing embryo or persist in some seeds (perisperm).
- The **embryo sac** is the female gametophyte, which contains the egg. After fertilization, the zygote inside develops into the embryo, and the primary endosperm cell develops into the endosperm.
- The **micropyle** is a small opening in the integuments through which the pollen tube enters. It often remains as a small pore in the seed coat, allowing water to enter during germination.

Therefore, the integuments of the ovule develop into the seed coat.



Final Answer : "Integuments"

Answer: (B)

Q49.

Solution

Concept: Meiosis is a specialized type of cell division that reduces the chromosome number by half, creating four haploid cells, each genetically distinct from the parent cell and from each other.

Solution: Genetic recombination, a key source of genetic variation, occurs primarily through crossing over. This event takes place during **Prophase I** of meiosis. Prophase I is an extended phase where several critical events happen:

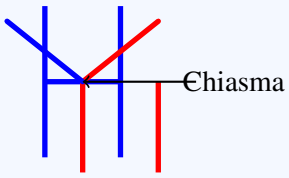
(a) Homologous chromosomes (one inherited from each parent) pair up in a process called synapsis, forming a structure called a bivalent or tetrad.

(b) While the homologous chromosomes are synapsed, non-sister chromatids may exchange segments of genetic material. This physical exchange is called **crossing over**.

(c) The points where crossing over occurs are visible as X-shaped structures called chiasmata.

This process shuffles the alleles on the homologous chromosomes, creating new combinations of genes that were not present in the parent chromosomes. The other stages listed involve the alignment (Metaphase I) and separation (Anaphase I) of these already-recombined homologous chromosomes.

Homologous Chromosomes in Prophase I



Crossing Over Occurs

Final Answer : "Prophase I"

Answer: (A)

Q50.

Solution

Concept: Pregnancy is established and maintained by a carefully orchestrated sequence of hormonal signals.

Solution: While several hormones are involved in pregnancy, **progesterone** is the most critical for its maintenance. It is often called the "hormone of pregnancy" for its essential roles:

- **Maintains the Endometrium:** Progesterone maintains the uterine lining (endometrium) in a thick, glandular, and highly vascularized state, which is necessary for the implantation and nourishment of the embryo. A drop in progesterone levels would lead to the shedding of the endometrium and termination of the pregnancy.
- **Inhibits Uterine Contractions:** It suppresses contractions of the uterine smooth muscle, preventing premature labor.
- **Promotes Glandular Development:** It stimulates the development of mammary glands in preparation for lactation.

Initially, progesterone is produced by the corpus luteum in the ovary. Later in pregnancy (after about 8-12 weeks), the placenta takes over as the primary source of progesterone. Estrogen is also important, but progesterone is the key maintenance hormone. LH and FSH levels are low during pregnancy.

Final Answer : "Progesterone"

Answer: (B)

Q51.

Solution

Concept: Double fertilization in angiosperms involves two separate fusion events within the ovule, leading to the formation of the embryo and its nutritive tissue.

Solution: Double fertilization is a hallmark of flowering plants (angiosperms). It involves two male gametes delivered by the pollen tube to the embryo sac within the ovule. The two fertilization events are:

(a) **Syngamy:** One male gamete (haploid, n) fuses with the egg cell (haploid, n) to form the diploid (2n) **zygote**. The zygote will subsequently develop into the embryo.

(b) **Triple Fusion:** The second male gamete (haploid, n) fuses with the two polar nuclei in the central cell (n + n). This forms the triploid (3n) primary endosperm nucleus, which develops into the **endosperm**, a food-storing tissue for the embryo.

Therefore, the two unique products resulting from this process are the zygote (which becomes the embryo) and the endosperm.

Final Answer : "Zygote and endosperm"

Answer: (B)

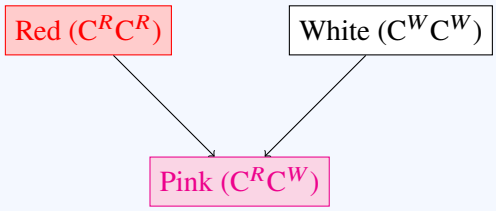
Q52.

Solution

Concept: Not all alleles exhibit simple dominant-recessive relationships; some interactions result in different phenotypic expressions in heterozygotes.

Solution: The different patterns of inheritance describe the relationship between alleles at a single genetic locus:

- **Complete Dominance:** The phenotype of the heterozygote is identical to that of the dominant homozygote. For example, in pea plants, a Tt plant is tall, just like a TT plant.
- **Incomplete Dominance:** The phenotype of the heterozygote is an intermediate blend between the phenotypes of the two homozygotes. The classic example is in snapdragon flowers: a cross between a homozygous red-flowered plant (C^RC^R) and a homozygous white-flowered plant (C^WC^W) produces heterozygous offspring (C^RC^W) with pink flowers. This matches the description of intermediate expression.
- **Codominance:** The heterozygote expresses both alleles' phenotypes simultaneously and distinctly. For example, in the human ABO blood group, an individual with the I^AI^B genotype has type AB blood, expressing both A and B antigens.
- **Polygenic Inheritance:** A single trait is controlled by multiple genes, resulting in a continuous range of phenotypes (e.g., height, skin colour).



Incomplete Dominance

Final Answer : "Incomplete dominance"

Answer: (B)

Q53.

Solution

Concept: Gene mutations are alterations in the DNA sequence and can be classified based on the nature and scale of the change.

Solution: Mutations can occur at different levels, from a single base to large segments of chromosomes.

- **Point Mutation:** This is a mutation that affects a single nucleotide pair in a DNA sequence. The most common type of point mutation is a **substitution**, where one base is replaced by another (e.g., A is replaced by G). Point mutations can also be small insertions or deletions of a single nucleotide.
- **Frameshift Mutation:** This is a specific consequence of an insertion or deletion of a number of nucleotides that is not a multiple of three. It shifts the "reading frame" of the genetic code, altering every codon and thus every amino acid downstream of the mutation, often resulting in a nonfunctional protein.
- **Deletion:** The loss of one or more nucleotides.
- **Duplication:** The repetition of a segment of DNA.

Since the question specifies the substitution of a single nucleotide base, it is describing a point mutation.

Final Answer : "Point mutation"

Answer: (B)

Q54.

Solution

Concept: The genetic code has several key properties that govern the translation of mRNA into protein.

Solution: The properties of the genetic code include:

- **Triplet Code:** The code is read in units of three nucleotides, called codons.
- **Unambiguous:** Each codon specifies only one particular amino acid. For example, AUG always codes for Methionine.
- **Degenerate (or Redundant):** This is the key property in the question. There are 64 possible codons (4 bases in combinations of 3) but only 20 common amino acids. This means that most amino acids are specified by more than one codon. For example, the amino acid Leucine is coded by six different codons (CUU, CUC, CUA, CUG, UUA, UUG). This degeneracy often provides a buffer against mutations, as a change in the third base of a codon may not change the resulting amino acid.
- **Non-overlapping and Comma-less:** The code is read sequentially, one codon after another, without any gaps or overlaps.

Therefore, degeneracy implies that multiple codons can code for the same amino acid.
Final Answer : "Multiple codons can code for the same amino acid"

Answer: (B)

Q55.

Solution

Concept: The Hardy-Weinberg principle describes a theoretical state where allele and genotype frequencies in a population remain constant from generation to generation in the absence of evolutionary influences.

Solution: For a population to be in Hardy-Weinberg equilibrium (i.e., not evolving), five main conditions must be met:

(a) **No Mutation:** No new alleles are generated, nor are alleles changed into other alleles.

(b) **Random Mating:** Individuals mate randomly, without any preference for particular genotypes.

(c) **No Gene Flow:** There is no migration of individuals into or out of the population.

(d) **No Natural Selection:** All genotypes have equal survival and reproductive rates.

(e) **Large Population Size:** The population must be large enough to prevent random changes in allele frequencies due to chance events (genetic drift).

Deviations from any of these conditions can cause a population to evolve. The option "Random mating and no mutation" lists two of these essential conditions. The other options describe conditions that cause evolution (small population size, high mutation rate, natural selection).
Final Answer : "Random mating and no mutation"

Answer: (B)

Q56.

Solution

Concept: The theory of evolution by natural selection, as proposed by Charles Darwin, is based on differential survival and reproduction.

Solution: Darwin's theory of natural selection can be summarized by a few key observations and inferences:

(a) **Variation:** There is heritable variation within any population of organisms.

(b) **Overproduction:** Organisms produce more offspring than can possibly survive.

(c) **Competition:** This overproduction leads to a "struggle for existence" where individuals compete for limited resources.

(d) **Differential Survival and Reproduction:** Individuals with inherited traits (adaptations) that make them better suited to their environment are more likely to survive and reproduce than those with less favorable traits.

The core of the theory is that this differential reproductive success leads to a gradual increase in the frequency of favorable traits in the population over generations. Therefore, the statement that "Individuals with favorable traits reproduce more successfully" is the best description of natural selection. "Survival of the fittest" is a common phrase but fitness in a biological sense is defined by reproductive success, not just strength.

Final Answer : "Individuals with favorable traits reproduce more successfully"

Answer: (C)

Q57.

Solution

Concept: DNA (Deoxyribonucleic acid) and RNA (Ribonucleic acid) are both nucleic acids, but they differ in their sugar component and one of their nitrogenous bases.

Solution: Both DNA and RNA are polymers made of nucleotides. Each nucleotide consists of a phosphate group, a five-carbon sugar, and a nitrogenous base.

- The nitrogenous bases are classified as purines (Adenine, Guanine) and pyrimidines (Cytosine, Thymine, Uracil).
- **In DNA:** The four bases are Adenine (A), Guanine (G), Cytosine (C), and **Thymine (T)**.
- **In RNA:** The four bases are Adenine (A), Guanine (G), Cytosine (C), and **Uracil (U)**.

Thus, Thymine is found in DNA but is replaced by Uracil in RNA. This is a key structural difference between the two molecules.

Component	DNA	RNA
Sugar	Deoxyribose	Ribose
Bases	A, G, C, **Thymine**	A, G, C, **Uracil**

Final Answer : "Thymine"

Answer: (D)

Q58.

Solution

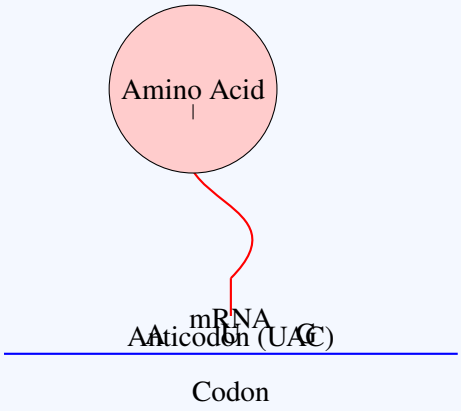
Concept: Transfer RNA (tRNA) is an adapter molecule in protein synthesis, linking codons on mRNA with specific amino acids.

Solution: During translation, the sequence of codons on an mRNA molecule is used to build a corresponding polypeptide chain. Transfer RNA (tRNA) is essential for this process. Each tRNA molecule has two key features:

(a) **Amino Acid Attachment Site:** At its 3' end, the tRNA is covalently linked to a specific amino acid.

(b) **Anticodon Loop:** At the other end of the molecule is a loop containing a three-nucleotide sequence called the **anticodon**.

The function of the anticodon is to base-pair with a complementary codon on the mRNA molecule being translated at the ribosome. For example, if the mRNA codon is AUG, the tRNA carrying methionine will have the anticodon UAC. This specific codon-anticodon recognition ensures that the correct amino acid is added to the growing polypeptide chain in the order specified by the mRNA.



Final Answer : "Recognizes complementary codon on mRNA"

Answer: (B)

Q59.

Solution

Concept: Transcription is the first step of gene expression, where a segment of DNA is copied into an RNA molecule.

Solution: The synthesis of different nucleic acids is carried out by specific enzymes called polymerases.

- **DNA Polymerase:** This enzyme is responsible for synthesizing DNA from a DNA template. This process is called DNA replication.
- **RNA Polymerase:** This is the main enzyme of **transcription**. It binds to a promoter region on a DNA template, unwinds the DNA, and synthesizes a complementary RNA strand (mRNA, tRNA, or rRNA) using ribonucleotides.
- **Ligase:** This enzyme joins fragments of DNA (or RNA) by forming phosphodiester bonds, for example, connecting Okazaki fragments during DNA replication.
- **Helicase:** This enzyme unwinds the double-stranded DNA helix, separating the two strands to make them available as templates for replication or transcription.

Therefore, RNA polymerase is the enzyme responsible for transcription.
Final Answer : "RNA polymerase"

Answer: (B)

Q60.

Solution

Concept: Natural selection can act on populations in different ways, leading to changes in the distribution of phenotypes over time.

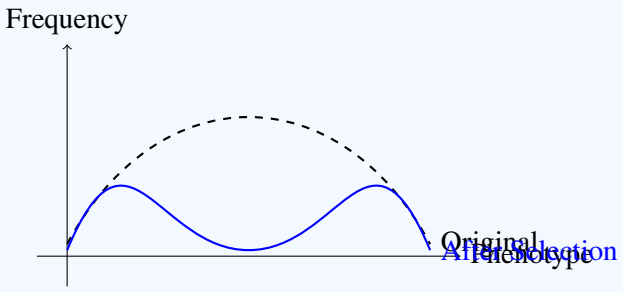
Solution: There are three main modes of natural selection:

(a) **Stabilizing Selection:** This is the most common mode. It favors intermediate phenotypes and acts against extreme variations. This reduces variation and maintains the status quo for a particular trait (e.g., favoring average birth weight in humans).

(b) **Directional Selection:** This mode favors individuals at one extreme of the phenotypic range. It is common during periods of environmental change or when a population migrates to a new habitat (e.g., increase in beak depth in finches during a drought).

(c) **Disruptive (or Diversifying) Selection:** This mode occurs when environmental conditions favor individuals at **both extremes** of the phenotypic range over intermediate phenotypes. This can lead to the population splitting into two distinct phenotypic groups and can be a driving force for speciation.

Therefore, disruptive selection results in the favoring of both extreme traits.



Disruptive Selection

Final Answer : "Favoring of both extreme traits"

Answer: (C)

Q61.

Solution

Concept: Infectious diseases are caused by pathogenic microorganisms.

Solution: Malaria is a life-threatening disease transmitted to humans through the bites of infected female Anopheles mosquitoes. The causative agent is not a virus, bacterium, or fungus. It is a single-celled eukaryotic parasite belonging to the genus *Plasmodium*. These organisms are classified as **Protozoa**. There are several species of *Plasmodium* that can infect humans, with *Plasmodium falciparum* being the most deadly. The parasite has a complex life cycle, involving stages in both the mosquito vector and the human host (infecting liver cells and red blood cells).
Final Answer : "Protozoa"

Answer: (C)

Q62.

Solution

Concept: Immunity is the body's ability to resist a particular disease and can be acquired in several ways, classified as active/passive and natural/artificial.

Solution: The types of acquired immunity are:

- **Active Immunity:** The body produces its own antibodies and memory cells in response to an antigen. This provides long-term protection.
  - **Natural Active:** Acquired by contracting the disease and recovering.
  - **Artificial Active:** Acquired through **vaccination**. A vaccine introduces a safe form of an antigen (killed/weakened pathogen or its components) to stimulate an immune response without causing the disease.
- **Passive Immunity:** The body receives pre-made antibodies from an external source. This provides immediate but temporary protection as the body does not create its own memory cells.
  - **Natural Passive:** Antibodies passed from mother to fetus via the placenta or to an infant via breast milk.
  - **Artificial Passive:** Injection of antibodies (antiserum or immune globulin) from an immune individual or animal.

Since vaccination involves introducing an antigen to stimulate the body's own immune response, it provides artificial active immunity.
Final Answer : "Artificial active immunity"

Answer: (C)

Q63.

Solution

Concept: AIDS is a syndrome caused by a viral infection that severely damages the immune system.

Solution: AIDS stands for Acquired Immunodeficiency Syndrome. It is the final and most severe stage of an infection caused by the **Human Immunodeficiency Virus (HIV)**. HIV is a retrovirus that primarily attacks and destroys a specific type of white blood cell called the CD4+ T-helper cell. These cells are crucial for coordinating the body's immune response. As HIV destroys more CD4 cells, the immune system becomes progressively weaker, making the person susceptible to a wide range of opportunistic infections and cancers that a healthy immune system would normally be able to fight off. Therefore, the pathogen that causes AIDS is a virus.

Final Answer : "Virus"

Answer: (B)

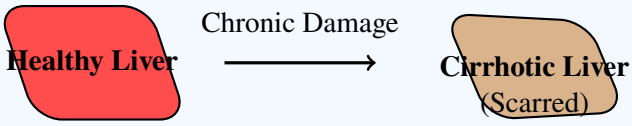
Q64.

Solution

Concept: Chronic diseases often target specific organs, leading to loss of function. Cirrhosis is the terminal stage of chronic liver disease.

Solution: Cirrhosis is a late-stage scarring (fibrosis) of the **liver** caused by long-term liver damage. The scar tissue replaces healthy liver tissue, blocking the flow of blood through the organ and preventing it from functioning properly. The main functions affected include processing nutrients, filtering blood, and making proteins. The most common causes of cirrhosis are chronic alcohol abuse, chronic viral hepatitis (Hepatitis B and C), and fatty liver disease.

- The **heart** is affected by conditions like atherosclerosis and hypertension.
- The **kidney** is affected by diseases like nephritis and chronic kidney disease.
- The **lung** is affected by diseases like emphysema and pulmonary fibrosis.



Final Answer : "Liver"

Answer: (B)

Q65.

Solution

Concept: Hormones regulate metabolic processes, and imbalances can lead to specific diseases.

Solution: Insulin is a hormone produced by the pancreas that allows cells to take up glucose from the blood for energy.

- **Diabetes mellitus** is a chronic metabolic disorder characterized by hyperglycemia (high blood glucose). It arises from two main issues:
  (a) **Type 1 Diabetes:** An autoimmune condition where the body's immune system destroys the insulin-producing beta cells in the pancreas, leading to an absolute insulin deficiency.
  (b) **Type 2 Diabetes:** The body's cells become resistant to the effects of insulin, or the pancreas cannot produce enough insulin to overcome this resistance.
- **Hypertension** is high blood pressure.
- **Asthma** is a chronic inflammatory disease of the airways.
- **Cancer** is a disease characterized by uncontrolled cell growth.

Therefore, insulin deficiency or resistance is the direct cause of diabetes mellitus.
Final Answer : "Diabetes mellitus"

Answer: (B)

Q66.

Solution

Concept: The Polymerase Chain Reaction (PCR) is a technique for in-vitro replication of DNA.

Solution: The Polymerase Chain Reaction (PCR) is a cornerstone technique in molecular biology that allows scientists to create millions to billions of copies of a specific DNA segment from a very small initial sample. This process is known as **DNA amplification**. It mimics the natural process of DNA replication in a test tube. The process involves a series of repeated cycles (typically 25-35), each consisting of three steps:

(a) **Denaturation:** Heating the sample to separate the double-stranded DNA into single strands.

(b) **Annealing:** Cooling the sample to allow short DNA primers to bind to the complementary sequences on the DNA templates.

(c) **Extension:** Raising the temperature to allow a heat-stable DNA polymerase (like Taq polymerase) to synthesize new DNA strands, starting from the primers.

This exponential amplification allows for the detection and analysis of DNA even when only a minute quantity is available, making it crucial for diagnostics, forensics, and genetic research.

Final Answer : "DNA amplification"

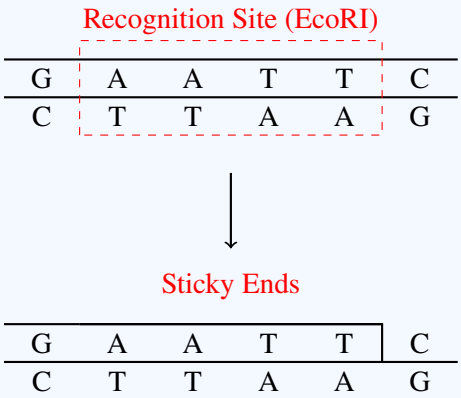
Answer: (B)

Q67.

Solution

Concept: Recombinant DNA technology relies on specific enzymes to manipulate DNA molecules.

Solution: Restriction enzymes, also known as restriction endonucleases, are enzymes that act like "molecular scissors." Their primary function is to recognize specific, short nucleotide sequences in a DNA molecule (known as recognition sites or restriction sites) and **cut the DNA's sugar-phosphate backbone** at or near these sites. Many restriction enzymes make staggered cuts, producing "sticky ends" which are short, single-stranded overhangs. These sticky ends are crucial for recombinant DNA technology because they can base-pair with complementary sticky ends of other DNA fragments cut with the same enzyme. This allows a foreign gene to be precisely inserted into a vector like a plasmid.



Final Answer : "Cutting DNA at specific sequences"

Answer: (B)

Q68.

Solution

Concept: Genetic engineering requires a vehicle or 'vector' to carry a gene of interest into a host organism.

Solution: In molecular cloning, a vector is a DNA molecule used as a vehicle to artificially carry foreign genetic material into another cell, where it can be replicated and/or expressed. A good cloning vector must have certain features, such as an origin of replication, a selectable marker (e.g., an antibiotic resistance gene), and one or more unique restriction sites where the foreign DNA can be inserted.

- **Plasmids** are small, circular, extrachromosomal DNA molecules found in bacteria. They replicate independently of the host chromosome and are easily isolated and manipulated. These characteristics make them ideal and most commonly used cloning vectors for introducing genes into bacteria.
- A ribosome is a cellular organelle responsible for protein synthesis.
- A lysosome is an organelle containing digestive enzymes.
- A mitochondrion is the powerhouse of the cell, responsible for ATP production.

None of the other options are DNA molecules suitable for use as vectors.
Final Answer : "Plasmid"

Answer: (B)

Q69.

Solution

Concept: Genetically modified (GM) crops are developed by inserting specific genes to confer desirable traits.

Solution: Bt cotton is a genetically modified pest-resistant cotton variety. The name "Bt" comes from the soil bacterium ***Bacillus thuringiensis***. This bacterium naturally produces a protein, known as the Cry protein or Bt toxin, which is toxic to certain types of insects, particularly the larvae of moths and butterflies like the cotton bollworm, a major pest of cotton crops. Genetic engineers isolated the gene responsible for producing this Cry protein from the bacterium and inserted it into the cotton plant's genome. As a result, the cotton plant itself produces the toxin in its tissues. When the insect pest feeds on the plant, it ingests the toxin, which disrupts its digestive system and kills it. This provides the plant with built-in **resistance to insect pests**, reducing the need for chemical insecticide sprays.
Final Answer : "Resistance to insect pests"

Answer: (B)

Q70.

Solution

Concept: ELISA is a widely used immunoassay technique based on antigen-antibody interactions.

Solution: ELISA stands for Enzyme-Linked Immunosorbent Assay. It is a highly sensitive and specific laboratory technique used to detect and quantify substances, most commonly proteins such as antibodies or antigens. Its primary application is in **disease detection** and medical diagnostics. The basic principle involves an antigen binding to a specific antibody. One of these components is attached to a solid surface. An enzyme is linked to one of the components, and in the final step, a substrate for the enzyme is added. If the antigen-antibody binding has occurred, the enzyme will convert the substrate into a detectable signal, usually a color change, which indicates a positive result. A common example is the ELISA test for HIV, which detects the presence of antibodies against the HIV virus in a person's blood serum.

Final Answer : "Disease detection"

Answer: (B)

Q71.

Solution

Concept: Organisms in an ecosystem are categorized into trophic levels based on their method of obtaining energy.

Solution: The trophic structure of an ecosystem is based on how organisms obtain their energy.

- **Producers:** These are organisms that form the base of the food chain. They produce their own organic food from simple inorganic substances, typically using light energy from the sun through photosynthesis. Organisms that can make their own food are called **autotrophs** (from Greek, "self-feeders"). Plants, algae, and cyanobacteria are the primary producers in most ecosystems.
- **Consumers (Heterotrophs):** These organisms obtain energy by feeding on other organisms.
  - **Herbivores** (Primary consumers) eat producers.
  - **Carnivores** (Secondary/Tertiary consumers) eat other animals.
- **Decomposers:** These organisms (like bacteria and fungi) break down dead organic matter, returning nutrients to the ecosystem.

Therefore, producers are, by definition, autotrophs.

Final Answer : "Autotrophs"

Answer: (C)

Q72.

Solution

Concept: Energy moves through ecosystems, while matter is cycled within them.

Solution: The flow of energy through an ecosystem is governed by the laws of thermodynamics. It follows a specific, one-way path:

(a) Energy enters the ecosystem, primarily as sunlight.

(b) Producers (autotrophs) capture this solar energy and convert it into chemical energy stored in organic molecules.

(c) This energy is transferred to consumers when they eat the producers or other consumers.

(d) At each transfer between trophic levels, a significant amount of energy (typically around 90

Because energy is constantly being lost as heat and does not get recycled, it must be continuously supplied to the ecosystem (by the sun). This one-way movement is described as **unidirectional**. It is a flow, not a cycle. In contrast, nutrients like carbon and nitrogen are recycled within the ecosystem.

Final Answer : "Unidirectional"

Answer: (B)

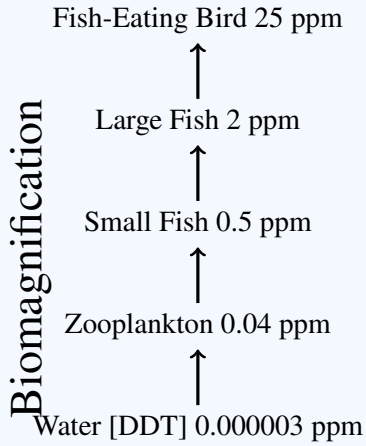
Q73.

Solution

Concept: Persistent, fat-soluble pollutants can accumulate in organisms and become more concentrated at higher trophic levels.

Solution: Biomagnification (or bioamplification) is the increasing concentration of a substance in organisms at successively higher levels in a food chain. For a substance to biomagnify, it must be persistent (not easily broken down) and lipophilic (fat-soluble), causing it to be stored in an organism's fatty tissues rather than being excreted.

- **DDT** (Dichlorodiphenyltrichloroethane) is a synthetic insecticide that is the classic textbook example of a substance that undergoes biomagnification. It persists in the environment for a long time, accumulates in the fat of organisms, and becomes more concentrated up the food chain. High concentrations of DDT in birds of prey, such as eagles and ospreys, caused eggshell thinning and led to severe population declines.
- Oxygen, nitrogen, and carbon dioxide are essential components of biogeochemical cycles and are not toxic persistent pollutants that accumulate in fatty tissues.



Final Answer : "DDT"

Answer: (C)

Q74.

Solution

Concept: Human-made chemicals can disrupt natural atmospheric cycles, leading to environmental problems like ozone depletion.

Solution: The stratospheric ozone layer protects life on Earth by absorbing harmful ultraviolet (UV) radiation from the sun. Ozone depletion refers to the thinning of this layer, most notably the "ozone hole" over Antarctica. The primary cause of this phenomenon is the release of ozone-depleting substances (ODS) by human activities.

- The main culprits are **Chlorofluorocarbons (CFCs)**. These are stable, man-made compounds previously used in refrigerants, aerosol propellants, and solvents.
- In the stratosphere, intense UV radiation breaks down CFC molecules, releasing chlorine atoms.
- A single chlorine atom can act as a catalyst in a destructive cycle, destroying tens of thousands of ozone (O_3) molecules before being removed from the atmosphere.

Other options like carbon dioxide contribute to global warming, and sulfur dioxide contributes to acid rain, but CFCs are the main group of chemicals responsible for ozone depletion.
Final Answer : "Chlorofluorocarbons"

Answer: (C)

Q75.

Solution

Concept: Food chains are a simplified model to illustrate the flow of energy in an ecosystem.

Solution: A food chain is a linear sequence that shows how energy is transferred from one living organism to another. It starts with a producer organism, which creates its own food (e.g., a plant), and follows the path of "who eats whom". Each step in the food chain is a trophic level. The arrows in a food chain do not indicate who eats whom, but rather point in the direction of **energy transfer**. For example, in the food chain "Grass → Grasshopper → Frog", the arrow indicates that energy is transferred from the grass to the grasshopper when the grasshopper eats it, and from the grasshopper to the frog when the frog eats it. While nutrients are also transferred, the primary concept depicted is the flow of energy through the ecosystem.
Final Answer : "Energy transfer"

Answer: (B)

Q76.

Solution

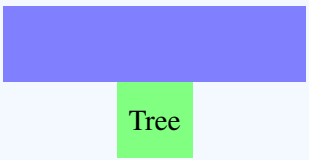
Concept: Ecological pyramids are used to model the quantitative relationships between trophic levels in an ecosystem.

Solution: There are three main types of ecological pyramids:

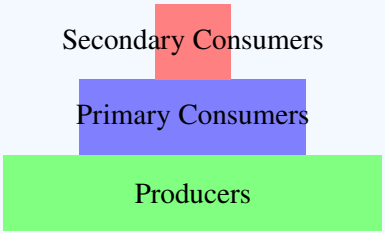
(a) **Pyramid of Numbers:** Represents the total number of individual organisms at each trophic level. This pyramid can be inverted. For example, a single large tree (one producer) can support thousands of herbivorous insects.

(b) **Pyramid of Biomass:** Represents the total dry weight (biomass) of all organisms at each trophic level. This can also be inverted, particularly in aquatic ecosystems. For example, the biomass of zooplankton (primary consumers) can at a given moment be greater than the biomass of phytoplankton (producers), because phytoplankton reproduce and are consumed very rapidly.

(c) **Pyramid of Energy:** Represents the rate of energy flow (productivity) at each successive trophic level. According to the second law of thermodynamics, energy transfer from one trophic level to the next is never 100% efficient; a large portion is always lost as heat. Therefore, the total energy available at each higher trophic level is always less than the level below it. This means the **pyramid of energy is always upright**.



Pyramid of Numbers (Inverted)



Pyramid of Energy (Always Upright)

Final Answer : "Pyramid of energy"

Answer: (C)

Q77.

Solution

Concept: The greenhouse effect is a natural process that warms the Earth, but it is being enhanced by human activities, leading to global warming.

Solution: The greenhouse effect is the process by which certain gases in the Earth's atmosphere trap heat. These gases, known as greenhouse gases, allow sunlight to pass through and warm the Earth's surface, but they absorb much of the infrared radiation (heat) that is radiated back from the surface, preventing it from escaping into space. While several gases contribute to this effect, including water vapor (H_2O), methane (CH_4), and nitrous oxide (N_2O), **carbon dioxide (CO_2)** is the most significant contributor to the *enhanced* greenhouse effect and global warming caused by humans. This is due to its long atmospheric lifetime and the massive quantities released from the burning of fossil fuels (coal, oil, and natural gas), deforestation, and industrial processes. Oxygen and nitrogen, which make up 99% of the atmosphere, are not significant greenhouse gases.

Final Answer : "Carbon dioxide"

Answer: (C)

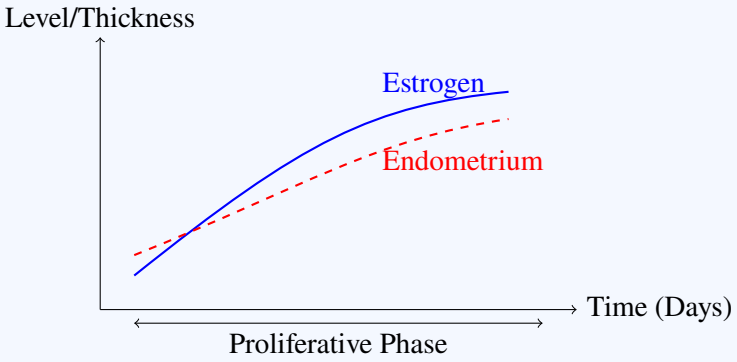
Q78.

Solution

Concept: The menstrual cycle is regulated by hormones, with estrogen and progesterone having distinct roles in different phases.

Solution: The menstrual cycle is divided into phases. The phase following menstruation is the proliferative phase (or follicular phase).

- During this phase, the pituitary hormone FSH stimulates the growth of ovarian follicles.
- The developing follicles produce increasing amounts of **estrogen**.
- The primary role of this rising estrogen is to act on the uterus, stimulating the regeneration and **thickening of the endometrial lining**, which was shed during menstruation. This prepares the uterus for potential implantation of an embryo.
- **Maintenance of pregnancy** is the primary role of progesterone.
- **Triggering milk secretion** is primarily controlled by prolactin.
- While very low or very high levels of estrogen can inhibit ovulation, its peak level actually triggers the LH surge that causes ovulation. Therefore, its main function in this phase is endometrial proliferation.



Final Answer : "Thickening of endometrial lining"

Answer: (B)

Q79.

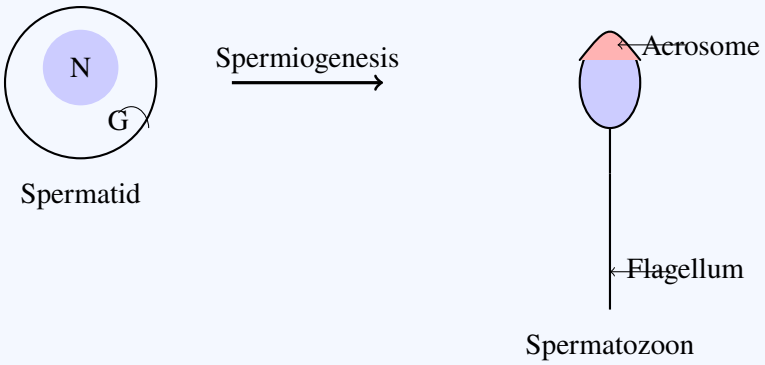
Solution

Concept: Spermiogenesis is the final stage of spermatogenesis where spermatids differentiate into mature sperm cells.

Solution: Spermiogenesis is a metamorphosis, not a cell division. It is the process of transforming a round, non-motile spermatid into a highly specialized, motile spermatozoon (sperm). This involves several key structural changes to create a streamlined cell designed for fertilization:

- The Golgi apparatus modifies to form the **acrosome**, a cap-like structure at the head of the sperm containing enzymes to penetrate the egg.
- A long tail, or **flagellum**, develops from the centrioles, which provides motility.
- Mitochondria aggregate in the midpiece to provide ATP for flagellar movement.
- The nucleus becomes highly condensed.
- The majority of the cytoplasm is shed as a residual body, which is phagocytosed by Sertoli cells. This reduces the cell's size and mass.

Therefore, the formation of the acrosome and flagellum are hallmark events of spermiogenesis.



Final Answer : "Formation of acrosome and flagellum"

Answer: (B)

Q80.

Solution

Concept: Codominance is a non-Mendelian inheritance pattern where two different alleles for a trait are both fully expressed in the phenotype of a heterozygote.

Solution: Let's analyze the given options:

- **Height variation, skin colour, and eye colour** are all examples of **polygenic inheritance**, where multiple genes contribute to a single trait, resulting in a continuous range of phenotypes. They do not represent codominance at a single gene locus.
- The **ABO blood group system** in humans is the classic example of both codominance and multiple alleles. There are three alleles: I^A, I^B, and i.
  - I^A and I^B are both dominant over i.
  - When an individual inherits both the I^A and I^B alleles (genotype I^AI^B), neither allele masks the other. Instead, both are fully and equally expressed, resulting in red blood cells that have both A and B antigens on their surface. This is type AB blood, a clear demonstration of codominance.

Final Answer : "ABO blood group system"

Answer: (B)

Q81.

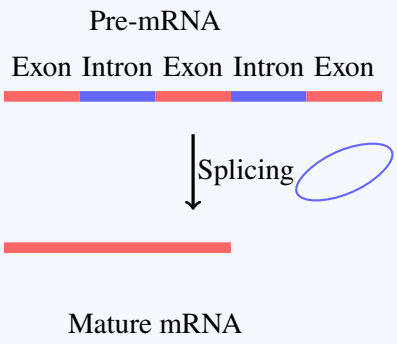
Solution

Concept: In eukaryotes, the initial RNA transcript (pre-mRNA) must undergo post-transcriptional modifications to become a mature messenger RNA (mRNA) before it can be translated.

Solution: The process of creating a protein from a gene involves transcription and translation. In eukaryotes, there is an intermediate step of RNA processing.

- **Transcription:** An RNA copy of a gene, called pre-mRNA, is made from a DNA template.
- **RNA Processing:** This pre-mRNA contains both coding regions (**exons**) and non-coding regions (**introns**). Before the RNA can leave the nucleus to be translated, it must be processed. This involves:
  (a) Addition of a 5' cap.
  (b) Addition of a 3' poly-A tail.
  (c) **Splicing:** The introns are precisely cut out, and the exons are joined together. This is carried out by a complex called the spliceosome.
- **Translation:** The mature mRNA is then exported to the cytoplasm, where ribosomes translate it into a protein.

DNA replication and protein folding are separate, unrelated processes.



Final Answer : "Splicing to remove introns"

Answer: (B)

Q82.

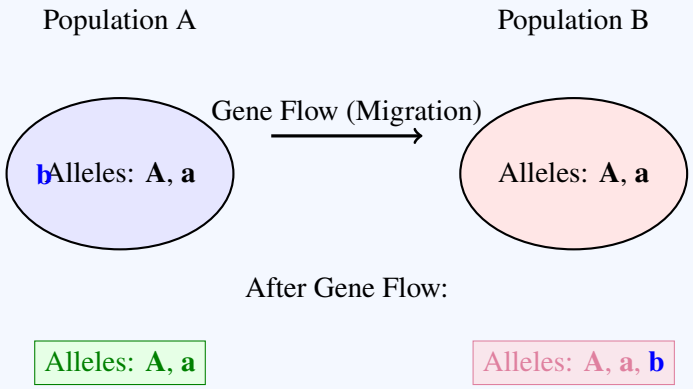
Solution

Concept: Gene flow is one of the primary mechanisms of evolution, involving the movement of alleles between populations.

Solution: Gene flow is the transfer of alleles from the gene pool of one population to another, typically through the migration of individuals or the dispersal of gametes (like pollen).

- When new alleles are introduced into a population via gene flow, the genetic diversity or variation **within that population increases**.
- At the same time, gene flow tends to reduce the genetic differences **between** the populations that are exchanging genes, making them more similar to each other over time.
- If gene flow is high enough, it can counteract the effects of natural selection and genetic drift that would otherwise cause populations to diverge.

Therefore, the primary effect of gene flow is to introduce new alleles, thus increasing genetic variation within the recipient population.



Final Answer : "Increases variation"

Answer: (B)

Q83.

Solution

Concept: DNA replication is a complex process involving multiple enzymes with specific roles, particularly in handling the discontinuous synthesis of the lagging strand.

Solution: During DNA replication, the two strands of the double helix are separated at the replication fork.

- The **leading strand** is synthesized continuously in the 5' to 3' direction.
- The **lagging strand** is synthesized discontinuously. **Primase** lays down short RNA primers, and **DNA polymerase** synthesizes short DNA segments called **Okazaki fragments** away from the replication fork.
- After the RNA primers are removed and replaced with DNA by another DNA polymerase, there are still small gaps or "nicks" in the sugar-phosphate backbone between the adjacent Okazaki fragments.
- The enzyme **DNA ligase** is responsible for sealing these nicks by forming the final phosphodiester bond. Its function is often described as "molecular glue," joining the fragments into a single, continuous DNA strand.
- **Helicase** is the enzyme that unwinds the DNA at the start of replication.

Final Answer : "DNA ligase"

Answer: (B)

Q84.

Solution

Concept: The creation of recombinant DNA molecules involves cutting and pasting DNA fragments using specific enzymes.

Solution: Recombinant DNA technology involves the manipulation of genetic material to combine DNA from different organisms. The process typically involves these key enzymes:

(a) **Restriction enzymes (endonucleases):** These act as "molecular scissors." They recognize and cut DNA at specific nucleotide sequences. Using the same restriction enzyme to cut both a gene of interest and a vector (like a plasmid) creates complementary "sticky ends."

(b) **DNA ligase:** This enzyme acts as "molecular glue." After the gene of interest and the vector have been mixed and their sticky ends have annealed (base-paired), DNA ligase is added. It forms permanent covalent phosphodiester bonds, sealing the fragments together to create a stable, single recombinant DNA molecule.

RNA polymerase is used for transcription, and protease digests proteins.
Final Answer : "DNA ligase"

Answer: (B)

Q85.

Solution

Concept: Genetic modification aims to improve agricultural crops by introducing genes for desirable traits.

Solution: Genetically modified (GM) crops are plants whose DNA has been altered using genetic engineering techniques. The primary purpose of this technology in agriculture is to improve crop varieties and enhance productivity. The main advantages stem from introducing traits that are difficult or impossible to achieve through traditional breeding. These include:

- **Resistance to biotic stresses:** This includes resistance to insect pests (e.g., Bt cotton, Bt corn), viral diseases, and fungal pathogens.
- **Resistance to abiotic stresses:** This includes tolerance to drought, salinity, extreme temperatures, and herbicides (e.g., "Roundup Ready" crops).
- **Improved nutritional quality:** This includes crops with enhanced vitamin content (e.g., Golden Rice with beta-carotene) or healthier fatty acid profiles.
- **Increased yield and shelf life.**

The other options describe potential risks or disadvantages, not the primary advantage or goal of developing GM crops. The overarching benefit is enhanced resistance to a variety of environmental stresses, both living (biotic) and non-living (abiotic).

Final Answer : "Enhanced resistance to biotic and abiotic stresses"

Answer: (C)

Q86.

Solution

Concept: Species in an ecosystem interact in various ways, which can be classified based on whether the interaction is beneficial (+), harmful (-), or neutral (0) for each species.

Solution: The types of ecological interactions are:

- **Parasitism (+/-):** One species (the parasite) benefits by living on or in another species (the host), which is harmed.
- **Commensalism (+/0):** One species benefits, while the other is neither harmed nor helped. An example is barnacles living on a whale.
- **Mutualism (+/+):** This is a symbiotic relationship where **both participating species benefit**. A classic example is the relationship between flowering plants and their pollinators (e.g., bees). The bee gets nectar (food), and the plant gets its pollen transferred for reproduction.
- **Predation (+/-):** One species (the predator) hunts, kills, and consumes another species (the prey).

Therefore, the interaction that benefits both species is mutualism.
Final Answer : "Mutualism"

Answer: (C)

Q87.

Solution

Concept: Ecological succession is the predictable process of change in an ecosystem's community structure over time, culminating in a stable state.

Solution: Ecological succession describes the gradual process by which ecosystems change and develop over time.

- The process begins with a **pioneer stage**, where hardy species like lichens and mosses colonize a new or disturbed environment.
- These pioneers modify the environment (e.g., by creating soil), allowing other species to establish.
- This leads to a series of intermediate or **seral stages** (also called transitional stages), where species composition continues to change.
- Eventually, the process culminates in a **climax community**. This is the final, relatively stable and mature stage of succession. The community is in equilibrium with its environment, and its species composition remains relatively constant unless there is a significant disturbance (like a fire or human activity).

Time / Increasing Complexity

Final Answer : "Climax community"

Answer: (C)

Q88.

Solution

Concept: The nitrogen cycle describes the movement and conversion of nitrogen through the environment, with key steps performed by specialized microorganisms.

Solution: The Earth's atmosphere is about 78% nitrogen gas (N_2), but most organisms cannot use it in this form. Nitrogen must be "fixed" into a usable form like ammonia.

- **Nitrogen Fixation:** This is the crucial process that converts inert atmospheric nitrogen gas (N_2) into ammonia (NH_3). This is accomplished by certain prokaryotes, including free-living soil bacteria and symbiotic bacteria (like *Rhizobium*) that live in the root nodules of leguminous plants.
- **Nitrification:** Bacteria convert ammonia (NH_3) into nitrites (NO_2^-) and then into nitrates (NO_3^-), which is the form most easily taken up by plants.
- **Ammonification:** Decomposers (bacteria and fungi) break down organic nitrogen from dead organisms and waste products back into ammonia (NH_3).
- **Denitrification:** Other bacteria convert nitrates (NO_3^-) back into atmospheric nitrogen gas (N_2), completing the cycle.

Therefore, the conversion of atmospheric nitrogen to ammonia is nitrogen fixation.
Final Answer : "Nitrogen fixation"

Answer: (C)

Q89.

Solution

Concept: Eutrophication is the process of nutrient enrichment in aquatic ecosystems, which leads to a cascade of negative ecological effects.

Solution: Eutrophication is a major form of water pollution. The process unfolds as follows:

(a) The primary cause is the introduction of **excess nutrients**, particularly **nitrates and phosphates**, into a water body. These nutrients commonly come from agricultural fertilizer runoff, sewage discharge, and industrial waste.

(b) These nutrients act as fertilizers, causing a massive and rapid growth of algae and other aquatic plants, an event known as an "algal bloom."

(c) The bloom blocks sunlight from reaching deeper water, killing submerged plants.

(d) When the large quantity of algae in the bloom dies, it sinks to the bottom.

(e) Aerobic decomposer bacteria feed on the dead algae, and their populations explode.

(f) This decomposition process consumes vast amounts of dissolved oxygen in the water.

(g) The severe depletion of oxygen (hypoxia or anoxia) kills fish and other aquatic animals, creating a "dead zone."

Thus, the root cause is the oversupply of nutrients.
Final Answer : “Excess nutrients like nitrates and phosphates”

Answer: (B)

Q90.

Solution

Concept: International environmental treaties are established to address specific global challenges, such as ozone depletion or climate change.

Solution: It is important to distinguish between the major international agreements and their specific environmental targets.

- **Kyoto Protocol (1997):** This was an international treaty that extended the 1992 United Nations Framework Convention on Climate Change (UNFCCC). Its primary goal was to commit industrialized nations to reduce their emissions of *greenhouse gases* to combat global warming.
- **Paris Agreement (2015):** This is a landmark agreement, also under the UNFCCC, dealing with climate change. Its central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels. It focuses on *greenhouse gas* emissions.
- **Montreal Protocol (1987):** The full title is the "Montreal Protocol on Substances that Deplete the Ozone Layer." This international treaty is specifically designed to protect the stratospheric ozone layer by phasing out the production and consumption of *ozone-depleting substances (ODS)*, such as chlorofluorocarbons (CFCs) and halons. It is widely regarded as one of the most successful international environmental agreements ever enacted.
- **Rio Declaration (1992):** This was a product of the Earth Summit in Rio de Janeiro. It is a non-binding declaration of 27 broad principles to guide countries on sustainable development and environmental protection, rather than a protocol with specific targets for reducing particular pollutants.

Therefore, the agreement that specifically targets ozone-depleting substances is the Montreal Protocol.

Final Answer : "Montreal Protocol"

Answer: (C)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	B	3	A	4	B	5	D
6	C	7	C	8	A	9	A	10	D
11	C	12	B	13	C	14	B	15	B
16	B	17	C	18	B	19	B	20	B
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26	C	27	B	28	B	29	B	30	C
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76	C	77	C	78	B	79	B	80	B
81	B	82	B	83	B	84	B	85	C
86	C	87	C	88	C	89	B	90	C