

MHT-CET Biology Sample Paper-1

Duration: 90 Minutes

Maximum Marks: 100

Instructions

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

Q1. A botanist observed that a certain plant species showed very high rate of photosynthesis even under conditions of high temperature and low CO₂ concentration. The plant also exhibited Kranz anatomy in leaf sections. Based on these observations, identify the first stable product formed during carbon fixation in this plant.

- (A) 3-Phosphoglyceric acid
- (B) Ribulose biphosphate
- (C) Oxaloacetic acid
- (D) Phosphoenol pyruvate

Q2. During an experiment on transpiration, a student covered both surfaces of a dorsiventral leaf with vaseline except a small region containing stomata. After a few hours, loss of water vapour was still observed. Which property of water transport best explains this phenomenon?

- (A) Imbibition pressure
- (B) Root pressure
- (C) Cohesion and adhesion of water molecules
- (D) Active transport through xylem



- Q3.** A flower was found to possess a long style, sticky stigma and exposed feathery surface for trapping pollen grains. The pollen grains were light, dry and produced in very large quantities. Which mode of pollination is best represented by these features?
- (A) Entomophily
 - (B) Hydrophily
 - (C) Ornithophily
 - (D) Anemophily
- Q4.** In C₄ plants, the primary CO₂ acceptor is regenerated in:
- (A) Bundle sheath chloroplast stroma
 - (B) Mesophyll chloroplast stroma
 - (C) Cytoplasm of bundle sheath cells
 - (D) Cytoplasm of mesophyll cells
- Q5.** The phenomenon responsible for opening and closing of stomata is primarily associated with movement of:
- (A) K⁺ ions only
 - (B) H⁺ ions only
 - (C) Water due to osmotic changes in guard cells
 - (D) Sugars from subsidiary cells
- Q6.** During photorespiration, glycolate is converted into glyoxylate in:
- (A) Chloroplast
 - (B) Peroxisome
 - (C) Mitochondria
 - (D) Cytosol



- Q7.** Which of the following enzymes is exclusively associated with C4 cycle?
- (A) RuBisCO
 - (B) PEP carboxylase
 - (C) Carbonic anhydrase
 - (D) ATP synthase
- Q8.** In a cross between two heterozygous pea plants for seed shape and seed colour, the offspring showed combinations not found in the parents. This observation can be best explained on the basis of which Mendelian principle?
- (A) Law of dominance
 - (B) Law of segregation
 - (C) Law of independent assortment
 - (D) Incomplete dominance
- Q9.** The cohesion-tension theory explaining ascent of sap was proposed by:
- (A) Dixon and Joly
 - (B) Strasburger
 - (C) Priestley
 - (D) Sachs
- Q10.** A triploid endosperm in angiosperms develops due to fusion of:
- (A) One male gamete and egg cell
 - (B) One male gamete and two synergids
 - (C) One male gamete and secondary nucleus
 - (D) Two male gametes and polar nuclei
- Q11.** Which of the following floral parts is correctly matched with its function?
- (A) Tapetum – protection of ovule
 - (B) Endothecium – nutrition to pollen grains



- (C) Filiform apparatus – guidance to pollen tube
- (D) Micropyle – formation of embryo sac

Q12. In Mendel's dihybrid cross, the phenotypic ratio 9:3:3:1 is obtained due to:

- (A) Linkage
- (B) Incomplete dominance
- (C) Independent assortment
- (D) Codominance

Q13. A DNA molecule contains 18% cytosine residues. If the total number of nitrogenous bases is 2000, calculate the number of adenine residues present in the molecule.

- (A) 320
- (B) 640
- (C) 820
- (D) 1280

Q14. During meiosis in a diploid organism, homologous chromosomes paired and exchanged genetic material. The exchange occurred at specific points called chiasmata. In which stage are these chiasmata clearly visible?

- (A) Pachytene
- (B) Leptotene
- (C) Diplotene
- (D) Zygotene

Q15. A population of insects became resistant to a pesticide after repeated exposure over several generations. This resistance developed because individuals possessing favourable heritable variations survived and reproduced. Which mechanism of evolution does this represent?

- (A) Genetic drift



- (B) Adaptive radiation
- (C) Natural selection
- (D) Artificial selection

Q16. A patient was diagnosed with severe deficiency of haemoglobin leading to reduced oxygen carrying capacity of blood. Which component of blood is directly responsible for transport of oxygen from lungs to tissues?

- (A) Platelets
- (B) Plasma proteins
- (C) Erythrocytes
- (D) Lymphocytes

Q17. During ventricular systole in humans, the pressure inside ventricles rises rapidly causing closure of atrioventricular valves. Which sound is produced due to this closure?

- (A) Dup
- (B) Lub
- (C) Murmur
- (D) Pulse sound

Q18. A mountaineer climbing a high-altitude region experienced rapid breathing and increased heart rate because the partial pressure of oxygen was significantly low. Which condition primarily triggered this physiological response?

- (A) Hypercapnia
- (B) Hypoxia
- (C) Hypertension
- (D) Hyperglycemia



- Q19.** A scientist observed that certain substances were selectively reabsorbed from the filtrate back into blood capillaries immediately after ultrafiltration. In which region of nephron does maximum reabsorption normally occur?
- (A) Descending limb of Henle
 - (B) Collecting duct
 - (C) Distal convoluted tubule
 - (D) Proximal convoluted tubule
- Q20.** A student accidentally touched a hot object and immediately withdrew his hand even before becoming consciously aware of pain. Which part of nervous system mainly coordinates this rapid response?
- (A) Cerebrum
 - (B) Cerebellum
 - (C) Spinal cord
 - (D) Hypothalamus
- Q21.** An individual suffering from deficiency of iodine showed enlargement of thyroid gland and reduced production of thyroxine hormone. This disorder is commonly known as:
- (A) Acromegaly
 - (B) Goitre
 - (C) Myxedema
 - (D) Addison's disease
- Q22.** A couple opted for a contraceptive device that releases copper ions into the uterus and prevents fertilization by suppressing sperm motility. Identify the contraceptive method used.
- (A) Oral pills
 - (B) Vasectomy
 - (C) Copper-T



(D) Tubectomy

Q23. During human embryonic development, implantation of blastocyst generally occurs after approximately one week of fertilization. The blastocyst gets embedded in which layer of uterus?

(A) Perimetrium

(B) Myometrium

(C) Endometrium

(D) Cervix

Q24. A child was vaccinated against tuberculosis using a weakened strain of pathogen. Which type of immunity is developed in the child after vaccination?

(A) Natural passive immunity

(B) Artificial active immunity

(C) Natural active immunity

(D) Artificial passive immunity

Q25. During recombinant DNA technology, scientists use a specific enzyme to cut DNA molecules at particular recognition sites producing sticky ends. Identify this enzyme.

(A) DNA polymerase

(B) DNA ligase

(C) Restriction endonuclease

(D) Reverse transcriptase

Q26. In polymerase chain reaction (PCR), repeated heating and cooling cycles are essential for amplification of DNA. Which enzyme remains stable even at very high temperatures used during denaturation?

(A) Taq polymerase

(B) DNA ligase



- (C) RNA polymerase
- (D) Restriction enzyme

Q27. In a food chain consisting of grass, grasshopper, frog and snake, the concentration of non-biodegradable toxic chemicals increased progressively at higher trophic levels. This phenomenon is known as:

- (A) Ecological succession
- (B) Eutrophication
- (C) Biomagnification
- (D) Mutualism

Q28. A stable ecological community with maximum diversity and efficient energy utilization develops at the end of ecological succession. Such a final stable stage is called:

- (A) Pioneer stage
- (B) Sere
- (C) Climax community
- (D) Ecotone

Q29. A large number of fish in a freshwater lake died suddenly after excessive growth of algae caused depletion of dissolved oxygen in water. Which ecological phenomenon is primarily responsible for this condition?

- (A) Biomagnification
- (B) Ecological succession
- (C) Eutrophication
- (D) Desertification



- Q30.** Scientists observed the formation of a large seasonal hole in the ozone layer above Antarctica. Which chemical compounds released into atmosphere are mainly responsible for depletion of ozone?
- (A) Sulphur oxides
 - (B) Nitrogen oxides
 - (C) Chlorofluorocarbons
 - (D) Carbon monoxide
- Q31.** An organism was found to possess membrane-bound organelles, a true nucleus and unicellular body organization. However, it lacked tissue level organization. To which kingdom should this organism be assigned?
- (A) Monera
 - (B) Protista
 - (C) Fungi
 - (D) Plantae
- Q32.** In roots of higher plants, a layer of cells possessing Casparian strips prevents free movement of water through intercellular spaces. Identify this specialized tissue layer.
- (A) Cortex
 - (B) Pericycle
 - (C) Epidermis
 - (D) Endodermis
- Q33.** A carbohydrate sample failed to reduce Fehling's solution because it lacked a free aldehyde or ketone group. Which of the following sugars is non-reducing in nature?
- (A) Glucose
 - (B) Maltose
 - (C) Lactose



(D) Sucrose

Q34. During fertilization in humans, the sperm first encounters a thick glycoprotein layer surrounding the ovum before fusion occurs. Identify this layer correctly.

(A) Corona radiata

(B) Zona pellucida

(C) Endometrium

(D) Blastomere

Q35. In an experiment, a plant kept in darkness for several days showed complete depletion of starch from leaves. When exposed again to sunlight, starch reappeared only in green regions of the leaf. Which conclusion can be drawn from this observation?

(A) Chlorophyll is essential for photosynthesis

(B) Oxygen is essential for respiration

(C) Light is unnecessary for starch formation

(D) Xylem transports starch

Q36. In snapdragon plants, crossing a red-flowered plant with a white-flowered plant produced pink flowers in F_1 generation. This inheritance pattern is an example of:

(A) Codominance

(B) Complete dominance

(C) Incomplete dominance

(D) Polygenic inheritance

Q37. During transcription in eukaryotic cells, the initial RNA transcript contains both coding and non-coding regions. The non-coding sequences removed before translation are known as:

(A) Exons



- (B) Introns
- (C) Codons
- (D) Anticodons

Q38. The forelimbs of humans, wings of bats and flippers of whales perform different functions but possess similar structural organization. These organs are considered evidence for:

- (A) Convergent evolution
- (B) Adaptive radiation
- (C) Homologous evolution
- (D) Analogous evolution

Q39. A patient suffering from blockage in coronary arteries experienced reduced blood supply to heart muscles resulting in severe chest pain. This condition is commonly referred to as:

- (A) Hypertension
- (B) Angina pectoris
- (C) Cardiac arrest
- (D) Bradycardia

Q40. During vigorous physical exercise, skeletal muscles temporarily shift from aerobic to anaerobic respiration leading to accumulation of a specific organic acid. Identify the acid formed.

- (A) Citric acid
- (B) Acetic acid
- (C) Lactic acid
- (D) Pyruvic acid



- Q41.** If a color-blind father and carrier mother have children, the probability of color-blind daughter is:
- (A) 0%
 - (B) 25%
 - (C) 50%
 - (D) 75%
- Q42.** The operator gene in lac operon acts as:
- (A) Binding site for RNA polymerase
 - (B) Structural gene for lactose metabolism
 - (C) Binding site for repressor protein
 - (D) Site for activator protein synthesis
- Q43.** The process of transferring pollen grains from anther to stigma of another flower of genetically different plant is called:
- (A) Autogamy
 - (B) Geitonogamy
 - (C) Xenogamy
 - (D) Cleistogamy
- Q44.** A person suffering from kidney failure undergoes artificial purification of blood through a medical procedure in which waste products diffuse across a semipermeable membrane. This process is known as:
- (A) Ultrafiltration
 - (B) Osmoregulation
 - (C) Dialysis
 - (D) Reabsorption



- Q45.** The gap between two successive neurons across which nerve impulses are chemically transmitted by neurotransmitters is called:
- (A) Node of Ranvier
 - (B) Synapse
 - (C) Schwann cell
 - (D) Dendrite
- Q46.** Excess secretion of growth hormone during childhood leads to abnormal increase in height and body size. This disorder is scientifically termed as:
- (A) Dwarfism
 - (B) Acromegaly
 - (C) Gigantism
 - (D) Cretinism
- Q47.** In the menstrual cycle of human females, ovulation is generally induced due to sudden increase in secretion of which hormone from anterior pituitary?
- (A) Prolactin
 - (B) FSH
 - (C) LH
 - (D) Oxytocin
- Q48.** A person infected with HIV showed drastic reduction in the number of helper T-lymphocytes, resulting in weakened immune responses. Which disease condition is associated with this infection?
- (A) Tuberculosis
 - (B) AIDS
 - (C) Malaria
 - (D) Pneumonia



- Q49.** A genetically engineered bacterium was used to synthesize human insulin on a commercial scale. Which scientist was awarded Nobel Prize for discovery of recombinant DNA technology?
- (A) Watson and Crick
 - (B) Boyer and Cohen
 - (C) Kary Mullis
 - (D) Meselson and Stahl
- Q50.** While preparing recombinant DNA, scientists inserted a desired gene into a circular self-replicating DNA molecule present in bacteria. This circular DNA molecule is called:
- (A) Chromosome
 - (B) Plasmid
 - (C) Nucleosome
 - (D) Histone
- Q51.** A species of orchid was found growing on the branch of a mango tree without obtaining nourishment from the host plant. Which ecological interaction is represented here?
- (A) Mutualism
 - (B) Parasitism
 - (C) Commensalism
 - (D) Predation
- Q52.** A farmer sprayed a hormone on sugarcane crop that promoted rapid internodal elongation and increased yield significantly. Which plant growth regulator was most likely used?
- (A) Cytokinin
 - (B) Ethylene
 - (C) Abscisic acid



(D) Gibberellin

Q53. A cell organelle possessing hydrolytic enzymes digests worn-out cell organelles and foreign particles entering the cell. Due to this destructive role, it is commonly called the suicidal bag of the cell. Identify it.

(A) Ribosome

(B) Lysosome

(C) Centrosome

(D) Golgi body

Q54. Electron microscopic studies revealed the presence of flattened membranous sacs arranged parallel to each other with ribosomes attached on their surface. Which organelle is being described?

(A) Smooth endoplasmic reticulum

(B) Golgi apparatus

(C) Rough endoplasmic reticulum

(D) Lysosome

Q55. In dicot stems, vascular bundles are arranged in a ring and possess cambium between xylem and phloem. Such vascular bundles are described as:

(A) Closed and radial

(B) Open and conjoint

(C) Closed and conjoint

(D) Radial and exarch

Q56. Double fertilization is considered a characteristic feature of angiosperms because two male gametes participate in separate fusion events inside the embryo sac. One of these fusion events forms:

(A) Diploid zygote

(B) Haploid embryo



- (C) Tetraploid endosperm
- (D) Triploid embryo

Q57. In humans, oxygenated blood from lungs enters the heart through:

- (A) Pulmonary artery
- (B) Pulmonary vein
- (C) Superior vena cava
- (D) Coronary sinus

Q58. The pacemaker of human heart is:

- (A) AV node
- (B) Bundle of His
- (C) SA node
- (D) Purkinje fibres

Q59. The maximum filtration pressure in nephron is observed in:

- (A) PCT
- (B) DCT
- (C) Bowman's capsule
- (D) Loop of Henle

Q60. The respiratory pigment in humans is:

- (A) Hemocyanin
- (B) Hemoglobin
- (C) Myoglobin
- (D) Hemerythrin

Q61. Which part of brain regulates body temperature and hunger?

- (A) Cerebellum



- (B) Medulla oblongata
- (C) Hypothalamus
- (D) Thalamus

Q62. The threshold stimulus for generation of action potential is due to sudden increase in permeability of membrane to:

- (A) K^+ ions
- (B) Na^+ ions
- (C) Ca^{2+} ions
- (D) Cl^- ions

Q63. Which endocrine gland is known as master gland?

- (A) Thyroid
- (B) Pituitary
- (C) Adrenal
- (D) Pineal

Q64. A man with blood group AB married a woman with blood group O. Which of the following blood groups can appear among their children?

- (A) Only AB
- (B) Only O
- (C) A and B
- (D) A, B and AB

Q65. ADH mainly acts on:

- (A) PCT
- (B) Ascending limb of Henle
- (C) Collecting duct
- (D) Glomerulus



- Q66.** Which blood group is called universal recipient?
- (A) A⁺
 - (B) AB⁺
 - (C) O⁺
 - (D) AB⁻
- Q67.** During muscle contraction, calcium ions bind with:
- (A) Actin
 - (B) Myosin
 - (C) Troponin
 - (D) Tropomyosin
- Q68.** Which stage of spermatogenesis involves reduction division?
- (A) Spermatogonial phase
 - (B) Growth phase
 - (C) Maturation phase
 - (D) Multiplication phase
- Q69.** Human chorionic gonadotropin is secreted by:
- (A) Corpus luteum
 - (B) Placenta
 - (C) Pituitary gland
 - (D) Ovary
- Q70.** Which contraceptive method prevents implantation of blastocyst?
- (A) Copper-T
 - (B) Condom
 - (C) Vasectomy



(D) Tubectomy

Q71. Which sexually transmitted disease is caused by bacterium?

(A) AIDS

(B) Syphilis

(C) Genital herpes

(D) Hepatitis-B

Q72. The sequence of nitrogenous bases present on mRNA determines the sequence of amino acids in a protein molecule. Each triplet code on mRNA responsible for specifying an amino acid is known as:

(A) Anticodon

(B) Codon

(C) Cistron

(D) Operon

Q73. Which hormone promotes senescence and abscission most effectively?

(A) Auxin

(B) Cytokinin

(C) Ethylene

(D) Gibberellin

Q74. Which structure is formed during dark reaction but consumed during light reaction?

(A) ATP

(B) NADPH

(C) ADP

(D) RuBP



- Q75.** The first stable product formed during Calvin cycle is:
- (A) Oxaloacetic acid
 - (B) Phosphoglyceric acid
 - (C) Pyruvic acid
 - (D) Ribulose phosphate
- Q76.** In DNA replication, Okazaki fragments are formed because:
- (A) DNA polymerase cannot initiate synthesis
 - (B) One strand is discontinuously synthesized
 - (C) Helicase breaks hydrogen bonds irregularly
 - (D) Primase works only on lagging strand
- Q77.** The enzyme responsible for joining Okazaki fragments is:
- (A) DNA polymerase I
 - (B) DNA ligase
 - (C) Primase
 - (D) Topoisomerase
- Q78.** In Hardy-Weinberg equilibrium, evolution is indicated by change in:
- (A) Population density
 - (B) Allele frequency
 - (C) Biomass
 - (D) Carrying capacity
- Q79.** Which scientist experimentally proved semi-conservative replication of DNA?
- (A) Watson and Crick
 - (B) Griffith
 - (C) Meselson and Stahl



(D) Hershey and Chase

Q80. Crossing over occurs during which stage of meiosis?

(A) Leptotene

(B) Zygotene

(C) Pachytene

(D) Diplotene

Q81. Which of the following is a connecting link between reptiles and birds?

(A) Peripatus

(B) Archaeopteryx

(C) Neopilina

(D) Balanoglossus

Q82. In a grassland ecosystem, grass represented producers while deer and tiger occupied higher trophic levels. According to the 10% law of energy transfer, only a small fraction of energy passes to the next trophic level. This law was proposed by:

(A) Odum

(B) Lindeman

(C) Elton

(D) Darwin

Q83. During blood clotting, an inactive plasma protein is converted into fibrin with the help of thrombin. The fibrin forms a network that traps blood cells and seals the wound. Identify the inactive precursor protein.

(A) Prothrombin

(B) Fibrinogen

(C) Heparin

(D) Globulin



- Q84.** A transgenic crop variety was developed to tolerate herbicides and resist insect pests, thereby reducing dependence on chemical pesticides. Such genetically modified crops are produced mainly through:
- (A) Tissue culture
 - (B) Hybridization
 - (C) Recombinant DNA technology
 - (D) Artificial selection
- Q85.** The vaccine developed against polio was first prepared by:
- (A) Edward Jenner
 - (B) Louis Pasteur
 - (C) Jonas Salk
 - (D) Robert Koch
- Q86.** Which immunoglobulin can cross placenta?
- (A) IgA
 - (B) IgM
 - (C) IgG
 - (D) IgE
- Q87.** Bt cotton is resistant against:
- (A) Aphids
 - (B) Bollworm
 - (C) Nematodes
 - (D) White rust
- Q88.** Restriction enzymes are also known as:
- (A) Molecular scissors
 - (B) Molecular probes



- (C) Cloning vectors
- (D) Ligases

Q89. PCR technique was developed by:

- (A) Har Gobind Khorana
- (B) Kary Mullis
- (C) Watson
- (D) Wilkins

Q90. Which of the following vectors is most commonly used in gene cloning?

- (A) Plasmid
- (B) Ribosome
- (C) Lysosome
- (D) Centrosome

Q91. In ecological succession, the first community established in a bare area is called:

- (A) Climax community
- (B) Pioneer community
- (C) Sere community
- (D) Ecotone

Q92. The pyramid of energy is always:

- (A) Inverted
- (B) Spindle-shaped
- (C) Upright
- (D) Irregular



- Q93.** Biomagnification refers to increase in concentration of toxic substances at:
- (A) Lower trophic levels
 - (B) Producer level only
 - (C) Successive trophic levels
 - (D) Abiotic components
- Q94.** Which of the following is an example of mutualism?
- (A) Cuscuta on hedge plant
 - (B) Lichen association
 - (C) Tiger and deer
 - (D) Tapeworm in intestine
- Q95.** Ozone depletion is primarily caused by:
- (A) Carbon dioxide
 - (B) Sulphur dioxide
 - (C) Chlorofluorocarbons
 - (D) Methane
- Q96.** Which of the following belongs to kingdom Protista?
- (A) Nostoc
 - (B) Amoeba
 - (C) Rhizopus
 - (D) Volvox
- Q97.** Casparian strips are present in:
- (A) Pericycle
 - (B) Endodermis
 - (C) Cortex



(D) Epidermis

Q98. The centromere divides first during:

- (A) Anaphase-I
- (B) Metaphase-I
- (C) Anaphase-II
- (D) Telophase-I

Q99. Which among the following is a non-reducing sugar?

- (A) Glucose
- (B) Maltose
- (C) Lactose
- (D) Sucrose

Q100. In human female reproductive system, fertilization usually occurs in:

- (A) Uterus
- (B) Cervix
- (C) Infundibulum-Ampulla junction
- (D) Vagina



Detailed Solutions**Q1.****Solution**

Concept: The question describes a plant exhibiting Kranz anatomy and high photosynthetic rates under challenging conditions (high temperature, low CO_2). These are characteristic features of C_4 plants. C_4 plants have a specialized mechanism for carbon fixation that minimizes photorespiration and maximizes efficiency in hot, dry environments. The initial carbon fixation in C_4 plants by PEP carboxylase produces a four-carbon compound.

Solution: Step 1: The presence of Kranz anatomy (thickened bundle sheath cells surrounding mesophyll cells) and high photosynthetic rates under high temperature and low CO_2 are hallmarks of C_4 plants.

Step 2: C_4 plants have a two-step carbon fixation process. The first step occurs in the mesophyll cells, where CO_2 is fixed by the enzyme PEP carboxylase.

Step 3: PEP carboxylase catalyzes the carboxylation of phosphoenol pyruvate (PEP) to form oxaloacetic acid (OAA).

Step 4: Oxaloacetic acid is a four-carbon compound and is the first stable product of carbon fixation in the C_4 pathway. It is then converted to other four-carbon compounds (like malate or aspartate) which are transported to the bundle sheath cells.

Step 5: In the bundle sheath cells, the CO_2 is released and refixed by RuBisCO in the Calvin cycle.

Step 6: 3-Phosphoglyceric acid (3-PGA) is the first stable product of the Calvin cycle (C_3 pathway). Ribulose biphosphate is the CO_2 acceptor. Phosphoenol pyruvate is the initial CO_2 acceptor in C_4 plants.

Final Answer: Oxaloacetic acid

Answer: (C)

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Q2.

Solution

Concept: Transpiration is the process of water movement through a plant and its evaporation from aerial parts, such as leaves, stems and flowers. Water transport in plants, especially in tall plants, relies on the cohesive and adhesive properties of water, along with the tension created by transpiration.

Solution: Step 1: Transpiration is the loss of water vapor from plants, mainly through stomata. Vaseline applied to leaf surfaces blocks stomata, preventing water loss.

Step 2: The observation that water loss continues even after covering both surfaces (except a small region with stomata) indicates that water is still moving through the plant.

Step 3: The movement of water from the roots to the leaves against gravity is explained by the cohesion-tension theory. This theory states that transpiration from the leaves creates a negative pressure (tension) in the xylem.

Step 4: Cohesion is the attraction between water molecules due to hydrogen bonding, which allows them to form a continuous column in the xylem. Adhesion is the attraction between water molecules and the xylem walls, which helps to counteract the force of gravity.

Step 5: This continuous column of water, under tension from transpiration pull, facilitates the upward movement of water. Imbibition pressure is related to water absorption by solid substances. Root pressure is a positive pressure that pushes water up, but it's insufficient for tall plants. Active transport through xylem is not the primary mechanism for bulk water movement; it's passive driven by transpiration.

STOMA OPEN



Guard cells turgid

High K^+ concentration \rightarrow Water influx

STOMA CLOSED



Guard cells flaccid

Low K^+ concentration \rightarrow Water efflux

Final Answer: Cohesion and adhesion of water molecules

Answer: (C)

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Q3.

Solution

Concept: Pollination is the transfer of pollen from the anther to the stigma. Different modes of pollination (anemophily, entomophily, hydrophily, ornithophily) have specific floral adaptations that facilitate them.

Solution: Step 1: The question describes a flower with a long style, sticky stigma, exposed feathery surface for trapping pollen, and light, dry, abundant pollen grains. These are adaptations for wind pollination.

Step 2: Let's analyze the features and relate them to pollination modes:

Entomophily (insect pollination): Typically involves bright petals, scent, nectar, sticky pollen, and a less exposed stigma and anther.

Hydrophily (water pollination): Pollen is transferred through water. Adaptations vary but often involve pollen that can float or is released underwater.

Ornithophily (bird pollination): Flowers are often brightly colored (red/orange), odorless, produce abundant nectar, and have a shape suitable for bird pollination.

Anemophily (wind pollination): Flowers typically lack bright colors, scent, and nectar. They have exposed anthers and stigmas, often feathery or large to catch wind-borne pollen. Pollen grains are usually light, dry, smooth, and produced in large quantities to compensate for losses during wind dispersal. The described features (long style, sticky stigma, exposed feathery surface, light/dry/abundant pollen) perfectly match the adaptations for wind pollination.

Final Answer: Anemophily

Answer: (D)

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Q4.

Solution

Concept: In C4 plants, photosynthesis involves spatial separation of initial CO₂ fixation and the Calvin cycle into two different cell types: mesophyll cells and bundle sheath cells. The primary CO₂ acceptor in mesophyll cells is phosphoenolpyruvate (PEP). The regeneration of PEP is crucial for the continuation of the C4 cycle.

Solution: Step 1: In C4 plants, CO₂ is initially fixed by the enzyme PEP carboxylase in the mesophyll cells, utilizing phosphoenolpyruvate (PEP) as the primary CO₂ acceptor. This forms a four-carbon compound, typically oxaloacetate.

Step 2: This four-carbon compound is then transported from the mesophyll cells to the bundle sheath cells.

Step 3: Within the bundle sheath cells, the four-carbon compound is decarboxylated, releasing CO₂. This concentrated CO₂ is then used by RuBisCO in the Calvin cycle.

Step 4: The resulting three-carbon compound (usually pyruvate) is transported back to the mesophyll cells.

Step 5: In the mesophyll cells, pyruvate is converted back to PEP, a process that requires ATP and involves enzymes located within the mesophyll chloroplasts. This regeneration of PEP ensures that the C4 cycle can continue.

Final Answer: Mesophyll chloroplast stroma

Answer: (B)

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Q5.

Solution

Concept: Stomatal movements (opening and closing) are regulated by changes in the turgor pressure of the guard cells, which surround the stomatal pore. These pressure changes are a result of osmotic water movement, driven by alterations in the solute concentration within the guard cells, primarily mediated by ion fluxes.

Solution: Step 1: Stomata are pores on the plant epidermis that control gas exchange. Their aperture is regulated by two specialized guard cells.

Step 2: When guard cells accumulate solutes (like K^+ ions and associated anions), their water potential decreases.

Step 3: This decrease in water potential causes water to move into the guard cells by osmosis, increasing their turgor pressure. The turgid guard cells bulge outwards, opening the stomatal pore.

Step 4: Conversely, when solutes are removed from guard cells, their water potential increases, causing water to move out by osmosis. This leads to a decrease in turgor pressure, and the guard cells become flaccid, closing the stomatal pore.

Step 5: Therefore, the opening and closing of stomata are fundamentally driven by the osmotic movement of water into and out of the guard cells, in response to changes in solute concentration.

Final Answer: Water due to osmotic changes in guard cells

Answer: (C)

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Q6.

Solution

Concept: Photorespiration is a metabolic pathway that occurs in plants and involves the consumption of oxygen and release of carbon dioxide, often occurring under conditions of high light intensity and low CO₂ concentration. This process is distributed across three organelles: chloroplasts, peroxisomes, and mitochondria.

Solution: Step 1: Photorespiration initiates in the chloroplast. The enzyme RuBisCO, instead of carboxylating ribulose-1,5-bisphosphate (RuBP), oxygenates it, forming phosphoglycolate.

Step 2: Phosphoglycolate is then rapidly dephosphorylated to glycolate within the chloroplast.

Step 3: Glycolate is transported from the chloroplast to the peroxisome.

Step 4: In the peroxisome, glycolate is oxidized by glycolate oxidase, utilizing oxygen, to produce glyoxylate and hydrogen peroxide (H₂O₂). The hydrogen peroxide is subsequently broken down by catalase within the same peroxisome.

Step 5: Thus, the specific conversion of glycolate to glyoxylate occurs within the peroxisome.

Final Answer: Peroxisome

Answer: (B)

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Q7.

Solution

Concept: The C₄ photosynthetic pathway is characterized by an initial fixation of CO₂ by PEP carboxylase in mesophyll cells, which has a high affinity for CO₂ and is insensitive to oxygen. This distinguishes it from RuBisCO, the enzyme used in C₃ photosynthesis and in the bundle sheath cells of C₄ plants.

Solution: Step 1: RuBisCO is the enzyme that catalyzes the carboxylation of RuBP in the Calvin cycle, which is common to both C₃ and C₄ plants. While essential in C₄ plants (in bundle sheath cells), it's not exclusively associated with the C₄ pathway itself.

Step 2: ATP synthase is a fundamental enzyme of photosynthesis responsible for ATP production through chemiosmosis, found in all photosynthetic organisms.

Step 3: Carbonic anhydrase can play a role in CO₂ concentration mechanisms in some plants, but PEP carboxylase is the defining enzyme for the initial CO₂ fixation in the C₄ pathway.

Step 4: PEP carboxylase is uniquely responsible for the first carboxylation step in C₄ plants, fixing CO₂ into a four-carbon acid in the mesophyll cells. This enzyme is absent in the photosynthetic machinery of C₃ plants for initial carbon fixation.

Final Answer: PEP carboxylase

Answer: (B)

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Q8.

Solution

Concept: Mendel's experiments with pea plants laid the foundation for classical genetics. His principles, such as the Law of Segregation and the Law of Independent Assortment, explain the patterns of inheritance observed in crosses. The appearance of new combinations of traits in offspring is a key indicator of independent assortment.

Solution: Step 1: The cross involves two heterozygous pea plants for seed shape and seed color. The offspring showed new combinations of traits not seen in the parents, known as recombination of traits.

Step 2: Among Mendel's laws, the **Law of Independent Assortment** explains this phenomenon. It states that alleles of different traits segregate independently during gamete formation, producing new combinations in the offspring.

The **Law of Dominance** and **Law of Segregation** do not explain the formation of new trait combinations, while **Incomplete Dominance** refers to intermediate phenotypes.

Step 3: Hence, the observation supports Mendel's **Law of Independent Assortment**.

$P_1 : RrYy$					$P_2 : RrYy$
↓					↓
Gametes					Gametes
	RY	Ry	rY	ry	
RY	$RRYY$	$RRYy$	$RrYY$	$RrYy$	
Ry	$RRYy$	$RRyy$	$RrYy$	$Rryy$	
rY	$RrYY$	$RrYy$	$rrYY$	$rrYy$	
ry	$RrYy$	$Rryy$	$rrYy$	$rryy$	

Independent assortment of alleles (R/r and Y/y) produces all possible gamete combinations, leading to the characteristic 9 : 3 : 3 : 1 phenotypic ratio.

Final Answer: Law of independent assortment

Answer: (C)

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Q9.

Solution

Concept: The cohesion-tension theory is the most widely accepted explanation for how water is transported upwards through the xylem vessels of plants, even to great heights. It relies on the physical properties of water and the process of transpiration.

Solution: Step 1: The cohesion-tension theory explains the mechanism of ascent of sap, which is the upward movement of water from the roots to the leaves through the xylem.

Step 2: This theory was proposed by Henry Horatio Dixon and John Joly in 1894.

Step 3: The theory posits that transpiration from the leaves creates a continuous tension or negative pressure in the xylem. This tension pulls the water column upwards.

Step 4: The cohesive forces between water molecules (due to hydrogen bonding) allow the water column to remain intact under this tension, preventing it from breaking. Adhesive forces between water molecules and the xylem walls also contribute to resisting the downward pull of gravity.

Final Answer: Dixon and Joly

Answer: (A)

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Q10.

Solution

Concept: Double fertilization is a characteristic reproductive process in angiosperms. It involves the fusion of two male gametes from a single pollen grain with different structures within the ovule, leading to the formation of both the embryo and the endosperm.

Solution: Step 1: In angiosperms, a pollen grain contains two male gametes. Upon germination on the stigma, a pollen tube grows down to the ovule.

Step 2: The pollen tube delivers the two male gametes to the embryo sac.

Step 3: One male gamete (haploid, n) fuses with the egg cell (haploid, n) to form the zygote (diploid, $2n$), which will develop into the embryo.

Step 4: The second male gamete (haploid, n) fuses with the central cell, which typically contains two polar nuclei (each haploid, n). These polar nuclei may have already fused to form a diploid secondary nucleus ($2n$).

Step 5: The fusion of the second male gamete (n) with the secondary nucleus ($2n$) results in the formation of a primary endosperm nucleus, which is triploid ($3n$). This triploid nucleus subsequently divides to form the endosperm, a nutritive tissue for the developing embryo.

Final Answer: One male gamete and secondary nucleus

Answer: (C)

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Q11.

Solution

Concept: This question assesses the knowledge of the specific functions of various floral parts and tissues within the reproductive structures of a flowering plant. Correctly identifying the functional role of each component is key.

Solution: Step 1: Evaluate the function assigned to each floral part:

Tapetum: The tapetum is the innermost layer of the anther wall and its primary function is to nourish the developing microspores (which develop into pollen grains). Therefore, "protection of ovule" is incorrect.

Endothecium: The endothecium is a layer in the anther wall that typically undergoes lignification and contributes to the dehiscence (opening) of the anther to release pollen. "Nutrition to pollen grains" is the role of the tapetum.

Filiform apparatus: This is a characteristic structure found at the apex of the synergids within the embryo sac. It plays a crucial role in guiding the pollen tube towards the embryo sac and facilitating the discharge of the male gametes. This is a correct match.

Micropyle: The micropyle is a small opening in the ovule's integuments. While the pollen tube usually enters through the micropyle, it is not directly involved in the formation of the embryo sac itself. The embryo sac develops within the nucellus of the ovule.

Step 2: Based on the analysis, only the function of the filiform apparatus is correctly matched.

Final Answer: Filiform apparatus

Answer: (C)

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Q12.

Solution

Concept: Mendel's Laws of Inheritance explain the patterns of heredity. The 9:3:3:1 phenotypic ratio observed in the F₂ generation of a dihybrid cross is a direct manifestation of the Law of Independent Assortment.

Solution: Step 1: In a dihybrid cross, two traits are simultaneously studied. Mendel's experiments showed that when he crossed plants differing in two traits (e.g., seed shape and seed color), the F₁ generation was heterozygous for both traits.

Step 2: Upon self-pollination of the F₁ generation, the F₂ generation exhibited a characteristic phenotypic ratio of 9:3:3:1.

Step 3: This ratio is obtained when the alleles of two different genes segregate independently of each other during gamete formation. This principle is known as Mendel's Law of Independent Assortment.

Step 4: Linkage (genes on the same chromosome inherited together), incomplete dominance (intermediate phenotype), and codominance (both alleles expressed) would result in deviations from this classic 9:3:3:1 ratio.

Final Answer: Independent assortment

Answer: (C)

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Q13.

Solution

Concept: DNA is a double-stranded molecule where the two strands are held together by hydrogen bonds between complementary nitrogenous bases: Adenine (A) pairs with Thymine (T), and Guanine (G) pairs with Cytosine (C). This complementary base pairing follows Chargaff's rules.

Solution: Step 1: According to Chargaff's rules, in a double-stranded DNA molecule, the amount of Adenine (A) is equal to the amount of Thymine (T), and the amount of Guanine (G) is equal to the amount of Cytosine (C). Mathematically, $A = T$ and $G = C$.

Step 2: The problem states that the DNA molecule contains 18% cytosine residues. Therefore, $\%C = 18\%$.

Step 3: From Chargaff's rules, the amount of Guanine (G) must be equal to the amount of Cytosine (C). So, $\%G = 18\%$.

Step 4: The total percentage of nitrogenous bases in DNA is 100%. The sum of percentages of all bases is: $\%A + \%T + \%G + \%C = 100\%$.

Step 5: Substituting the known percentages: $\%A + \%T + 18\% + 18\% = 100\%$.

Step 6: This simplifies to $\%A + \%T + 36\% = 100\%$.

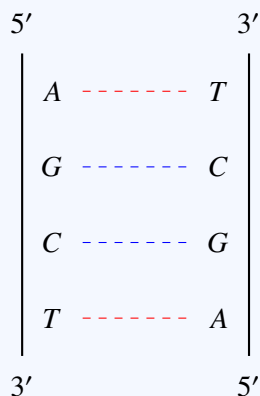
Step 7: Therefore, $\%A + \%T = 100\% - 36\% = 64\%$.

Step 8: Since $A = T$, we can write $2 * \%A = 64\%$.

Step 9: Solving for $\%A$, we get $\%A = 64\% / 2 = 32\%$.

Step 10: The DNA molecule contains 2000 nitrogenous bases in total. The number of adenine residues is 32% of the total number of bases.

Step 11: Number of adenine residues = 32% of 2000 = $(32/100) * 2000 = 32 * 20 = 640$.



Chargaff's Rules

$$A = T$$

$$G = C$$

If Total Bases = 2000

and $A = 32\%$

Then,

$$A = 0.32 \times 2000 = 640$$

Final Answer: 640

Answer: (B)

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Q14.

Solution

Concept: Meiosis is a process of cell division that reduces the chromosome number by half and is crucial for sexual reproduction. Prophase I of Meiosis I is a complex stage divided into several substages, during which homologous chromosomes pair and exchange genetic material.

Solution: Step 1: Meiosis involves two successive nuclear divisions, Meiosis I and Meiosis II. Prophase I of Meiosis I is a prolonged and intricate stage, further divided into five substages.

Step 2: Let's examine the substages of Prophase I and their key events:

Leptotene: Chromosomes begin to condense and become visible as thin threads.

Zygotene: Homologous chromosomes start to pair up synaptically. This pairing process is called synapsis, and the paired structure is called a bivalent or tetrad.

Pachytene: During this stage, the homologous chromosomes are fully synapsed. Crossing over, the reciprocal exchange of genetic material between non-sister chromatids of homologous chromosomes, occurs at specific points.

Diplotene: Homologous chromosomes begin to separate, but they remain attached at the sites where crossing over occurred. These attachment points are visible as chiasmata. Chiasmata are clearly visible during this stage, indicating the points of genetic exchange.

Diakinesis: Chromosomes condense further, and the nuclear envelope breaks down.

Step 3: The question asks in which stage chiasmata are clearly visible. Chiasmata, which represent the physical manifestation of crossing over, become distinctly visible during the diplotene stage. While crossing over happens in pachytene, the chiasmata become clearly visible as the homologous chromosomes start to pull apart in diplotene.

Final Answer: Diplotene

Answer: (C)

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Q15.

Solution

Concept: Evolution is the process of change in the heritable characteristics of biological populations over successive generations. Several mechanisms drive evolution, including natural selection, genetic drift, gene flow, and mutation.

Solution: Step 1: The question describes a scenario where a population of insects develops resistance to a pesticide over generations due to the survival and reproduction of individuals with favorable variations. This is a classic example of evolutionary change.

Step 2: Let's analyze the given mechanisms of evolution:

Genetic drift: Random changes in allele frequencies, particularly significant in small populations. It doesn't necessarily lead to adaptation.

Adaptive radiation: The diversification of a single lineage into different species that occupy different ecological niches, usually in response to new opportunities or challenges.

Natural selection: The process whereby organisms better adapted to their environment tend to survive and produce more offspring. In this case, the pesticide acts as a selective pressure, favoring insects with resistance genes. These resistant individuals survive, reproduce, and pass on their resistance traits, leading to an increase in the frequency of resistance alleles in the population.

Artificial selection: The intentional breeding of organisms by humans for specific desired traits. This is driven by human choice, not by environmental pressures on survival.

Step 3: The development of pesticide resistance in insects after repeated exposure is a direct result of environmental pressure (the pesticide) selecting for individuals with inherent resistance. This perfectly describes the mechanism of natural selection.

Final Answer: Natural selection

Answer: (C)

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Q16.

Solution

Concept: The transport of oxygen in the blood is primarily carried out by hemoglobin, a protein found in red blood cells (erythrocytes). Different blood components have distinct functions.

Solution: Step 1: The question asks which blood component is directly responsible for transporting oxygen from the lungs to the body's tissues.

Step 2: Let's consider the functions of the given blood components:

Platelets: Primarily involved in blood clotting.

Plasma proteins: Play roles in maintaining osmotic balance, immunity (antibodies), and transport of various substances, but not direct oxygen transport in large quantities.

Erythrocytes (Red blood cells): These cells contain large amounts of hemoglobin, the protein that binds to oxygen. Red blood cells are specialized for oxygen transport.

Lymphocytes: A type of white blood cell involved in the immune response.

Step 3: The reduced oxygen-carrying capacity mentioned in the diagnosis ("severe deficiency of haemoglobin") directly points to an issue with hemoglobin, which is contained within erythrocytes. Therefore, erythrocytes are the component directly responsible for oxygen transport.

Final Answer: Erythrocytes

Answer: (C)

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Q17.

Solution

Concept: The heart sounds heard during a cardiac cycle are produced by the closure of heart valves. The characteristic "lub-dub" sounds are associated with the closing of the atrioventricular and semilunar valves, respectively.

Solution: Step 1: The cardiac cycle involves the coordinated contraction and relaxation of the heart chambers. Heart sounds are produced by the closure of the heart valves.

Step 2: The first heart sound, often described as "lub," is produced by the closure of the atrioventricular (AV) valves – the mitral valve (between the left atrium and left ventricle) and the tricuspid valve (between the right atrium and right ventricle). This closure occurs at the beginning of ventricular systole (contraction) when the pressure in the ventricles rises above the pressure in the atria, preventing backflow of blood into the atria.

Step 3: The second heart sound, often described as "dub," is produced by the closure of the semilunar valves – the aortic valve (between the left ventricle and the aorta) and the pulmonary valve (between the right ventricle and the pulmonary artery). This closure occurs at the beginning of ventricular diastole (relaxation) when ventricular pressure falls below the pressure in the aorta and pulmonary artery, preventing backflow of blood into the ventricles.

Step 4: Murmurs are abnormal heart sounds, often caused by leaky or narrowed valves. Pulse sound is not a standard term for heart sounds.

Final Answer: Lub

Answer: (B)

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Q18.

Solution

Concept: At high altitudes, the atmospheric pressure is lower, resulting in a lower partial pressure of oxygen. This condition can lead to physiological responses aimed at compensating for the reduced oxygen availability.

Solution: Step 1: The condition described is a mountaineer climbing to a high-altitude region, experiencing rapid breathing and increased heart rate due to low oxygen levels.

Step 2: Let's define the given conditions:

Hypercapnia: Abnormally high level of carbon dioxide in the blood.

Hypoxia: A condition characterized by a deficiency of oxygen reaching the tissues. This can be due to low oxygen levels in the air (hypobaric hypoxia), problems with blood or circulation, or cellular respiration issues.

Hypertension: Abnormally high blood pressure.

Hyperglycemia: Abnormally high level of glucose in the blood.

Step 3: At high altitudes, the atmospheric pressure is lower, leading to a reduced partial pressure of oxygen (pO_2) in the inhaled air. This means less oxygen is available for uptake by the lungs, resulting in a lower oxygen saturation in the blood. This condition is known as hypoxia.

Step 4: The physiological response to hypoxia includes increased breathing rate (to take in more air) and increased heart rate (to circulate the available oxygen more quickly), aiming to compensate for the reduced oxygen supply.

Final Answer: Hypoxia

Answer: (B)

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Q19.

Solution

Concept: The nephron is the functional unit of the kidney, responsible for filtering blood and producing urine. This process involves glomerular filtration, tubular reabsorption, and tubular secretion. Tubular reabsorption is the process by which useful substances are transported from the glomerular filtrate back into the blood.

Solution: Step 1: The nephron consists of several parts: the renal corpuscle (glomerulus and Bowman's capsule), proximal convoluted tubule (PCT), loop of Henle, distal convoluted tubule (DCT), and collecting duct.

Step 2: Glomerular filtration occurs in the renal corpuscle, where plasma is filtered into Bowman's capsule.

Step 3: After filtration, the filtrate passes through the various parts of the nephron tubule. A significant amount of reabsorption of essential substances occurs along these tubules.

Step 4: The proximal convoluted tubule (PCT) is the site of maximum tubular reabsorption. Approximately 65-70% of the filtered water, electrolytes (like Na^+ , K^+ , Cl^-), and almost all glucose, amino acids, and vitamins are reabsorbed here. This reabsorption occurs actively and passively.

Step 5: The descending limb of Henle's loop is permeable to water but not solutes. The collecting duct reabsorbs water (under ADH influence) and some urea and ions. The DCT reabsorbs more ions and water under hormonal control. However, the PCT handles the largest volume and variety of reabsorbed substances.

Final Answer: Proximal convoluted tubule

Answer: (D)

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Q20.

Solution

Concept: Reflex actions are rapid, involuntary responses to stimuli that bypass conscious processing in the cerebrum. They are primarily mediated by the spinal cord.

Solution: Step 1: The scenario describes a rapid, involuntary withdrawal of the hand from a hot object, occurring even before conscious perception of pain. This is characteristic of a reflex action.

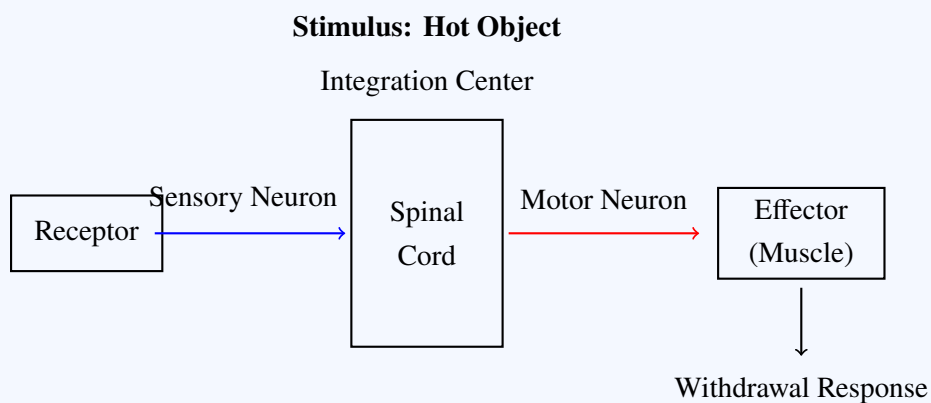
Step 2: Reflex arcs, the neural pathways underlying reflex actions, typically involve a sensory receptor, a sensory neuron, an integration center (often in the spinal cord), a motor neuron, and an effector.

Step 3: The spinal cord acts as the integration center for most somatic reflexes. Sensory neurons from the stimulated receptor (in the skin of the hand) transmit the signal to the spinal cord.

Step 4: Interneurons within the spinal cord process the signal and relay it to motor neurons.

Step 5: Motor neurons then transmit the impulse to the effector muscles (in the arm), causing a rapid withdrawal response.

Step 6: While the sensory information eventually reaches the cerebrum (causing awareness of pain) and other brain regions like the hypothalamus (for general physiological responses), the rapid, coordinated withdrawal reflex itself is primarily managed by the spinal cord, allowing for a much faster response than if the signal had to travel all the way to the brain for conscious processing and then back down. The cerebellum is involved in coordination of movement but not typically the primary center for simple withdrawal reflexes.



Final Answer: Spinal cord

Answer: (C)

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Q21.

Solution

Concept: Endocrine glands produce hormones that regulate various bodily functions. Iodine is essential for the synthesis of thyroid hormones, and a deficiency can lead to specific disorders related to the thyroid gland.

Solution: Step 1: The question describes a disorder resulting from iodine deficiency, which leads to reduced production of thyroxine hormone and enlargement of the thyroid gland.

Step 2: Let's analyze the given options:

Acromegaly: Caused by excessive production of growth hormone in adults, leading to the enlargement of extremities and facial features. It's not related to iodine deficiency or thyroxine.

Goitre: This is a condition characterized by the enlargement of the thyroid gland. Iodine deficiency is a common cause of simple goitre because the thyroid gland tries to compensate for the lack of iodine by growing larger in an attempt to capture more iodine from the blood and produce more thyroxine.

Myxedema: A condition caused by severe hypothyroidism (underactive thyroid), often leading to swelling of the skin and underlying tissues, fatigue, and weight gain. While iodine deficiency can cause hypothyroidism, myxedema is a symptom rather than the primary disorder of thyroid enlargement due to iodine deficiency.

Addison's disease: A disorder of the adrenal glands, caused by insufficient production of cortisol and aldosterone.

Step 3: The enlargement of the thyroid gland due to iodine deficiency and subsequent reduced thyroxine production is specifically known as goitre.

Final Answer: Goitre

Answer: (B)

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Q22.

Solution

Concept: Contraceptive methods employ various strategies to prevent pregnancy. Some methods primarily focus on preventing fertilization, while others interfere with implantation of the embryo.

Solution: Step 1: The question describes a couple using a contraceptive device that works by releasing copper ions into the uterus and suppressing sperm motility, thereby preventing fertilization. The question implies this is the primary mechanism described.

Step 2: Let's examine the mechanism of action for each contraceptive option:

Oral pills: These typically contain synthetic hormones (estrogen and progesterone) that inhibit ovulation, alter cervical mucus to make it less permeable to sperm, and sometimes affect the uterine lining, potentially hindering implantation.

Vasectomy: A surgical sterilization method for males that involves cutting or blocking the vas deferens, preventing sperm transport. It prevents fertilization.

Copper-T (Copper IUD): This intrauterine device releases copper ions, which are spermicidal (kill sperm) and suppress sperm motility, thus preventing fertilization. Copper ions also alter the uterine environment, making it unsuitable for implantation, thus also preventing implantation.

Tubectomy: A surgical sterilization method for females that involves cutting or blocking the fallopian tubes, preventing the egg from meeting sperm. It prevents fertilization.

Step 3: The Copper-T is described as releasing copper ions and preventing fertilization by suppressing sperm motility. This is consistent with its known mechanism. While it also prevents implantation, the question highlights its effect on sperm motility and fertilization.

Final Answer: Copper-T

Answer: (C)

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Q23.

Solution

Concept: Implantation is the process by which the early-stage embryo, known as a blastocyst, attaches to and embeds within the uterine wall. This is a critical step in early embryonic development and pregnancy.

Solution: Step 1: Following fertilization, the zygote undergoes rapid cell divisions to form a morula, which then develops into a blastocyst.

Step 2: The blastocyst consists of an outer layer of cells called the trophoblast and an inner cell mass. The trophoblast cells are responsible for implantation.

Step 3: Implantation is the process where the blastocyst burrows into the uterine lining. The uterine lining has different layers:

Perimetrium: The outer serous layer of the uterus.

Myometrium: The thick middle layer composed of smooth muscle.

Endometrium: The inner lining of the uterus, rich in blood vessels and glands. It undergoes cyclic changes in preparation for implantation.

Cervix: The lower, narrow part of the uterus that opens into the vagina.

Step 4: The blastocyst typically implants in the endometrium, the highly vascularized and glandular inner lining of the uterus, which provides nourishment and support for the developing embryo.

Final Answer: Endometrium

Answer: (C)

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Q24.

Solution

Concept: Immunity can be acquired in different ways. Active immunity is developed when the body's own immune system is stimulated to produce antibodies, while passive immunity involves receiving antibodies from an external source. Vaccination is a form of artificial active immunity.

Solution: Step 1: Immunity can be classified into natural and artificial, and active and passive.
Natural immunity: Acquired through normal life experiences (e.g., getting an infection). Artificial immunity: Acquired through medical interventions (e.g., vaccines, antibody injections).

Active immunity: Developed when the body's immune system produces its own antibodies in response to exposure to an antigen. This takes time to develop but is long-lasting.

Passive immunity: Acquired when antibodies are received from an external source (e.g., from the mother or via antibody injection). This provides immediate but temporary protection.

Step 2: Vaccination involves introducing a weakened or inactive form of a pathogen (or its antigen) into the body. The immune system then mounts a response and produces its own antibodies and memory cells.

Step 3: Since this process is induced by a medical intervention (vaccination) and involves the body's own immune system producing antibodies, it is classified as artificial active immunity.

Step 4: Natural passive immunity occurs, for example, when antibodies are transferred from mother to fetus across the placenta. Artificial passive immunity involves receiving antibodies from another person or animal (e.g., antitoxin injections). Natural active immunity occurs after recovery from an infection.

Final Answer: Artificial active immunity

Answer: (B)

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Q25.

Solution

Concept: Recombinant DNA technology involves manipulating DNA molecules. Key enzymes are used for cutting, joining, and copying DNA fragments. Restriction endonucleases are particularly important for cutting DNA at specific sites.

Solution: Step 1: Recombinant DNA technology relies on a set of molecular tools that enable scientists to cut, paste, and replicate DNA.

Step 2: The process of inserting a gene of interest into a vector requires the DNA to be cut at specific points.

Step 3: Restriction endonucleases (often called restriction enzymes) are enzymes that recognize specific nucleotide sequences (restriction sites) within a DNA molecule and cleave the DNA at or near these sites.

Step 4: Many restriction enzymes produce staggered cuts, leaving short, single-stranded overhangs called "sticky ends," which can readily base-pair with complementary sticky ends from another DNA fragment cut with the same enzyme. This property is crucial for joining DNA fragments.

Step 5: DNA polymerase synthesizes new DNA strands. DNA ligase joins DNA fragments. Reverse transcriptase synthesizes DNA from an RNA template. These enzymes have different roles and do not perform the specific cutting function of restriction enzymes.

Final Answer: Restriction endonuclease

Answer: (C)

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Q26.

Solution

Concept: The Polymerase Chain Reaction (PCR) is a technique used to amplify specific DNA sequences. It involves repeated cycles of temperature changes. The enzyme responsible for DNA synthesis must withstand these high temperatures.

Solution: Step 1: The Polymerase Chain Reaction (PCR) involves repeated cycles of DNA denaturation (high temperature), primer annealing (low temperature), and DNA synthesis (intermediate temperature). Step 2: The denaturation step typically involves heating the DNA to temperatures around 94-98°C to separate the double strands.

Step 3: Standard DNA polymerases from mesophilic organisms would be denatured and inactivated at these high temperatures.

Step 4: Taq polymerase, isolated from the thermophilic bacterium *Thermus aquaticus* (which lives in hot springs), is a thermostable DNA polymerase. It can withstand the high temperatures required for DNA denaturation during PCR without losing its enzymatic activity.

Step 5: DNA ligase joins DNA fragments. RNA polymerase synthesizes RNA. Restriction enzymes cut DNA. None of these are directly involved in the high-temperature DNA synthesis step of PCR.

Final Answer: Taq polymerase

Answer: (A)

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Q27.

Solution

Concept: Biomagnification is the process by which the concentration of certain persistent toxic substances increases in organisms at successively higher levels in a food chain. This leads to higher exposure and potential harm at the top trophic levels.

Solution: Step 1: The scenario describes a food chain (grass → grasshopper → frog → snake) where a non-biodegradable toxic chemical accumulates and its concentration increases at each step.

Step 2: Let's define the ecological terms:

Ecological succession: The process of change in the species structure of an ecological community over time.

Eutrophication: Excessive richness of nutrients in a lake or other body of water, frequently due to runoff from the land, which causes a dense growth of plant life and death of animal life from lack of oxygen.

Biomagnification: The increasing concentration of a substance, such as a toxic chemical, in the tissues of organisms at successively higher levels in a food chain. This occurs because the substance is absorbed faster than it is metabolized or excreted.

Mutualism: An interaction between two or more species where all species benefit.

Step 3: The progressive increase in the concentration of toxic chemicals at higher trophic levels directly matches the definition of biomagnification.

Final Answer: Biomagnification

Answer: (C)

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Q28.

Solution

Concept: Ecological succession leads to the development of a stable and mature ecological community that is in relative equilibrium with its environment. This final stage is known as the climax community.

Solution: Step 1: Ecological succession is the process of directional change in species composition and structure over time in an ecological community.

Step 2: The process begins with the colonization of a habitat by pioneer species, forming a pioneer stage. This is followed by a series of intermediate stages (seral stages or seres).

Step 3: As succession progresses, the community structure becomes more complex, and species diversity generally increases. Energy flow becomes more efficient.

Step 4: The climax community represents the final, stable stage of succession. It is a mature, self-perpetuating community that is in equilibrium with its prevailing environmental conditions and is characterized by high species diversity and efficient energy utilization. It tends to remain relatively unchanged over long periods unless disturbed.

Step 5: The pioneer stage is the beginning of succession. A sere is a sequence of communities over time (a whole successional pathway). An ecotone is a transition zone between two different ecosystems.

Final Answer: Climax community

Answer: (C)

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Q29.

Solution

Concept: Eutrophication is a process where a body of water becomes overly enriched with minerals and nutrients, leading to excessive growth of aquatic plant life and subsequent depletion of dissolved oxygen.

Solution: Step 1: The scenario describes a freshwater lake experiencing a fish kill due to oxygen depletion, which was caused by excessive algal growth following nutrient enrichment.

Step 2: Let's examine the ecological phenomena:

Biomagnification: The increasing concentration of toxic substances at successive trophic levels. This does not directly cause fish kills due to oxygen depletion.

Ecological succession: The gradual process of change in species structure over time in an ecological community. While succession occurs in lakes, this specific event is a rapid disruption.

Eutrophication: This process is characterized by an over-enrichment of water bodies with nutrients, often from agricultural runoff (fertilizers) or sewage. This nutrient enrichment fuels rapid growth of algae and aquatic plants (algal blooms). When these organisms die, their decomposition by bacteria consumes large amounts of dissolved oxygen in the water, leading to hypoxia or anoxia, which can cause mass fish kills.

Desertification: The process by which fertile land becomes desert, typically as a result of drought, deforestation, or inappropriate agriculture. This relates to land ecosystems, not aquatic ones in this context.

Step 3: The observed phenomenon—algal bloom leading to oxygen depletion and fish death—is a direct consequence of eutrophication.

Final Answer: Eutrophication

Answer: (C)

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Q30.

Solution

Concept: The ozone layer in the Earth's stratosphere protects life from harmful ultraviolet (UV) radiation. The depletion of this layer, particularly the formation of seasonal "ozone holes," is primarily caused by certain human-produced chemicals.

Solution: Step 1: The ozone layer's thickness is crucial for absorbing most of the Sun's UV radiation. Its depletion leads to increased UV exposure on the Earth's surface.

Step 2: The observation of a large seasonal hole in the ozone layer above Antarctica is a well-documented phenomenon of ozone depletion.

Step 3: Scientific investigations have identified chlorofluorocarbons (CFCs) and related halocarbons as the primary culprits responsible for this depletion. These compounds are extremely stable in the lower atmosphere and persist long enough to reach the stratosphere.

Step 4: In the stratosphere, UV radiation breaks down CFCs, releasing highly reactive chlorine atoms. These chlorine atoms act as catalysts in a chain reaction that destroys ozone molecules. A single chlorine atom can destroy thousands of ozone molecules.

Step 5: Sulphur oxides and nitrogen oxides contribute to acid rain and air pollution, while carbon monoxide is a pollutant from incomplete combustion. These do not directly cause significant ozone layer depletion.

Final Answer: Chlorofluorocarbons

Answer: (C)

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Q31.

Solution

Concept: The five-kingdom system of classification categorizes organisms based on their cellular organization, mode of nutrition, and level of organization. The Protista kingdom is a diverse group of eukaryotic organisms that do not fit neatly into the other eukaryotic kingdoms.

Solution: Step 1: Let's analyze the characteristics given and compare them with the definitions of the kingdoms:

Kingdom Monera: Contains prokaryotic organisms (lacking a true nucleus and membrane-bound organelles).

Kingdom Protista: Contains eukaryotic organisms. These are typically unicellular, but can be colonial or simple multicellular. They possess membrane-bound organelles and a true nucleus. They do not have specialized tissue-level organization like plants or fungi.

Kingdom Fungi: Eukaryotic organisms, mostly multicellular, heterotrophic (absorptive nutrition), and possess tissue-level organization (except for unicellular yeasts).

Kingdom Plantae: Eukaryotic, multicellular organisms, autotrophic (photosynthetic), and possess well-developed tissue-level organization.

Step 2: The described organism possesses:

Membrane-bound organelles and a true nucleus: This indicates it is eukaryotic. This excludes Monera.

Unicellular body organization: This is characteristic of many protists, but also unicellular fungi (yeasts).

Lacked tissue level organization: This is a key differentiator. While yeasts are unicellular, most fungi and all plants and animals exhibit tissue-level organization.

Protists, being primarily unicellular or simple colonial forms, lack true tissues.

Step 3: Therefore, an organism that is eukaryotic, unicellular, has a nucleus and membrane-bound organelles, but lacks tissue-level organization, best fits the description of an organism from the kingdom Protista.

Final Answer: Protista

Answer: (B)

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Q32.

Solution

Concept: In plant roots, the endodermis is a crucial tissue layer that regulates the movement of water and dissolved minerals from the cortex into the vascular cylinder. This regulation is achieved through the presence of Casparian strips.

Solution: Step 1: The question describes a specialized tissue layer in plant roots that possesses Casparian strips and prevents the free movement of water through intercellular spaces (apoplast pathway) after ultrafiltration.

Step 2: Let's consider the location and function of the mentioned tissues:

Cortex: The tissue between the epidermis and the endodermis. It is primarily involved in storage and transport of substances. Cells are generally loosely packed with intercellular spaces.

Pericycle: A layer of cells just inside the endodermis, surrounding the vascular cylinder.

It is responsible for the formation of lateral roots.

Epidermis: The outermost protective layer of cells.

Endodermis: The innermost layer of the cortex, which contains Casparian strips. These strips are bands of suberin and lignin within the cell walls that are impermeable to water.

Step 3: The Casparian strips are a characteristic feature of the endodermis. They force water and solutes to cross the plasma membrane of endodermal cells, allowing the plant to control what enters the vascular cylinder. This ensures that only essential substances are transported to the xylem.

Final Answer: Endodermis

Answer: (D)

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Q33.

Solution

Concept: Carbohydrates can be classified as reducing or non-reducing sugars based on the presence of a free aldehyde or ketone group that can participate in redox reactions.

Solution: Step 1: Reducing sugars possess a free aldehyde (-CHO) or ketone (-C=O) group that can be oxidized, thus reducing other chemical agents like Fehling's solution or Tollen's reagent. Monosaccharides are always reducing sugars.

Step 2: Disaccharides can be reducing or non-reducing depending on how the monosaccharide units are linked. If the anomeric carbon of at least one unit is free, it's a reducing sugar.

Step 3: Let's analyze the given sugars:

Glucose: A monosaccharide, therefore a reducing sugar.

Maltose: A disaccharide composed of two glucose units linked $\alpha(1 \rightarrow 4)$. The anomeric carbon of one glucose unit is free, making it a reducing sugar.

Lactose: A disaccharide composed of galactose and glucose linked $\beta(1 \rightarrow 4)$. The anomeric carbon of the glucose unit is free, making it a reducing sugar.

Sucrose: A disaccharide formed from glucose and fructose. The glycosidic bond links the anomeric carbon of glucose (C1) to the anomeric carbon of fructose (C2). Since both anomeric carbons are involved in the bond, there is no free aldehyde or ketone group. Thus, sucrose is a non-reducing sugar.

Final Answer: Sucrose

Answer: (D)

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Q34.

Solution

Concept: Fertilization in humans is the fusion of a sperm and an egg. The egg is surrounded by protective layers, including the corona radiata and the zona pellucida, which the sperm must penetrate to achieve fertilization.

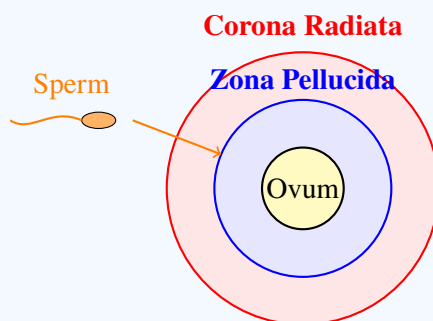
Solution: Step 1: Fertilization is the process where a sperm cell fuses with an ovum (egg cell). This typically occurs in the ampulla of the fallopian tube.

Step 2: The ovum is surrounded by several layers. Immediately outside the ovum's plasma membrane is the vitelline membrane, which in mammals is called the zona pellucida. This is a thick, transparent glycoprotein layer.

Step 3: Outside the zona pellucida are cells derived from the ovarian follicle that produced the egg. These cells form the corona radiata, which is a layer of radially elongated cells held together by hyaluronic acid.

Step 4: When a sperm encounters the ovum, it first penetrates the corona radiata, often aided by enzymes released from the sperm's acrosome. It then binds to receptors on the zona pellucida, triggering the acrosome reaction, which releases enzymes that digest the zona pellucida, allowing the sperm to reach the ovum's plasma membrane for fusion.

Step 5: The endometrium is the uterine lining where implantation occurs. Blastomeres are the cells formed by cleavage of the zygote.



Sperm penetrates the Corona Radiata and Zona Pellucida to reach the ovum during fertilization.

Final Answer: Zona pellucida

Answer: (B)

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Q35.

Solution

Concept: Photosynthesis is the process by which green plants use light energy to synthesize organic compounds from carbon dioxide and water. Starch is a storage form of glucose produced during photosynthesis. The presence of chlorophyll and light is essential for this process.

Solution: Step 1: The experiment involves a plant kept in darkness, then exposed to sunlight. Starch is observed to reappear only in the green regions of the leaf after light exposure.

Step 2: Starch is a product of photosynthesis, where glucose produced during photosynthesis is converted into starch for storage.

Step 3: The fact that starch reappeared only in the green regions of the leaf after exposure to sunlight strongly suggests that these green parts are involved in the process that leads to starch formation.

Step 4: Green color in leaves is due to the presence of chlorophyll, the primary pigment involved in capturing light energy for photosynthesis.

Step 5: The experiment demonstrates that light is necessary for starch formation (since it reappeared only after light exposure) and that chlorophyll is essential for this process (since it only reappeared in green areas). Oxygen is produced during photosynthesis and consumed during respiration, but its direct role in starch formation itself isn't highlighted here. Light is not unnecessary for starch formation; it's crucial. Xylem transports water and minerals, not starch.

Final Answer: Chlorophyll is essential for photosynthesis

Answer: (A)

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Q36.

Solution

Concept: Inheritance patterns describe how traits are passed from parents to offspring. Different types of dominance relationships exist between alleles, affecting the phenotype of heterozygotes.

Solution: Step 1: The question describes a cross between a red-flowered plant and a white-flowered plant, which resulted in pink flowers in the F_1 generation. This means the heterozygote phenotype is intermediate between the two homozygous phenotypes.

Step 2: Let's analyze the types of dominance:

Codominance: Both alleles in a heterozygote are fully and simultaneously expressed in the phenotype (e.g., AB blood group, where both A and B antigens are present). This would result in flowers showing both red and white patches, not pink.

Complete dominance: One allele (dominant) completely masks the effect of the other allele (recessive) in the heterozygote. If red were dominant, all F_1 would be red. If white were dominant, all F_1 would be white. This is not observed here.

Incomplete dominance: The heterozygous phenotype is an intermediate blend of the two homozygous phenotypes. In this case, if the red allele (R) and white allele (r) exhibit incomplete dominance, RR would be red, rr would be white, and Rr would be pink. This perfectly matches the observation.

Polygenic inheritance: A trait is controlled by multiple genes, resulting in a continuous variation in phenotype (e.g., human height, skin color). This typically results in a bell-shaped distribution of phenotypes, not a simple intermediate color in F_1 .

Step 3: The intermediate pink color in the F_1 generation from a cross between red and white parents is a classic example of incomplete dominance.

Final Answer: Incomplete dominance

Answer: (C)

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Q37.

Solution

Concept: In eukaryotic cells, gene expression involves transcription and translation. The initial RNA transcript (pre-mRNA) undergoes processing, including the removal of non-coding sequences before it is translated into protein.

Solution: Step 1: Transcription in eukaryotic cells produces a primary RNA transcript, often called pre-messenger RNA (pre-mRNA).

Step 2: This pre-mRNA contains both coding sequences, which will eventually be translated into protein, and non-coding sequences, which are not translated.

Step 3: Before the mRNA can be translated, it undergoes processing. One of the key steps is the removal of the non-coding sequences.

Step 4: The coding sequences that are expressed and remain in the mature mRNA are called exons.

Step 5: The non-coding sequences that are transcribed but are removed during RNA processing are called introns. These are spliced out by a process called splicing.

Step 6: Codons are three-nucleotide sequences on mRNA that specify amino acids. Anticodons are complementary sequences on tRNA.

Final Answer: Introns

Answer: (B)

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Q38.

Solution

Concept: Evolutionary evidence comes from various sources, including comparative anatomy. Homologous organs are structures in different species that have a similar underlying structural organization and evolutionary origin, despite performing different functions.

Solution: Step 1: The question describes forelimbs of humans, wings of bats, and flippers of whales, which perform different functions (grasping, flying, swimming) but share a similar basic structural organization (e.g., same bones like humerus, radius, ulna, carpals, metacarpals, phalanges).

Step 2: This similarity in underlying structure, despite functional diversity, points to a common ancestry.

Step 3: Let's analyze the evolutionary concepts:

Convergent evolution: Unrelated species independently evolve similar traits (analogous structures) in response to similar environmental pressures or ecological niches. (e.g., wings of birds and insects).

Adaptive radiation: The diversification of a single ancestral lineage into multiple species that occupy different ecological niches. This often leads to homologous structures.

Homologous evolution (or homology): The development of different structures from a common ancestral structure. Organs that share a common ancestry and basic structural plan but may have different functions are called homologous organs. The forelimbs in humans, bats, and whales are a classic example of homology.

Analogous evolution (or analogy): The development of similar functions in unrelated species due to similar environmental pressures, but with different underlying structures.

Step 4: The forelimbs of humans, bats, and whales are considered homologous structures, providing evidence for common ancestry and thus evolution from a shared ancestor. The term "homologous evolution" refers to the process leading to these structures.

Final Answer: Homologous evolution

Answer: (C)

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Q39.

Solution

Concept: Coronary arteries supply blood to the heart muscle itself. Blockage in these arteries leads to reduced blood flow and oxygen supply to the heart muscle, causing chest pain.

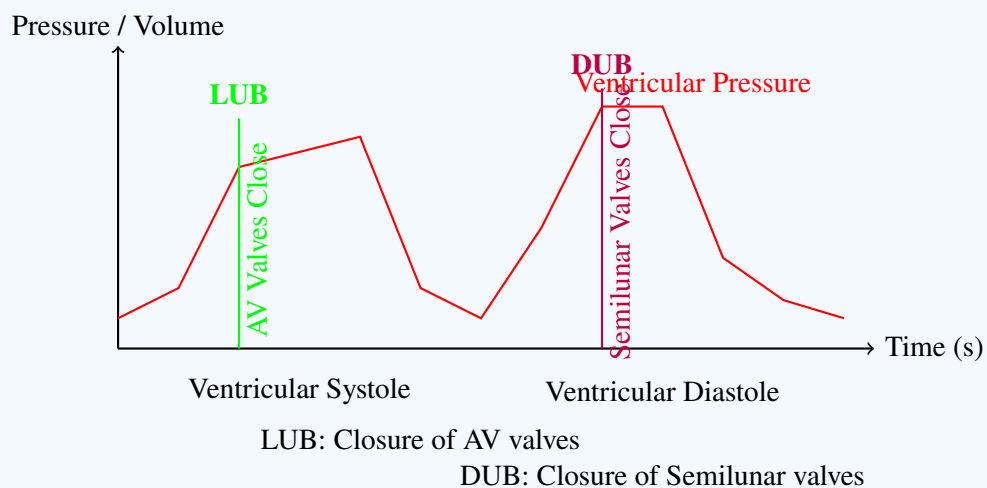
Solution: Step 1: The heart muscle, like any other tissue, requires a constant supply of oxygen and nutrients, which is provided by the coronary arteries.

Step 2: Blockage in the coronary arteries, often due to the buildup of plaque (atherosclerosis), restricts blood flow to the heart muscle.

Step 3: When the heart muscle doesn't receive enough oxygenated blood, it experiences ischemia (lack of oxygen). This typically results in a characteristic type of chest pain.

Step 4: This chest pain, often described as tightness, pressure, or squeezing, is specifically known as angina pectoris. It usually occurs during exertion or stress when the heart's demand for oxygen increases.

Step 5: Hypertension is high blood pressure. Cardiac arrest is the sudden cessation of heart function. Bradycardia is a slow heart rate. These are different conditions.



Final Answer: Angina pectoris

Answer: (B)

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Q40.

Solution

Concept: Under normal conditions, skeletal muscles produce ATP through aerobic respiration. However, during strenuous exercise when oxygen supply is insufficient, muscles temporarily switch to anaerobic respiration to generate ATP.

Solution: Step 1: Aerobic respiration is the primary pathway for ATP production in skeletal muscles, utilizing oxygen to completely break down glucose into carbon dioxide and water, yielding a large amount of ATP.

Step 2: During vigorous physical exercise, the demand for ATP increases significantly, and the oxygen supply may become insufficient to meet this demand.

Step 3: In such conditions, muscle cells resort to anaerobic respiration.

Step 4: In human skeletal muscle, anaerobic respiration involves the breakdown of glucose to pyruvate (glycolysis), followed by the reduction of pyruvate to lactic acid. This process regenerates NAD^+ , which is essential for glycolysis to continue, allowing for a limited but rapid production of ATP.

Step 5: Citric acid is an intermediate in the Krebs cycle (aerobic respiration). Acetic acid is found in vinegar. Pyruvic acid is the intermediate product before the formation of lactic acid in anaerobic respiration.

Final Answer: Lactic acid

Answer: (C)

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Q41.

Solution

Concept: Color blindness is an X-linked recessive trait. This means the gene responsible for normal color vision is located on the X chromosome, and the allele for color blindness is recessive. Males have XY chromosomes, while females have XX.

Solution: Step 1: Let X^B represent the allele for normal color vision (dominant) and X^b represent the allele for color blindness (recessive).

Step 2: The father is color-blind, so his genotype is X^bY . He passes his Y chromosome to his sons and his X^b chromosome to his daughters.

Step 3: The mother is a carrier, meaning she has one normal allele and one color-blind allele. Her genotype is X^BX^b . She can pass either X^B or X^b to her offspring.

Step 4: To have a color-blind daughter, the daughter must inherit the X^b chromosome from her father and the X^b chromosome from her mother.

Step 5: The father will always contribute X^b to his daughters. The mother will contribute X^b to her daughters with a probability of 50%.

Step 6: Therefore, the probability of a daughter being color-blind (inheriting X^b from both parents) is 50% (from mother) \times 100% (from father for daughters) = 50% for daughters. Out of all possible children, the probability of a color-blind daughter is 25% (she must be a daughter, which is 50% of children, and she must be color-blind, which is 50% of daughters).

Final Answer: 25

Answer: (B)

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Q42.

Solution

Concept: The lac operon is a unit of gene expression in bacteria that allows them to utilize lactose as an energy source. It consists of regulatory and structural genes. The operator is a key regulatory region that controls the transcription of structural genes.

Solution: Step 1: The lac operon includes a promoter region, where RNA polymerase binds to initiate transcription, and structural genes (lacZ, lacY, lacA) that code for enzymes involved in lactose metabolism.

Step 2: The operator is a DNA sequence located within or adjacent to the promoter.

Step 3: A regulatory protein, the lac repressor, produced by the lacI gene, can bind to the operator region.

Step 4: When the repressor protein is bound to the operator, it physically obstructs RNA polymerase, preventing it from transcribing the structural genes. This effectively "switches off" the operon.

Step 5: Therefore, the operator gene's primary role is to act as a binding site for the repressor protein, thereby controlling gene expression.

Final Answer: Binding site for repressor protein

Answer: (C)

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Q43.

Solution

Concept: Pollination is the transfer of pollen grains from the anther to the stigma. Different types of pollination are classified based on the source of pollen and the genetic relationship between the pollen donor and the recipient flower.

Solution: Step 1: Understand the definitions of the different types of pollination:

Autogamy: Self-pollination within the same flower.

Geitonogamy: Pollination between different flowers on the same plant. Genetically, it is similar to autogamy as the plant is genetically identical.

Xenogamy: Pollination between flowers on genetically different plants. This is cross-pollination where the pollen comes from a different individual.

Cleistogamy: Pollination that occurs when flowers remain closed and do not open. This ensures self-pollination.

Step 2: The question describes the transfer of pollen grains from the anther to the stigma of another flower of a genetically different plant. This explicitly defines xenogamy.

Final Answer: Xenogamy

Answer: (C)

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Q44.

Solution

Concept: Kidney failure impairs the ability of the kidneys to filter waste products from the blood. Dialysis is a medical procedure used to artificially perform this function.

Solution: Step 1: In kidney failure, the body accumulates toxic waste products and excess fluid, which can be life-threatening.

Step 2: Dialysis is a medical treatment that artificially purifies the blood when the kidneys are unable to do so effectively.

Step 3: The procedure involves circulating the patient's blood through a machine containing a semipermeable membrane. Waste products and excess fluid diffuse from the blood across this membrane into a dialysis fluid, while essential substances are retained in the blood.

Step 4: Ultrafiltration is a process of separating components of a fluid based on size using a semipermeable membrane, and is a part of dialysis and normal kidney function. Osmoregulation is the maintenance of osmotic balance. Reabsorption is the process within the nephron where useful substances are moved back into the blood. Dialysis is the overall artificial purification process.

Final Answer: Dialysis

Answer: (C)

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Q45.

Solution

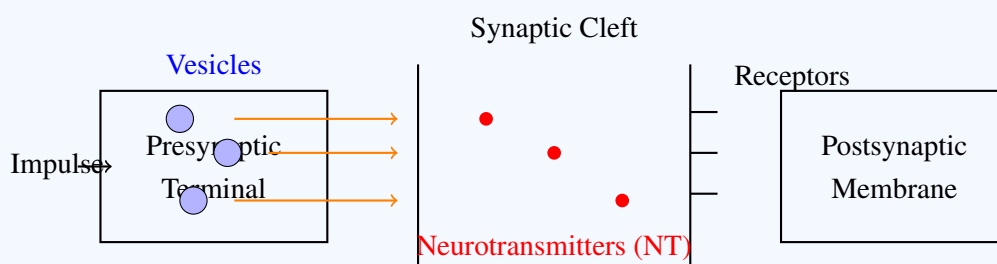
Concept: Communication between neurons occurs at specialized junctions called synapses. These junctions allow for the transmission of nerve impulses from one neuron to another, typically through chemical messengers.

Solution: Step 1: Neurons communicate with each other through electrical and chemical signals.
Step 2: A synapse is the junction between two neurons, or between a neuron and an effector cell (like a muscle or gland cell). It is the site where information is transmitted from one neuron to the next.

Step 3: At most synapses, the nerve impulse arrives at the axon terminal of the presynaptic neuron. This triggers the release of chemical messengers called neurotransmitters into the synaptic cleft (the small gap between the neurons).

Step 4: These neurotransmitters diffuse across the synaptic cleft and bind to receptors on the membrane of the postsynaptic neuron, either exciting or inhibiting it.

Step 5: Nodes of Ranvier are gaps in the myelin sheath along an axon that speed up nerve impulse conduction (saltatory conduction). Schwann cells are glial cells that form the myelin sheath in the peripheral nervous system. Dendrites are branched extensions of a neuron that receive signals from other neurons.



Chemical transmission occurs when neurotransmitters cross the synaptic cleft and bind to receptors on the postsynaptic membrane.

Final Answer: Synapse

Answer: (B)

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Q46.

Solution

Concept: Hormones are chemical messengers produced by endocrine glands that regulate various physiological processes. Growth hormone (GH), secreted by the pituitary gland, plays a critical role in growth and development.

Solution: Step 1: The question describes a condition caused by the excess secretion of growth hormone (GH) during childhood, leading to abnormal increases in height and body size.

Step 2: Let's examine the disorders related to growth hormone secretion:

Dwarfism: Caused by insufficient secretion of GH during childhood, resulting in significantly reduced stature.

Acromegaly: Caused by excess GH secretion **after** the epiphyseal plates have closed (in adulthood), leading to the enlargement of extremities (hands, feet) and facial features, but not increased height.

Gigantism: Caused by excess GH secretion **before** the epiphyseal plates have closed (during childhood and adolescence). This leads to abnormally long bones and excessive height, resulting in greatly increased stature.

Cretinism: Caused by severe hypothyroidism (underactive thyroid) during infancy or childhood, leading to stunted growth and intellectual disability.

Step 3: The description of abnormal increase in height and body size due to excess GH secretion during childhood precisely matches the definition of gigantism.

Final Answer: Gigantism

Answer: (C)

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Q47.

Solution

Concept: The menstrual cycle is regulated by a complex interplay of hormones, including those secreted by the hypothalamus, pituitary gland, and ovaries. Ovulation, the release of an egg, is triggered by a surge in a specific pituitary hormone.

Solution: Step 1: The menstrual cycle is regulated by hormones. Key pituitary hormones involved are Follicle-Stimulating Hormone (FSH) and Luteinizing Hormone (LH).

Step 2: FSH is responsible for the initial growth and development of ovarian follicles during the follicular phase. As follicles grow, they produce estrogen.

Step 3: A surge in estrogen levels towards the end of the follicular phase has a positive feedback effect on the pituitary gland.

Step 4: This positive feedback triggers a rapid and significant increase in the secretion of Luteinizing Hormone (LH). This LH surge is the primary trigger for ovulation, causing the mature follicle to rupture and release the egg.

Step 5: Prolactin is involved in milk production. Oxytocin plays a role in uterine contractions during labor and milk ejection. FSH initiates follicle development but does not directly induce ovulation.

Final Answer: LH

Answer: (C)

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Q48.

Solution

Concept: HIV (Human Immunodeficiency Virus) is a virus that attacks the immune system, specifically targeting helper T-lymphocytes (also known as CD4⁺ T cells). This progressive destruction of immune cells leads to a severely weakened immune system, a condition known as AIDS.

Solution: Step 1: The question describes a person infected with HIV who experiences a drastic reduction in helper T-lymphocytes, leading to a weakened immune system.

Step 2: Helper T-lymphocytes (CD4⁺ T cells) are crucial components of the adaptive immune system, coordinating immune responses.

Step 3: HIV specifically infects and destroys these helper T-cells. As the number of helper T-cells declines, the immune system's ability to fight off infections and diseases becomes severely compromised.

Step 4: The advanced stage of HIV infection, characterized by severe immune deficiency and opportunistic infections or cancers, is known as AIDS (Acquired Immunodeficiency Syndrome).

Step 5: Tuberculosis, malaria, and pneumonia are infectious diseases, but they are not the name of the disease condition itself associated with HIV's impact on the immune system. While these can be opportunistic infections in an AIDS patient, AIDS is the underlying condition of immune deficiency caused by HIV.

Final Answer: AIDS

Answer: (B)

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Q49.

Solution

Concept: Recombinant DNA technology, a cornerstone of modern biotechnology, involves the manipulation of DNA to create novel genetic combinations. The development of techniques for creating and replicating recombinant DNA has been a major scientific achievement.

Solution: Step 1: Recombinant DNA technology involves cutting DNA fragments and inserting them into vectors for replication. The development of this field has involved the contributions of many scientists.

Step 2: The question specifically asks about the scientists awarded the Nobel Prize for the discovery of recombinant DNA technology.

Step 3: Stanley Boyer and Herbert Cohen are credited with developing the first recombinant DNA molecule in 1973 and successfully introducing it into a bacterium, thereby demonstrating the feasibility of gene cloning. They were awarded the Nobel Prize in Physiology or Medicine in 1980 for their groundbreaking work in this area.

Step 4: Watson and Crick discovered the double helix structure of DNA. Kary Mullis developed the PCR technique. Meselson and Stahl proved semi-conservative DNA replication.

Final Answer: Boyer and Cohen

Answer: (B)

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Q50.

Solution

Concept: Gene cloning is the process of creating multiple copies of a specific DNA segment. This often involves inserting the DNA fragment into a self-replicating DNA molecule, known as a vector, which is then introduced into a host cell.

Solution: Step 1: Gene cloning requires a vehicle to carry the desired DNA fragment and replicate it within a host organism. This vehicle is called a cloning vector.

Step 2: The question describes a circular, self-replicating DNA molecule found in bacteria, used to carry a desired gene.

Step 3: Plasmids are small, circular, extrachromosomal DNA molecules commonly found in bacteria. They possess an origin of replication (ori), which allows them to replicate independently within the bacterial cell, making them ideal cloning vectors.

Step 4: A chromosome is the main genetic material within the nucleus of eukaryotic cells or the nucleoid region of prokaryotes. Nucleosomes are structures formed by DNA wrapped around histones in eukaryotes. Histones are proteins that package DNA. None of these function as vectors for gene cloning in the way plasmids do.

Final Answer: Plasmid

Answer: (B)

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Q51.

Solution

Concept: Ecological interactions describe the relationships between different species in an ecosystem. Commensalism is an interaction where one species benefits, and the other species is neither harmed nor helped.

Solution: Step 1: The scenario describes an orchid growing on a mango tree. The orchid benefits from the physical support and access to sunlight provided by the mango tree.

Step 2: Crucially, the orchid is described as "without obtaining nourishment from the host plant." This means the mango tree is not harmed by the orchid's presence.

Step 3: Let's analyze the types of ecological interactions:

Mutualism: Both species benefit (+/+). (e.g., Lichen: fungus + alga).

Parasitism: One species benefits, and the other is harmed (+/-). (e.g., Cuscuta on a plant, tapeworm in an intestine).

Commensalism: One species benefits, and the other is neither harmed nor significantly helped (+/0). (e.g., Barnacles on a whale, orchids or epiphytes on trees).

Predation: One species (predator) hunts and kills another species (prey) for food (+/-). (e.g., Tiger and deer).

Step 4: Since the orchid benefits (gains support and light exposure) and the mango tree is neither harmed nor helped, this interaction is a classic example of commensalism.

Final Answer: Commensalism

Answer: (C)

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Q52.

Solution

Concept: Plant growth regulators (PGRs) are small organic molecules that influence plant growth and development. They are often used by farmers to improve crop yield and quality. Gibberellins are known for their role in stem elongation.

Solution: Step 1: The farmer used a hormone on sugarcane that significantly promoted rapid internodal elongation and increased yield. We need to identify which plant growth regulator (PGR) is responsible for these effects.

Step 2: Let's consider the functions of the given PGRs:

Cytokinin: Primarily promotes cell division, shoot growth, and delays senescence. While it influences growth, it doesn't typically cause dramatic internodal elongation on its own.

Ethylene: Involved in fruit ripening, senescence, and abscission. It generally inhibits elongation in most cases.

Abscisic acid (ABA): Primarily acts as a stress hormone, inhibiting growth, promoting dormancy, and abscission. It counteracts the effects of growth-promoting hormones.

Gibberellin: A group of PGRs that promote stem elongation, seed germination, flowering, and fruit development. They are particularly known for their ability to cause rapid internodal elongation, which can increase sugarcane yield by increasing the length of the cane.

Step 3: The observed effect of rapid internodal elongation and increased yield in sugarcane strongly points to the application of gibberellins.

Final Answer: Gibberellin

Answer: (D)

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Q53.

Solution

Concept: Cell organelles are functional units within cells. Lysosomes are membrane-bound organelles containing hydrolytic enzymes that break down waste materials and cellular debris.

Solution: Step 1: The question describes a cell organelle characterized by the presence of hydrolytic enzymes capable of digesting worn-out organelles and foreign particles. It is also referred to as the "suicidal bag" of the cell.

Step 2: Let's identify the function of each organelle listed:

Ribosome: Responsible for protein synthesis.

Lysosome: Membrane-bound sacs containing a variety of hydrolytic enzymes (like proteases, nucleases, lipases, carbohydrases) that function optimally in an acidic environment. These enzymes break down waste materials, cellular debris, and foreign invaders (like bacteria). If the lysosomal membrane breaks, these enzymes can digest the cell itself, hence the term "suicidal bag."

Centrosome: Involved in cell division, organizing microtubules.

Golgi body: Modifies, sorts, and packages proteins and lipids for secretion or delivery to other organelles.

Step 3: The description perfectly matches the function and common name of the lysosome.

Final Answer: Lysosome

Answer: (B)

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Q54.

Solution

Concept: The endoplasmic reticulum (ER) is a network of membranes within eukaryotic cells. It exists in two forms: smooth ER and rough ER, distinguished by the presence or absence of ribosomes on their surface.

Solution: Step 1: The description mentions flattened membranous sacs arranged parallel to each other, with ribosomes attached to their surface. Electron microscopic studies are used to visualize such ultra-structural details.

Step 2: Let's identify the organelles based on the description:

Smooth endoplasmic reticulum (SER): A network of interconnected tubules and sacs, but it lacks ribosomes on its surface. It is involved in lipid synthesis, detoxification, and calcium storage.

Golgi apparatus: Consists of flattened, membrane-bound sacs called cisternae, typically arranged in a stack. It is involved in modifying, sorting, and packaging proteins and lipids. Ribosomes are not attached to its surface.

Rough endoplasmic reticulum (RER): A network of interconnected sacs and tubules that is studded with ribosomes on its outer surface. The attached ribosomes are involved in the synthesis of proteins that are destined for secretion, insertion into membranes, or delivery to other organelles. The flattened, parallel arrangement is characteristic of RER cisternae. Lysosome: A membrane-bound vesicle containing hydrolytic enzymes.

Step 3: The presence of flattened membranous sacs arranged in parallel, with attached ribosomes, is a defining characteristic of the rough endoplasmic reticulum.

Final Answer: Rough endoplasmic reticulum

Answer: (C)

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Q55.

Solution

Concept: Vascular bundles are the primary conducting tissues in plants, containing xylem and phloem. Their arrangement and the presence or absence of cambium distinguish different types of stems and roots.

Solution: Step 1: The question describes vascular bundles in dicot stems that are arranged in a ring and possess cambium between xylem and phloem.

Step 2: Let's analyze the terms used to describe vascular bundles:

Arrangement: In dicot stems, vascular bundles are typically arranged in a ring. In monocot roots and stems, they are often scattered. In roots, they are usually radial (xylem and phloem are on different radii).

Conjoint: Xylem and phloem are situated on the same radius, with phloem located towards the outside of the xylem. This is typical for stems.

Radial: Xylem and phloem are arranged on different radii, alternating with each other. This is typical for roots.

Open: Vascular bundles that possess cambium between the xylem and phloem. This cambium allows for secondary growth (increase in thickness).

Closed: Vascular bundles that lack cambium. They do not undergo secondary growth.

Exarch: In roots, the xylem is described as exarch if the protoxylem (the first formed xylem) is located towards the outside (periphery) and metaxylem (later formed xylem) is towards the inside (center).

Step 3: The description states vascular bundles are arranged in a ring (characteristic of stems) and are conjoint (xylem and phloem together on the same radius). They also possess cambium between xylem and phloem, which makes them open. Therefore, these vascular bundles are described as open and conjoint.

Final Answer: Open and conjoint

Answer: (B)

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Q56.

Solution

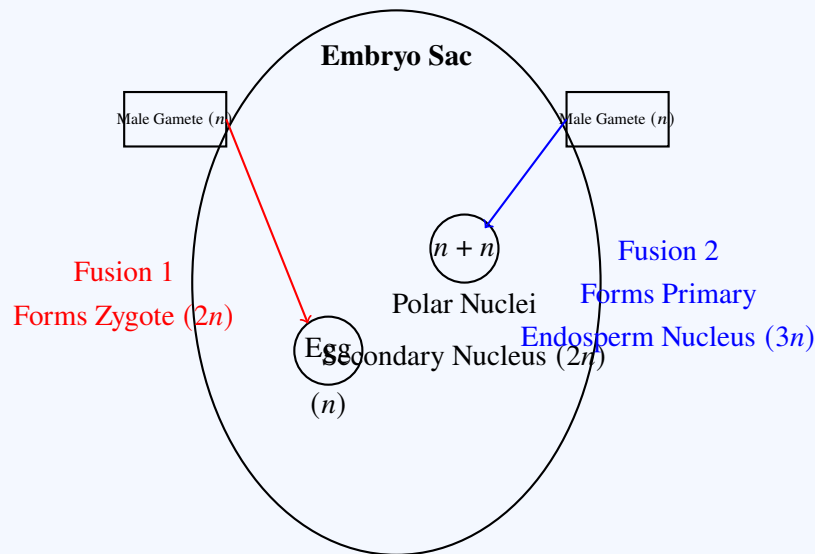
Concept: Double fertilization is a unique reproductive event in angiosperms, involving the fusion of two male gametes with two different structures within the embryo sac. This process leads to the formation of the zygote and the primary endosperm nucleus.

Solution: Step 1: Double fertilization is a characteristic feature of angiosperms and involves two fusion events inside the embryo sac.

Step 2: In the first fusion, one male gamete (n) fuses with the egg cell (n) to form a diploid zygote ($2n$), which later develops into the embryo.

Step 3: In the second fusion, the other male gamete (n) fuses with the secondary nucleus ($2n$) formed by the two polar nuclei. This produces a triploid primary endosperm nucleus ($3n$), which develops into the endosperm.

Step 4: Therefore, the fusion of one male gamete with the egg cell forms the diploid zygote. A haploid embryo, triploid embryo, or tetraploid endosperm are incorrect.



Double Fertilization:

One male gamete fuses with the egg cell to form the zygote, while the second male gamete fuses with the polar nuclei to form the primary endosperm nucleus.

Final Answer: Diploid zygote

Answer: (A)

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Q57.

Solution

Concept: The human circulatory system is a closed system where blood continuously circulates through the heart, lungs, and the rest of the body. The pulmonary circulation specifically deals with the transport of blood between the heart and the lungs for gas exchange.

Solution: Step 1: The lungs are the primary site of oxygen uptake and carbon dioxide removal from the blood. After gaseous exchange, the blood in the lungs becomes oxygenated.

Step 2: This oxygenated blood, rich in O_2 and low in CO_2 , needs to return to the heart to be pumped to the systemic circulation (rest of the body).

Step 3: The pulmonary veins are the blood vessels that carry oxygenated blood from the lungs. There are typically four pulmonary veins (two from each lung), which empty into the left atrium of the heart.

Step 4: In contrast, the pulmonary artery carries deoxygenated blood from the right ventricle to the lungs. The vena cavae (superior and inferior) bring deoxygenated blood from the body to the right atrium. The coronary sinus carries deoxygenated blood from the heart muscle itself to the right atrium.

Final Answer: Pulmonary vein

Answer: (B)

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Q58.

Solution

Concept: The heart's rhythmic contraction is initiated and coordinated by a specialized electrical conduction system. The sinoatrial (SA) node acts as the natural pacemaker, generating the electrical impulses that drive the heartbeat.

Solution: Step 1: The heart possesses an intrinsic electrical conduction system composed of specialized cardiac muscle cells that generate and transmit electrical impulses.

Step 2: The sinoatrial (SA) node, located in the superior posterior wall of the right atrium, is the primary pacemaker. It has the highest intrinsic rate of depolarization (automaticity), spontaneously generating electrical impulses at a rate of approximately 60-100 times per minute at rest.

Step 3: This impulse from the SA node spreads across the atrial walls, causing them to contract.

Step 4: The impulse then reaches the atrioventricular (AV) node, situated at the junction of the atria and ventricles. The AV node delays the impulse by about 0.1 seconds, allowing for complete atrial contraction before ventricular contraction begins.

Step 5: Following the AV node, the impulse travels down the Bundle of His (atrioventricular bundle) and then branches into the left and right bundle branches, which further divide into Purkinje fibers that distribute the impulse throughout the ventricular myocardium, causing coordinated ventricular contraction.

Step 6: While the AV node, Bundle of His, and Purkinje fibers are essential for conduction, the SA node is the pacemaker because it initiates the electrical impulse at the highest rate.

Final Answer: SA node

Answer: (C)

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Q59.

Solution

Concept: Glomerular filtration is the initial step in urine formation within the nephron. It is a pressure-driven process where fluid and small solutes are forced from the blood in the glomerulus into Bowman's capsule. The pressure gradient is a critical factor.

Solution: Step 1: The nephron, the functional unit of the kidney, performs filtration, reabsorption, and secretion to form urine.

Step 2: The renal corpuscle, consisting of the glomerulus and Bowman's capsule, is the site of glomerular filtration.

Step 3: The driving force for filtration is the net filtration pressure (NFP), which is the difference between the glomerular hydrostatic pressure (GHP) and the sum of the capsular hydrostatic pressure (CHP) and the blood colloid osmotic pressure (BCOP). $NFP = GHP - (CHP + BCOP)$.

Step 4: The glomerular hydrostatic pressure (GHP) is the blood pressure within the glomerular capillaries. This pressure is significantly higher (around 55 mmHg) than in other capillary beds due to the specific arrangement of the afferent arteriole (wider) and efferent arteriole (narrower), which creates resistance to outflow.

Step 5: This high GHP is the primary factor that enables filtration. Bowman's capsule is the receptacle for the filtered fluid, and while it experiences capsular hydrostatic pressure, the driving filtration pressure itself is highest within the glomerular capillaries where filtration occurs. PCT, DCT, and Loop of Henle are involved in subsequent tubular modification of the filtrate.

Final Answer: Bowman's capsule

Answer: (C)

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Q60.

Solution

Concept: Oxygen transport in the blood relies on specialized molecules called respiratory pigments, which have the ability to bind and release oxygen. In humans, hemoglobin is the principal pigment responsible for this function.

Solution: Step 1: Efficient transport of oxygen from the lungs to the tissues is essential for cellular respiration and survival.

Step 2: The blood contains respiratory pigments that facilitate this oxygen transport by reversibly binding with oxygen molecules.

Step 3: In humans, the most abundant and primary respiratory pigment is hemoglobin, located within red blood cells. Each molecule of hemoglobin can bind up to four molecules of oxygen.

Step 4: Other respiratory pigments exist in different organisms: Hemocyanin (containing copper) is found in some arthropods and mollusks. Myoglobin is an oxygen-binding protein found in muscle cells, serving as an oxygen reservoir. Hemerythrin is another oxygen-binding protein found in some marine invertebrates.

Final Answer: Hemoglobin

Answer: (B)

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Q61.

Solution

Concept: The human brain is a complex organ with distinct regions responsible for various functions. The hypothalamus, a small but vital structure, plays a central role in maintaining homeostasis by regulating fundamental physiological processes.

Solution: Step 1: The brain's different regions are specialized for specific tasks. We need to identify the region controlling body temperature and hunger.

Step 2: Cerebellum: Primarily involved in motor control, coordination, and balance.

Step 3: Medulla oblongata: Controls vital autonomic functions like breathing, heart rate, and blood pressure.

Step 4: Hypothalamus: This region, located at the base of the brain, is the main control center for homeostatic regulation. It contains centers that regulate body temperature (thermoregulation) by initiating responses like sweating or shivering. It also houses centers that control hunger and satiety, regulating appetite and food intake.

Step 5: Thalamus: Acts as a relay station for most sensory information reaching the cerebral cortex and plays a role in consciousness and sleep.

Final Answer: Hypothalamus

Answer: (C)

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Q62.

Solution

Concept: An action potential is the rapid rise and subsequent fall in membrane potential across a neuron's membrane. It is triggered when the membrane potential reaches a critical level called the threshold stimulus. This rapid depolarization is primarily due to the influx of sodium ions.

Solution: Step 1: Neurons maintain a resting membrane potential (polarized state) where the inside of the cell is negative relative to the outside.

Step 2: A stimulus causes a change in this potential. If the stimulus is sufficient to reach the threshold potential (typically around -55 mV for a neuron), it triggers the generation of an action potential.

Step 3: Reaching the threshold potential causes the rapid opening of voltage-gated sodium (Na^+) channels in the neuron's membrane.

Step 4: This opening allows a massive, rapid influx of positively charged Na^+ ions into the cell.

Step 5: The influx of positive charge causes rapid depolarization, leading to the rising phase of the action potential (becoming positive inside).

Step 6: While K^+ channels open later to cause repolarization, and Ca^{2+} and Cl^- ions have roles in other aspects of neuronal signaling, the sudden increase in Na^+ permeability is the direct cause of initiating the action potential at threshold.

Final Answer: Na^+ ions

Answer: (B)

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Q63.

Solution

Concept: The endocrine system is a network of glands that secrete hormones regulating various bodily functions. The pituitary gland, due to its control over many other endocrine glands, is often referred to as the "master gland."

Solution: Step 1: Endocrine glands produce and secrete hormones directly into the bloodstream, which then travel to target cells to regulate physiological processes.

Step 2: The pituitary gland, located at the base of the brain, is a small but highly influential endocrine gland.

Step 3: It is often called the "master gland" because it produces hormones that control the function of many other endocrine glands, including the thyroid gland, adrenal glands, ovaries, and testes. For example, it secretes tropic hormones like TSH (thyroid-stimulating hormone), ACTH (adrenocorticotropic hormone), FSH (follicle-stimulating hormone), and LH (luteinizing hormone).

Step 4: While the thyroid, adrenal, and pineal glands are important endocrine glands, they do not exert the same broad regulatory control over the entire endocrine system as the pituitary gland.

Final Answer: Pituitary

Answer: (B)

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Q64.

Solution

Concept: Blood groups are determined by the presence or absence of specific antigens (A, B, Rh) on the surface of red blood cells and corresponding antibodies in the plasma. Understanding these can predict the blood groups of offspring.

Solution: Step 1: Determine the possible gametes produced by each parent.

Man with blood group AB: His genotype is AB. He can produce gametes with either the A allele or the B allele.

Woman with blood group O: Her genotype is OO. She can produce gametes only with the O allele.

Step 2: Set up a Punnett square to show the possible combinations of alleles in the offspring:

	A	B
O	AO	BO
O	AO	BO

Step 3: Analyze the genotypes of the offspring:

AO genotype results in blood group A (since A is dominant over O).

BO genotype results in blood group B (since B is dominant over O).

Step 4: Therefore, the children can have either blood group A or blood group B. They cannot have blood group AB because the father cannot contribute an A allele and the mother cannot contribute a B allele. They cannot have blood group O because neither parent has the O allele to contribute to both gametes.

Final Answer: A and B

Answer: (C)

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Q65.

Solution

Concept: Antidiuretic hormone (ADH), also known as vasopressin, is a crucial hormone produced by the hypothalamus and released by the posterior pituitary. Its primary function is to regulate water reabsorption in the kidneys, thereby controlling body water balance and urine concentration.

Solution: Step 1: ADH's main role is to increase the permeability of specific segments of the nephron to water, allowing for greater water reabsorption from the filtrate back into the bloodstream.

Step 2: The primary target sites for ADH action are the distal convoluted tubules (DCT) and, more significantly, the collecting ducts of the nephron.

Step 3: In these segments, ADH binds to receptors and triggers the insertion of aquaporin water channels into the apical (luminal) membranes of the epithelial cells. This significantly enhances water reabsorption, especially when the body is dehydrated and ADH levels are high.

Step 4: While ADH can have some minor effects on the ascending limb of the loop of Henle, its principal and most potent action is on the collecting duct system. It does not directly act on the proximal convoluted tubule (PCT) or the glomerulus to influence water reabsorption.

Final Answer: Collecting duct

Answer: (C)

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Q66.

Solution

Concept: Blood groups are determined by the presence of antigens on red blood cells and antibodies in the plasma. A universal recipient is an individual whose blood type can be transfused into individuals of any blood type without causing a significant immune reaction.

Solution: Step 1: Blood transfusions are safe only when the donor's red blood cells do not agglutinate (clump) in the recipient's plasma. Agglutination occurs if the recipient's antibodies react against the donor's antigens.

Step 2: The ABO blood group system involves antigens A and B on red blood cells and corresponding antibodies anti-A and anti-B in the plasma.

Group O has no A or B antigens but has both anti-A and anti-B antibodies.

Group A has A antigens and anti-B antibodies.

Group B has B antigens and anti-A antibodies.

Group AB has both A and B antigens but neither anti-A nor anti-B antibodies.

Step 3: The Rh factor is determined by the Rh antigen. Rh-positive individuals have the antigen, while Rh-negative individuals do not. Rh-negative individuals can develop anti-Rh antibodies if exposed to Rh-positive blood.

Step 4: A universal recipient must lack antibodies against all common antigens. Individuals with blood group AB⁺ have both A and B antigens, and the Rh antigen on their red blood cells. Crucially, their plasma lacks anti-A, anti-B, and anti-Rh antibodies. Therefore, they can accept red blood cells from donors of any ABO and Rh blood type (O⁻, O⁺, A⁻, A⁺, B⁻, B⁺, AB⁻, AB⁺).

Final Answer: AB⁺

Answer: (B)

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Q67.

Solution

Concept: Muscle contraction involves the interaction between actin and myosin filaments, a process regulated by calcium ions and a complex of regulatory proteins, troponin and tropomyosin.

Solution: Step 1: In a relaxed skeletal muscle, myosin-binding sites on the actin filaments are blocked by the tropomyosin-troponin complex, preventing myosin from attaching to actin.

Step 2: Muscle contraction is initiated by a nerve impulse, which leads to the release of calcium ions (Ca^{2+}) from the sarcoplasmic reticulum into the sarcoplasm.

Step 3: These released Ca^{2+} ions bind specifically to one of the subunits of the troponin complex.

Step 4: This binding causes a conformational change in the troponin complex.

Step 5: This conformational change is transmitted to tropomyosin, causing it to shift its position and unblock the myosin-binding sites on the actin filaments.

Step 6: Once the binding sites are exposed, myosin heads can bind to actin, leading to the formation of cross-bridges and the subsequent sliding of filaments, resulting in muscle contraction.

Final Answer: Troponin

Answer: (C)

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Q68.

Solution

Concept: Spermatogenesis is the complex process by which male gametes (spermatozoa) are produced from diploid spermatogonia. This process involves mitotic proliferation, growth, and two meiotic divisions, culminating in the differentiation of spermatids into mature sperm. Reduction division (meiosis) is critical for halving the chromosome number.

Solution: Step 1: Spermatogenesis begins with diploid germ cells called spermatogonia ($2n$) located in the seminiferous tubules of the testes.

Step 2: The multiplication phase involves mitotic divisions of spermatogonia to produce more spermatogonia, ensuring a continuous supply of cells for sperm production.

Step 3: Following multiplication, spermatogonia enter a growth phase, during which they grow in size and prepare for meiosis. A spermatogonium that has completed growth and entered meiosis is called a primary spermatocyte.

Step 4: The maturation phase encompasses the meiotic divisions. The primary spermatocyte ($2n$) undergoes the first meiotic division, which is a reductional division (Meiosis I). This division reduces the chromosome number by half, producing two haploid secondary spermatocytes (n).

Step 5: Each secondary spermatocyte then undergoes the second meiotic division, which is an equational division (Meiosis II), producing two haploid spermatids (n) each. In total, one primary spermatocyte yields four spermatids.

Step 6: Finally, spermatids undergo a process of differentiation called spermiogenesis to become mature spermatozoa. This entire sequence of growth and division leading to mature sperm is considered part of the maturation phase. Therefore, reduction division is part of the maturation phase.

Final Answer: Maturation phase

Answer: (C)

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Q69.

Solution

Concept: Human chorionic gonadotropin (hCG) is a key hormone produced during pregnancy. Its primary role is to maintain the corpus luteum, which is essential for sustaining the early stages of pregnancy. The source of hCG is the developing placental tissue.

Solution: Step 1: Following fertilization, the zygote undergoes cleavage and develops into a blastocyst. The outer layer of the blastocyst, the trophoblast, is crucial for implantation and the formation of the placenta.

Step 2: After the blastocyst implants in the uterine wall, the trophoblast cells differentiate and proliferate to form the initial structure of the placenta.

Step 3: The trophoblast cells of the developing placenta are the primary source of human chorionic gonadotropin (hCG).

Step 4: hCG's main function is to signal the corpus luteum in the ovary to continue producing progesterone and estrogen. These hormones are vital for maintaining the uterine lining (endometrium) and preventing menstruation, thereby supporting the pregnancy.

Step 5: The corpus luteum is stimulated by hCG; it does not secrete hCG itself. The pituitary gland regulates the ovarian cycle before pregnancy but does not secrete hCG during pregnancy. The ovary (corpus luteum) is indirectly involved but not the direct producer of hCG in pregnancy.

Final Answer: Placenta

Answer: (B)

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Q70.

Solution

Concept: Contraception aims to prevent pregnancy by interfering with various stages of reproduction, including ovulation, fertilization, and implantation. Different methods have distinct mechanisms of action.

Solution: Step 1: The process of reproduction involves ovulation, fertilization (fusion of sperm and egg), and implantation (attachment of the blastocyst to the uterine wall). Contraceptives work by blocking one or more of these steps.

Step 2: We examine the mechanism of each option:

Copper-T (Intrauterine Device - IUD): Copper ions released by the IUD create a hostile environment in the uterus that is toxic to sperm and eggs, thereby preventing fertilization.

Crucially, it also alters the uterine lining, making it unreceptive to the implantation of a fertilized egg (blastocyst).

Condom: A barrier method that physically prevents sperm from entering the female reproductive tract, thus inhibiting fertilization.

Vasectomy: A surgical procedure in males that severs or blocks the vas deferens, preventing sperm from being transported out of the testes. This prevents fertilization.

Tubectomy: A surgical procedure in females that severs or blocks the fallopian tubes, preventing the egg from reaching the uterus and sperm from reaching the egg. This prevents fertilization.

Step 3: The question specifically asks which method prevents implantation. The Copper-T is unique among these options in that it directly interferes with the implantation process.

Final Answer: Copper-T

Answer: (A)

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Q71.

Solution

Concept: Sexually transmitted diseases (STDs), also known as sexually transmitted infections (STIs), are caused by a variety of pathogens, including bacteria, viruses, fungi, and protozoa. Identifying the causative agent is important for diagnosis and treatment.

Solution: Step 1: Let's identify the causative agent for each listed STD:

AIDS (Acquired Immunodeficiency Syndrome): Caused by the Human Immunodeficiency Virus (HIV), which is a retrovirus (a type of virus).

Syphilis: Caused by the bacterium *Treponema pallidum*.

Genital herpes : Caused by the Herpes Simplex Virus (HSV), which is a virus.

Hepatitis – B : Caused by the Hepatitis B virus (HBV), which is a virus.

Step 2: The question asks for an STD caused by a bacterium. Based on the analysis, Syphilis fits this description.

Final Answer: Syphilis

Answer: (B)

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Q72.

Solution

Concept: Gene expression involves the process of transcription, where a DNA sequence is copied into an RNA molecule. In eukaryotes, this initial RNA transcript (pre-mRNA) undergoes processing, including splicing, to remove non-coding regions.

Solution: Step 1: In eukaryotic gene expression, transcription produces a precursor mRNA molecule (pre-mRNA).

Step 2: This pre-mRNA contains both coding regions, which are translated into proteins, and non-coding regions, which are not translated.

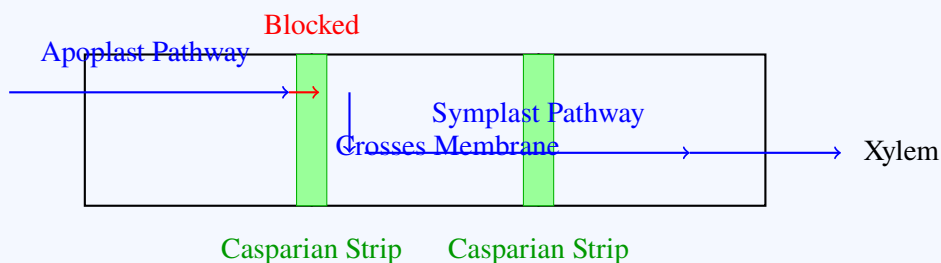
Step 3: Before translation, the pre-mRNA undergoes processing. One critical step is splicing, where the non-coding sequences are removed and the coding sequences are joined together.

Step 4: The coding sequences that are retained in the mature mRNA and are translated into protein are called exons.

Step 5: The non-coding sequences that are removed from the pre-mRNA during splicing are called introns.

Step 6: Codons are three-base sequences on mRNA that specify amino acids. Anticodons are found on tRNA and are complementary to codons. Cistrons are segments of DNA that code for a polypeptide. Operons are functional units of genetic expression in prokaryotes.

Casparian Strip in Endodermis



Casparian strips block water movement through cell walls and force water to enter the symplast by crossing the plasma membrane.

Final Answer: Codon

Answer: (B)

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Q73.

Solution

Concept: Plant growth regulators (hormones) play critical roles in various developmental processes, including aging (senescence) and the shedding of plant parts (abscission). Different hormones have distinct, and sometimes opposing, effects.

Solution: Step 1: Consider the primary roles of each hormone:

Auxin: Primarily involved in cell elongation, root formation, and apical dominance. It generally delays senescence and abscission when present in sufficient concentrations.

Cytokinin: Promotes cell division and differentiation, delays senescence, and can counteract the effects of auxin in some contexts.

Ethylene: A gaseous hormone known to promote ripening of fruits, senescence of leaves and flowers, and abscission of fruits, flowers, and leaves. It is considered the senescence and abscission-promoting hormone.

Gibberellin: Primarily involved in stem elongation, germination, and flowering. It can counteract some senescence effects.

Step 2: The question asks for the hormone that most effectively promotes senescence and abscission. Ethylene is well-known for its role in inducing these processes.

Final Answer: Ethylene

Answer: (C)

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Q74.

Solution

Concept: The Calvin cycle (light-independent reactions) and the light-dependent reactions of photosynthesis are interconnected processes. Molecules are cycled between these two stages: ATP and NADPH produced in the light reactions are consumed in the Calvin cycle, while ADP and NADP^+ are produced in the Calvin cycle and utilized in the light reactions. The question asks about a molecule formed in the dark reaction and consumed in the light reaction.

Solution: Step 1: Photosynthesis involves two main stages: the light-dependent reactions and the Calvin cycle (dark reactions).

Step 2: The light-dependent reactions capture light energy and use it to produce ATP (adenosine triphosphate) and NADPH (nicotinamide adenine dinucleotide phosphate). These molecules store chemical energy and reducing power.

Step 3: The Calvin cycle utilizes the ATP and NADPH generated during the light reactions to fix atmospheric carbon dioxide (CO_2) and synthesize sugars.

Step 4: During the Calvin cycle, ATP is hydrolyzed to ADP (adenosine diphosphate) and inorganic phosphate (Pi), and NADPH is oxidized to NADP^+ . Thus, ADP and NADP^+ are formed during the Calvin cycle.

Step 5: ADP and NADP^+ are then transported back to the light-dependent reactions, where they serve as substrates for the synthesis of ATP and NADPH, respectively. In the light reactions, ADP is phosphorylated to ATP, and NADP^+ is reduced to NADPH. Therefore, ADP and NADP^+ are consumed during the light-dependent reactions.

Step 6: Among the given options, ADP is formed during the dark reaction and consumed during the light reaction. RuBP is consumed and regenerated within the Calvin cycle. ATP and NADPH are produced in the light reactions and consumed in the dark reactions.

Final Answer: ADP

Answer: (C)

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Q75.

Solution

Concept: The Calvin cycle, also known as the light-independent reactions or dark reactions of photosynthesis, is a series of biochemical reactions that convert carbon dioxide into glucose. The cycle begins with the fixation of CO_2 onto a five-carbon sugar.

Solution: Step 1: The Calvin cycle begins with the carboxylation of ribulose-1,5-bisphosphate (RuBP), a five-carbon sugar, by the enzyme RuBisCO.

Step 2: This reaction produces an unstable six-carbon intermediate, which immediately breaks down into two molecules of 3-phosphoglycerate (3-PGA) or 3-phosphoglyceric acid.

Step 3: 3-PGA is a three-carbon molecule and is considered the first stable product of the Calvin cycle.

Step 4: These 3-PGA molecules are then further processed through reduction and regeneration steps to produce sugars and regenerate RuBP.

Step 5: Oxaloacetic acid is involved in the C_4 pathway. Pyruvic acid is a product of glycolysis. Ribulose phosphate is part of RuBP.

Final Answer: Phosphoglyceric acid

Answer: (B)

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Q76.

Solution

Concept: DNA replication is a semi-conservative process where each parental DNA strand serves as a template for the synthesis of a new complementary strand. DNA polymerase can only synthesize DNA in the 5' to 3' direction.

Solution: Step 1: DNA replication occurs bidirectionally from an origin of replication. The two parental DNA strands are antiparallel (one runs 5' to 3', the other 3' to 5').

Step 2: DNA polymerase requires a free 3'-OH group to add nucleotides and can only synthesize new DNA strands in the 5' to 3' direction.

Step 3: The leading strand is synthesized continuously in the 5' to 3' direction, following the replication fork.

Step 4: The lagging strand runs in the 3' to 5' direction relative to the replication fork movement. Because DNA polymerase can only synthesize in the 5' to 3' direction, the lagging strand must be synthesized discontinuously in short fragments, called Okazaki fragments. Each fragment starts with an RNA primer laid down by primase.

Step 5: Helicase unwinds the DNA, but it doesn't cause the fragmentation. DNA polymerase initiates synthesis on a primer, and primase synthesizes the primers. The discontinuous synthesis is a direct consequence of the antiparallel nature of the DNA and the unidirectional activity of DNA polymerase.

Final Answer: One strand is discontinuously synthesized

Answer: (B)

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Q77.

Solution

Concept: DNA replication involves multiple enzymes, each with a specific role. After Okazaki fragments are synthesized on the lagging strand, they need to be joined together to form a continuous DNA molecule.

Solution: Step 1: DNA replication on the lagging strand occurs discontinuously, producing short DNA fragments called Okazaki fragments.

Step 2: Each Okazaki fragment is synthesized by DNA polymerase III (in prokaryotes), starting from an RNA primer synthesized by primase.

Step 3: DNA polymerase I then removes the RNA primers and replaces them with DNA nucleotides.

Step 4: However, after the RNA primers are replaced, there are still nicks (gaps) between the DNA fragments.

Step 5: DNA ligase is the enzyme responsible for sealing these nicks by forming phosphodiester bonds between the adjacent Okazaki fragments, thus creating a continuous DNA strand.

Step 6: Topoisomerase relaxes the supercoiling of DNA. Primase synthesizes RNA primers. DNA polymerase I has a role in primer removal and repair, but ligase is the primary enzyme for joining fragments.

Final Answer: DNA ligase

Answer: (B)

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Q78.

Solution

Concept: Hardy-Weinberg equilibrium is a principle that describes the genetic makeup of a population that is not evolving. It states that allele and genotype frequencies will remain constant from generation to generation in the absence of specific evolutionary influences. Evolution, therefore, is indicated by a change in these frequencies.

Solution: Step 1: The Hardy-Weinberg equilibrium principle predicts that in a non-evolving population, the allele frequencies and genotype frequencies will remain constant over time.

Step 2: Evolution, by definition, is a change in the genetic composition of a population over successive generations.

Step 3: The genetic composition is defined by the frequencies of different alleles and genotypes within the population.

Step 4: Therefore, if the allele frequencies or genotype frequencies change from one generation to the next, it indicates that the population is undergoing evolution.

Step 5: Population density, biomass, and carrying capacity are ecological factors that can be influenced by evolution but do not directly indicate evolutionary change in the genetic sense described by Hardy-Weinberg equilibrium.

Final Answer: Allele frequency

Answer: (B)

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Q79.

Solution

Concept: DNA replication is semi-conservative, meaning that each new DNA molecule consists of one parental strand and one newly synthesized strand. This was experimentally demonstrated by Meselson and Stahl.

Solution: Step 1: The semi-conservative model of DNA replication, proposed by Watson and Crick, suggested that each new DNA molecule would contain one old strand and one new strand. Step 2: Matthew Meselson and Franklin Stahl designed an elegant experiment in 1958 to test this hypothesis.

Step 3: They grew bacteria (*Escherichia coli*) in a medium containing a heavy isotope of nitrogen (^{15}N) for many generations, so that all their DNA incorporated ^{15}N .

Step 4: They then transferred these bacteria to a medium containing a light isotope of nitrogen (^{14}N) and allowed them to replicate for one, two, and subsequent generations.

Step 5: By centrifuging the DNA from each generation in a cesium chloride density gradient, they observed that after one generation, the DNA was a hybrid ($^{15}\text{N}/^{14}\text{N}$), and after two generations, it was a mixture of hybrid ($^{15}\text{N}/^{14}\text{N}$) and light ($^{14}\text{N}/^{14}\text{N}$) DNA. This pattern of density distribution supported the semi-conservative replication model.

Step 6: Griffith's experiment demonstrated bacterial transformation. Hershey and Chase used radioactive isotopes to prove that DNA, not protein, is the genetic material. Watson and Crick proposed the double helix structure and the semi-conservative model but did not experimentally prove it.

Final Answer: Meselson and Stahl

Answer: (C)

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Q80.

Solution

Concept: Meiosis is a type of cell division that reduces the chromosome number by half and is essential for sexual reproduction. It involves two successive divisions, Meiosis I and Meiosis II. Meiosis I is further divided into prophase I, metaphase I, anaphase I, and telophase I. Prophase I is a complex stage with several substages.

Solution: Step 1: Meiosis I begins with Prophase I, which is the longest and most complex phase of meiosis.

Step 2: Prophase I is divided into five substages:

Leptotene: Chromosomes begin to condense and become visible.

Zygotene: Homologous chromosomes begin to pair up, forming synaptonemal complexes, a process called synapsis.

Pachytene: Homologous chromosomes are fully synapsed and appear as bivalents (or tetrads). Crossing over, the exchange of genetic material between non-sister chromatids of homologous chromosomes, occurs during this stage.

Diplotene: Homologous chromosomes begin to separate, but remain attached at points called chiasmata, which represent the sites of crossing over.

Diakinesis: Chromosomes condense further, and the nuclear envelope breaks down.

Step 3: The question asks specifically when crossing over occurs. This event is characteristic of the pachytene stage.

Final Answer: Pachytene

Answer: (C)

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Q81.

Solution

Concept: Evolutionary biology often identifies "connecting links" as fossil or living organisms that exhibit traits of two distinct groups, suggesting a transitional phase in their evolutionary history.

Solution: Step 1: The question asks for a connecting link between reptiles and birds. This implies an organism that possesses characteristics of both groups.

Step 2: Consider the options provided:

Peripatus: This is an invertebrate, considered a connecting link between annelids and arthropods.

Archaeopteryx: This is a well-known fossil animal that exhibits a remarkable combination of reptilian and avian features. It has teeth, a long bony tail, and claws on its wings (reptilian traits), as well as feathers and a furcula (wishbone) (avian traits). It is widely regarded as a transitional fossil between reptiles and birds.

Neopilina: This is a mollusc, sometimes considered a connecting link between annelids and other molluscs.

Balanoglossus: This is a hemichordate, considered a connecting link between invertebrates and chordates.

Step 3: Based on its evolutionary significance and its mix of reptilian and avian characteristics, Archaeopteryx is recognized as the connecting link between reptiles and birds.

Final Answer: Archaeopteryx

Answer: (B)

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Q82.

Solution

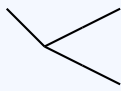
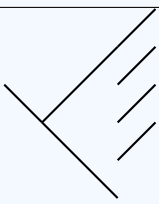
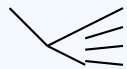
Concept: Energy transfer between trophic levels in an ecosystem follows specific ecological laws. The 10% law, proposed by Raymond Lindeman, describes the efficiency of energy transfer.

Solution: Step 1: The question describes a food chain (grass → grasshopper → frog → snake) and mentions the progressive increase in energy at higher trophic levels as per the 10% law.

Step 2: The 10% law of energy transfer states that only about 10% of the energy from one trophic level is transferred to the next trophic level. The remaining energy is lost, mainly as heat during metabolic processes.

Step 3: This concept of energy transfer efficiency and the quantification of energy flow through ecosystems was pioneered by Raymond Lindeman in his seminal work on trophic dynamics in Cedar Bog Lake in 1942. He established the concept of ecological energetics.

Step 4: Odum (E.P. Odum) was a prominent ecologist who further developed ecological concepts, including energy flow and ecosystem structure. Elton (Charles Elton) contributed significantly to the understanding of food chains and ecological pyramids. Darwin is known for the theory of evolution by natural selection. While all are important scientists in biology, Lindeman is specifically credited with the quantitative study of energy transfer efficiency through trophic levels.

Human Forelimb (Grasping)	Bat Wing (Flying)	Whale Flipper (Swimming)
		
Homologous Organs: These organs have a similar structural plan and common ancestry, but perform different functions in different organisms.		

Final Answer: Lindeman

Answer: (B)

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Q83.

Solution

Concept: Blood clotting, also known as coagulation, is a vital process that stops bleeding from an injured blood vessel. It involves a cascade of enzymatic reactions involving plasma proteins.

Solution: Step 1: Blood clotting is a complex physiological process initiated when a blood vessel is injured.

Step 2: The process involves a series of reactions involving plasma proteins, clotting factors, and platelets.

Step 3: Initially, a cascade leads to the activation of a clotting factor called prothrombin. Step 4: Activated prothrombin (thrombin) then acts on a soluble plasma protein called fibrinogen, converting it into insoluble fibrin.

Step 5: Fibrin forms a meshwork of fibers that traps blood cells (red blood cells, white blood cells, platelets) and plasma, forming a clot that seals the wound and stops bleeding.

Step 6: Heparin is an anticoagulant that prevents clotting. Globulins are a diverse group of plasma proteins, some involved in immunity, but fibrinogen is the specific precursor to fibrin in the clotting cascade.

Final Answer: Fibrinogen

Answer: (B)

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Q84.

Solution

Concept: Genetically modified (GM) crops are developed to enhance desirable traits like pest resistance, herbicide tolerance, or improved nutritional value. These modifications are achieved through biotechnological techniques that alter the plant's genetic material.

Solution: Step 1: The question describes a transgenic crop variety developed for herbicide tolerance and insect resistance, reducing the need for chemical pesticides. This indicates genetic modification.

Step 2: Let's examine the biotechnological approaches mentioned:

Tissue culture: A technique used to grow plant cells, tissues, or organs in sterile culture media under controlled conditions. It is useful for micropropagation, virus eradication, and sometimes for producing haploids or transgenic plants via genetic transformation steps, but it's not the primary method for introducing entire traits like pest resistance.

Hybridization: The process of crossing different varieties or species to combine desirable traits. This is a conventional breeding method, not directly genetic engineering.

Recombinant DNA technology: This is the core technology for genetic modification. It involves isolating specific genes (like the Bt gene for insect resistance or genes for herbicide tolerance) and inserting them into the plant's genome using vectors. This allows for the direct transfer of desired traits.

Artificial selection: A process where humans selectively breed organisms with desired traits over many generations. This is a classical breeding technique, not genetic engineering.

Step 3: The development of crops with traits like herbicide tolerance and insect resistance, achieved by introducing specific genes, is primarily accomplished through recombinant DNA technology (also known as genetic engineering).

Final Answer: Recombinant DNA technology

Answer: (C)

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Q85.

Solution

Concept: The development of vaccines has been a cornerstone of modern medicine in combating infectious diseases. Several pioneering scientists have made seminal contributions to this field.

Solution: Step 1: Understanding the contributions of each scientist to vaccination:

Edward Jenner: In the late 18th century, Jenner pioneered the concept of vaccination by observing that milkmaids who contracted cowpox seemed immune to smallpox. He then deliberately inoculated a boy with cowpox material and later exposed him to smallpox, demonstrating immunity. This led to the development of the smallpox vaccine.

Louis Pasteur: In the 19th century, Pasteur developed the principles of pasteurization and further advanced vaccine development by creating attenuated (weakened) vaccines for diseases like rabies and anthrax.

Jonas Salk: In the mid-20th century, Jonas Salk developed the first widely successful inactivated polio vaccine (IPV), administered by injection. Later, Albert Sabin developed an oral polio vaccine using live-attenuated virus.

Robert Koch: Koch is renowned for identifying the specific causative agents (bacteria) of major infectious diseases like tuberculosis and cholera, and for establishing Koch's postulates, a set of criteria to prove a specific microorganism causes a specific disease. He was not directly involved in developing the polio vaccine.

Step 2: The question specifically asks who prepared the first vaccine against polio. Jonas Salk is the scientist credited with this achievement.

Final Answer: Jonas Salk

Answer: (C)

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Q86.

Solution

Concept: Immunoglobulins, or antibodies, are Y-shaped proteins crucial for the adaptive immune response. They are classified into different classes (IgA, IgM, IgG, IgE, IgD), each with specific functions and properties. One of these classes can traverse the placental barrier.

Solution: Step 1: The immune system protects the fetus from infections. Passive immunity can be transferred from mother to fetus.

Step 2: Immunoglobulins (antibodies) are responsible for humoral immunity. There are five main classes: IgA, IgM, IgG, IgE, and IgD.

Step 3: Let's consider the properties of each class in relation to placental transfer:

IgA: Primarily found in mucosal secretions (like saliva, tears, breast milk) and plays a role in mucosal immunity. It does not cross the placenta.

IgM: It is a large molecule, typically existing as a pentamer. Its size prevents it from crossing the placenta. It is the first antibody produced during a primary immune response.

IgG: This is the most abundant immunoglobulin in the blood serum and is the only class that can actively cross the placental barrier. This transfer provides the fetus with passive immunity against various pathogens the mother has encountered.

IgE: Primarily involved in allergic reactions and defense against parasites. It does not cross the placenta.

Step 4: Therefore, IgG is the immunoglobulin that can cross the placenta.

Final Answer: IgG

Answer: (C)

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Q87.

Solution

Concept: Bt cotton is a genetically modified crop engineered to produce a protein derived from the bacterium *Bacillus thuringiensis* (Bt). This protein acts as an insecticide, providing resistance against specific insect pests.

Solution: Step 1: Bt cotton is developed by inserting a gene from *Bacillus thuringiensis* into the cotton plant's genome. This gene codes for a Cry protein (crystal protein), which is toxic to certain insects when ingested.

Step 2: The Bt toxin is highly specific and primarily targets certain types of insect larvae that feed on the plant.

Step 3: The Bt toxin is particularly effective against lepidopteran pests, which include various types of caterpillars. The cotton bollworm (*Helicoverpa armigera* and related species) is a major agricultural pest that feeds on cotton bolls. Bt cotton is engineered to be resistant to these bollworms.

Step 4: While Bt toxins can have effects on other insects, they are not generally effective against aphids (which are sap-sucking insects, hemipterans), nematodes (microscopic roundworms), or pathogens like the fungus causing white rust.

Final Answer: Bollworm

Answer: (B)

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Q88.

Solution

Concept: Recombinant DNA technology, the cornerstone of modern biotechnology, involves cutting DNA at specific sites and joining fragments to create new DNA molecules. Restriction enzymes are essential tools for this process.

Solution: Step 1: Gene cloning and manipulation require the ability to cut DNA precisely.

Step 2: Restriction enzymes, also known as restriction endonucleases, are enzymes that recognize specific short sequences of DNA (called restriction sites) and cleave the DNA molecule at or near these sites.

Step 3: Different restriction enzymes recognize different DNA sequences, allowing scientists to cut DNA into specific fragments. This ability to perform precise cuts is analogous to using scissors for molecular work. Hence, they are often referred to as "molecular scissors."

Step 4: Molecular probes are short nucleic acid sequences used to detect the presence of complementary sequences. Cloning vectors (like plasmids) are DNA molecules that carry foreign DNA into host cells. Ligases are enzymes that join DNA fragments together by forming phosphodiester bonds.

Final Answer: Molecular scissors

Answer: (A)

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Q89.

Solution

Concept: The Polymerase Chain Reaction (PCR) is a powerful and widely used technique in molecular biology that allows for the amplification of specific DNA sequences. Its development revolutionized genetic research and diagnostics.

Solution: Step 1: The Polymerase Chain Reaction (PCR) is a method to exponentially amplify a specific target DNA sequence in vitro.

Step 2: This technique involves repeated cycles of DNA denaturation (heating), primer annealing (cooling), and DNA synthesis (extension by DNA polymerase).

Step 3: The development of the PCR technique, including the use of thermostable DNA polymerase (like Taq polymerase), is credited to Kary Mullis. He published his groundbreaking work on PCR in 1985, for which he later received the Nobel Prize in Chemistry.

Step 4: Har Gobind Khorana was instrumental in deciphering the genetic code. Watson and Wilkins determined the double helix structure of DNA.

Final Answer: Kary Mullis

Answer: (B)

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Q90.

Solution

Concept: Gene cloning, a fundamental technique in biotechnology, involves making multiple copies of a specific DNA fragment. This requires a suitable vehicle, known as a cloning vector, to carry the DNA fragment into a host cell for replication.

Solution: Step 1: Gene cloning aims to isolate and amplify a specific DNA sequence. This is typically achieved by inserting the DNA fragment of interest into a cloning vector.

Step 2: The vector then introduces this recombinant DNA into a host organism (usually bacteria), where it can be replicated along with the host's own DNA.

Step 3: Among the various types of cloning vectors, plasmids are the most commonly used. Plasmids are small, circular, extrachromosomal DNA molecules found naturally in bacteria. They possess an origin of replication, allowing them to be replicated independently within the host cell. They can also be easily manipulated using restriction enzymes and ligases.

Step 4: Ribosomes are cellular machinery for protein synthesis, lysosomes are organelles for degradation, and centrosomes are involved in cell division. These are not DNA molecules and cannot function as cloning vectors.

Final Answer: Plasmid

Answer: (A)

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Q91.

Solution

Concept: Ecological succession is the directional and predictable process of change in the species structure of an ecological community over time. It involves the colonization and replacement of species, starting from a bare or disturbed area and progressing towards a stable climax community.

Solution: Step 1: Ecological succession begins with the colonization of a habitat that is either newly formed (like volcanic rock or sand dunes) or has been severely disturbed (like a burnt forest or cleared land). Such areas lack a pre-existing community.

Step 2: The first organisms to establish themselves in these barren environments are called pioneer species. These are typically hardy organisms with traits that allow them to survive in harsh conditions, such as the ability to colonize bare soil, fix nitrogen, or tolerate extreme temperatures. Examples include lichens and mosses on bare rock.

Step 3: The community formed by these initial colonizers is termed the pioneer community. This community plays a vital role in modifying the environment, such as creating soil, adding organic matter, and altering microclimatic conditions.

Step 4: Over time, the modifications made by the pioneer community facilitate the establishment of new species, leading to a series of intermediate communities known as seral communities or seres. This gradual process continues until a stable, self-perpetuating community, the climax community, is reached, which is in equilibrium with its environment. An ecotone is a transitional area between two distinct ecosystems.

Final Answer: Pioneer community

Answer: (B)

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Q92.

Solution

Concept: Ecological pyramids are graphical representations that illustrate the trophic structure of an ecosystem. They can depict the number of organisms, the total biomass, or the flow of energy at each trophic level. The pyramid of energy is a fundamental representation of ecological efficiency.

Solution: Step 1: Ecological pyramids are used to visualize the relationships between different trophic levels in an ecosystem. The base of the pyramid represents the producers, followed by primary consumers, secondary consumers, and so on, towards the apex.

Step 2: The pyramid of energy quantifies the amount of energy available at each trophic level. Energy flows from producers to consumers.

Step 3: A critical principle of energy flow in ecosystems is the loss of energy at each trophic transfer. A significant portion of the energy consumed at one trophic level is used for metabolic activities (respiration, movement, etc.) and is dissipated as heat. Typically, only about 10% of the energy from one trophic level is incorporated into the biomass of the next trophic level.

Step 4: Due to this progressive energy loss at each transfer, the amount of energy available decreases significantly as one moves up the trophic levels. Consequently, the producer trophic level always contains the most energy, and subsequent trophic levels contain progressively less energy.

Step 5: This consistent pattern of decreasing energy at higher trophic levels results in an upright pyramid of energy, where the base is broad and tapers towards the apex. Pyramids of numbers and biomass can sometimes be inverted or irregular depending on the specific ecosystem.

Final Answer: Upright

Answer: (C)

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Q93.

Solution

Concept: Biomagnification, also known as bioamplification, is the process by which certain substances, particularly persistent and toxic chemicals, increase in concentration in organisms at successively higher trophic levels within a food chain or food web.

Solution: Step 1: Biomagnification specifically refers to the accumulation and increasing concentration of persistent toxic substances in the tissues of living organisms as they move up through the food chain. Step 2: These substances are often poorly metabolized or excreted, meaning they remain in the organism's body for extended periods.

Step 3: When producers (organisms at the lowest trophic level, typically plants or algae) absorb these toxins from the environment (e.g., water, soil), they accumulate in their tissues.

Step 4: Primary consumers (herbivores) then ingest producers. Since they consume large quantities of producers to meet their energy needs, the toxins are transferred and become more concentrated in the primary consumers' bodies.

Step 5: This process is repeated at each subsequent trophic level. Secondary consumers that eat primary consumers accumulate even higher concentrations of the toxin, and tertiary consumers accumulate the highest concentrations. Thus, the concentration of these toxic substances increases at successive trophic levels. Abiotic components are non-living parts of the environment and are not directly involved in this biological accumulation process.

Final Answer: Successive trophic levels

Answer: (C)

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Q94.

Solution

Concept: Ecological interactions describe the relationships between different species within an ecosystem. These interactions can be beneficial, harmful, or neutral to the species involved. Mutualism is a type of interaction where both participating species benefit.

Solution: Step 1: Let's analyze the ecological interaction in each option:

Cuscuta on hedge plant: Cuscuta is a parasitic plant that obtains nutrients and water from a host plant. The host plant is harmed, while Cuscuta benefits. This is an example of parasitism (+/-).

Lichen association: Lichens are formed by a symbiotic relationship between a fungus and an alga or cyanobacterium. The alga (or cyanobacterium) performs photosynthesis, providing food for both partners, while the fungus provides protection, structure, and absorbs water and minerals. Both partners benefit from this interaction, making it a classic example of mutualism (+/+).

Tiger and deer: This represents a predator-prey relationship. The tiger (predator) benefits by obtaining food, while the deer (prey) is harmed by being killed and eaten. This is a predation relationship (+/-).

Tapeworm in intestine: Tapeworms are endoparasites that live inside the digestive tract of their hosts. They absorb digested food, benefiting themselves while harming the host by depriving it of nutrients. This is another example of parasitism (+/-).

Step 2: The question asks for an example of mutualism. The lichen association is the only interaction where both species involved benefit.

Final Answer: Lichen association

Answer: (B)

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Q95.

Solution

Concept: The ozone layer in the Earth's stratosphere plays a vital role in absorbing harmful ultraviolet (UV) radiation from the sun. Its depletion, primarily caused by human-made chemicals, has significant environmental implications.

Solution: Step 1: The ozone layer is crucial for protecting life on Earth by filtering out most of the sun's damaging UV-B and UV-C radiation.

Step 2: Ozone depletion refers to the significant decrease in the concentration of ozone (O₃) in the stratosphere, particularly noticeable over the polar regions (ozone holes).

Step 3: Scientific consensus points to chlorofluorocarbons (CFCs) and related halocarbons (like halons) as the main culprits responsible for ozone depletion. These compounds are synthesized chemicals that were widely used in the past in refrigerants, aerosol propellants, solvents, and fire extinguishers.

Step 4: When CFCs reach the stratosphere, they are broken down by UV radiation, releasing highly reactive chlorine atoms. A single chlorine atom can catalyze the destruction of thousands of ozone molecules through a chain reaction, leading to significant ozone thinning.

Step 5: Carbon dioxide and methane are greenhouse gases contributing to global warming. Sulfur dioxide is a major air pollutant contributing to acid rain. While these substances impact the environment, CFCs are the direct cause of ozone layer depletion.

Final Answer: Chlorofluorocarbons

Answer: (C)

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Q96.

Solution

Concept: The five-kingdom system of classification, proposed by R.H. Whittaker, categorizes all living organisms into Monera, Protista, Fungi, Plantae, and Animalia based on their cellular structure, mode of nutrition, and body organization.

Solution: Step 1: Let's review the characteristics of each kingdom relevant to the options:

Monera: Contains prokaryotic organisms (lacking a true nucleus and membrane-bound organelles). Examples include bacteria and cyanobacteria (like Nostoc).

Protista: Contains eukaryotic organisms that are primarily unicellular but can be colonial or simple multicellular. This kingdom is a diverse catch-all for organisms that don't fit into the other eukaryotic kingdoms. Examples include protozoa (like Amoeba) and some algae (like Volvox).

Fungi: Eukaryotic, heterotrophic organisms that absorb nutrients from their environment. This kingdom includes yeasts, molds (like Rhizopus), and mushrooms.

Plantae: Eukaryotic, multicellular organisms that are autotrophic (photosynthetic).

Animalia: Eukaryotic, multicellular organisms that are heterotrophic and ingest their food.

Step 2: Evaluate each option based on kingdom classification:

Nostoc: A cyanobacterium, which is prokaryotic. Belongs to Monera.

Amoeba: A unicellular, eukaryotic protozoan. Belongs to Protista.

Rhizopus: A multicellular fungus (mold). Belongs to Fungi.

Volvox: A colonial green alga, which is eukaryotic. Belongs to Protista.

Step 3: The question asks which belongs to kingdom Protista. Both Amoeba and Volvox are correct examples of organisms in kingdom Protista. In such cases, it is common for one answer to be considered the "primary" or most archetypal example in introductory biology. Amoeba is a quintessential example of a unicellular protozoan protist.

Final Answer: Amoeba

Answer: (B)

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Q97.

Solution

Concept: In plant anatomy, the endodermis is a specialized layer of cells found in the roots and stems of vascular plants. It is characterized by the presence of Casparian strips, which regulate the passage of water and solutes into the vascular cylinder.

Solution: Step 1: The plant root structure, from outermost to innermost, generally consists of the epidermis, cortex, endodermis, pericycle, and vascular tissues (xylem and phloem).

Step 2: The endodermis forms the innermost layer of the cortex and surrounds the vascular cylinder.

Step 3: A defining feature of endodermal cells is the presence of Casparian strips. These are ribbon-like, thickened areas within the radial and transverse cell walls, impregnated with suberin and lignin.

Step 4: Casparian strips are impermeable to water and dissolved solutes. This means that water and minerals absorbed by the root epidermis and traveling through the apoplast pathway (cell walls) are forced to cross the plasma membrane of the endodermal cells and enter the symplast pathway (cytoplasm) before reaching the vascular tissues. This selective barrier allows the plant to regulate the uptake of substances into the xylem.

Step 5: The pericycle is the layer just inside the endodermis, responsible for lateral root formation. The cortex is the region between the epidermis and endodermis. The epidermis is the outermost protective layer.

Final Answer: Endodermis

Answer: (B)

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Q98.

Solution

Concept: Meiosis is a two-stage cell division process essential for sexual reproduction. Meiosis I separates homologous chromosomes, while Meiosis II separates sister chromatids. The division of the centromere is a critical event in the separation of sister chromatids.

Solution: Step 1: Meiosis involves two consecutive nuclear divisions, Meiosis I and Meiosis II, following DNA replication during the preceding interphase.

Step 2: In Anaphase-I, homologous chromosomes (each consisting of two sister chromatids) are pulled apart towards opposite poles of the cell. The centromeres holding the sister chromatids together do not divide at this stage.

Step 3: In Metaphase-I, homologous chromosome pairs align at the metaphase plate. The centromeres are intact.

Step 4: In Telophase-I, the cell divides, resulting in two haploid cells, but each chromosome still consists of two sister chromatids.

Step 5: In Anaphase-II, the centromeres that hold the sister chromatids together finally divide. The sister chromatids then separate and are individually referred to as chromosomes, moving to opposite poles of the cell. This is the first time the centromere divides during meiosis.

Step 6: Therefore, the centromere divides first during Anaphase-II.

Final Answer: Anaphase-II

Answer: (C)

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Q99.

Solution

Concept: Carbohydrates can be classified based on their reducing properties. Reducing sugars possess a free aldehyde or ketone group that can reduce oxidizing agents, while non-reducing sugars do not have such a free group.

Solution: Step 1: The distinction between reducing and non-reducing sugars lies in the presence or absence of a free anomeric carbon with an aldehyde or ketone group. This free group allows the sugar to act as a reducing agent.

Step 2: Monosaccharides, such as glucose and fructose, are always reducing sugars because they possess a free aldehyde or ketone group.

Step 3: Disaccharides are formed by the glycosidic linkage of two monosaccharides. If the anomeric carbon of at least one of the monosaccharide units is free (not involved in the glycosidic bond), the disaccharide is a reducing sugar.

Maltose: A disaccharide of glucose linked $\alpha(1 \rightarrow 4)$. The anomeric carbon of one glucose unit is free, making maltose a reducing sugar.

Lactose: A disaccharide of galactose and glucose linked $\beta(1 \rightarrow 4)$. The anomeric carbon of the glucose unit is free, making lactose a reducing sugar.

Sucrose: A disaccharide formed from glucose and fructose. The glycosidic bond is between the anomeric carbon of glucose (C1) and the anomeric carbon of fructose (C2). Since both anomeric carbons are involved in the glycosidic linkage, there is no free aldehyde or ketone group. Therefore, sucrose is a non-reducing sugar.

Final Answer: Sucrose

Answer: (D)

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Q100.

Solution

Concept: Fertilization in humans is the process where a sperm cell fuses with an egg cell to form a zygote. This typically occurs in the female reproductive tract, specifically within the fallopian tubes.

Solution: Step 1: In the human female reproductive system, ovulation releases a mature egg (ovum) from the ovary.

Step 2: This ovum is then picked up by the fimbriated end of the fallopian tube (oviduct) and begins to travel towards the uterus.

Step 3: During sexual intercourse, sperm are deposited in the vagina and travel through the cervix into the uterus, and then into the fallopian tubes.

Step 4: Fertilization, the fusion of the sperm nucleus with the egg nucleus, usually occurs in the ampulla of the fallopian tube. The ampulla is the wider, outer part of the fallopian tube, located distally to the uterus. The infundibulum is the funnel-shaped opening near the ovary, and it leads into the ampulla. The junction of the ampulla and isthmus (the narrower part of the tube closer to the uterus) is also a common site for fertilization. The term "Infundibulum-Ampulla junction" covers this critical fertilization region.

Step 5: The uterus is where implantation of the blastocyst occurs, not fertilization. The cervix is the lower part of the uterus, and the vagina is the passageway for sperm deposition and childbirth.

Final Answer: Infundibulum-Ampulla junction

Answer: (C)

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Answer Key

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

