

MHT-CET Biology Sample Paper- 10

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 characteristic feature of the gametophyte of bryophytes that distinguishes it from the gametophyte of pteridophytes is:

- (A) Presence of vascular tissues
- (B) Independent existence from the sporophyte
- (C) Requirement of water for fertilization
- (D) Photosynthetic nature

Q2. In a dicot root showing secondary growth, the cork cambium (phellogen) usually originates from the activity of:

- (A) Epidermal cells
- (B) Cortical cells
- (C) Pericycle cells
- (D) Endodermal cells

Q3. Which of the following represents the correct floral formula for the family Fabaceae?

- (A) $\%K_{(5)} C_{1+2+(2)} A_{(9)+1} \underline{G}_1$
- (B) $\oplus K_{(5)} C_{(5)} A_5 \underline{G}_{(2)}$



(C) ${}^{\circ}K_5 C_5 A_{10} \underline{G}_1$

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

Q4. During the S-phase of the cell cycle in animal cells, which of the following events occurs simultaneously in the nucleus and the cytoplasm?

(A) DNA replication and Centriole duplication

(B) RNA synthesis and Protein synthesis

(C) DNA replication and Histone synthesis

(D) Centromere division and DNA replication

Q5. The fluid mosaic model states that the "quasi-fluid" nature of lipids enables lateral movement of proteins. This ability to move within the membrane is measured as its:

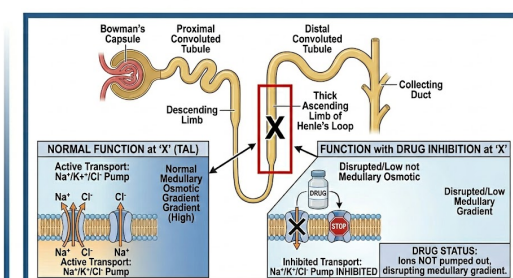
(A) Permeability

(B) Fluidity

(C) Elasticity

(D) Selective Translocation

Q6. Observe the provided diagram of the human nephron. If a drug inhibits the active transport of ions in the region labeled 'X' (the Thick Ascending Limb of Henle's Loop), what is the most likely physiological consequence?



(A) The urine becomes highly concentrated.

(B) The medullary osmotic gradient is disrupted, resulting in dilute urine.

(C) Glucose begins to appear in the urine (glycosuria).

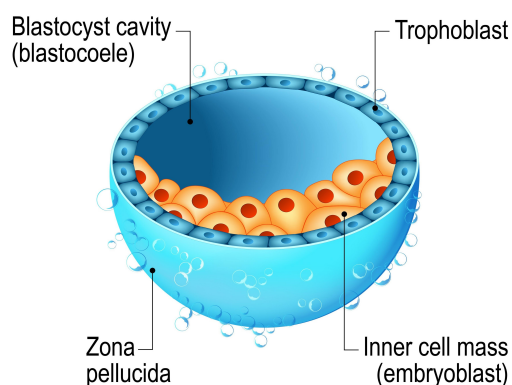


- (D) The pH of the blood increases significantly.
- Q7.** In the electron transport system (ETS) of mitochondria, Cytochrome *c* acts as a mobile carrier for transfer of electrons between:
- (A) Complex I and Complex II
 - (B) Complex II and Complex III
 - (C) Complex III and Complex IV
 - (D) Complex IV and Complex V
- Q8.** If a plant cell with $\Psi_s = -15$ bars and $\Psi_p = 5$ bars is placed in a solution with $\Psi_w = -12$ bars, the net movement of water will be:
- (A) Out of the cell
 - (B) Into the cell
 - (C) No net movement
 - (D) Movement will depend on the temperature
- Q9.** A cross between a red-flowered plant and a white-flowered plant produces all pink offspring. When these pink plants are selfed, the phenotypic ratio is 1:2:1. This is a classic example of:
- (A) Complete dominance
 - (B) Epistasis
 - (C) Incomplete dominance
 - (D) Codominance
- Q10.** Which of the following is a "molecular glue" used to join DNA fragments by forming phosphodiester bonds?
- (A) DNA Polymerase I
 - (B) Restriction Endonuclease
 - (C) DNA Ligase
 - (D) Alkaline Phosphatase



- Q11.** In the PCR technique, the process of 'Annealing' requires a temperature of approximately:
- (A) 94°C
 - (B) 50–60°C
 - (C) 72°C
 - (D) 40°C
- Q12.** The transition from a diploid sporophyte to a haploid gametophyte in angiosperms occurs specifically during which process?
- (A) Germination of the pollen grain
 - (B) Microsporogenesis and Megasporogenesis
 - (C) Formation of the primary endosperm nucleus
 - (D) Syngamy and Triple fusion
- Q13.** In the diagram of the human blastocyst shown below, identify the layer labeled 'A' and its primary functional role during implantation.

BLASTOCYST



- (A) Inner cell mass; forms the embryo proper.
- (B) Trophoblast; secretes enzymes for implantation and forms the chorion.
- (C) Blastocoele; provides nourishment to the epiblast.
- (D) Zona pellucida; prevents ectopic pregnancy.



- Q14.** In a plant species that exhibits self-incompatibility, which of the following pollination mechanisms is strictly prohibited?
- (A) Xenogamy
 - (B) Geitonogamy
 - (C) Autogamy
 - (D) Both Autogamy and Geitonogamy
- Q15.** Which specific layer of the microsporangium wall provides nourishment to the developing pollen grains and contains cells that are often multinucleate?
- (A) Endothecium
 - (B) Middle layers
 - (C) Tapetum
 - (D) Epidermis
- Q16.** What is the fate of the two male gametes released into the synergid?
- (A) One fuses with the egg, the other degenerates.
 - (B) One fuses with the egg, the other fuses with the central cell nuclei.
 - (C) Both fuse with the egg cell.
 - (D) One fuses with the synergid, the other with the egg.
- Q17.** Which part of the embryo is situated above the level of attachment of the scutellum in a grass embryo?
- (A) Coleorhiza
 - (B) Radicle
 - (C) Epicotyl
 - (D) Hypocotyl
- Q18.** The phenomenon where the ovary develops into a fruit without fertilization is known as:



- (A) Apomixis
- (B) Parthenocarpy
- (C) Parthenogenesis
- (D) Polyembryony

Q19. The filiform apparatus is a characteristic feature of:

- (A) Antipodal cells
- (B) Egg cell
- (C) Synergids
- (D) Zygote

Q20. If an angiospermic male plant is diploid and the female plant is tetraploid, the ploidy level of the endosperm will be:

- (A) $3n$
- (B) $4n$
- (C) $5n$
- (D) $6n$

Q21. In a test cross involving an F_1 dihybrid, the appearance of parental phenotypes in significantly higher frequency than recombinant phenotypes indicates:

- (A) Independent assortment
- (B) Linkage between the two genes
- (C) Epistatic interaction
- (D) Multiple allelism

Q22. How many types of gametes will be produced by an individual with the genotype $AaBbCcDd$ if the genes A and B are completely linked?

- (A) 4
- (B) 8



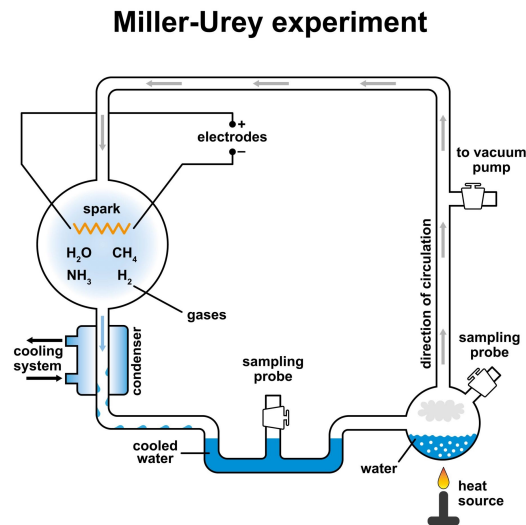
(C) 16

(D) 32

Q23. According to the chromosomal theory of inheritance, which behavior of chromosomes is parallel to the behavior of genes?

- (A) Crossing over during Prophase II
- (B) Pairing and separation during Meiosis
- (C) Segregation during Mitosis
- (D) Fragmentation during Amitosis

Q24. The following diagram illustrates the "Miller-Urey Experiment." Which specific organic molecules were identified in the liquid at the end of the experiment (labeled 'B')?



- (A) Long-chain polysaccharides
- (B) Amino acids like Glycine, Alanine, and Aspartic acid
- (C) Complex double-stranded DNA
- (D) Fully functional ribozymes

Q25. The distance between two genes on a chromosome is measured in map units. One centiMorgan (cM) is equivalent to:

- (A) 1% recombination frequency
- (B) 10% recombination frequency
- (C) 100% recombination frequency
- (D) 0.1% recombination frequency

Q26. Which Mendelian law is considered universal and has no known exceptions?

- (A) Law of Dominance
- (B) Law of Segregation
- (C) Law of Independent Assortment
- (D) Law of Unit Characters

Q27. Which of the following enzymes is used to remove the phosphate group from the 5' end of a linearized plasmid to prevent self-ligation?

- (A) DNA Ligase
- (B) Reverse Transcriptase
- (C) Alkaline Phosphatase
- (D) Exonuclease III

Q28. The 'Ti' plasmid, used extensively in plant genetic engineering, is naturally found in:

- (A) Escherichia coli
- (B) Agrobacterium tumefaciens
- (C) Bacillus thuringiensis
- (D) Thermus aquaticus

Q29. During DNA gel electrophoresis, DNA fragments move toward the anode because:

- (A) DNA is positively charged
- (B) DNA is negatively charged due to phosphate groups



- (C) The anode is the negative electrode
- (D) Smaller fragments are attracted to the cathode

Q30. What is the specific role of 'Ethidium Bromide' in biotechnology?

- (A) To cut DNA at specific sites
- (B) To visualize DNA under UV light
- (C) To act as a selectable marker
- (D) To denature the DNA double helix

Q31. In the context of PCR, the primers are:

- (A) Double-stranded DNA sequences
- (B) Small, chemically synthesized oligonucleotides
- (C) Protein molecules that initiate replication
- (D) Specific restriction enzymes

Q32. Downstream processing in biotechnology includes which of the following stages?

- (A) Gene isolation and cloning
- (B) Separation and purification of the product
- (C) Culturing cells in a bioreactor
- (D) Insertion of the gene into the host

Q33. In an ecosystem, the rate of production of organic matter during photosynthesis is termed as:

- (A) Net Primary Productivity (NPP)
- (B) Gross Primary Productivity (GPP)
- (C) Secondary Productivity
- (D) Net Community Productivity



- Q34.** According to Gause's Competitive Exclusion Principle, two species competing for the same limiting resources cannot coexist if:
- (A) Their niches are identical
 - (B) They have different predatory habits
 - (C) One species is larger than the other
 - (D) They reproduce at different times of the year
- Q35.** The pyramid of energy is always upright because:
- (A) Energy is gained at each higher trophic level
 - (B) Energy is lost as heat at each trophic level transfer
 - (C) Producers have the lowest energy content
 - (D) Carnivores have the highest energy content
- Q36.** An association where one species is harmed and the other remains unaffected is known as:
- (A) Commensalism
 - (B) Amensalism
 - (C) Parasitism
 - (D) Mutualism
- Q37.** Which of the following is an example of 'Ex-situ' conservation of biodiversity?
- (A) National Parks
 - (B) Wildlife Sanctuaries
 - (C) Seed Banks
 - (D) Biosphere Reserves
- Q38.** The 'Sixth Extinction' currently in progress is different from previous mass extinctions because it is:
- (A) Occurring at a much slower rate



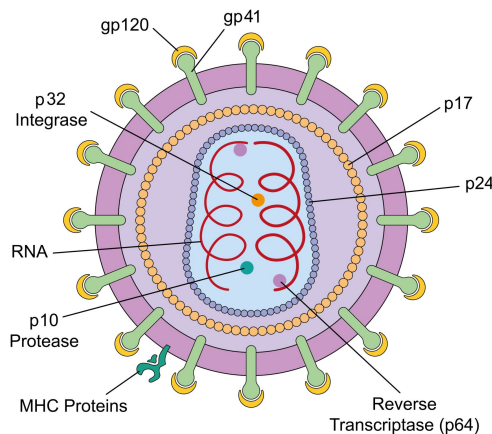
- (B) Primarily caused by human activities
- (C) Due to natural volcanic eruptions
- (D) Limited only to marine species

Q39. In a pond ecosystem, if the GPP is 100 units, and the respiration loss (R) is 20 units, the NPP available to herbivores is:

- (A) 120 units
- (B) 80 units
- (C) 50 units
- (D) 10 units

Q40. Identify the pathogen shown in the image below and the specific cells it targets within the human immune system.

Human Immunodeficiency Virus (HIV)



- (A) *Plasmodium*; targets Red Blood Cells.
- (B) HIV; targets Helper T-lymphocytes (T_H cells).
- (C) *Salmonella*; targets intestinal epithelial cells.
- (D) *Microsporium*; targets keratinized layers of the skin.

Q41. Which of the following describes the 'Chloride Shift' (Hamburger phenomenon) correctly in the context of CO_2 transport?



- (A) Cl^- moves from plasma to RBCs to maintain ionic balance when HCO_3^- moves out.
- (B) Cl^- moves from RBCs to plasma to facilitate the binding of O_2 to Hemoglobin.
- (C) HCO_3^- moves into RBCs to neutralize the acidity of Carbonic acid.
- (D) Cl^- binds with Hemoglobin to displace CO_2 in the lungs.

Q42. In the human kidney, the 'Counter-Current Multiplier' mechanism primarily relies on the active transport of sodium in the:

- (A) Descending limb of Henle's loop
- (B) Proximal Convoluted Tubule (PCT)
- (C) Ascending limb of Henle's loop
- (D) Collecting duct

Q43. A person suffering from 'Diabetes Insipidus' shows symptoms of polydipsia and polyuria. This condition is caused by the hyosecretion of:

- (A) Insulin from the Pancreas
- (B) Glucagon from the Pancreas
- (C) ADH (Vasopressin) from the Neurohypophysis
- (D) Aldosterone from the Adrenal Cortex

Q44. During skeletal muscle contraction, the hydrolysis of ATP by the Myosin head allows it to:

- (A) Bind to the Actin filament (Cross-bridge formation)
- (B) Release from the Actin filament
- (C) Perform the "Power Stroke"
- (D) Move Tropomyosin away from the active site

Q45. Which part of the human brain is responsible for controlling the "Urge for eating" and "Thermoregulation"?



- (A) Thalamus
- (B) Corpus Callosum
- (C) Hypothalamus
- (D) Medulla Oblongata

Q46. The 'Bohr Effect' refers to the shift in the Oxygen-Hemoglobin dissociation curve to the right when:

- (A) $p\text{CO}_2$ decreases and pH increases
- (B) $p\text{CO}_2$ increases and pH decreases
- (C) $p\text{O}_2$ increases and temperature decreases
- (D) $p\text{O}_2$ decreases and pH increases

Q47. Which hormone is responsible for the contraction of the gallbladder to release bile into the duodenum?

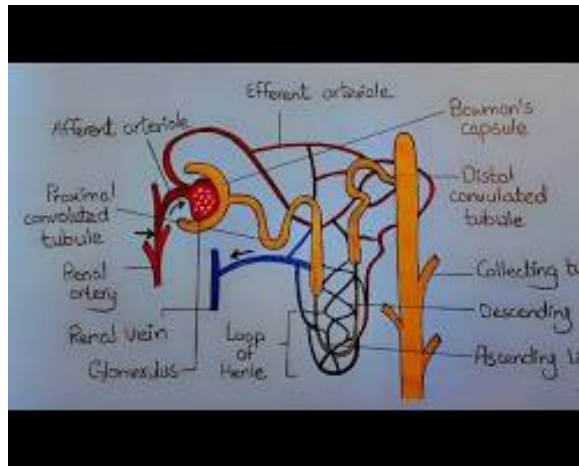
- (A) Gastrin
- (B) Secretin
- (C) Cholecystokinin (CCK)
- (D) Enterogastrone

Q48. The depolarization of a neuron occurs due to the:

- (A) Efflux of K^+ ions
- (B) Influx of Na^+ ions
- (C) Efflux of Na^+ ions
- (D) Influx of Cl^- ions

Q49. In the provided diagram of the nephron, which labeled part is responsible for the conditional reabsorption of Na^+ and water under the influence of Aldosterone and ADH?





- (A) Proximal Convoluted Tubule
- (B) Descending limb of Henle's loop
- (C) Distal Convoluted Tubule
- (D) Bowman's Capsule

Q50. The function of 'Enterokinase' enzyme is the conversion of:

- (A) Proteins into Polypeptides
- (B) Trypsinogen into Trypsin
- (C) Caseinogen into Casein
- (D) Pepsinogen into Pepsin

Q51. The secretory phase in the human menstrual cycle is also called the luteal phase and lasts for about:

- (A) 5 days
- (B) 13 days
- (C) 10 days
- (D) 7 days

Q52. The 'Capacitation' of sperm occurs in the:

- (A) Epididymis
- (B) Vas deferens



- (C) Female reproductive tract
- (D) Rete testis

Q53. Which hormone is detected in a pregnancy test kit to confirm conception?

- (A) Estrogen
- (B) Progesterone
- (C) Human Chorionic Gonadotropin (hCG)
- (D) Luteinizing Hormone (LH)

Q54. The fluid-filled cavity found in a Tertiary Follicle is known as:

- (A) Zona pellucida
- (B) Antrum
- (C) Corpus albicans
- (D) Stroma

Q55. What is the correct sequence of embryonic development?

- (A) Zygote → Morula → Blastocyst → Gastrula
- (B) Zygote → Blastocyst → Morula → Gastrula
- (C) Zygote → Gastrula → Morula → Blastocyst
- (D) Zygote → Morula → Gastrula → Blastocyst

Q56. The function of 'Inhibin' in males is to:

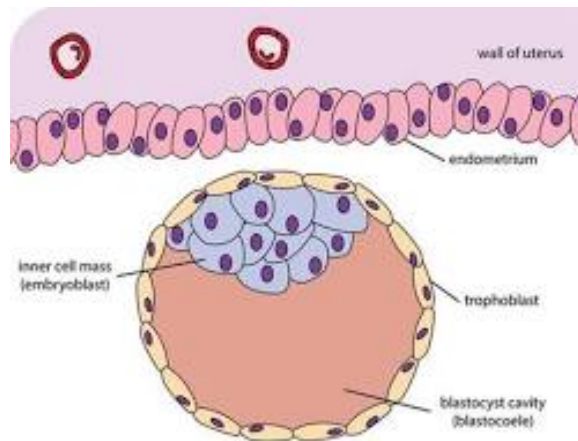
- (A) Stimulate the secretion of LH
- (B) Inhibit the secretion of FSH
- (C) Stimulate Spermatogenesis directly
- (D) Inhibit Testosterone production

Q57. The "Industrial Melanism" observed in the peppered moth (*Biston betularia*) is a classic example of:



- (A) Stabilizing Selection
- (B) Directional Selection
- (C) Disruptive Selection
- (D) Genetic Drift

Q58. In the blastocyst diagram below, identify the layer that will eventually form the chorionic villi and the fetal portion of the placenta.



- (A) Inner cell mass
 - (B) Trophoblast
 - (C) Blastocoel
 - (D) Zona Pellucida
- Q59.** The wings of a bird and the wings of an insect are considered:
- (A) Homologous structures (Divergent evolution)
 - (B) Analogous structures (Convergent evolution)
 - (C) Vestigial structures
 - (D) Phylogenetic structures
- Q60.** Which of the following was the most significant trend in the evolution of modern humans (*Homo sapiens*)?
- (A) Binocular vision
 - (B) Upright posture



- (C) Increase in cranial capacity
- (D) Shortening of the jaws

Q61. The "Founder Effect" is a specific type of:

- (A) Gene flow
- (B) Natural Selection
- (C) Genetic Drift
- (D) Mutation

Q62. In Miller's experiment, which of the following gases were used to simulate the primitive atmosphere?

- (A) CH₄, NH₃, H₂, H₂O
- (B) CO₂, NH₃, O₂, H₂
- (C) CH₄, NO₂, H₂, H₂O
- (D) CH₄, NH₃, O₂, H₂O

Q63. Water vascular system (ambulacral system) is a unique diagnostic feature of which Phylum?

- (A) Porifera
- (B) Cnidaria
- (C) Echinodermata
- (D) Mollusca

Q64. Metameric segmentation is first observed in the Phylum:

- (A) Platyhelminthes
- (B) Aschelminthes
- (C) Annelida
- (D) Arthropoda

Q65. Flame cells (Protonephridia) are the excretory structures found in:



- (A) Earthworms
- (B) Planaria
- (C) Cockroaches
- (D) Prawns

Q66. Which of the following is a "Living Fossil" among Arthropods?

- (A) Laccifer
- (B) Limulus (King Crab)
- (C) Locusta
- (D) Apis

Q67. The presence of a "Pneumatic bone" is a characteristic adaptation of:

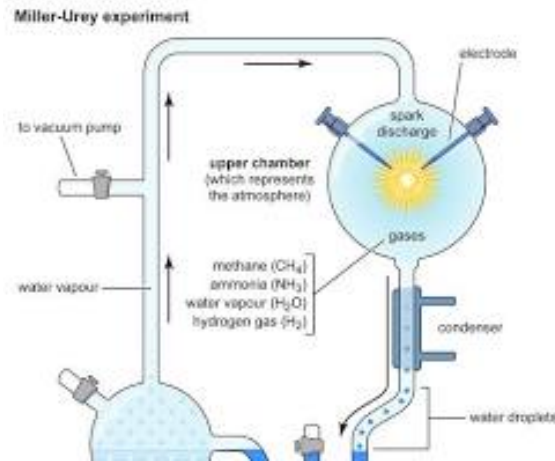
- (A) Amphibians
- (B) Reptiles
- (C) Aves
- (D) Mammals

Q68. Which class of Vertebrata is characterized by the presence of a 3-chambered heart, except for one specific order which has 4 chambers?

- (A) Amphibia
- (B) Reptilia
- (C) Osteichthyes
- (D) Cyclostomata

Q69. The Miller-Urey experiment apparatus is shown below. What was the specific temperature and the energy source used to simulate lightning in the "primitive atmosphere" flask?





- (A) 100°C ; UV Radiation
- (B) 800°C ; Electric discharge
- (C) 500°C ; Volcanic heat
- (D) 1200°C ; Radioactive decay

Q70. In the connective tissue, the cells that secrete fibers and ground substance are:

- (A) Histiocytes
- (B) Mast cells
- (C) Fibroblasts
- (D) Macrophages

Q71. The "Gap Junctions" in animal tissues function to:

- (A) Stop substance leakage across a tissue
- (B) Cement neighboring cells together
- (C) Facilitate communication between cells by connecting the cytoplasm
- (D) Separate two cells via a thick protein layer

Q72. Which type of muscle fiber is spindle-shaped, uninucleate, and involuntary?

- (A) Skeletal muscle
- (B) Smooth muscle
- (C) Cardiac muscle



(D) Striated muscle

Q73. The matrix of cartilage is composed of:

- (A) Chondroitin salts
- (B) Calcium phosphates
- (C) Hemoglobin
- (D) Keratin

Q74. In human genetics, a "Haemophilic" man marries a "Normal" woman (not a carrier). What is the probability of their son being haemophilic?

- (A) 100%
- (B) 50%
- (C) 25%
- (D) 0%

Q75. During DNA replication, the enzyme 'Topoisomerase' functions to:

- (A) Unwind the double helix
- (B) Release the tension created by supercoiling
- (C) Join Okazaki fragments
- (D) Synthesize RNA primers

Q76. The human genome project revealed that the chromosome with the highest number of genes is:

- (A) Chromosome 1
- (B) Chromosome X
- (C) Chromosome 22
- (D) Chromosome Y

Q77. If the sequence of the coding strand of DNA is 5'-ATGCATGC-3', the sequence of the transcribed mRNA will be:



- (A) 3'-UACGUACG-5'
- (B) 5'-UACGUACG-3'
- (C) 5'-AUGCAUGC-3'
- (D) 3'-TACGTACG-5'

Q78. Klinefelter syndrome is characterized by which of the following chromosomal constitutions?

- (A) 45, XO
- (B) 47, XXY
- (C) 47, XY, +21
- (D) 47, XXX

Q79. The 'Lac Operon' is considered to be "switched off" when the repressor protein binds to the:

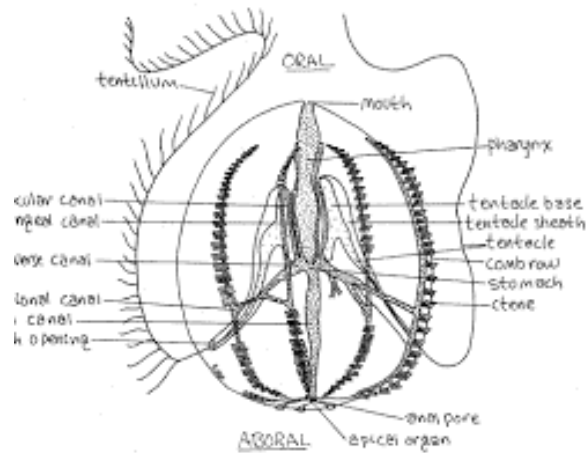
- (A) Structural genes
- (B) Promoter site
- (C) Operator site
- (D) Regulator gene

Q80. The first gene therapy was successfully conducted in 1990 on a 4-year-old girl for the deficiency of:

- (A) Insulin
- (B) Adenosine Deaminase (ADA)
- (C) Tyrosine Kinase
- (D) Glucocerebrosidase

Q81. The organism shown in the diagram belongs to a phylum characterized by bioluminescence and the presence of 'Comb plates'. Identify the phylum and the number of comb plates present.





- (A) Cnidaria; 6
- (B) Ctenophora; 8
- (C) Platyhelminthes; 4
- (D) Porifera; 10

Q82. The 'Rosie' cow was genetically engineered to produce milk that was enriched with:

- (A) Human alpha-lactalbumin
- (B) Beta-carotene
- (C) Vitamin B12
- (D) Human Insulin

Q83. Malignant tumors are different from benign tumors because they show the property of:

- (A) Contact inhibition
- (B) Metastasis
- (C) Slow growth
- (D) Encapsulation

Q84. The 'Widal Test' is used for the diagnosis of:

- (A) Malaria



- (B) Pneumonia
- (C) Typhoid
- (D) AIDS

Q85. When a quick immune response is required, such as in a snake bite, the injection given contains:

- (A) Attenuated pathogens
- (B) Preformed antibodies
- (C) Recombinant antigens
- (D) Inactivated toxins

Q86. The vector responsible for the transmission of 'Elephantiasis' (Filariasis) is:

- (A) Female Anopheles mosquito
- (B) Female Culex mosquito
- (C) Aedes aegypti mosquito
- (D) Housefly

Q87. Which of the following describes the "All-or-None" law in the context of muscle fibers?

- (A) The entire muscle contracts or does not contract at all.
- (B) A single muscle fiber contracts maximally or not at all when stimulated by a threshold stimulus.
- (C) All muscles in a motor unit relax simultaneously.
- (D) The force of contraction is independent of the strength of the stimulus for the whole muscle.

Q88. The "Juxtaglomerular Apparatus" (JGA) releases Renin into the bloodstream when there is a fall in:

- (A) Blood Osmolarity
- (B) Glomerular Filtration Rate (GFR)



- (C) Plasma Glucose levels
- (D) Atrial Natriuretic Factor (ANF)

Q89. The partial pressure of Oxygen (pO_2) in the systemic arteries and systemic veins is respectively:

- (A) 95 mmHg and 40 mmHg
- (B) 40 mmHg and 95 mmHg
- (C) 104 mmHg and 40 mmHg
- (D) 45 mmHg and 40 mmHg

Q90. Which of the following neurotransmitters is primarily excitatory at the neuromuscular junction?

- (A) Dopamine
- (B) GABA
- (C) Acetylcholine
- (D) Glycine

Q91. The function of 'Surfactant' (Lecithin) produced by Type II pneumocytes in the alveoli is to:

- (A) Increase surface tension to aid expiration.
- (B) Decrease surface tension to prevent alveolar collapse.
- (C) Facilitate the diffusion of CO_2 .
- (D) Protect the lungs from bacterial infection.

Q92. If the Hymen is ruptured, it cannot be used as a definitive indicator of:

- (A) Menstrual health
- (B) Fertility
- (C) Virginity or sexual experience
- (D) Congenital defects



- Q93.** The 'Fast Block' to polyspermy in humans is achieved by:
- (A) The cortical reaction and hardening of Zona Pellucida.
 - (B) Depolarization of the oocyte membrane.
 - (C) The release of acrosomal enzymes.
 - (D) The completion of Meiosis II.
- Q94.** Which embryonic membrane is primarily responsible for the formation of the placenta in humans?
- (A) Yolk sac
 - (B) Amnion
 - (C) Chorion
 - (D) Allantois
- Q95.** Which of the following is a "Uricotelic" animal, adapted for maximum water conservation?
- (A) Cartilaginous fish
 - (B) Aquatic amphibians
 - (C) Pigeons and Lizards
 - (D) Mammals
- Q96.** The 'Haversian Canal' system is a characteristic feature of:
- (A) Spongy bone
 - (B) Compact bone of mammals
 - (C) Hyaline cartilage
 - (D) Calcified cartilage
- Q97.** In Cockroaches, the "Mushroom-shaped glands" are found in the:
- (A) 4th to 6th abdominal segments of males
 - (B) 6th to 7th abdominal segments of males



- (C) 2nd to 4th abdominal segments of females
- (D) Head region near the esophagus

Q98. Which of the following enzymes is responsible for the "Charging" of tRNA (Aminoacylation)?

- (A) Peptidyl transferase
- (B) RNA Polymerase III
- (C) Aminoacyl-tRNA synthetase
- (D) DNA Ligase

Q99. The use of 'RNA interference' (RNAi) has been used to develop plants resistant to:

- (A) Fungi
- (B) Viruses
- (C) Nematodes (*Meloidogyne incognita*)
- (D) Insects

Q100. In 'ELISA', the primary principle used for detection of diseases is:

- (A) DNA-DNA Hybridization
- (B) Antigen-Antibody interaction
- (C) Amplification of Nucleic acids
- (D) Electrophoretic mobility of proteins



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

Concept: Bryophytes possess a dominant, independent gametophyte that performs photosynthesis and survives freely for most of the life cycle. In contrast, the gametophyte of pteridophytes is comparatively reduced and short-lived. Both groups require water for fertilization and have photosynthetic members, but bryophytes are especially characterized by a free-living gametophyte generation. Bryophytes also lack vascular tissues, which differentiates them from pteridophytes that possess well-developed vascular tissues in the sporophyte stage.

Solution: The question asks for a characteristic feature of the gametophyte of bryophytes that distinguishes it from the gametophyte of pteridophytes. Bryophytes have a dominant gametophytic phase that exists independently and performs all major physiological functions. The sporophyte generally remains attached to and dependent on the gametophyte for nutrition. In pteridophytes, although the gametophyte may initially be independent, the dominant plant body is the sporophyte, which possesses vascular tissues and becomes the major photosynthetic structure. The requirement of water for fertilization is common to both bryophytes and pteridophytes, so it cannot distinguish them. Similarly, photosynthetic nature is also seen in both groups. Bryophytes do not possess vascular tissues at all. Therefore, the distinguishing feature of bryophyte gametophytes is their independent existence and dominance in the life cycle.

Final Answer: Independent existence from the sporophyte

Answer: (B)

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Q2.

Solution

Concept: In dicot roots undergoing secondary growth, the cork cambium or phellogen usually develops from the pericycle. The phellogen produces cork cells outwardly and secondary cortex inwardly, forming the protective periderm. This replaces the epidermis, which ruptures during secondary growth. The pericycle is therefore important in both lateral root formation and secondary protective tissue formation in roots of dicotyledonous plants.

Solution: Secondary growth in dicot roots involves an increase in girth due to the activity of vascular cambium and cork cambium. As the vascular tissues expand, the outer tissues such as the epidermis and cortex cannot stretch sufficiently and eventually rupture. To protect the root, a secondary protective layer called periderm is formed. The periderm consists of phellogen (cork cambium), phellem (cork), and phelloderm (secondary cortex). In roots, the cork cambium generally originates from the pericycle, which lies just inside the endodermis. The pericycle cells become meristematic and start dividing to produce cork cells towards the outside. Epidermal and endodermal cells do not usually give rise to phellogen in dicot roots. Cortical cells may contribute in stems, but in roots the usual origin is the pericycle. Therefore, the correct answer is pericycle cells.

Final Answer:

Answer: (C)

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Q3.

Solution

Concept: Members of the family **Fabaceae** possess zygomorphic flowers with vexillary aestivation and diadelphous stamens.

Key Floral Characters:

- Flower: Zygomorphic ($\%$)
- Calyx: $K_{(5)}$
- Corolla: $C_{1+2+(2)}$
- Androecium: $A_{(9)+1}$
- Gynoecium: Monocarpellary superior ovary

Correct Floral Formula:

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

Explanation:

- One large standard petal, two wings, and two fused keel petals form vexillary aestivation.
- Stamens are typically diadelphous (9) + 1.
- Ovary is superior and monocarpellary.

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

Answer: (A)

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Q4.

Solution

Concept: The S-phase or synthesis phase of the cell cycle is characterized mainly by DNA replication. In animal cells, centriole duplication also occurs during this phase. Histone proteins are synthesized simultaneously to package newly formed DNA into chromatin. The chromosome number remains unchanged, but the DNA content doubles, preparing the cell for mitosis.

Solution: During the S-phase of interphase, the most important event occurring inside the nucleus is DNA replication. Each chromosome duplicates to form two sister chromatids joined at the centromere. Along with DNA synthesis, histone proteins are also produced to organize the newly synthesized DNA into chromatin. In animal cells, an additional event occurs in the cytoplasm: centriole duplication. Since centrioles are essential for spindle formation during cell division, their duplication ensures proper chromosome segregation during mitosis. The question specifically asks for simultaneous events in the nucleus and cytoplasm. DNA replication takes place in the nucleus, while centriole duplication occurs in the cytoplasm during the same phase. RNA and protein synthesis occur throughout interphase but are not the defining simultaneous events of S-phase. Centromere division occurs later during anaphase of mitosis, not during S-phase. Hence, the correct combination is DNA replication and centriole duplication.

Final Answer:

Answer: (A)

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Q5.

Solution

Concept: According to the fluid mosaic model proposed by Singer and Nicolson, biological membranes consist of a phospholipid bilayer with proteins embedded within it. Lipids provide a quasi-fluid environment that allows proteins and lipids to move laterally within the membrane. This dynamic movement is called membrane fluidity, which is essential for transport, signaling, endocytosis, and membrane flexibility in living cells.

Solution: The fluid mosaic model describes the plasma membrane as a dynamic and flexible structure rather than a rigid layer. The phospholipid molecules form a bilayer where hydrophilic heads face outward and hydrophobic tails face inward. Embedded proteins can move laterally within this lipid matrix because the lipids themselves possess a quasi-fluid nature. This lateral mobility is crucial for membrane functions such as transport of substances, cell communication, enzyme activity, and membrane fusion. The property that measures the ease of movement of proteins and lipids within the membrane is called fluidity. Permeability refers to the ability of substances to pass through the membrane, while elasticity relates to stretching capability. Selective translocation is not the term used for lateral movement in the membrane. Therefore, the correct answer describing this membrane property is fluidity.

Final Answer:

Answer: (B)

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Q6.

Solution

Concept: The Thick Ascending Limb of Henle's loop actively transports sodium and chloride ions into the medullary interstitial fluid but is impermeable to water. This process helps establish the medullary osmotic gradient necessary for concentration of urine. Any inhibition of ion transport in this segment disrupts the counter-current mechanism and reduces the kidney's ability to reabsorb water efficiently.

Solution: In the nephron, the Thick Ascending Limb of Henle's loop plays a major role in maintaining the medullary osmotic gradient. Cells in this region actively transport sodium and chloride ions into the surrounding medullary tissue while remaining impermeable to water. This creates a hyperosmotic medulla, which later allows water reabsorption from the collecting duct under the influence of ADH. If a drug inhibits active ion transport in this segment, the medullary interstitium loses its high osmolarity. As a result, less water is reabsorbed from the collecting duct, causing the urine to become dilute rather than concentrated. Glycosuria is related to proximal convoluted tubule dysfunction, not the loop of Henle. Significant changes in blood pH are also not the primary effect of this inhibition. Therefore, disruption of the medullary osmotic gradient leading to dilute urine is the most likely consequence.

Final Answer: The medullary osmotic gradient is disrupted, resulting in dilute urine

Answer: (B)

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Q7.

Solution

Concept: Cytochrome *c* is a small mobile protein of the mitochondrial electron transport system that transfers electrons between respiratory complexes.

Explanation:

- Electrons move through the ETS in a sequential manner.
- Complex III transfers electrons to Cytochrome *c*.
- Cytochrome *c* then carries electrons to Complex IV.
- This process contributes to oxidative phosphorylation and ATP synthesis.

Electron Transfer Pathway:



Final Answer: Complex III and Complex IV

Answer: (C)

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Q8.

Solution

Concept: Water movement in plant cells depends on water potential (Ψ_w), which is the sum of solute potential (Ψ_s) and pressure potential (Ψ_p). Water moves from higher water potential to lower water potential. If the water potential inside the cell equals that of the surrounding solution, there is no net movement of water across the plasma membrane.

Solution: To determine the direction of water movement, the water potential of the cell must first be calculated. Water potential is given by:

$$\Psi_w = \Psi_s + \Psi_p$$

For the plant cell:

$$\Psi_w = -15 + 5 = -10 \text{ bars}$$

The surrounding solution has:

$$\Psi_w = -12 \text{ bars}$$

Water always moves from a region of higher water potential to lower water potential. Since the cell has a water potential of -10 bars and the surrounding solution has a lower water potential of -12 bars, water will move from the cell to the external solution. This causes the cell to lose water and become less turgid. If both values had been equal, there would be no net movement. Temperature may affect the rate of movement but not the direction under these conditions. Therefore, the net movement of water will be outward from the cell.

Final Answer:

Answer: (A)

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Q9.

Solution

Concept: Incomplete dominance occurs when neither allele is completely dominant over the other. As a result, the heterozygous individual shows an intermediate phenotype between the two homozygous parents. Inheritance of flower colour in snapdragon and four-o'clock plant is a classic example, where red and white flowers produce pink offspring in the heterozygous condition.

Solution: In the given cross, a red-flowered plant crossed with a white-flowered plant produces all pink offspring in the first filial generation. This indicates that neither the red allele nor the white allele completely masks the expression of the other. Instead, the heterozygous condition produces an intermediate phenotype, which is pink. When these pink plants are self-pollinated, the offspring appear in the phenotypic ratio of 1 red : 2 pink : 1 white. This ratio is characteristic of incomplete dominance because both phenotypic and genotypic ratios become identical. In complete dominance, the F_2 phenotypic ratio would be 3:1. Epistasis involves interaction between different genes, while codominance shows simultaneous expression of both alleles without blending. Since the phenotype here is intermediate, the correct example is incomplete dominance.

Final Answer:

Answer: (C)

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Q10.

Solution

Concept: DNA ligase is an enzyme that joins DNA fragments by forming phosphodiester bonds between adjacent nucleotides. It acts like a molecular glue during DNA replication, repair, and recombinant DNA technology. This enzyme is especially important in genetic engineering where foreign DNA fragments are inserted into vector DNA to create recombinant molecules.

Solution: Recombinant DNA technology involves cutting and joining DNA fragments from different sources. Restriction endonucleases are used to cut DNA at specific recognition sequences, producing sticky or blunt ends. After the desired DNA fragment and vector are cut, they must be joined together to form recombinant DNA. This joining is carried out by DNA ligase, which catalyzes the formation of phosphodiester bonds between the sugar-phosphate backbones of DNA fragments. Because of this function, DNA ligase is often called a molecular glue. DNA Polymerase I mainly synthesizes DNA strands, while alkaline phosphatase removes phosphate groups from DNA ends. Restriction enzymes cut DNA rather than join it. Therefore, the enzyme responsible for joining DNA fragments is DNA ligase.

Final Answer:

Answer: (C)

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Q11.

Solution

Concept: PCR (Polymerase Chain Reaction) involves three major steps: denaturation, annealing, and extension.

PCR Temperature Cycle:

- Denaturation: $\sim 94^{\circ}\text{C}$
- Annealing: $\sim 50\text{--}60^{\circ}\text{C}$
- Extension: $\sim 72^{\circ}\text{C}$

Explanation:

- During annealing, primers bind to complementary DNA strands.
- This step requires a lower temperature to allow hydrogen bond formation.
- The exact temperature depends on primer sequence and composition.

PCR Cycle Representation:
$$94^{\circ}\text{C} \rightarrow 50\text{--}60^{\circ}\text{C} \rightarrow 72^{\circ}\text{C}$$
Final Answer:

50–60°C

Answer: (B)

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Q12.

Solution

Concept: In angiosperms, the transition from diploid sporophytic generation to haploid gametophytic generation occurs through meiosis. This reduction division takes place during microsporogenesis in anthers and megasporogenesis in ovules, producing haploid microspores and megaspores respectively, which later develop into male and female gametophytes.

Solution: Angiosperms show alternation of generations between the diploid sporophyte and haploid gametophyte. The sporophytic phase is represented by the flowering plant, while the gametophytic phase includes pollen grains and embryo sacs. The transition from diploid to haploid condition occurs through meiosis, also called reduction division. In the anther, microspore mother cells undergo meiosis during microsporogenesis to form haploid microspores. Similarly, in the ovule, the megaspore mother cell undergoes meiosis during megasporogenesis to produce haploid megaspores. These spores develop into male and female gametophytes respectively. Germination of pollen grains occurs after gametophyte formation and does not involve reduction division. Syngamy and triple fusion restore diploidy rather than produce haploidy. Therefore, the transition from sporophyte to gametophyte occurs during microsporogenesis and megasporogenesis.

Final Answer: Microsporogenesis and Megasporogenesis

Answer: (B)

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Q13.

Solution

Concept: The trophoblast is the outer layer of the blastocyst and plays a major role during implantation. Its cells attach to the uterine endometrium, secrete enzymes that help embed the embryo into maternal tissue, and later contribute to formation of the chorion and placenta. The inner cell mass forms the embryo proper.

Solution: The blastocyst consists mainly of an outer trophoblast, an inner cell mass, and a fluid-filled cavity called the blastocoel. During implantation, the trophoblast comes into direct contact with the uterine endometrium. Trophoblastic cells proliferate and secrete enzymes that digest the endometrial lining, allowing the blastocyst to embed itself into the uterus. These cells later contribute to the formation of extraembryonic membranes, especially the chorion, which participates in placenta formation. The inner cell mass forms the embryo proper and gives rise to the tissues of the developing fetus. The blastocoel mainly provides space within the blastocyst and does not directly perform implantation functions. The zona pellucida disappears before implantation begins. Therefore, the labeled structure responsible for implantation and chorion formation is the trophoblast.

Final Answer: Trophoblast; secretes enzymes for implantation and forms the chorion

Answer: (B)

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Q14.

Solution

Concept: Self-incompatibility is a genetically controlled mechanism that prevents self-pollination and promotes cross-pollination. It inhibits pollen germination or pollen tube growth when pollen from the same plant or genetically similar plant lands on the stigma. Therefore, mechanisms involving self pollen, such as autogamy and geitonogamy, are prevented in self-incompatible species.

Solution: In self-incompatible plants, pollen grains from the same genetic background fail to achieve fertilization because of biochemical recognition mechanisms between pollen and stigma. Autogamy involves transfer of pollen from the anther to the stigma of the same flower, while geitonogamy involves transfer between different flowers of the same plant. Genetically, both represent self-pollination because the pollen and ovules belong to the same plant. Since self-incompatibility prevents self-fertilization, both autogamy and geitonogamy are restricted. Xenogamy, on the other hand, involves pollen transfer between flowers of different plants and is therefore encouraged in self-incompatible species. Hence, the pollination mechanisms prohibited are both autogamy and geitonogamy.

Final Answer: Both Autogamy and Geitonogamy

Answer: (D)

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Q15.

Solution

Concept: The tapetum is the innermost layer of the microsporangium wall and provides nourishment to developing pollen grains. Tapetal cells are metabolically active and often become multinucleate due to repeated nuclear division without cytokinesis. They also contribute materials required for pollen wall formation and pollen grain maturation.

Solution: The wall of a microsporangium consists of four layers: epidermis, endothecium, middle layers, and tapetum. Among these, the tapetum forms the innermost layer surrounding the sporogenous tissue. It plays a vital nutritive role by supplying enzymes, proteins, lipids, and other materials to developing microspores and pollen grains. Tapetal cells are usually dense in cytoplasm and frequently become multinucleate or polyploid because of rapid metabolic activity. They also secrete sporopollenin precursors required for exine formation of pollen grains. The epidermis mainly provides protection, while the endothecium helps in anther dehiscence. Middle layers generally degenerate during pollen development. Therefore, the layer responsible for nourishment and possessing multinucleate cells is the tapetum.

Final Answer: Tapetum

Answer: (C)

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Q16.

Solution

Concept: Double fertilization is a unique feature of angiosperms. Two male gametes are released into a synergid by the pollen tube. One male gamete fuses with the egg cell to form the diploid zygote, while the other fuses with the two polar nuclei or secondary nucleus in the central cell to form the triploid primary endosperm nucleus.

Solution: After pollen germination, the pollen tube enters the embryo sac through one of the synergids and releases two male gametes into its cytoplasm. One male gamete moves toward the egg cell and fuses with it, resulting in syngamy and formation of a diploid zygote. The second male gamete migrates to the central cell and fuses with the two polar nuclei or diploid secondary nucleus. This process is called triple fusion because three haploid nuclei participate, producing a triploid primary endosperm nucleus. Together, syngamy and triple fusion constitute double fertilization, which is characteristic of flowering plants. Both male gametes do not fuse with the egg cell, nor does one fuse with the synergid. Therefore, the correct fate is fusion of one gamete with the egg and the other with the central cell nuclei.

Final Answer: One fuses with the egg, the other fuses with the central cell nuclei

Answer: (B)

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Q17.

Solution

Concept: In a grass embryo, the scutellum is the single cotyledon attached laterally to the embryonal axis. The embryonal axis is differentiated into the epicotyl above the scutellum attachment and the hypocotyl below it. The epicotyl bears the plumule, which is enclosed by the protective coleoptile.

Solution: The embryo of grasses such as maize and wheat is specialized due to the presence of a single cotyledon called the scutellum. The embryonal axis attached to the scutellum is divided into two regions based on the point of attachment. The portion above the scutellum is known as the epicotyl, which terminates in the plumule. The plumule later develops into the shoot system and is protected by a sheath called the coleoptile. The portion below the scutellum is the hypocotyl, which bears the radicle. The radicle is enclosed by another protective sheath known as the coleorhiza. Since the question asks for the part situated above the level of attachment of the scutellum, the correct answer is the epicotyl.

Final Answer: Epicotyl

Answer: (C)

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Q18.

Solution

Concept: Parthenocarpy is the development of fruit without fertilization. Such fruits are usually seedless because embryo and seed formation do not occur. Natural examples include banana and seedless grapes. This process may occur naturally or can be induced artificially using plant growth regulators such as auxins and gibberellins for commercial fruit production.

Solution: Normally, fruit development in flowering plants begins after fertilization, when the ovary matures into a fruit and ovules develop into seeds. In parthenocarpy, however, the ovary develops into a fruit even though fertilization does not take place. Since no fertilization occurs, seeds are absent or poorly developed. This phenomenon is agriculturally important because seedless fruits are often preferred commercially. Apomixis refers to seed formation without fertilization, while parthenogenesis specifically refers to development of an organism from an unfertilized egg. Polyembryony involves formation of multiple embryos within a single seed. Therefore, the process where the ovary alone develops into a fruit without fertilization is known as parthenocarpy.

Final Answer: Parthenocarpy

Answer: (B)

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Q19.

Solution

Concept: The filiform apparatus is a specialized thickening present at the micropylar end of synergid cells in the embryo sac of angiosperms. It helps guide the pollen tube toward the egg apparatus and assists in absorption and transfer of nutrients. Synergids therefore play an important role in successful fertilization during sexual reproduction in flowering plants.

Solution: The mature embryo sac of angiosperms contains seven cells and eight nuclei arranged in a characteristic pattern. At the micropylar end lies the egg apparatus, which consists of one egg cell and two synergids. Each synergid possesses a finger-like wall thickening called the filiform apparatus. This structure increases the surface area and helps direct the incoming pollen tube toward the egg cell for fertilization. It also aids in nutrient transfer within the embryo sac. Antipodal cells are present at the chalazal end and lack filiform apparatus. The egg cell and zygote also do not possess this structure. Therefore, the filiform apparatus is specifically associated with synergid cells.

Final Answer: Synergids

Answer: (C)

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Q20.

Solution

Concept: In angiosperms, endosperm formation occurs through triple fusion, where one male gamete fuses with two polar nuclei present in the central cell. The ploidy of the endosperm depends on the ploidy of the polar nuclei and the male gamete contributed by the pollen grain.

Solution: The male plant is diploid, so meiosis produces haploid pollen grains carrying one haploid male gamete of ploidy n . The female plant is tetraploid, so the embryo sac formed from meiosis will contain haploid nuclei of ploidy $2n$. Therefore, each polar nucleus in the central cell is $2n$. During triple fusion, one male gamete (n) fuses with two polar nuclei ($2n + 2n$). Hence, the total ploidy of the primary endosperm nucleus becomes:

$$n + 2n + 2n = 5n$$

Thus, the resulting endosperm is pentaploid. The zygote formed by syngamy would have a different ploidy level, but the question specifically concerns the endosperm. Therefore, the correct ploidy level is $5n$.

Final Answer:

Answer: (C)

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Q21.

Solution

Concept: Linkage refers to the tendency of genes located on the same chromosome to be inherited together. In a test cross, linked genes produce parental combinations more frequently than recombinant combinations because crossing over between closely placed genes occurs less often during meiosis.

Solution: A test cross involving an F_1 dihybrid is commonly used to study gene interactions and recombination. If the genes assort independently, parental and recombinant phenotypes appear in approximately equal proportions. However, when parental phenotypes occur much more frequently than recombinants, it indicates that the genes are linked on the same chromosome. Linked genes tend to remain together during inheritance because they do not assort independently. Recombinant phenotypes arise only when crossing over occurs between homologous chromosomes during prophase I of meiosis. The closer the genes are on the chromosome, the lower the recombination frequency. Epistasis involves interaction between different genes affecting phenotype, while multiple allelism refers to more than two alleles controlling a trait. Therefore, the predominance of parental phenotypes indicates linkage between the two genes.

Final Answer:

Answer: (B)

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Q22.

Solution

Concept: The number of gamete types produced by an individual depends on the number of independently assorting gene pairs. For completely linked genes, the linked pair behaves as a single unit during inheritance. Therefore, linked genes do not contribute separately to gamete variation, reducing the total number of possible gametes formed.

Solution: The genotype given is $AaBbCcDd$. Normally, if all four gene pairs assort independently, the number of gamete types would be:

$$2^4 = 16$$

However, genes A and B are stated to be completely linked. This means they are inherited together as one unit and do not undergo recombination. Therefore, instead of contributing four combinations, the linked pair contributes only two parental combinations. The remaining genes C and D assort independently and each contributes two possibilities. Hence, the total number of gamete types becomes:

$$2 \times 2 \times 2 = 8$$

Thus, complete linkage reduces the number of possible gametes from sixteen to eight. Therefore, the correct answer is 8 gamete types.

Final Answer:

Answer: (B)

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Q23.

Solution

Concept: The chromosomal theory of inheritance proposed by Sutton and Boveri states that genes are located on chromosomes, and the behavior of chromosomes during meiosis parallels the behavior of genes described by Mendel. Homologous chromosomes pair and separate during meiosis in a manner similar to segregation of alleles.

Solution: According to the chromosomal theory of inheritance, chromosomes are the carriers of hereditary information. During meiosis, homologous chromosomes pair with each other and later separate into different gametes. This behavior closely resembles Mendel's law of segregation, where allele pairs separate during gamete formation. Chromosomes also assort independently when homologous pairs align randomly during metaphase I, paralleling Mendel's law of independent assortment. Crossing over occurs during prophase I rather than prophase II. Segregation during mitosis does not explain inheritance because mitosis maintains chromosome number without gamete formation. Amitosis involves direct cell division and has no significant role in genetic inheritance. Therefore, the chromosomal behavior parallel to gene behavior is pairing and separation during meiosis.

Final Answer:

Answer: (B)

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Q24.

Solution

Concept: The Miller-Urey experiment demonstrated that simple organic molecules could form under conditions resembling the primitive Earth atmosphere. By passing electric sparks through gases such as methane, ammonia, hydrogen, and water vapor, scientists produced amino acids and other organic compounds, supporting the idea of chemical evolution proposed by Oparin and Haldane.

Solution: Stanley Miller and Harold Urey designed an experiment to simulate the atmospheric conditions believed to exist on primitive Earth. They circulated a mixture of methane, ammonia, hydrogen, and water vapor through a closed apparatus and exposed it to electric sparks representing lightning. After running the experiment for several days, the liquid collected in the trap contained several organic compounds. Analysis revealed amino acids such as glycine, alanine, and aspartic acid, which are basic building blocks of proteins. The experiment did not produce complex molecules like DNA, ribozymes, or polysaccharides. Its significance lay in proving that organic molecules necessary for life could arise spontaneously from inorganic substances under prebiotic conditions. Therefore, the molecules identified were amino acids like glycine, alanine, and aspartic acid.

Final Answer: Amino acids like Glycine, Alanine, and Aspartic acid

Answer: (B)

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Q25.

Solution

Concept: Genetic distance between genes on a chromosome is measured in map units or centiMorgans. One centiMorgan represents a 1% recombination frequency between two genes. Greater recombination frequency indicates that genes are farther apart, while closely linked genes show lower recombination frequencies due to reduced crossing over.

Solution: During meiosis, crossing over between homologous chromosomes can exchange segments carrying genes. The frequency of recombination between two genes depends on the distance separating them on a chromosome. Scientists use recombination frequency to construct linkage maps. A recombination frequency of 1% is defined as one map unit or one centiMorgan (cM). For example, if recombinant offspring constitute 1% of the total progeny, the genes are said to be one centiMorgan apart. Genes farther apart undergo crossing over more frequently and therefore show higher recombination percentages. A recombination frequency of 50% indicates independent assortment rather than linkage. Hence, one centiMorgan corresponds specifically to a 1% recombination frequency.

Final Answer: 1% recombination frequency

Answer: (A)

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Q26.

Solution

Concept: Mendel's law of segregation states that the two alleles of a gene separate during gamete formation so that each gamete receives only one allele. This law is considered universal because all sexually reproducing organisms exhibit segregation of alleles during meiosis without known exceptions.

Solution: Mendel proposed three major laws of inheritance based on his experiments with pea plants. The law of dominance and law of independent assortment show several exceptions such as incomplete dominance, codominance, linkage, and epistasis. However, the law of segregation remains universally valid because alleles of a gene always separate during gamete formation. During meiosis, homologous chromosomes carrying different alleles move to opposite poles, ensuring that each gamete receives only one allele of each gene. Even in cases involving incomplete dominance or codominance, segregation still occurs normally. Since no known exceptions violate the separation of alleles during meiosis, the law of segregation is considered universal among Mendelian principles.

Final Answer: Law of Segregation

Answer: (B)

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Q27.

Solution

Concept: Alkaline phosphatase is an enzyme used in recombinant DNA technology to remove phosphate groups from the 5' ends of DNA molecules. Treating a linearized plasmid with this enzyme prevents the vector from rejoining its own ends, thereby reducing self-ligation and increasing the efficiency of insertion of foreign DNA fragments.

Solution: During cloning experiments, plasmid vectors are cut open using restriction enzymes to create sites for insertion of foreign DNA. However, the cut plasmid can sometimes rejoin its own ends without incorporating the desired DNA fragment, a process called self-ligation. To prevent this, the plasmid is treated with alkaline phosphatase, which removes phosphate groups from the 5' ends of DNA. Since DNA ligase requires a 5' phosphate group to form phosphodiester bonds, the plasmid cannot self-ligate after dephosphorylation. When foreign DNA carrying phosphate groups is added, ligation becomes possible between vector and insert. DNA ligase joins DNA fragments, reverse transcriptase synthesizes DNA from RNA, and exonuclease III removes nucleotides from DNA ends. Therefore, the enzyme used to prevent self-ligation is alkaline phosphatase.

Final Answer: Alkaline Phosphatase

Answer: (C)

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Q28.

Solution

Concept: The Ti plasmid is a tumor-inducing plasmid naturally present in the bacterium *Agrobacterium tumefaciens*. This bacterium infects plants and transfers a segment of its DNA into plant cells. Scientists modify this plasmid to serve as a vector for introducing foreign genes into plants during genetic engineering.

Solution: *Agrobacterium tumefaciens* is a soil bacterium known for causing crown gall disease in dicot plants. The disease-causing ability of this bacterium depends on the presence of a large plasmid called the Ti (tumor-inducing) plasmid. During infection, a portion of this plasmid called T-DNA integrates into the plant genome and alters normal cell growth. In biotechnology, scientists remove the disease-causing genes and use the modified Ti plasmid as a cloning vector to transfer useful genes into plants. *Escherichia coli* is commonly used as a bacterial host in cloning but does not naturally possess the Ti plasmid. *Bacillus thuringiensis* produces Bt toxin, while *Thermus aquaticus* provides Taq polymerase for PCR. Therefore, the Ti plasmid is naturally found in *Agrobacterium tumefaciens*.

Final Answer: Agrobacterium tumefaciens

Answer: (B)

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Q29.

Solution

Concept: DNA molecules possess a negative charge because of the phosphate groups present in their sugar-phosphate backbone. During gel electrophoresis, an electric field is applied across the gel, causing negatively charged DNA fragments to migrate toward the positively charged electrode called the anode. Smaller DNA fragments move faster through the gel matrix than larger fragments.

Solution: Gel electrophoresis is a technique used to separate DNA fragments based on their size. DNA molecules contain phosphate groups that ionize in solution, giving DNA an overall negative charge. When an electric current is passed through the gel, negatively charged DNA fragments migrate toward the positively charged anode. The agarose gel acts as a molecular sieve through which smaller fragments move more rapidly than larger ones. The anode is the positive electrode, not the negative one. DNA is not positively charged, so it does not move toward the cathode. The direction of movement depends mainly on the negative charge carried by DNA due to its phosphate backbone. Therefore, DNA fragments move toward the anode because DNA is negatively charged owing to phosphate groups.

Final Answer: DNA is negatively charged due to phosphate groups

Answer: (B)

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Q30.

Solution

Concept: Ethidium bromide is a fluorescent dye commonly used in molecular biology to visualize DNA fragments after gel electrophoresis. It intercalates between nitrogenous base pairs of DNA and fluoresces under ultraviolet light, allowing researchers to observe DNA bands within the agarose gel.

Solution: During agarose gel electrophoresis, separated DNA fragments are not naturally visible to the naked eye. To detect them, the gel is treated with ethidium bromide, a fluorescent compound that inserts itself between adjacent base pairs of DNA. When the stained gel is exposed to ultraviolet light, the ethidium bromide-DNA complex emits bright fluorescence, making the DNA bands clearly visible. This enables scientists to identify and compare DNA fragments of different sizes. Ethidium bromide does not cut DNA or denature the double helix. It also does not function as a selectable marker in cloning experiments. Therefore, its primary role in biotechnology is visualization of DNA under UV light.

Final Answer: To visualize DNA under UV light

Answer: (B)

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Q31.

Solution

Concept: Primers used in PCR are short, single-stranded DNA sequences called oligonucleotides. They are chemically synthesized to match sequences complementary to the target DNA region. Primers provide a free 3' hydroxyl end for DNA polymerase to begin synthesis during amplification of the desired DNA segment.

Solution: Polymerase Chain Reaction (PCR) is a technique used to amplify specific DNA sequences. DNA polymerase cannot initiate synthesis on its own and therefore requires short nucleotide sequences called primers. These primers are artificially synthesized single-stranded oligonucleotides, usually containing about 18–30 nucleotides. During the annealing step of PCR, primers bind to complementary sequences on the template DNA strands. Once attached, Taq DNA polymerase extends the primers by adding nucleotides, thereby synthesizing new DNA strands. Primers are not proteins or restriction enzymes, and they are not double-stranded DNA molecules. Their essential role is to define the boundaries of the DNA region to be amplified. Therefore, primers are small, chemically synthesized oligonucleotides.

Final Answer: Small, chemically synthesized oligonucleotides

Answer: (B)

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Q32.

Solution

Concept: Downstream processing refers to all the processes involved after the biosynthetic stage in biotechnology. It includes separation, purification, formulation, and quality control of the desired product obtained from cultured cells or microorganisms. These steps ensure that the final product is safe, pure, and suitable for commercial or medical use.

Solution: In biotechnology, production of a desired substance generally involves upstream and downstream processes. Upstream processing includes gene isolation, cloning, insertion into the host, and culturing organisms in bioreactors. Once the desired product is synthesized, downstream processing begins. This stage involves extraction of the product from the culture medium, followed by separation and purification to remove impurities and unwanted byproducts. Additional steps may include formulation, preservation, packaging, and quality testing before the product reaches consumers. Since the question asks specifically about downstream processing, the correct stage is separation and purification of the product. Gene isolation and insertion belong to recombinant DNA technology, while culturing cells occurs during upstream processing.

Final Answer: Separation and purification of the product

Answer: (B)

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Q33.

Solution

Concept: Gross Primary Productivity (GPP) is the total rate at which producers capture solar energy and convert it into organic matter through photosynthesis. A portion of this energy is later used in respiration. The remaining energy available after respiratory loss is termed Net Primary Productivity (NPP).

Solution: In ecosystems, green plants and other autotrophs synthesize organic matter using sunlight during photosynthesis. The total amount of organic matter or energy fixed by producers per unit area and time is called Gross Primary Productivity (GPP). Producers use part of this fixed energy for their own metabolic activities through respiration. After subtracting respiratory losses from GPP, the remaining energy stored as biomass becomes Net Primary Productivity (NPP), which is available to herbivores and higher trophic levels. Secondary productivity refers to biomass production by consumers, while net community productivity concerns the balance between ecosystem production and respiration. Since the question asks for the rate of production of organic matter during photosynthesis itself, the correct term is Gross Primary Productivity.

Final Answer: Gross Primary Productivity (GPP)

Answer: (B)

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Q34.

Solution

Concept: Gause's Competitive Exclusion Principle states that two species competing for exactly the same limiting resources cannot stably coexist in the same habitat. If their ecological niches are identical, one species eventually outcompetes and excludes the other due to intense competition for resources.

Solution: Every species occupies a specific ecological niche that includes its role, habitat, food source, and interactions within the ecosystem. According to Gause's Competitive Exclusion Principle, when two species compete for the same limiting resource and occupy identical niches, coexistence becomes impossible over time. The superior competitor gradually utilizes resources more efficiently and ultimately eliminates the weaker competitor from that habitat. Species can coexist only if they reduce competition by occupying slightly different niches or using different resources. Differences in size, reproduction timing, or predatory habits alone do not necessarily prevent competition if the resource requirements remain identical. Therefore, the condition leading to exclusion is identical ecological niches between the competing species.

Final Answer: Their niches are identical

Answer: (A)

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Q35.

Solution

Concept: Energy flow in an ecosystem follows the laws of thermodynamics. At each trophic level, a large portion of energy is lost as heat during metabolic activities, and only a small fraction is transferred to the next level. Because energy continuously decreases upward along the food chain, the pyramid of energy is always upright.

Solution: Producers capture solar energy and convert it into chemical energy through photosynthesis. Herbivores obtain only a fraction of this energy by consuming plants, and carnivores receive even less energy from herbivores. During every transfer between trophic levels, much of the energy is lost as heat through respiration, movement, and other metabolic processes. According to the ten percent law, only about 10% of the energy available at one trophic level is transferred to the next trophic level. As a result, the total available energy decreases progressively from producers to top carnivores. This continuous reduction ensures that the pyramid of energy can never be inverted and always remains upright. Producers therefore contain the highest energy content, not the lowest.

Final Answer: Energy is lost as heat at each trophic level transfer

Answer: (B)

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Q36.

Solution

Concept: Amensalism is an ecological interaction in which one species is harmed while the other species remains unaffected. This relationship commonly occurs when one organism produces substances or creates conditions that inhibit the survival or growth of another organism without itself gaining or losing any benefit.

Solution: Ecological interactions among species may be beneficial, harmful, or neutral. In amensalism, one organism suffers harm whereas the other remains unaffected. A classic example is the fungus *Penicillium*, which secretes penicillin that inhibits bacterial growth while the fungus itself experiences no significant effect. This differs from parasitism, where one organism benefits and the other is harmed. In commensalism, one species benefits while the other remains unaffected. Mutualism benefits both interacting species. Since the question specifically describes a relationship where one species is harmed and the other remains neutral, the correct ecological interaction is amensalism.

Final Answer: Amensalism

Answer: (B)

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Q37.

Solution

Concept: Ex-situ conservation involves protecting endangered species outside their natural habitats. Seed banks, botanical gardens, zoos, and cryopreservation centers are examples of ex-situ conservation methods. These approaches help preserve genetic material and species populations under controlled conditions when natural habitats are threatened or degraded.

Solution: Biodiversity conservation can occur through in-situ or ex-situ methods. In-situ conservation protects organisms within their natural habitats through national parks, wildlife sanctuaries, and biosphere reserves. Ex-situ conservation, on the other hand, involves conserving species outside their natural environments under artificial or controlled conditions. Seed banks store seeds of rare and economically important plant species for long periods, preserving their genetic diversity and allowing future regeneration. Botanical gardens and zoological parks are also examples of ex-situ conservation. Since national parks, sanctuaries, and biosphere reserves conserve species within their original habitats, they are not ex-situ methods. Therefore, the correct example of ex-situ conservation is seed banks.

Final Answer: Seed Banks

Answer: (C)

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Q38.

Solution

Concept: The ongoing “Sixth Extinction” refers to the rapid loss of biodiversity occurring in modern times. Unlike previous mass extinctions caused mainly by natural events such as volcanic eruptions or asteroid impacts, the current extinction crisis is largely driven by human activities including habitat destruction, pollution, overexploitation, climate change, and introduction of invasive species.

Solution: Earth has experienced several major mass extinctions in geological history, many of which were caused by natural catastrophes such as volcanic eruptions, climate shifts, or asteroid impacts. The present biodiversity crisis is called the Sixth Extinction because species are disappearing at exceptionally high rates compared to natural background extinction levels. What makes this extinction unique is that it is primarily caused by human activities. Deforestation, urbanization, industrial pollution, overhunting, climate change, and habitat fragmentation have accelerated species loss across terrestrial and aquatic ecosystems. The extinction is not restricted to marine organisms and is occurring much faster rather than slower than natural rates. Therefore, the defining feature of the Sixth Extinction is its strong association with human actions.

Final Answer: Primarily caused by human activities

Answer: (B)

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Q39.

Solution

Concept: Net Primary Productivity (NPP) represents the amount of organic matter available to consumers after producers utilize some energy in respiration. It is calculated by subtracting respiratory losses from Gross Primary Productivity (GPP). NPP therefore indicates the actual biomass or energy accessible to herbivores and higher trophic levels in an ecosystem.

Solution: In an ecosystem, producers capture solar energy through photosynthesis and convert it into organic matter. The total amount of energy fixed is called Gross Primary Productivity (GPP). However, plants use a portion of this energy for their own metabolic activities such as respiration. The remaining energy stored as biomass becomes Net Primary Productivity (NPP), which is available to herbivores. The relationship is:

$$NPP = GPP - R$$

Given:

$$GPP = 100 \text{ units}$$

$$R = 20 \text{ units}$$

Therefore,

$$NPP = 100 - 20 = 80 \text{ units}$$

This means 80 units of energy remain available for transfer to the next trophic level. Hence, the correct answer is 80 units.

Final Answer: 80 units

Answer: (B)

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Q40.

Solution

Concept: Human Immunodeficiency Virus (HIV) is the causative agent of AIDS. It specifically attacks Helper T-lymphocytes (T_H cells), which are essential for coordinating immune responses. Gradual destruction of these cells weakens the immune system and makes the body vulnerable to opportunistic infections and diseases.

Solution: The image represents HIV, an enveloped retrovirus responsible for Acquired Immunodeficiency Syndrome (AIDS). HIV primarily infects Helper T-lymphocytes, also called $CD4^+$ T-cells. These immune cells play a central role in activating B-lymphocytes, cytotoxic T-cells, and macrophages during immune responses. The virus enters the T_H cells using specific receptors, replicates inside them, and gradually destroys them. As the number of helper T-cells decreases, the immune system becomes severely weakened, making the individual susceptible to infections and certain cancers. *Plasmodium* infects red blood cells, *Salmonella* mainly affects intestinal cells, and *Microsporium* attacks keratinized tissues of skin and hair. Therefore, the pathogen shown is HIV, which targets Helper T-lymphocytes.

Final Answer: HIV; targets Helper T-lymphocytes (T_H cells)

Answer: (B)

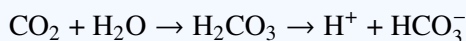
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Q41.

Solution

Concept: The chloride shift or Hamburger phenomenon is an important mechanism in carbon dioxide transport. In tissues, bicarbonate ions formed inside red blood cells diffuse into plasma, while chloride ions move into RBCs to maintain electrical neutrality. This exchange facilitates efficient transport of carbon dioxide in blood.

Solution: Most carbon dioxide transported in blood is converted into bicarbonate ions inside red blood cells. Carbon dioxide combines with water in RBCs under the action of carbonic anhydrase to form carbonic acid, which dissociates into hydrogen ions and bicarbonate ions:



The bicarbonate ions diffuse out of the RBCs into plasma for transport. To maintain ionic and electrical balance, chloride ions move from the plasma into the RBCs. This exchange of bicarbonate and chloride ions is called the chloride shift or Hamburger phenomenon. In the lungs, the process reverses to facilitate carbon dioxide release. Chloride ions do not bind hemoglobin for displacement of carbon dioxide. Therefore, the correct description is movement of Cl^- from plasma into RBCs when bicarbonate moves out.

Final Answer: Cl^- moves from plasma to RBCs to maintain ionic balance when HCO_3^- move out

Answer: (A)

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Q42.

Solution

Concept: The counter-current multiplier mechanism in the kidney establishes the medullary osmotic gradient required for urine concentration. This mechanism depends mainly on active transport of sodium and chloride ions from the ascending limb of Henle's loop, which is impermeable to water.

Solution: The loop of Henle plays a crucial role in concentrating urine through the counter-current multiplier system. The descending limb is permeable to water but relatively impermeable to salts, whereas the ascending limb is impermeable to water and actively transports sodium and chloride ions into the medullary interstitium. This active transport increases the osmolarity of the medulla, creating a gradient that facilitates water reabsorption from the descending limb and collecting duct under the influence of ADH. The proximal convoluted tubule mainly performs bulk reabsorption, while the collecting duct mainly responds to ADH for final water reabsorption. Since active sodium transport essential for the counter-current multiplier occurs primarily in the ascending limb, it is the correct answer.

Final Answer: Ascending limb of Henle's loop

Answer: (C)

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Q43.

Solution

Concept: Diabetes insipidus is a disorder caused by insufficient secretion of Antidiuretic Hormone (ADH), also called vasopressin. ADH is released from the neurohypophysis or posterior pituitary and promotes water reabsorption in the kidneys. Deficiency of ADH leads to excessive urine production and increased thirst.

Solution: ADH regulates water balance in the body by increasing water reabsorption from the distal convoluted tubule and collecting duct of the nephron. It is synthesized in the hypothalamus and released from the neurohypophysis. When ADH secretion is insufficient, the kidneys fail to reabsorb adequate amounts of water, resulting in production of large volumes of dilute urine, a condition known as polyuria. Excessive loss of water also stimulates intense thirst, known as polydipsia. This disorder is called diabetes insipidus. Insulin deficiency causes diabetes mellitus, while glucagon and aldosterone regulate blood glucose and sodium balance respectively. Therefore, diabetes insipidus is caused by hyposecretion of ADH from the neurohypophysis.

Final Answer: ADH (Vasopressin) from the Neurohypophysis

Answer: (C)

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Q44.

Solution

Concept: During muscle contraction, ATP binds to the myosin head and causes detachment from actin. Hydrolysis of ATP into ADP and inorganic phosphate energizes the myosin head and repositions it into a high-energy state, enabling it to bind again to actin for cross-bridge formation.

Solution: Skeletal muscle contraction follows the sliding filament mechanism. The myosin head first binds ATP, which causes release from the actin filament. The ATP is then hydrolyzed into ADP and inorganic phosphate by ATPase activity of myosin. This hydrolysis provides energy and changes the orientation of the myosin head into a cocked or energized position. In this activated state, the myosin head can attach to a new active site on actin, resulting in cross-bridge formation. Release of inorganic phosphate then triggers the power stroke that pulls the actin filament. Tropomyosin movement is controlled by calcium ions binding to troponin, not directly by ATP hydrolysis. Therefore, ATP hydrolysis mainly energizes the myosin head to enable cross-bridge formation with actin.

Final Answer: Bind to the Actin filament (Cross-bridge formation)

Answer: (A)

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Q45.

Solution

Concept: The hypothalamus is an important regulatory center of the brain that maintains homeostasis. It controls hunger, thirst, body temperature, sleep, endocrine activities, and autonomic functions. Specific nuclei within the hypothalamus regulate feeding behavior and thermoregulation.

Solution: The human brain contains several specialized regions responsible for different physiological activities. The hypothalamus, located below the thalamus, plays a central role in maintaining internal body balance. It contains hunger and satiety centers that regulate the urge for eating and control food intake. It also acts as the body's thermostat by regulating heat production, sweating, and blood flow to maintain normal body temperature. The thalamus mainly functions as a relay center for sensory impulses, while the corpus callosum connects the two cerebral hemispheres. The medulla oblongata controls involuntary functions such as heartbeat and respiration. Therefore, the part of the brain responsible for eating behavior and thermoregulation is the hypothalamus.

Final Answer: Hypothalamus

Answer: (C)

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Q46.

Solution

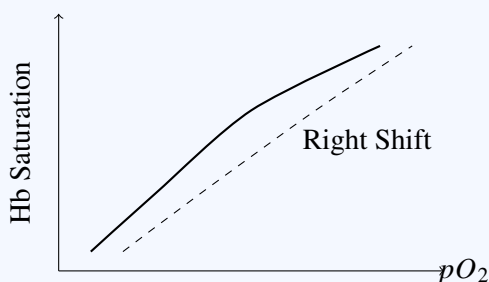
Concept: The Bohr Effect describes the influence of carbon dioxide concentration and pH on the oxygen-binding affinity of hemoglobin.

- In metabolically active tissues:
 - pCO_2 increases
 - H^+ concentration increases (pH decreases)
- This reduces hemoglobin's affinity for oxygen, causing a **right shift** in the oxygen-hemoglobin dissociation curve.
- A right shift facilitates greater oxygen release to tissues.

Key Relationship:

$\uparrow pCO_2, \uparrow H^+, \downarrow pH \Rightarrow$ Right Shift

Visual Representation:



Explanation:

- Increased CO_2 leads to more acidic conditions.
- Lower pH decreases oxygen affinity of hemoglobin.
- This is adaptive during active respiration.

Final Answer: pCO_2 increases and pH decreases

Answer: (A)

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Q47.

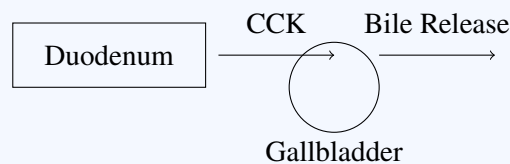
Solution

Concept: Digestive hormones regulate secretion and movement of digestive juices. One key hormone controls bile release from the gallbladder.

- **Cholecystokinin (CCK)** is secreted by the intestinal mucosa (especially duodenum) in response to fats and proteins.
- It stimulates:
 - Contraction of the **gallbladder**
 - Release of bile into the duodenum
 - Also slows gastric emptying

Key Function:

CCK \Rightarrow Gallbladder contraction + Bile release

Visual Representation:**Explanation:**

- Gastrin mainly stimulates gastric acid secretion.
- Secretin stimulates bicarbonate secretion from pancreas.
- Enterogastrone inhibits gastric motility.

Final Answer: Cholecystokinin (CCK)

Answer: (C)

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Q48.

Solution

Concept: Depolarization of a neuron occurs when sodium channels open and sodium ions rapidly enter the neuron. This influx of positively charged ions reduces the membrane potential and reverses the polarity of the membrane, generating an action potential that travels along the nerve fiber.

Solution: A resting neuron maintains a membrane potential of approximately -70 mV, with the inside of the membrane being negatively charged relative to the outside. When a stimulus reaches threshold level, voltage-gated sodium channels open suddenly. Sodium ions move into the neuron due to both concentration and electrical gradients. This rapid influx of Na^+ ions decreases the negativity of the membrane and eventually makes the inside positively charged. This phase is called depolarization. Repolarization occurs later when potassium ions move out of the cell. Chloride ion influx generally contributes to inhibition rather than excitation. Therefore, depolarization is specifically caused by the influx of sodium ions.

Final Answer:

Answer: (B)

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Q49.

Solution

Concept: The Distal Convoluted Tubule (DCT) and collecting duct are involved in conditional reabsorption of sodium and water. Aldosterone increases sodium reabsorption, while ADH enhances water reabsorption. These hormonal controls help regulate body fluid balance and osmotic concentration according to physiological needs.

Solution: Different parts of the nephron perform specialized functions in urine formation. The proximal convoluted tubule carries out obligatory reabsorption of most filtered substances. The loop of Henle establishes the medullary osmotic gradient. The distal convoluted tubule and collecting duct, however, are sites of conditional reabsorption regulated by hormones. Aldosterone increases sodium ion reabsorption and potassium secretion, while Antidiuretic Hormone (ADH) increases permeability to water, allowing greater water reabsorption. These mechanisms help maintain blood pressure, osmolarity, and water balance. Bowman's capsule is mainly involved in ultrafiltration and not hormone-regulated reabsorption. Therefore, the labeled nephron part responsible for conditional reabsorption under Aldosterone and ADH influence is the Distal Convoluted Tubule.

Final Answer:

Answer: (C)

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Q50.

Solution

Concept: Enterokinase, also called enteropeptidase, is an enzyme secreted by the intestinal mucosa. Its main function is to activate trypsinogen into trypsin in the small intestine. Trypsin then activates several other pancreatic enzymes required for protein digestion.

Solution: Pancreatic juice contains several inactive enzymes called zymogens to prevent digestion of pancreatic tissues. One such zymogen is trypsinogen. When pancreatic juice enters the duodenum, the intestinal mucosa secretes enterokinase. This enzyme converts inactive trypsinogen into active trypsin by removing a small peptide segment. Activated trypsin subsequently converts other inactive enzymes such as chymotrypsinogen and procarboxypeptidase into their active forms. Pepsinogen is activated into pepsin by hydrochloric acid in the stomach, while rennin converts caseinogen into casein in infants. Therefore, the specific function of enterokinase is conversion of trypsinogen into trypsin.

Final Answer: Trypsinogen into Trypsin

Answer: (B)

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Q51.

Solution

Concept: The menstrual cycle in human females is divided into menstrual, proliferative, ovulatory, and secretory phases. The secretory phase is also called the luteal phase because it is dominated by the activity of the corpus luteum, which secretes progesterone. In a normal 28-day cycle, this phase extends approximately from day 15 to day 28.

Solution: After ovulation, the ruptured Graafian follicle transforms into the corpus luteum under the influence of luteinizing hormone (LH). The corpus luteum secretes large amounts of progesterone and some estrogen, which prepare the endometrium for implantation and maintenance of pregnancy. This period is known as the secretory or luteal phase because the uterine glands become highly active and secretory. In a standard 28-day menstrual cycle, ovulation occurs around day 14. Therefore, the luteal phase generally lasts from day 15 to day 28, making its duration about 13–14 days. Among the given options, 13 days is the closest and most appropriate answer. If fertilization does not occur, the corpus luteum degenerates and menstruation begins.

Final Answer: 13 days

Answer: (B)

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Q52.

Solution

Concept: Capacitation is the physiological maturation process that sperm undergo after entering the female reproductive tract. This process removes inhibitory substances from the sperm membrane, increasing sperm motility and enabling the acrosome reaction necessary for fertilization of the ovum.

Solution: Sperm produced in the testes become motile during passage through the epididymis, but they are not yet capable of fertilizing an ovum. Fertilization capacity is acquired only after sperm enter the female reproductive tract, especially the uterus and fallopian tubes. During capacitation, changes occur in the sperm plasma membrane, including removal of glycoprotein coatings and cholesterol. These modifications increase membrane fluidity and prepare the sperm for the acrosome reaction, which helps penetrate the zona pellucida of the ovum. Capacitation therefore occurs inside the female reproductive tract and not in the epididymis, vas deferens, or rete testis. Hence, the correct location of sperm capacitation is the female reproductive tract.

Final Answer: Female reproductive tract

Answer: (C)

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Q53.

Solution

Concept: Human Chorionic Gonadotropin (hCG) is a hormone secreted by the trophoblastic cells of the developing embryo soon after implantation. It maintains the corpus luteum during early pregnancy and is the hormone detected in pregnancy test kits to confirm conception.

Solution: After fertilization and implantation, trophoblast cells of the developing embryo begin secreting hCG. This hormone maintains the corpus luteum so that progesterone secretion continues, preventing degeneration of the uterine endometrium. Because hCG appears in maternal blood and urine shortly after implantation, it serves as an important indicator of pregnancy. Pregnancy test kits detect the presence of hCG in urine to confirm conception. Estrogen and progesterone levels also increase during pregnancy but are not the primary hormones detected in standard test kits. Luteinizing hormone is involved in ovulation and corpus luteum formation, not pregnancy detection. Therefore, the hormone identified by pregnancy tests is hCG.

Final Answer: Human Chorionic Gonadotropin (hCG)

Answer: (C)

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Q54.

Solution

Concept: During follicular development in the ovary, the tertiary follicle develops a fluid-filled cavity called the antrum. This cavity contains follicular fluid and enlarges as the follicle matures into a Graafian follicle prior to ovulation.

Solution: Ovarian follicles pass through several stages of development: primary, secondary, tertiary, and Graafian follicle. In the tertiary follicle stage, spaces appear between granulosa cells and gradually fuse to form a large fluid-filled cavity known as the antrum. The follicular fluid within the antrum nourishes the developing oocyte and contributes to follicle enlargement. The zona pellucida is a glycoprotein layer surrounding the ovum. Corpus albicans is the degenerated form of the corpus luteum after its function ends. Stroma refers to the supportive connective tissue of the ovary. Therefore, the fluid-filled cavity of the tertiary follicle is called the antrum.

Final Answer: Antrum

Answer: (B)

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Q55.

Solution

Concept: Embryonic development in animals follows a sequential pattern beginning with the zygote. Cleavage divisions produce a solid mass of cells called the morula, which later develops into a hollow blastocyst or blastula. Subsequent gastrulation forms the gastrula containing primary germ layers.

Solution: Fertilization results in formation of a diploid zygote. The zygote undergoes rapid mitotic divisions called cleavage without significant increase in size. These divisions produce a compact mass of blastomeres known as the morula. As development continues, a cavity forms within the embryo, producing the blastocyst in mammals or blastula in general embryology. The blastocyst contains an inner cell mass, trophoblast, and blastocoel. The next major developmental event is gastrulation, during which the embryo reorganizes to form three primary germ layers: ectoderm, mesoderm, and endoderm. The embryo at this stage is called the gastrula. Therefore, the correct developmental sequence is:

Zygote → Morula → Blastocyst → Gastrula

Final Answer: Zygote → Morula → Blastocyst → Gastrula

Answer: (A)

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Q56.

Solution

Concept: Inhibin is a hormone secreted mainly by Sertoli cells in the testes. Its primary function is to provide negative feedback on the anterior pituitary gland and inhibit secretion of Follicle Stimulating Hormone (FSH), thereby regulating spermatogenesis and maintaining hormonal balance in males.

Solution: Spermatogenesis in males is controlled by hormones of the hypothalamic-pituitary-gonadal axis. Follicle Stimulating Hormone stimulates Sertoli cells to support sperm production, while Luteinizing Hormone stimulates Leydig cells to produce testosterone. Sertoli cells also secrete inhibin, which specifically inhibits secretion of FSH from the anterior pituitary gland through negative feedback regulation. This helps maintain an appropriate rate of sperm production. Inhibin does not directly stimulate spermatogenesis or inhibit testosterone synthesis. Instead, testosterone production is mainly regulated by LH. Therefore, the primary role of inhibin in males is inhibition of FSH secretion.

Final Answer:

Answer: (B)

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Q57.

Solution

Concept: Industrial melanism in the peppered moth demonstrates directional selection, where environmental changes favor one extreme phenotype over another. During industrialization, darker moths gained survival advantage in polluted environments, causing an increase in their frequency within the population through natural selection.

Solution: Before industrialization in England, light-colored peppered moths were more common because they blended well with lichen-covered tree trunks and escaped predation. After industrial pollution darkened tree bark and destroyed lichens, dark-colored moths became better camouflaged and survived more successfully than light-colored moths. Birds preferentially preyed upon the more visible light moths, leading to an increase in the dark-colored population. This shift in population toward one extreme phenotype due to environmental pressure is known as directional selection. Stabilizing selection favors intermediate forms, while disruptive selection favors both extremes simultaneously. Genetic drift involves random changes in gene frequency. Therefore, industrial melanism is a classic example of directional selection.

Final Answer:

Answer: (B)

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Q58.

Solution

Concept: The trophoblast is the outer layer of the blastocyst that attaches to the uterine wall during implantation. It later forms chorionic villi, which contribute to the fetal part of the placenta and facilitate exchange of nutrients, gases, and wastes between maternal and fetal blood.

Solution: The mammalian blastocyst consists mainly of an outer trophoblast, an inner cell mass, and a fluid-filled cavity called the blastocoel. During implantation, trophoblastic cells proliferate and invade the endometrium. These cells later give rise to chorionic villi, finger-like projections that greatly increase the surface area for exchange between maternal and fetal circulations. The chorionic villi form the fetal component of the placenta, an organ essential for nourishment and respiration of the developing embryo. The inner cell mass develops into the embryo proper, while the blastocoel is simply a cavity within the blastocyst. The zona pellucida degenerates before implantation. Therefore, the layer responsible for formation of chorionic villi and the fetal placenta is the trophoblast.

Final Answer: Trophoblast

Answer: (B)

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Q59.

Solution

Concept: Analogous organs perform similar functions but differ in origin and structural organization. They arise due to convergent evolution, where unrelated organisms independently evolve similar adaptations in response to similar environmental pressures. Wings of birds and insects are classic examples of analogous structures.

Solution: The wings of birds and insects both enable flight, so they perform the same function. However, their structural organization and evolutionary origins are entirely different. Bird wings are modified forelimbs supported by bones and muscles, while insect wings are outgrowths of the exoskeleton without homologous skeletal structures. Because these organs perform similar functions but evolved independently from different ancestral structures, they are considered analogous organs. Such similarities arise through convergent evolution, where unrelated organisms adapt similarly to comparable environmental demands. Homologous organs, in contrast, share common ancestry and structural similarity despite functional differences. Therefore, wings of birds and insects are analogous structures resulting from convergent evolution.

Final Answer: Analogous structures (Convergent evolution)

Answer: (B)

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Q60.

Solution

Concept: One of the most important evolutionary trends in modern humans was the progressive increase in cranial capacity and brain development. Enlargement of the brain enhanced intelligence, language, reasoning, social organization, and tool-making abilities, distinguishing *Homo sapiens* from earlier hominids.

Solution: Human evolution involved several important changes, including upright posture, reduced jaws, improved hand coordination, and binocular vision. However, the most significant evolutionary advancement was the dramatic increase in cranial capacity. Early hominids such as *Australopithecus* possessed relatively small brains, whereas modern humans developed much larger cerebral hemispheres and advanced cortical functions. Increased cranial capacity supported higher intelligence, abstract thinking, speech, memory, and cultural development. Upright posture evolved earlier in hominid history and is not unique to modern humans. Jaw reduction and binocular vision also occurred but were less influential than brain enlargement in shaping human evolution. Therefore, the major evolutionary trend in *Homo sapiens* was increased cranial capacity.

Final Answer: Increase in cranial capacity

Answer: (C)

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Q61.

Solution

Concept: The founder effect is a type of genetic drift that occurs when a small group of individuals becomes isolated from a larger population and establishes a new population. Because the founding members carry only a limited sample of the original gene pool, allele frequencies in the new population may differ significantly.

Solution: Genetic drift refers to random changes in allele frequencies that occur especially in small populations. The founder effect is a special case of genetic drift in which a few individuals migrate or become isolated and form a new population. Since this new group represents only a small portion of the genetic diversity of the original population, certain alleles may become unusually common or rare purely by chance. Over generations, this can produce significant genetic differences between populations. Unlike natural selection, the founder effect does not necessarily involve adaptive advantage. Gene flow involves transfer of genes between populations, while mutation introduces new genetic variations. Therefore, the founder effect is classified as a form of genetic drift.

Final Answer: Genetic Drift

Answer: (C)

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Q62.

Solution

Concept: The Miller-Urey experiment was designed to test the chemical origin of life on early Earth. The experiment simulated the reducing atmosphere believed to exist on primitive Earth using gases such as methane, ammonia, hydrogen, and water vapor in the presence of electrical discharges representing lightning.

Solution: Stanley Miller and Harold Urey proposed that organic molecules necessary for life could have formed spontaneously under primitive Earth conditions. To test this idea, they created an experimental setup containing gases believed to be abundant in the primitive atmosphere. The gases used were methane (CH_4), ammonia (NH_3), hydrogen (H_2), and water vapor (H_2O). Water was heated to generate vapor, and electric sparks were passed through the gaseous chamber to simulate lightning. After several days, the apparatus produced organic compounds including amino acids. Oxygen was deliberately excluded because the primitive atmosphere was considered reducing rather than oxidizing. Therefore, the correct combination of gases used in Miller's experiment was CH_4 , NH_3 , H_2 , and H_2O .

Final Answer: $\text{CH}_4, \text{NH}_3, \text{H}_2, \text{H}_2\text{O}$

Answer: (A)

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Q63.

Solution

Concept: The water vascular or ambulacral system is a unique hydraulic system found exclusively in echinoderms. It consists of canals and tube feet that function in locomotion, feeding, respiration, and sensory reception, making it a characteristic diagnostic feature of Phylum Echinodermata.

Solution: Echinoderms such as starfish, sea urchins, brittle stars, and sea cucumbers possess a specialized water vascular system. This system contains a network of fluid-filled canals connected to tube feet. Movement of water through these canals generates hydraulic pressure, allowing extension and retraction of tube feet. The tube feet assist in locomotion, capturing food, gaseous exchange, and sensory activities. No other animal phylum possesses such a system. Poriferans have canal systems for water circulation, cnidarians possess a gastrovascular cavity, and molluscs lack an ambulacral system entirely. Therefore, the presence of a water vascular system is the distinctive feature of Phylum Echinodermata.

Final Answer: Echinodermata

Answer: (C)

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Q64.

Solution

Concept: Metameric segmentation refers to the serial repetition of body segments along the longitudinal axis of an organism. This feature first appears distinctly in Phylum Annelida and represents an important evolutionary advancement in body organization and locomotion.

Solution: In lower invertebrate phyla such as Platyhelminthes and Aschelminthes, the body is unsegmented. The first clear appearance of true metameric segmentation occurs in annelids such as earthworms and leeches. In these animals, the body is divided externally and internally into repeated segments called metameres. Each segment contains repeated arrangements of organs and muscles, which improves flexibility and efficiency of movement. Arthropods also exhibit segmentation, but it appears later in evolution and often shows specialization into head, thorax, and abdomen. Therefore, the earliest phylum showing metameric segmentation is Annelida.

Final Answer:

Answer: (C)

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Q65.

Solution

Concept: Flame cells or protonephridia are specialized excretory structures found in flatworms. These structures help in osmoregulation and removal of metabolic wastes. Their beating cilia resemble a flickering flame, which gives them the name flame cells.

Solution: Planaria belongs to Phylum Platyhelminthes, whose members possess protonephridia as excretory organs. Flame cells consist of a tubular system ending in specialized cells containing bundles of cilia. Continuous beating of the cilia creates currents that help remove excess water and nitrogenous wastes from the body. Earthworms possess nephridia, while cockroaches and prawns have Malpighian tubules and green glands respectively for excretion. Therefore, flame cells are characteristic excretory structures of planaria and other flatworms.

Final Answer:

Answer: (B)

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Q66.

Solution

Concept: A living fossil is an organism that has remained relatively unchanged over millions of years and closely resembles its ancient ancestors. Among arthropods, *Limulus* or the horseshoe crab is considered a classic living fossil because of its remarkable evolutionary stability.

Solution: *Limulus*, commonly called the king crab or horseshoe crab, belongs to the subphylum Chelicerata. Fossil evidence shows that its body structure has remained largely unchanged for hundreds of millions of years. Because of this long evolutionary persistence with minimal modification, *Limulus* is regarded as a living fossil. Other arthropods such as *Locusta* (grasshopper), *Apis* (honeybee), and *Laccifer* (lac insect) have undergone greater evolutionary diversification and are not considered living fossils. Therefore, the arthropod recognized as a living fossil is *Limulus*.

Final Answer:

Answer: (B)

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Q67.

Solution

Concept: Pneumatic bones are hollow, air-filled bones that reduce body weight while maintaining strength. This adaptation is characteristic of birds and greatly assists in efficient flight by making the skeleton lightweight.

Solution: Birds require a lightweight yet strong skeleton for aerial locomotion. Many bones in birds contain air cavities connected with the respiratory system, making them hollow or pneumatic. These pneumatic bones reduce body mass without significantly decreasing strength, thereby improving flight efficiency. In addition, the respiratory air sacs extending into these bones help maintain continuous airflow during respiration. Amphibians, reptiles, and mammals generally lack true pneumatic bones as a characteristic adaptation. Therefore, pneumatic bones are a distinctive feature of Class Aves.

Final Answer:

Answer: (C)

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Q68.

Solution

Concept: Most reptiles possess a three-chambered heart consisting of two atria and one incompletely divided ventricle. However, crocodylians are exceptional reptiles because they possess a fully four-chambered heart, similar to birds and mammals.

Solution: The vertebrate heart shows progressive evolutionary specialization. Amphibians generally possess a three-chambered heart with some mixing of oxygenated and deoxygenated blood. Most reptiles also have a three-chambered heart with a partially divided ventricle that reduces mixing. However, members of the order Crocodylia are exceptions among reptiles because they possess a completely four-chambered heart. This arrangement allows efficient separation of oxygenated and deoxygenated blood. Fishes such as Osteichthyes possess a two-chambered heart, while cyclostomes have simpler circulatory systems. Therefore, the vertebrate class characterized by a three-chambered heart except for one order with four chambers is Reptilia.

Final Answer: Reptilia

Answer: (B)

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Q69.

Solution

Concept: In the Miller-Urey experiment, high temperature and electric sparks were used to simulate the environmental conditions of primitive Earth. The electric discharge represented lightning, which provided energy for chemical reactions leading to formation of organic compounds.

Solution: The Miller-Urey experiment aimed to recreate conditions believed to exist on primitive Earth. Water was heated to produce steam, and the gaseous mixture containing methane, ammonia, and hydrogen circulated through the apparatus. In the atmospheric chamber, electric sparks were passed continuously to simulate lightning, which was considered a major energy source on early Earth. The spark chamber temperature reached approximately 800°C during these discharges. This energy drove reactions among the gases, resulting in formation of simple organic molecules such as amino acids. Ultraviolet radiation and volcanic heat were not the primary energy sources used in the experimental setup. Therefore, the correct combination was 800°C and electric discharge.

Final Answer: 800°C; Electric discharge

Answer: (B)

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Q70.

Solution

Concept: Fibroblasts are the principal cells of connective tissue responsible for synthesis and secretion of fibers such as collagen and elastin, along with the extracellular ground substance. These cells play a major role in tissue repair and structural support.

Solution: Connective tissue contains different types of cells embedded in an extracellular matrix. Fibroblasts are the most abundant and active cells within this tissue. They synthesize collagen fibers, elastic fibers, reticular fibers, and the amorphous ground substance that forms the matrix. These secretions provide mechanical support and flexibility to tissues. Mast cells mainly release histamine and heparin during inflammatory responses, while histiocytes and macrophages are involved in phagocytosis and defense. Therefore, the cells responsible for secreting connective tissue fibers and ground substance are fibroblasts.

Final Answer: Fibroblasts

Answer: (C)

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Q71.

Solution

Concept: Gap junctions are specialized intercellular junctions that permit direct communication between adjacent animal cells. They contain channels connecting the cytoplasm of neighboring cells, allowing movement of ions and small molecules for coordination of cellular activities.

Solution: Animal tissues contain several types of cell junctions with different functions. Tight junctions prevent leakage of substances across tissues, while adhering junctions and desmosomes help cement neighboring cells together mechanically. Gap junctions, however, are specialized for communication. They consist of protein channels called connexons that directly connect the cytoplasm of adjacent cells. Through these channels, ions, metabolites, and small signaling molecules can pass rapidly from one cell to another. This enables coordinated activity in tissues such as cardiac muscle and smooth muscle. Gap junctions therefore function primarily in intercellular communication by linking the cytoplasm of neighboring cells.

Final Answer: Facilitate communication between cells by connecting the cytoplasm

Answer: (C)

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Q72.

Solution

Concept: Smooth muscle fibers are involuntary muscles found in the walls of internal organs such as the stomach, intestine, urinary bladder, and blood vessels. These fibers are spindle-shaped, uninucleate, and lack striations, allowing slow and sustained contractions.

Solution: Muscle tissues are classified into skeletal, smooth, and cardiac muscles based on structure and function. Skeletal muscles are voluntary, cylindrical, multinucleate, and striated. Cardiac muscles are branched, striated, and involuntary with intercalated discs. Smooth muscles differ from both because they are spindle-shaped with tapering ends, contain a single centrally located nucleus, and lack visible striations. These muscles function involuntarily under autonomic nervous control and produce slow, rhythmic contractions in visceral organs. Since the question asks for spindle-shaped, uninucleate, involuntary muscle fibers, the correct answer is smooth muscle.

Final Answer:

Answer: (B)

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Q73.

Solution

Concept: Cartilage is a specialized connective tissue with a firm yet flexible matrix. The matrix contains proteins and mucopolysaccharides, mainly chondroitin sulfate salts, which provide resilience and elasticity. Chondrocytes are embedded within this matrix in small spaces called lacunae.

Solution: Cartilage forms supportive structures in the body such as the nose, ear pinna, trachea, and articular surfaces of bones. Its extracellular matrix is solid but pliable due to the presence of collagen fibers and chondroitin sulfate salts. These salts are complex mucopolysaccharides that help retain water and provide flexibility and resistance to compression. Calcium phosphate is mainly associated with bone tissue, hemoglobin is found in red blood cells, and keratin is a structural protein present in hair, nails, and epidermis. Therefore, the characteristic matrix component of cartilage is chondroitin salts.

Final Answer:

Answer: (A)

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Q74.

Solution

Concept: Haemophilia is an X-linked recessive disorder. A haemophilic male has the genotype X^hY , while a normal non-carrier female has the genotype $X^H X^H$. Sons inherit the Y chromosome from the father and the X chromosome from the mother.

Solution: In X-linked inheritance, the father contributes the Y chromosome to sons and the X chromosome to daughters. A haemophilic man has genotype:



A normal non-carrier woman has genotype:



The possible offspring are:



All sons receive the normal X chromosome from the mother and the Y chromosome from the father, making them genetically normal. Since none of the sons inherit the haemophilic allele, the probability of a haemophilic son is zero. Daughters become carriers but are not affected.

Final Answer:

Answer: (D)

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Q75.

Solution

Concept: During DNA replication, unwinding of the double helix creates torsional strain ahead of the replication fork. Topoisomerase enzymes relieve this supercoiling tension by cutting and rejoining DNA strands, thereby preventing tangling and allowing smooth progression of replication.

Solution: DNA helicase unwinds the parental double helix during replication. As unwinding continues, the DNA ahead of the replication fork becomes overwound and develops supercoils. Excessive supercoiling can hinder further separation of strands and stall replication. Topoisomerase enzymes solve this problem by temporarily cutting one or both DNA strands, allowing relaxation of tension, and then resealing the strands. DNA ligase joins Okazaki fragments, while primase synthesizes RNA primers required for initiation of replication. Therefore, the primary role of topoisomerase is to relieve the tension generated by supercoiling during DNA replication.

Final Answer:

Answer: (B)

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Q76.

Solution

Concept: The Human Genome Project mapped and analyzed all human chromosomes. Among all chromosomes, Chromosome 1 was found to contain the highest number of genes, while the Y chromosome possesses the fewest genes.

Solution: The Human Genome Project provided extensive information about gene distribution across chromosomes. Chromosome 1 is the largest human chromosome and contains the maximum number of genes involved in various cellular and physiological functions. In contrast, the Y chromosome is relatively small and gene-poor. Chromosome 22 and the X chromosome also contain important genes but fewer than Chromosome 1. Because of its large size and high gene density, Chromosome 1 was identified as the chromosome with the highest number of genes in the human genome.

Final Answer:

Answer: (A)

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Q77.

Solution

Concept: The coding strand of DNA has the same nucleotide sequence as mRNA except that thymine (T) in DNA is replaced by uracil (U) in RNA. mRNA is synthesized in the 5' → 3' direction during transcription.

Solution: The coding strand of DNA given is:



During transcription, RNA polymerase uses the template strand to synthesize complementary mRNA. The resulting mRNA sequence becomes identical to the coding strand except that uracil replaces thymine. Therefore:



The sequence written in the opposite direction or with thymine instead of uracil would be incorrect for mRNA. Hence, the correct transcribed mRNA sequence is:



Final Answer:

Answer: (C)

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Q78.

Solution

Concept: Klinefelter syndrome is a chromosomal disorder caused by the presence of an extra X chromosome in males. Individuals affected by this condition possess a 47, XXY chromosomal constitution and commonly show features such as reduced fertility and underdeveloped secondary sexual characteristics.

Solution: Normally, human males possess the chromosomal constitution:

$$46, XY$$

In Klinefelter syndrome, nondisjunction during gamete formation results in an additional X chromosome, producing:

$$47, XXY$$

Affected individuals are phenotypically male but may exhibit gynecomastia, sparse body hair, and sterility due to impaired testicular development. The chromosomal constitution 45, XO corresponds to Turner syndrome, while 47, XY, +21 represents Down syndrome in a male. Therefore, the characteristic chromosomal constitution of Klinefelter syndrome is 47, XXY.

Final Answer:

Answer: (B)

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Q79.

Solution

Concept: The lac operon regulates lactose metabolism in bacteria. In the absence of lactose, the repressor protein binds to the operator site and blocks RNA polymerase from transcribing the structural genes, thereby switching the operon off.

Solution: The lac operon consists of a promoter, operator, structural genes, and a regulator gene. The regulator gene produces a repressor protein. When lactose is absent, the repressor binds specifically to the operator region. This prevents RNA polymerase from moving along the DNA and transcribing the structural genes required for lactose metabolism. As a result, the lac operon remains switched off. When lactose becomes available, it acts as an inducer by binding the repressor and preventing its attachment to the operator. Therefore, the operon is considered off when the repressor binds to the operator site.

Final Answer:

Answer: (C)

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Q80.

Solution

Concept: The first successful human gene therapy was performed in 1990 for Severe Combined Immunodeficiency (SCID) caused by deficiency of the enzyme Adenosine Deaminase (ADA). Functional ADA genes were introduced into the patient's lymphocytes to restore immune function.

Solution: Severe Combined Immunodeficiency due to ADA deficiency results in severe impairment of the immune system because lymphocytes cannot function properly. In 1990, scientists successfully performed gene therapy on a four-year-old girl suffering from this disorder. Functional ADA genes were introduced into the patient's lymphocytes using a suitable vector, enabling the cells to produce the missing enzyme. This marked the first successful demonstration of gene therapy in humans. Insulin deficiency causes diabetes mellitus, while tyrosine kinase and glucocerebrosidase deficiencies are associated with different disorders. Therefore, the first successful gene therapy was conducted for ADA deficiency.

Final Answer: Adenosine Deaminase (ADA)

Answer: (B)

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Q81.

Solution

Concept: Members of Phylum Ctenophora are marine animals characterized by bioluminescence and the presence of eight rows of ciliary comb plates used for locomotion. These comb plates beat in coordination and give the animals their common name, comb jellies.

Solution: The organism shown belongs to Phylum Ctenophora, which includes comb jellies such as Pleurobrachia and Ctenoplana. A distinctive feature of this phylum is the presence of eight external rows of ciliary comb plates arranged longitudinally on the body surface. Coordinated beating of these comb plates enables locomotion through water. Many ctenophores also exhibit bioluminescence, producing light through specialized cells. Cnidarians possess tentacles with cnidoblasts, while poriferans and platyhelminths lack comb plates entirely. Therefore, the organism belongs to Phylum Ctenophora and possesses eight comb plates.

Final Answer: Ctenophora; 8

Answer: (B)

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Q82.

Solution

Concept: Rosie was the first transgenic cow engineered to produce nutritionally enriched milk. The milk contained increased levels of human alpha-lactalbumin, making it more balanced and nutritionally suitable for human infants.

Solution: Genetic engineering techniques have been used to produce transgenic animals capable of synthesizing medically or nutritionally important substances. Rosie, a genetically modified cow, was engineered to produce milk enriched with human alpha-lactalbumin. This protein is an important component of human milk and improves nutritional quality. The transgenic milk produced by Rosie contained higher protein content and was considered more suitable for infant nutrition. Rosie was not engineered for production of beta-carotene, vitamin B₁₂, or insulin. Therefore, the enriched component in Rosie's milk was human alpha-lactalbumin.

Final Answer:

Answer: (A)

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Q83.

Solution

Concept: Malignant tumors are cancerous growths characterized by uncontrolled cell division and the ability to invade surrounding tissues and spread to distant organs. This spreading property is called metastasis and distinguishes malignant tumors from benign tumors.

Solution: Tumors are abnormal masses of proliferating cells and are classified as benign or malignant. Benign tumors remain localized, are usually encapsulated, and do not invade surrounding tissues. Malignant tumors, however, grow aggressively and possess the ability to spread from the primary site to other parts of the body through blood or lymphatic circulation. This process is known as metastasis. Cancer cells also lose contact inhibition, allowing uncontrolled proliferation. Slow growth and encapsulation are generally features of benign tumors rather than malignant ones. Therefore, the defining property distinguishing malignant tumors is metastasis.

Final Answer:

Answer: (B)

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Q84.

Solution

Concept: The Widal test is a serological test used for diagnosis of typhoid fever caused by *Salmonella typhi*. The test detects specific antibodies against O and H antigens of the bacterium in the patient's serum.

Solution: Typhoid fever is a bacterial disease caused by *Salmonella typhi*. During infection, the immune system produces antibodies against bacterial antigens. The Widal test identifies these antibodies by observing agglutination reactions between patient serum and antigen suspensions of *Salmonella*. A significant antibody titer suggests typhoid infection. Malaria is diagnosed by blood smear examination, pneumonia through clinical and microbiological methods, and AIDS through HIV-specific tests such as ELISA. Therefore, the Widal test is specifically used for diagnosing typhoid fever.

Final Answer: Typhoid

Answer: (C)

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Q85.

Solution

Concept: In emergencies such as snake bite, immediate protection is required before the body can produce its own antibodies. Therefore, antiserum containing preformed antibodies is administered to provide rapid passive immunity against snake venom toxins.

Solution: Vaccines containing attenuated pathogens or inactivated toxins stimulate active immunity, but they require time for the immune system to generate antibodies. In conditions like snake bite, rapid neutralization of venom is essential to prevent severe tissue damage and death. For this reason, antivenom serum containing preformed antibodies against snake venom is injected. These antibodies bind directly to venom toxins and neutralize them immediately, providing passive immunity. Recombinant antigens are mainly used for vaccination and diagnostic purposes rather than emergency neutralization. Therefore, the injection administered in snake bite contains preformed antibodies.

Final Answer: Preformed antibodies

Answer: (B)

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Q86.

Solution

Concept: Elephantiasis or lymphatic filariasis is caused by filarial worms such as *Wuchereria bancrofti*. The disease is transmitted through the bite of infected female *Culex* mosquitoes, which act as vectors carrying infective larvae from one person to another.

Solution: Filariasis is a parasitic disease affecting the lymphatic system and leading to severe swelling of body parts, especially the legs and scrotum. The causative worms are transmitted by mosquito vectors. In tropical countries including India, the common vector responsible for transmission is the female *Culex* mosquito. During blood feeding, the mosquito introduces infective larvae into the human bloodstream. Female *Anopheles* mosquitoes transmit malaria, while *Aedes aegypti* spreads dengue and chikungunya. Houseflies are mechanical carriers of several pathogens but do not transmit filariasis. Therefore, the correct vector of elephantiasis is the female *Culex* mosquito.

Final Answer: Female *Culex* mosquito

Answer: (B)

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Q87.

Solution

Concept: The all-or-none law states that an individual muscle fiber or neuron responds completely when stimulated by a threshold or stronger stimulus, but shows no response if the stimulus is below threshold. Partial contraction of a single muscle fiber does not occur.

Solution: Skeletal muscles are composed of many individual muscle fibers. Each muscle fiber behaves independently according to the all-or-none principle. When a threshold stimulus reaches the fiber, it contracts maximally. If the stimulus is below threshold, the fiber does not contract at all. This law applies to a single muscle fiber or neuron, not to the whole muscle. Entire muscles can show graded responses because different numbers of fibers are recruited depending on stimulus strength. Therefore, the correct description of the all-or-none law is that a single muscle fiber contracts fully or not at all when stimulated by a threshold stimulus.

Final Answer: A muscle fiber shows an all-or-none response.

Answer: (B)

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Q88.

Solution

Concept: The juxtaglomerular apparatus (JGA) helps regulate blood pressure and kidney filtration. A decrease in glomerular filtration rate stimulates juxtaglomerular cells to release renin, activating the renin-angiotensin-aldosterone system to restore blood pressure and filtration.

Solution: The juxtaglomerular apparatus is located where the distal convoluted tubule comes in close contact with the afferent arteriole. Specialized juxtaglomerular cells monitor blood pressure and filtration status. When blood pressure or glomerular filtration rate (GFR) falls, these cells secrete renin into the bloodstream. Renin converts angiotensinogen into angiotensin I, eventually leading to formation of angiotensin II, which increases blood pressure and stimulates aldosterone secretion. This mechanism helps restore normal filtration and sodium balance. Plasma glucose levels and ANF are not the primary direct triggers for renin release. Therefore, a fall in GFR stimulates the JGA to release renin.

Final Answer:

Answer: (B)

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Q89.

Solution

Concept: Oxygen partial pressure differs between systemic arteries and veins due to gas exchange in tissues. Oxygen-rich blood in systemic arteries has a higher partial pressure, while systemic venous blood returning from tissues has a much lower oxygen partial pressure.

Solution: In human circulation, oxygenated blood leaving the lungs enters systemic arteries with a partial pressure of oxygen approximately equal to 95 mmHg. As blood passes through body tissues, oxygen diffuses into cells for respiration, reducing oxygen content in the blood. Consequently, systemic venous blood returning to the heart possesses a lower oxygen partial pressure of about 40 mmHg. This difference maintains diffusion gradients required for efficient tissue oxygenation. Therefore, the correct values for systemic arterial and venous blood are 95 mmHg and 40 mmHg respectively.

Final Answer:

Answer: (A)

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Q90.

Solution

Concept: Acetylcholine is the primary excitatory neurotransmitter released at the neuromuscular junction. It transmits nerve impulses from motor neurons to skeletal muscle fibers and initiates muscle contraction by depolarizing the muscle membrane.

Solution: At the neuromuscular junction, an arriving nerve impulse causes release of acetylcholine from synaptic vesicles of the motor neuron. Acetylcholine diffuses across the synaptic cleft and binds to receptors on the muscle membrane, opening ion channels and producing depolarization. This generates a muscle action potential leading to contraction. GABA and glycine are mainly inhibitory neurotransmitters in the central nervous system, while dopamine functions primarily in brain pathways related to movement and reward. Therefore, the neurotransmitter acting as the main excitatory signal at the neuromuscular junction is acetylcholine.

Final Answer: Acetylcholine

Answer: (C)

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Q91.

Solution

Concept: Surfactant is a phospholipid-rich substance secreted by Type II pneumocytes in the alveoli. Its primary role is to reduce surface tension at the air-water interface, thereby preventing collapse of alveoli during expiration and maintaining efficient gas exchange.

Solution: The inner surface of alveoli is lined with a thin film of fluid that generates surface tension. Excessive surface tension tends to collapse the alveoli, especially during expiration. Type II pneumocytes secrete surfactant, mainly composed of lecithin, which lowers this surface tension. By reducing collapsing forces, surfactant stabilizes alveoli, decreases the effort required for breathing, and improves lung compliance. Premature infants lacking sufficient surfactant may develop respiratory distress syndrome. Although surfactant indirectly supports gas exchange, its primary function is prevention of alveolar collapse through reduction of surface tension.

Final Answer: Decrease surface tension to prevent alveolar collapse

Answer: (B)

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Q92.

Solution

Concept: The hymen is a thin membrane partially covering the vaginal opening. Its rupture may occur due to several non-sexual activities such as sports, cycling, physical exercise, or accidental injury, and therefore it is not a reliable indicator of virginity.

Solution: Traditionally, rupture of the hymen was incorrectly associated with sexual intercourse. However, medically it is well established that hymenal rupture can occur from various causes unrelated to sexual activity, including vigorous physical activity, tampon use, gymnastics, cycling, or accidental trauma. In some females, the hymen may remain intact even after intercourse because of its elasticity. Therefore, the condition of the hymen cannot be used as definitive evidence regarding virginity or prior sexual experience. It has no reliable association with fertility or menstrual health either. Hence, rupture of the hymen is not a conclusive indicator of virginity.

Final Answer:

Answer: (C)

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Q93.

Solution

Concept: The fast block to polyspermy prevents entry of multiple sperms immediately after fertilization. In humans and many animals, this rapid mechanism occurs through depolarization of the oocyte membrane soon after fusion of the first sperm.

Solution: Polyspermy, the entry of more than one sperm into an ovum, would produce abnormal chromosomal numbers and nonviable embryos. Therefore, mechanisms exist to prevent additional sperm entry after fertilization. The rapid or fast block occurs almost immediately when the first sperm fuses with the oocyte membrane. This fusion triggers membrane depolarization, altering the electrical potential of the egg membrane and preventing fusion of additional sperms. A slower and more permanent block follows through cortical reaction and hardening of the zona pellucida. Since the question specifically asks about the fast block, the correct mechanism is depolarization of the oocyte membrane.

Final Answer:

Answer: (B)

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Q94.

Solution

Concept: The chorion is the outer embryonic membrane that contributes significantly to placenta formation in humans. Chorionic villi develop from the chorion and establish intimate contact with maternal tissues for exchange of nutrients and gases.

Solution: Human embryos develop several extraembryonic membranes including the amnion, chorion, yolk sac, and allantois. Among these, the chorion plays the most important role in placental development. Finger-like projections called chorionic villi arise from the chorion and penetrate the uterine endometrium. These villi become richly supplied with fetal blood vessels and form the fetal portion of the placenta. The placenta enables exchange of oxygen, nutrients, wastes, and hormones between mother and fetus. The amnion forms the amniotic sac, while the yolk sac and allantois have other supportive roles. Therefore, the embryonic membrane primarily responsible for placenta formation is the chorion.

Final Answer:

Answer: (C)

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Q95.

Solution

Concept: Uricotelic animals excrete nitrogenous waste mainly as uric acid, which requires very little water for elimination. This adaptation is highly advantageous for terrestrial animals living in dry environments and helps conserve body water efficiently.

Solution: Nitrogenous waste excretion varies among animal groups. Aquatic animals often excrete ammonia directly, while mammals mainly excrete urea. Birds and many reptiles, including pigeons and lizards, are uricotelic and eliminate nitrogenous waste in the form of uric acid. Uric acid is relatively non-toxic and almost insoluble in water, allowing excretion as semisolid paste with minimal water loss. This adaptation is particularly useful for conserving water in terrestrial habitats and during egg development. Cartilaginous fishes are mainly ureotelic, while aquatic amphibians are generally ammonotelic. Therefore, pigeons and lizards are classic uricotelic animals.

Final Answer:

Answer: (C)

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Q96.

Solution

Concept: The Haversian canal system, or osteon system, is a characteristic structural feature of compact bone in mammals. These canals contain blood vessels and nerves that nourish bone tissue and maintain its metabolic activity.

Solution: Compact bone is organized into cylindrical structural units called osteons or Haversian systems. At the center of each osteon lies a Haversian canal containing blood vessels, lymph vessels, and nerves. Surrounding the canal are concentric layers of calcified matrix called lamellae, with osteocytes present in lacunae between them. This arrangement provides both strength and nourishment to bone tissue. Spongy bone lacks well-developed Haversian systems and instead contains trabeculae. Cartilage tissues also do not possess Haversian canals because they are avascular. Therefore, the Haversian canal system is characteristic of compact bone of mammals.

Final Answer:

Answer: (B)

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Q97.

Solution

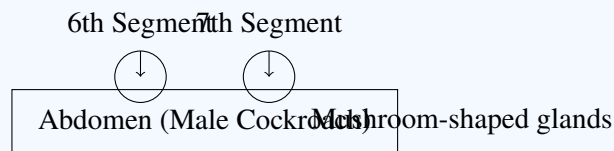
Concept: In cockroaches, accessory reproductive glands differ in males and females and are associated with reproductive functions.

- The **mushroom-shaped glands** are accessory glands present in male cockroaches.
- They are located in the **6th and 7th abdominal segments**.
- These glands contribute to the formation of the spermatophore and secretion of seminal fluids.

Key Point:

Male cockroach → 6th to 7th abdominal segments

Visual Representation:



Explanation:

- Present only in males, not females.
- Not located near the head or digestive tract.

Final Answer: 6th to 7th abdominal segments of males

Answer: (B)

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Q98.

Solution

Concept: Aminoacyl-tRNA synthetase is the enzyme responsible for charging or aminoacylation of tRNA molecules. It attaches the correct amino acid to its corresponding tRNA, ensuring accuracy during protein synthesis.

Solution: During translation, each tRNA molecule must carry its specific amino acid before participating in protein synthesis. Aminoacyl-tRNA synthetase catalyzes this process using ATP. The enzyme recognizes both the amino acid and its corresponding tRNA and forms an aminoacyl-tRNA complex. This charging process is essential because the ribosome does not verify amino acid identity directly. Peptidyl transferase forms peptide bonds during translation, while RNA polymerase III synthesizes certain RNA molecules. DNA ligase functions in DNA replication and repair. Therefore, aminoacyl-tRNA synthetase is the enzyme responsible for tRNA charging.

Final Answer: Aminoacyl-tRNA synthetase

Answer: (C)

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Q99.

Solution

Concept: RNA interference (RNAi) is a biological process in which double-stranded RNA silences specific genes by degrading complementary messenger RNA. This technique has been used to develop plants resistant to nematode infestation, especially *Meloidogyne incognita*.

Solution: Root-knot nematodes such as *Meloidogyne incognita* infect plant roots and reduce agricultural productivity. Scientists developed transgenic plants expressing double-stranded RNA corresponding to essential nematode genes. When the nematode feeds on these plants, the dsRNA triggers RNA interference inside the parasite, leading to degradation of specific mRNA molecules and preventing synthesis of vital proteins. As a result, the nematode cannot survive effectively on the plant. Although RNAi can also target viral genes, the classic NCERT example specifically involves resistance against *Meloidogyne incognita*. Therefore, RNAi technology was used to develop nematode-resistant plants.

Final Answer: Nematodes (*Meloidogyne incognita*)

Answer: (C)

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Q100.

Solution

Concept: ELISA (Enzyme-Linked Immunosorbent Assay) is a diagnostic technique based on highly specific antigen-antibody interactions. It is widely used for detecting infections, hormones, and other biological molecules in blood samples.

Solution: In ELISA, either an antigen or an antibody is immobilized on a solid surface. When the corresponding antibody or antigen from the patient's sample is added, a specific immune complex forms. This complex is detected using enzyme-linked antibodies that produce a color change upon addition of substrate. The intensity of the color indicates the presence or quantity of the target molecule. ELISA is commonly used for diseases such as HIV infection and hepatitis. The method does not rely on nucleic acid amplification or electrophoretic separation. Therefore, the fundamental principle behind ELISA is antigen-antibody interaction.

Final Answer:

Answer: (B)

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Answer Key

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

