

UPCATET Biology Sample Paper-3

Duration: 80 Minutes

Maximum Marks: 320

Instructions

- This paper contains **80** Multiple Choice Questions.
- Each correct answer carries **+4** mark. Incorrect answer: **-1** marks. Only **one** correct option.
- Unattempted questions carry **0** marks.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. In the Kranz anatomy of C_4 plants, the bundle sheath cells are characterized by having:

- (A) Thin walls, many intercellular spaces, and no chloroplasts
- (B) Thick walls, no intercellular spaces, and large agranal chloroplasts
- (C) Thin walls, no intercellular spaces, and granal chloroplasts
- (D) Thick walls, large intercellular spaces, and few chloroplasts

Q2. Which of the following elements is primarily responsible for maintaining the turgidity of guard cells during stomatal opening?

- (A) Magnesium
- (B) Calcium
- (C) Potassium
- (D) Phosphorus

Q3. During skeletal muscle contraction, which of the following regions within a sarcomere does not shorten or change its length?

- (A) I-band
- (B) H-zone



- (C) A-band
- (D) Distance between consecutive Z-lines

Q4. In a classic Mendelian dihybrid cross between two heterozygous individuals ($RrYy \times RrYy$), what is the probability of obtaining an offspring that is completely homozygous for both traits?

- (A) $\frac{9}{16}$
- (B) $\frac{3}{16}$
- (C) $\frac{4}{16}$
- (D) $\frac{1}{16}$

Q5. If the sequence of the coding strand of a double-stranded DNA fragment is 5'-ATGCATGCATGC-3', what will be the corresponding sequence of the transcribed mRNA?

- (A) 5'-AUGCAUGCAUGC-3'
- (B) 3'-AUGCAUGCAUGC-3'
- (C) 5'-UACGUACGUACG-3'
- (D) 3'-UACGUACGUACG-3'

Q6. A cell at the end of G_1 phase contains $2C$ amount of DNA. What will be the DNA content of this cell at the end of anaphase of mitosis?

- (A) $2C$
- (B) $4C$
- (C) $1C$
- (D) $8C$

Q7. In a stable terrestrial ecosystem, if the net primary productivity (NPP) is $20,000 \text{ kcal/m}^2/\text{year}$, approximately how much energy will be available to the tertiary consumers based on Lindeman's efficiency law?

- (A) $2,000 \text{ kcal/m}^2/\text{year}$



- (B) $200 \text{ kcal/m}^2/\text{year}$
- (C) $20 \text{ kcal/m}^2/\text{year}$
- (D) $2 \text{ kcal/m}^2/\text{year}$

Q8. Plants belonging to the family Solanaceae can be easily distinguished by which of the following combinations of floral characters?

- (A) Actinomorphic, epipetalous stamens, swollen placenta with oblique septum
- (B) Zygomorphic, diadelphous stamens, marginal placentation
- (C) Actinomorphic, monadelphous stamens, axile placentation with twisted aestivation
- (D) Zygomorphic, epipetalous stamens, parietal placentation with replum

Q9. In an angiospermic embryo sac, what is the ploidy level of the functional megaspore, the central cell, and the endosperm mother cell after triple fusion, respectively?

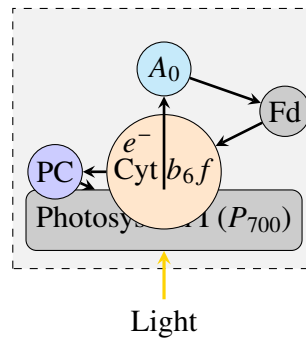
- (A) $n, n, 2n$
- (B) $n, 2n, 3n$
- (C) $2n, 2n, 3n$
- (D) $n, n, 3n$

Q10. Which of the following host enzymes is exploited by a researcher to create blunt ends from sticky ends during a recombinant DNA cloning experiment?

- (A) Alkaline phosphatase
- (B) DNA ligase
- (C) DNA polymerase I or Klenow fragment
- (D) Reverse transcriptase

Q11. During cyclic photophosphorylation, the primary electron acceptor from the excited reaction center (P_{700}) transfers its electron directly to:





- (A) Plastoquinone
- (B) Cytochrome b_6f complex
- (C) Ferredoxin
- (D) Plastocyanin

Q12. What prevents the backflow of blood from the right ventricle into the right atrium during ventricular systole?

- (A) Bicuspid valve
- (B) Tricuspid valve
- (C) Semilunar valve
- (D) Eustachian valve

Q13. In a population of 1000 individuals obeying Hardy-Weinberg equilibrium, 360 individuals express a recessive homozygous phenotype (aa). What is the frequency of the heterozygous carrier genotype (Aa)?

- (A) 0.6
- (B) 0.4
- (C) 0.48
- (D) 0.24

Q14. Which cell organelle is responsible for the synthesis of steroidal hormones in animal cells and is heavily developed in the cells of the adrenal cortex?

- (A) Rough Endoplasmic Reticulum
- (B) Smooth Endoplasmic Reticulum



- (C) Golgi Apparatus
- (D) Lysosomes

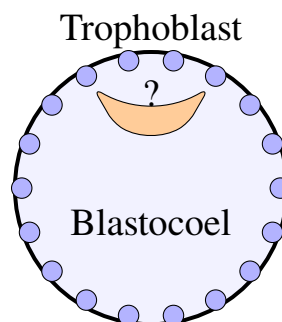
Q15. The interaction between sea anemone and clownfish, where the clownfish gets protection from predators while the sea anemone is neither harmed nor benefited, is an example of:

- (A) Mutualism
- (B) Commensalism
- (C) Amensalism
- (D) Parasitism

Q16. Flame cells (protonephridia) are specialized excretory structures characteristic of which phylum?

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

Q17. Which portion of the human blastocyst differentiates to form the primary germ layers (ectoderm, endoderm, and mesoderm) during gastrulation?



- (A) Trophoblast
- (B) Inner cell mass
- (C) Syncytiotrophoblast
- (D) Blastocoel roof



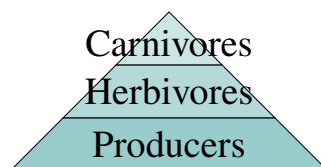
- Q18.** In the production of Bt cotton, the Bt toxin activation inside the insect gut requires:
- (A) Acidic pH of the foregut
 - (B) Alkaline pH of the midgut
 - (C) High temperature conditions
 - (D) Mechanical churning actions
- Q19.** The physiological process of guttation occurs through specialized pores called hydathodes when there is:
- (A) High root pressure and high rate of transpiration
 - (B) High root pressure and low rate of transpiration
 - (C) Low root pressure and high rate of transpiration
 - (D) Negative xylem pressure and low atmospheric humidity
- Q20.** A person who is suffering from diabetes insipidus shows symptoms of extreme thirst and excessive urination (polyuria). This clinical condition arises due to the hyposecretion of:
- (A) Insulin from pancreas
 - (B) Glucagon from pancreas
 - (C) Antidiuretic hormone from posterior pituitary
 - (D) Aldosterone from adrenal cortex
- Q21.** How many codons out of the total 64 genetic codons explicitly code for amino acids during translation?
- (A) 64
 - (B) 61
 - (C) 60
 - (D) 32



Q22. Choose the correct chemical nature of the bond linking two adjacent monosaccharide units in a molecule of glycogen.

- (A) α -(1 \rightarrow 4) and α -(1 \rightarrow 6) glycosidic bonds
- (B) β -(1 \rightarrow 4) and β -(1 \rightarrow 6) glycosidic bonds
- (C) α -(1 \rightarrow 4) glycosidic bonds only
- (D) β -(1 \rightarrow 4) glycosidic bonds only

Q23. Which of the following ecological pyramids can never be inverted in a healthy, natural ecosystem?



- (A) Pyramid of numbers in a tree ecosystem
- (B) Pyramid of biomass in a marine ecosystem
- (C) Pyramid of energy in any ecosystem
- (D) Pyramid of biomass in a forest ecosystem

Q24. Dictyosomes are the structural sub-units commonly used to refer to which organelle in plant cells?

- (A) Mitochondria
- (B) Golgi apparatus
- (C) Peroxisomes
- (D) Glyoxysomes

Q25. The regulatory protein that covers the active binding sites for myosin on the actin filaments during the resting state of skeletal muscle is:

- (A) Troponin
- (B) Tropomyosin
- (C) Meromyosin



(D) Titin

Q26. Which plant growth regulator is extensively utilized to break seed dormancy and induce the synthesis of α -amylase enzymes in germinating cereal grains?

(A) Indole-3-acetic acid

(B) Abscisic acid

(C) Gibberellic acid

(D) Zeatin

Q27. The volume of air that remains in the human lungs even after a forceful, maximum expiration is known as:

(A) Tidal Volume

(B) Expiratory Reserve Volume

(C) Residual Volume

(D) Vital Capacity

Q28. In DNA fingerprinting, the genomic regions showing high degree of polymorphism that are utilized as probes are called:

(A) RMPs

(B) SNPs

(C) VNTRs

(D) ESTs

Q29. Peptide bond formation during protein synthesis inside the ribosome is catalyzed by which specific ribozyme in prokaryotes?

(A) 16S rRNA

(B) 23S rRNA

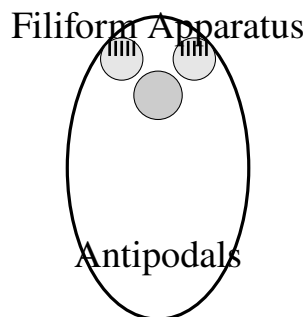
(C) 5S rRNA

(D) Spliceosome



- Q30.** Which of the following statements correctly differentiates between Mitosis and Meiosis-I?
- (A) Homologous chromosomes pair up during mitosis but not in meiosis-I.
 - (B) Sister chromatids separate during anaphase-I of meiosis, whereas homologous chromosomes separate in mitotic anaphase.
 - (C) Homologous chromosomes separate during anaphase-I, while sister chromatids separate during mitotic anaphase.
 - (D) Crossing over occurs during mitotic prophase but is absent in prophase-I.
- Q31.** The localized enrichment of nutrients in an aquatic ecosystem, such as a lake, which leads to excessive algal growth and oxygen depletion is known as:
- (A) Biomagnification
 - (B) Eutrophication
 - (C) Biofortification
 - (D) Alien species invasion
- Q32.** In the context of classification, warm-blooded animals with a four-chambered heart, pneumatic bones, and an oviparous reproductive strategy belong to the class:
- (A) Reptilia
 - (B) Amphibia
 - (C) Aves
 - (D) Mammalia
- Q33.** What is the precise function of the filiform apparatus located within the synergids of a mature embryo sac?





- (A) To guide the entry of the pollen tube into the synergid
- (B) To initiate triple fusion with the central cell
- (C) To nourish the developing zygote
- (D) To prevent self-incompatibility on the stigma

Q34. Which vector is most widely used to introduce foreign functional genes into dicotyledonous crop plants to create transgenic varieties?

- (A) pBR322
- (B) Ti plasmid of *Agrobacterium tumefaciens*
- (C) λ phage
- (D) BAC (Bacterial Artificial Chromosome)

Q35. During aerobic respiration, how many molecules of ATP are directly generated via Substrate-Level Phosphorylation (SLP) from one complete turn of the Krebs cycle?

- (A) 1
- (B) 2
- (C) 12
- (D) 34

Q36. The partial pressure of oxygen (pO_2) in the atmospheric air, oxygenated blood, and tissue cells under normal resting conditions follows which descending order?

- (A) Alveoli > Atmospheric air > Oxygenated blood



- (B) Atmospheric air > Oxygenated blood > Alveoli
- (C) Atmospheric air > Alveoli > Oxygenated blood
- (D) Oxygenated blood > Alveoli > Tissue cells

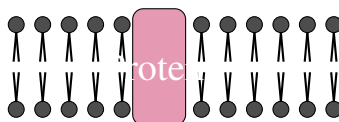
Q37. A child born with Klinefelter syndrome exhibits a distinct genetic constitution. Identify the exact chromosomal complement of this individual.

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

Q38. In cellular respiration, Cytochrome *c* oxidase complex, which transfers electrons to oxygen, corresponds to which structural complex of the electron transport chain (ETC)?

- (A) Complex I
- (B) Complex II
- (C) Complex III
- (D) Complex IV

Q39. According to the fluid mosaic model of cell membranes, the quasi-fluid nature of lipids enables lateral movement of proteins. This fluidity is largely increased by the presence of:



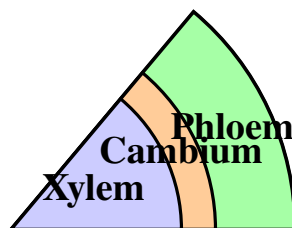
- (A) Highly saturated fatty acids
- (B) Polyunsaturated fatty acids
- (C) Integral proteins
- (D) Glycolipids



- Q40.** The Ramsar Convention signed in 1971 is an international treaty primarily dedicated to the global conservation and sustainable use of:
- (A) Endangered bird species
 - (B) Wetlands
 - (C) Tropical rainforests
 - (D) Ozone layer depletion
- Q41.** Plants belonging to the family Cruciferae (Brassicaceae) are characterized by possessing which unique type of fruit structure?
- (A) Legume
 - (B) Siliqua
 - (C) Caryopsis
 - (D) Drupe
- Q42.** Which human contraceptive method functions principally by preventing ovulation as well as altering the quality of cervical mucus to retard sperm entry?
- (A) CuT (Copper T)
 - (B) Oral contraceptive pills
 - (C) Tubectomy
 - (D) Condoms
- Q43.** What is the fundamental principle behind using a thermal cycler in a Polymerase Chain Reaction (PCR) setup?
- (A) To denature proteins present in the template mixture
 - (B) To repeatedly change temperatures to permit denaturation, annealing, and extension phases
 - (C) To maintain a constant cold temperature for enzyme stabilization
 - (D) To synthesize RNA primers automatically



Q44. In a vascular bundle of a dicot stem, the presence of cambium sandwiched between xylem and phloem classifies the bundle structurally as:



- (A) Conjoint, closed, endarch
- (B) Conjoint, open, endarch
- (C) Radial, open, exarch
- (D) Conjoint, open, exarch

Q45. The conversion of harmful ammonia into urea within the human body occurs primarily via the urea cycle inside the cells of the:

- (A) Kidneys
- (B) Liver
- (C) Spleen
- (D) Pancreas

Q46. The structural model of DNA double helix proposed by Watson and Crick shows that the pitch of a standard B-DNA helix is:

- (A) 3.4 nm
- (B) 0.34 nm
- (C) 2.0 nm
- (D) 34 nm

Q47. If a plant tissue culture sample is treated with a hormone mixture having a very high ratio of auxin to cytokinin, what morphological response is expected to be induced in the explant?

- (A) Profuse shoot differentiation



- (B) Root differentiation
- (C) Callus remains unorganized without differentiation
- (D) Immediate senescent decay

Q48. Which cell organelle contains its own circular DNA, 70S ribosomes, divides by fission, and is involved in photorespiration alongside peroxisomes and chloroplasts?

- (A) Mitochondrion
- (B) Golgi body
- (C) Nucleolus
- (D) Lysosome

Q49. The rate of decomposition of organic detritus becomes significantly slower under which environmental conditions?

- (A) Warm temperature and high moisture levels
- (B) Rich nitrogen and water-soluble substance content in detritus
- (C) Low temperature and anaerobic environments
- (D) Aerobic environments with optimum soil pH

Q50. Organisms that are strictly restricted to a narrow range of environmental salinity fluctuations are biologically classified as:

- (A) Euryhaline
- (B) Stenohaline
- (C) Eurythermal
- (D) Stenothermal

Q51. The specific type of placentation found in the family Fabaceae, where the ovary is unilocular and ovules are borne along the ventral suture, is:

- (A) Axile
- (B) Parietal

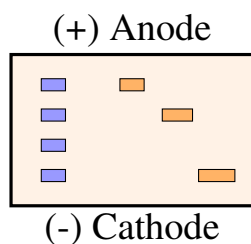


- (C) Marginal
- (D) Basal

Q52. During the menstrual cycle, the sudden mid-cycle surge of which hormone triggers the rupture of the Graafian follicle and causes ovulation?

- (A) Progesterone
- (B) Estrogen
- (C) Luteinizing Hormone (LH)
- (D) Follicle Stimulating Hormone (FSH)

Q53. Which technique is most appropriate to separate DNA fragments based on their molecular size after being digested by a restriction endonuclease enzyme?



- (A) Polymerase Chain Reaction
- (B) Agarose Gel Electrophoresis
- (C) Southern Blotting
- (D) Centrifugation

Q54. During the process of glycolysis, which specific enzyme catalyzes the irreversible conversion of Fructose-6-phosphate into Fructose-1,6-bisphosphate?

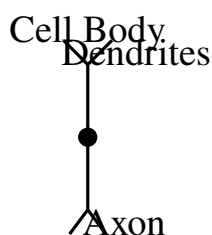
- (A) Hexokinase
- (B) Phosphofructokinase
- (C) Phosphoglucose isomerase
- (D) Pyruvate kinase

Q55. Identify the correct sequence of anatomical regions encountered from outside to inside in a typical dicotyledonous root:



- (A) Epiblema → Cortex → Endodermis → Pericycle
- (B) Epiblema → Endodermis → Cortex → Pericycle
- (C) Epidermis → Pericycle → Endodermis → Cortex
- (D) Epiblema → Cortex → Pericycle → Endodermis

Q56. What type of neurons are exclusively found within the human retina?



- (A) Unipolar neurons
- (B) Bipolar neurons
- (C) Multipolar neurons
- (D) Pseudounipolar neurons

Q57. In the Hershey-Chase experiment proving DNA as the genetic material, which radioactive isotopes were chosen to label the bacteriophage DNA and protein coat, respectively?

- (A) ^{14}C and ^{15}N
- (B) ^{32}P and ^{35}S
- (C) ^{35}S and ^{32}P
- (D) ^3H and ^{14}C

Q58. Chiasmata formation, which structurally represents the site of crossing over between non-sister chromatids of homologous chromosomes, becomes visible during which stage of prophase-I?

- (A) Pachytene
- (B) Diplotene



- (C) Zygotene
- (D) Leptotene

Q59. The Montreal Protocol was an international milestone agreement signed in 1987 to control the global emission of:

- (A) Greenhouse gases causing global warming
- (B) Ozone-depleting substances
- (C) Industrial effluents into marine bodies
- (D) Heavy metal pollutants in soil

Q60. According to the Five-Kingdom classification system proposed by R.H. Whittaker, unicellular eukaryotic organisms like Amoeba and Chlamydomonas are grouped under which kingdom?

- (A) Monera
- (B) Protista
- (C) Fungi
- (D) Plantae

Q61. The structural transition phase of the human embryo that consists of a solid sphere of 8 to 16 blastomeres before reaching the uterus is termed the:

- (A) Blastocyst
- (B) Morula
- (C) Gastrula
- (D) Neurula

Q62. In a bioreactor system, the primary utility of a sparger assembly is to:

- (A) Agitate the thick culture medium broth
- (B) Maintain optimum operational temperature
- (C) Provide continuous sterile air bubbles for oxygen availability



(D) Regulate the pH fluctuations automatically

Q63. The primary carbon dioxide (CO₂) acceptor molecule in the mesophyll cells of a C₄ plant like maize is:

(A) Ribulose-1,5-bisphosphate (RuBP)

(B) Phosphoenolpyruvate (PEP)

(C) Oxaloacetic acid (OAA)

(D) 3-phosphoglyceric acid (PGA)

Q64. Cells of the human stomach lining secrete Pepsinogen. Which specialized cell type is directly responsible for this secretion?

(A) Parietal cells

(B) Oxyntic cells

(C) Chief or Peptic cells

(D) Goblet cells

Q65. If a segment of DNA molecule has 30% Adenine bases, what will be the calculated percentage of Guanine bases in that DNA segment according to Chargaff's rule?

(A) 30%

(B) 20%

(C) 40%

(D) 70%

Q66. The cell wall of fungi is distinct from plant cell walls and is composed of a complex polymer called:

(A) Cellulose

(B) Hemicellulose

(C) Chitin

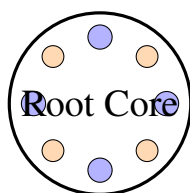
(D) Pectin



Q67. Which of the following areas is designated as an *in-situ* method for biodiversity conservation?

- (A) Botanical Gardens
- (B) Wildlife Sanctuaries
- (C) Zoological Parks
- (D) Gene Banks

Q68. Radial vascular bundles, where xylem and phloem strands alternate with each other along different radii, are a characteristic anatomical feature of:



- (A) Dicot stems
- (B) Monocot stems
- (C) All roots
- (D) Isobilateral leaves

Q69. The functional temporary endocrine structure that forms inside the human ovary from the remnants of the ruptured follicle after ovulation is the:

- (A) Corpus albicans
- (B) Corpus callosum
- (C) Corpus luteum
- (D) Corona radiata

Q70. In recombinant DNA technology, which enzyme is utilized to covalently join a foreign passenger DNA segment into a cut plasmid vector backbone?

- (A) EcoRI
- (B) DNA Helicase
- (C) DNA Ligase



(D) DNA Polymerase III

Q71. Photorespiration (the C_2 cycle) is initiated inside chloroplasts when the bifunctional enzyme RuBisCO binds with oxygen instead of carbon dioxide. This oxygenation reaction yields:

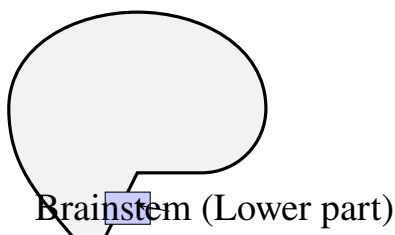
(A) Two molecules of 3-PGA

(B) One molecule of 3-PGA and one molecule of phosphoglycolate

(C) Two molecules of phosphoglycolate

(D) One molecule of oxaloacetate

Q72. Which portion of the human brain acts as the primary regulatory center for controlling homeostatic visceral functions like respiration, cardiovascular reflexes, and gastric secretions?



(A) Cerebellum

(B) Cerebrum

(C) Medulla oblongata

(D) Hypothalamus

Q73. The non-coding intervening sequences present within a primary eukaryotic mRNA transcript (*hnRNA*) that must be removed during splicing are called:

(A) Exons

(B) Introns

(C) Promoters

(D) Transposons

Q74. Which of the following biomolecules acts as an essential competitive inhibitor of the enzyme succinate dehydrogenase?



- (A) Malonate
- (B) Succinate
- (C) Oxaloacetate
- (D) α -ketoglutarate

Q75. The specific pattern of ecological succession that initiates on a completely bare, newly exposed volcanic rock surface is referred to as:

- (A) Primary succession
- (B) Secondary succession
- (C) Hydrarch succession
- (D) Autogenic degradation

Q76. Plants belonging to the family Liliaceae exhibit which characteristic set of vegetative and floral features?

- (A) Tricarpellary syncarpous ovary, superior, with epitepalous stamens
- (B) Bicarpellary syncarpous ovary with oblique septum
- (C) Monocarpellary inferior ovary with marginal placentation
- (D) Polycarpellary apocarpous ovary with parietal placentation

Q77. The process of fast block to polyspermy during human fertilization involves:

- (A) Depolarization of the oocyte plasma membrane by sodium influx
- (B) Cortical reaction hardening the zona pellucida layer
- (C) Loss of receptors on the corona radiata cells
- (D) Extrusion of the second polar body

Q78. RNA interference (RNAi) technology used to create pest-resistant tobacco plants against *Meloidogyne incognita* operates via:

- (A) Translational enhancement of viral proteins
- (B) Silencing of specific mRNA due to a complementary dsRNA molecule

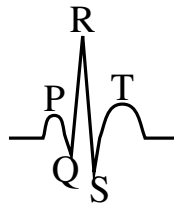


- (C) Mutation of genomic target sequences
- (D) Cleavage of cellular ribosomal machinery

Q79. The hormone primarily responsible for ripening of fruits and inducing triple response in seedlings is:

- (A) Abscisic acid
- (B) Ethylene
- (C) Cytokinin
- (D) Gibberellin

Q80. In a typical mammalian electrocardiogram (ECG), the structural event corresponding to the QRS complex represents:



- (A) Atrial depolarization
- (B) Ventricular depolarization
- (C) Ventricular repolarization
- (D) Atrial repolarization



Detailed Solutions**Q1.****Solution****Concept:**

Plants utilizing the C_4 photosynthetic pathway possess a specialized leaf anatomy known as Kranz anatomy. This structural arrangement physically segregates initial carbon fixation from the Calvin cycle to eliminate photorespiration under high temperature conditions.

Solution:

Step 1: Kranz anatomy features large, specialized bundle sheath cells arranged in a wreath-like layer around the vascular bundles, surrounded by outer mesophyll cells.

Step 2: The bundle sheath cells evolve thick cell walls that are highly impervious to gaseous exchange, preventing oxygen from entering and keeping carbon dioxide tightly contained inside.

Step 3: Intercellular spaces are completely absent within the bundle sheath layer to block any atmospheric gas leakage.

Step 4: These cells contain large, agranal chloroplasts specialized for the Calvin cycle, which lack grana stacks but contain abundance of starch grains.

Final Answer: Thick walls, no intercellular spaces, and large agranal chloroplasts

Answer: (B)

[Go Back to Question 1](#)



Q2.

Solution**Concept:**

The opening and closing of stomata depend entirely on the turgidity changes of guard cells. This process is driven by an active ion transport mechanism that creates an osmotic gradient across the plasma membrane.

Solution:

Step 1: During daytime, light stimulates the active proton pumps (H^+ -ATPase) on the guard cell membrane to pump protons out of the cytoplasm.

Step 2: The hyperpolarization of the membrane triggers the inward influx of potassium (K^+) ions from surrounding subsidiary cells into the guard cells.

Step 3: Accumulation of potassium ions, balanced by malate and chloride anions, significantly decreases the osmotic potential inside the vacuole.

Step 4: Water moves osmotically into the guard cells, increasing turgor pressure, causing them to swell outward and open the stomatal pore.

Final Answer:

Answer: (C)

[Go Back to Question 2](#)



Q3.

Solution**Concept:**

The sliding filament theory explains that muscle contraction occurs when thin actin filaments slide past thick myosin filaments, changing the dimensions of specific zones within the microscopic sarcomere unit.

Solution:

Step 1: A sarcomere is bounded between two adjacent Z-lines. The I-band contains only thin actin filaments, the H-zone contains only thick myosin filaments, and the A-band spans the full length of the thick filaments.

Step 2: When a muscle receives an activation signal, myosin cross-bridges pull actin filaments toward the center of the sarcomere.

Step 3: The I-band shortens significantly and the H-zone narrows or completely disappears as actin overlaps the myosin.

Step 4: The length of the thick myosin filaments themselves does not change during the sliding process. Consequently, the A-band remains perfectly constant in length.

Final Answer:

Answer: (C)

[Go Back to Question 3](#)



Q4.

Solution**Concept:**

A Mendelian dihybrid cross analyzes the independent assortment of two distinct genes. The phenotypic ratio is typically 9 : 3 : 3 : 1, while the underlying genotypic ratio consists of nine distinct classes.

Solution:

Step 1: The cross involves two heterozygous individuals: $RrYy \times RrYy$.

Step 2: A completely homozygous individual can either be homozygous dominant for both traits ($RRYY$), homozygous recessive for both traits ($rryy$), or homozygous dominant for one and recessive for the other ($RRyy$ and $rrYY$).

Step 3: Let us calculate individual probabilities from the Punnett square. The genotype $RRYY$ occurs with a frequency of $1/16$. The genotype $rryy$ occurs with a frequency of $1/16$.

Step 4: Similarly, the recombinant homozygous genotypes $RRyy$ and $rrYY$ each occur with a frequency of $1/16$.

Step 5: Summing these four mutually exclusive homozygous combinations gives: $1/16 + 1/16 + 1/16 + 1/16 = 4/16$.

Final Answer:

$$\frac{4}{16}$$

Answer: (C)[Go Back to Question 4](#)

Q5.

Solution**Concept:**

Transcription is the synthesis of RNA using a DNA template. The RNA polymerase enzyme synthesizes mRNA in a 5' to 3' direction, matching the base sequence of the coding strand exactly, except that thymine is replaced by uracil.

Solution:

Step 1: A double-stranded DNA molecule contains a template strand (3' to 5') and a coding strand (5' to 3').

Step 2: The given sequence is the coding strand: 5'-ATGCATGCATGC-3'.

Step 3: The mRNA sequence is identical in polarity and sequence to the coding strand because both are complementary to the same template strand.

Step 4: Replace every Thymine (T) base in the coding DNA sequence with a Uracil (U) base for the RNA equivalent.

Step 5: This substitution gives the unique mRNA sequence: 5'-AUGCAUGCAUGC-3'.

Final Answer:

Answer: (A)

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Q6.

Solution**Concept:**

The cell cycle involves alternating phases of growth and division. DNA replication occurs exclusively during the synthesis (S) phase, while the distribution of chromosomes occurs during the stages of mitosis.

Solution:

Step 1: At the G₁ phase, the cell has not replicated its genome, so its DNA content is stated as 2C.

Step 2: During the S phase, DNA replication doubles the amount of genetic material from 2C to 4C, though chromosome number remains identical.

Step 3: The cell passes through G₂ phase and enters mitosis with a DNA content of 4C.

Step 4: In mitotic anaphase, sister chromatids are pulled to opposite poles, but they are still contained within the single undivided cytoplasm of the same cell.

Step 5: Because cytokinesis has not yet occurred to partition the cell into two, the total amount of DNA inside the cell at anaphase remains 4C.

Final Answer:

Answer: (B)

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Q7.

Solution**Concept:**

Lindeman's ten percent law of trophic efficiency states that during the transfer of organic energy from one trophic level to the next higher level, only about ten percent of the entered energy is stored as biomass.

Solution:

Step 1: The Net Primary Productivity (NPP) represents the energy stored at the producer level (Trophic Level 1, T_1), which is given as 20,000 kcal/m²/year.

Step 2: Energy available to primary consumers (herbivores, T_2) is 10% of 20,000, which equals 2,000 kcal/m²/year.

Step 3: Energy transferred to secondary consumers (primary carnivores, T_3) is 10% of 2,000, which equals 200 kcal/m²/year.

Step 4: Energy reaching tertiary consumers (secondary carnivores, T_4) is 10% of 200, which calculates to 20 kcal/m²/year.

Final Answer:

Answer: (C)

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Q8.

Solution**Concept:**

Taxonomic identification of angiospermic families relies heavily on diagnostic floral structures. The family Solanaceae, commonly known as the potato family, exhibits a unique combination of reproductive anatomy.

Solution:

Step 1: Flowers of Solanaceae are actinomorphic, meaning they exhibit radial symmetry and can be divided into equal halves along multiple radial planes.

Step 2: The androecium consists of five stamens that are epipetalous, meaning their filaments are physically attached to the petals.

Step 3: The gynoecium is bicarpellary and syncarpous, featuring a characteristically swollen placenta that bears numerous ovules.

Step 4: A key diagnostic anatomical feature of this family is that the septum separating the two locules is positioned obliquely rather than along the absolute vertical plane.

Final Answer:

Answer: (A)

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Q9.

Solution**Concept:**

Double fertilization is a characteristic process unique to angiosperms. It involves two separate fertilization events occurring simultaneously inside the female gametophyte (embryo sac).

Solution:

Step 1: The functional megaspore is a direct product of meiosis and develops into the embryo sac. Being a haploid gametophytic cell, its ploidy is n .

Step 2: The central cell contains two polar nuclei that fuse together before or during fertilization to form a diploid secondary nucleus, making its baseline ploidy $2n$.

Step 3: During triple fusion, one haploid (n) male gamete fuses with this diploid ($2n$) central cell nucleus.

Step 4: This fusion event produces the primary endosperm nucleus (PEN), which converts the endosperm mother cell into a triploid ($3n$) structure. Thus, the respective ploidies are n , $2n$, and $3n$.

Final Answer:

Answer: (B)

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Q10.

Solution**Concept:**

In recombinant DNA cloning, restriction enzymes often generate single-stranded overhangs called sticky ends. To insert these into a blunt-ended vector, researchers must fill in or chew back the overhangs to create flush double-stranded blunt ends.

Solution:

Step 1: Sticky ends possess unpaired nucleotide extensions on either the 5' or 3' ends of the DNA strand.

Step 2: To convert a 5' overhang into a blunt end, a polymerase enzyme must synthesize a complementary strand using the single-stranded tail as a template.

Step 3: DNA polymerase I or its structural subunit, the Klenow fragment, possesses 5' → 3' polymerase activity along with 3' → 5' exonuclease activity.

Step 4: The Klenow fragment incorporates matching dNTPs to extend the shorter strand until it is flush with the end, creating a fully blunt-ended DNA terminus.

Final Answer:

Answer: (C)

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Q11.

Solution**Concept:**

Cyclic photophosphorylation occurs in the stroma lamellae membranes when light energy of longer wavelengths excites Photosystem I (P_{700}). The expelled electron travels through a closed loop of carriers to generate ATP without producing NADPH.

Solution:

Step 1: Photons of light strike the reaction center (P_{700}) of Photosystem I, driving an electron to a high energy level.

Step 2: The energized electron is captured by a primary electron acceptor molecule (A_0 , a modified chlorophyll molecule).

Step 3: From the primary acceptor, the electron is immediately passed down an exergonic path to Ferredoxin (Fd), an iron-sulfur protein.

Step 4: Instead of transferring to $NADP^+$ reductase, Ferredoxin diverts the electron back to the cytochrome b_6f complex, completing the cyclical loop. Therefore, Ferredoxin is the direct recipient from the primary pathways.

Final Answer:

Answer: (C)

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Q12.

Solution**Concept:**

The mammalian heart utilizes specialized fibrous valves to maintain a strictly unidirectional flow of blood through its chambers and prevent harmful backflow during the high pressures of the cardiac cycle.

Solution:

Step 1: The human heart consists of four chambers, where the right side manages deoxygenated blood and the left side manages oxygenated blood.

Step 2: The right atrium opens into the right ventricle through an aperture guarded by an atrioventricular valve composed of three distinct flaps or cusps.

Step 3: This specific structure is named the tricuspid valve.

Step 4: During ventricular systole, the right ventricle contracts powerfully to push blood into the pulmonary artery. The rising intraventricular pressure forces the flaps of the tricuspid valve to snap shut, sealing the opening to the right atrium.

Final Answer:

Answer: (B)

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Q13.

Solution**Concept:**

The Hardy-Weinberg principle states that allele and genotype frequencies in a large, stable population remain constant over generations unless disturbed by specific evolutionary forces. The mathematical expression is $p^2 + 2pq + q^2 = 1$.

Solution:

Step 1: Let p be the frequency of the dominant allele (A) and q be the frequency of the recessive allele (a).

Step 2: The frequency of the homozygous recessive phenotype (aa) corresponds to q^2 . Given 360 individuals out of 1000, we find:

$$q^2 = \frac{360}{1000} = 0.36$$

Step 3: Solve for the recessive allele frequency q by taking the square root:

$$q = \sqrt{0.36} = 0.6$$

Step 4: Since $p + q = 1$, we calculate the dominant allele frequency p :

$$p = 1 - 0.6 = 0.4$$

Step 5: The frequency of the heterozygous genotype (Aa) is represented by $2pq$:

$$\text{Frequency} = 2 \times 0.4 \times 0.6 = 0.48$$

Final Answer:

Answer: (C)

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Q14.

Solution**Concept:**

Endoplasmic reticulum exists in two structurally and functionally distinct forms. While rough endoplasmic reticulum is covered with ribosomes for protein synthesis, smooth endoplasmic reticulum lacks ribosomes and contains enzymes for lipid metabolism.

Solution:

Step 1: The Smooth Endoplasmic Reticulum (SER) acts as the primary site for the synthesis of lipids, phospholipids, and fatty acids within eukaryotic cells.

Step 2: In animal cells, the biochemical pathways for manufacturing steroidal hormones, such as glucocorticoids and mineralocorticoids, are located within the SER membrane.

Step 3: Cells of the adrenal cortex are highly specialized for secreting massive amounts of these steroidal stress hormones.

Step 4: Consequently, these cortical cells characteristically possess an extensively developed network of smooth endoplasmic reticulum to meet metabolic demands.

Final Answer:

Answer: (B)

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Q15.

Solution**Concept:**

Interspecific interactions occur between different species residing within an ecological community. These relationships can be beneficial (+), detrimental (-), or neutral (0) to the participating organisms.

Solution:

Step 1: Analyze the interaction described between the sea anemone and the clownfish.

Step 2: The clownfish lives among the stinging tentacles of the sea anemone, gaining reliable protection from its natural predators. Thus, the clownfish receives a clear benefit (+).

Step 3: The sea anemone does not derive any measurable advantage, food source, or metabolic harm from the presence of the fish. Thus, its status is completely unaffected or neutral (0).

Step 4: An ecological interaction categorized as a (+, 0) relationship, where one species gains an advantage while the other remains entirely unaffected, is defined as commensalism.

Final Answer:

Answer: (B)

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Q16.

Solution**Concept:**

Animal phyla are categorized based on anatomical features, including structural body symmetry, embryonic germ layers, coelom types, and specialized physiological systems like excretion.

Solution:

Step 1: Flame cells, or protonephridia, are primitive, specialized excretory structures containing a cluster of beating cilia that look like a flickering flame under magnification.

Step 2: These specialized cells function primarily in osmoregulation (maintaining fluid balance) and removing metabolic wastes.

Step 3: The presence of flame cells as the primary component of the excretory system is a key diagnostic characteristic of acoelomate flatworms.

Step 4: Flatworms belong taxonomically to the phylum Platyhelminthes. Members of Aschelminthes utilize renette cells, while Annelids possess nephridia.

Final Answer:

Answer: (B)

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Q17.

Solution**Concept:**

During early mammalian embryonic development, the zygote undergoes cleavage divisions to form a blastocyst. The blastocyst possesses a distinct structural layout that separates protective tissue from embryo-forming tissue.

Solution:

Step 1: The blastocyst consists of an outer single layer of flattened cells called the trophoblast and an inner localized cluster of cells.

Step 2: The outer trophoblast layer is specialized for uterine attachment and eventually forms the embryonic contribution to the placenta.

Step 3: The clustered mass of cells attached to one pole inside the trophoblast shell is known as the inner cell mass (ICM).

Step 4: The inner cell mass contains pluripotential stem cells that undergo morphogenetic movements during gastrulation.

Step 5: These cell sheets differentiate into the three primary embryonic germ layers: ectoderm, endoderm, and mesoderm, which give rise to all body organs.

Final Answer:

Answer: (B)

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Q18.

Solution**Concept:**

The bacterium *Bacillus thuringiensis* produces crystalline endotoxin proteins (Cry proteins) during sporulation. These proteins function as highly targeted biological insecticides without damaging the producing host or mammalian tissue.

Solution:

Step 1: The Cry protein is synthesized by the bacterium as an inactive, non-toxic crystalline protoxin, which prevents auto-toxicity.

Step 2: When an insect ingest the transgenic plant tissue, the crystalline protoxin enters its digestive tract.

Step 3: The midgut environment of susceptible insect larvae is characterized by a highly alkaline pH.

Step 4: This alkaline condition dissolves the protein crystals, allowing midgut proteases to cleave the protoxin into its active, low-molecular-weight toxic form.

Step 5: The active toxin binds to epithelial cell receptors, creating lytic pores that destroy the insect's gut lining.

Final Answer:

Answer: (B)

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Q19.

Solution**Concept:**

Guttation is the loss of liquid water droplets from the uninjured margins of leaves through specialized secretory structures called hydathodes, contrasting with transpiration which releases gaseous water vapor.

Solution:

Step 1: During conditions of high soil moisture and warm soil temperatures, plant roots actively absorb water, building up a substantial positive hydrostatic pressure called root pressure.

Step 2: If the atmospheric humidity is simultaneously high (such as at night or early morning), the rate of transpiration falls extremely low because the water vapor concentration gradient is reduced.

Step 3: The high root pressure continues to force liquid water up the xylem columns, but it cannot evaporate through the stomata.

Step 4: This excess pressure pushes liquid water out through xylem terminations at the leaf tips via hydathodes, resulting in guttation.

Final Answer:

Answer: (B)

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Q20.

Solution**Concept:**

The endocrine system coordinates physiological homeostasis via circulating hormones. Water balance in the human body is tightly regulated by a feedback loop involving osmoreceptors and a posterior pituitary hormone.

Solution:

Step 1: The hypothalamus synthesizes Antidiuretic Hormone (ADH), also known as vasopressin, which is stored and released by the posterior pituitary gland.

Step 2: ADH acts on the distal convoluted tubules and collecting ducts of the kidneys, inserting aquaporin channels to facilitate water reabsorption back into the bloodstream.

Step 3: Hyposecretion or structural deficiency of ADH prevents the kidneys from conserving water, leading to the excretion of massive volumes of highly dilute urine.

Step 4: This specific clinical condition is named diabetes insipidus, distinguishing it from diabetes mellitus, which involves insulin dysfunction and glucose imbalance.

Final Answer:

Answer: (C)

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Q21.

Solution**Concept:**

The genetic code is a triplet-based system where sequences of three nucleotide bases, called codons, specify particular amino acids during the translation phase of protein synthesis.

Solution:

Step 1: Since there are four distinct nitrogenous bases (A, U, G, C) in mRNA, combinations of three bases yield a total mathematical matrix of $4 \times 4 \times 4 = 64$ unique triplet codons.

Step 2: Biologists discovered that three of these 64 codons do not specify any amino acid. These triplets (UAA, UAG, and UGA) are recognized as stop or termination codons.

Step 3: When a ribosome encounters a stop codon, translation stops and the completed polypeptide chain is released.

Step 4: To find the number of functional sense codons that explicitly code for amino acids, subtract the three stop codons from the total pool: $64 - 3 = 61$.

Final Answer:

Answer: (B)

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Q22.

Solution**Concept:**

Glycogen is a highly branched homopolysaccharide that serves as the primary reservoir of carbohydrate storage in animal tissues and fungi, structurally analogous to amylopectin in plants.

Solution:

Step 1: Glycogen is entirely composed of repeating monomeric units of α -D-glucose linked together in long polymeric chains.

Step 2: Within the straight, linear segments of the glycogen molecule, adjacent glucose molecules are connected by a covalent glycosidic bond between carbon-1 of one glucose and carbon-4 of the next. This is an α -(1 \rightarrow 4) glycosidic bond.

Step 3: Glycogen is highly branched, with a branch point occurring roughly every 8 to 12 glucose residues.

Step 4: These precise branch points are formed by creating a secondary glycosidic linkage between carbon-1 of the branching glucose and carbon-6 of the main chain glucose, establishing an α -(1 \rightarrow 6) glycosidic bond.

Final Answer:

Answer: (A)

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Q23.

Solution**Concept:**

Ecological pyramids graphically depict the parameters of trophic levels (numbers, biomass, or energy) within an ecosystem. Depending on ecosystem structure, these geometric shapes can be upright, spindle-shaped, or inverted.

Solution:

Step 1: The pyramid of numbers can be inverted, as seen when hundreds of insects feed on a single large tree producer.

Step 2: The pyramid of biomass can also be inverted, typical in marine ecosystems where a small standing crop of phytoplankton supports a much larger biomass of zooplankton and fish.

Step 3: The pyramid of energy measures the total rate of energy flow through each progressive trophic level over time.

Step 4: Because of thermodynamics and respiratory heat losses, energy is inevitably lost at each step. Thermodynamics dictates that energy entering a level must decrease sequentially, meaning the pyramid of energy is always strictly upright.

Final Answer:

Answer: (C)

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Q24.

Solution**Concept:**

Eukaryotic cells distribute metabolic tasks among specialized, membrane-bound cellular structures. The terminology used to describe these organelles can vary between plant and animal disciplines.

Solution:

Step 1: The Golgi apparatus is a highly organized membrane system consisting of flattened, fluid-filled sacs called cisternae stacked parallel to each other.

Step 2: In animal cells, the Golgi apparatus typically forms a singular, highly interconnected, complex network located near the nucleus.

Step 3: In plant cells, the Golgi system is fragmented into many distinct, isolated, simpler stacks of cisternae distributed throughout the cytoplasm.

Step 4: These decentralized, individual plant Golgi stacks are specifically called dictyosomes. They maintain the same sorting and modification functions but differ in distribution.

Final Answer:

Answer: (B)

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Q25.

Solution**Concept:**

The molecular physiology of muscle contraction is governed by a calcium-dependent regulatory mechanism that alters the structural positioning of thin filament proteins to permit cross-bridge cycling.

Solution:

Step 1: Thin filaments are primarily composed of helical F-actin polymers wound together. In a resting muscle state, actin filaments cannot bind to myosin because their active binding sites are physically blocked.

Step 2: A long, fibrous regulatory protein called tropomyosin runs along the groove of the F-actin helix.

Step 3: This tropomyosin strand is positioned to mask the specific myosin-binding sites on the actin monomers when the cell is at rest.

Step 4: Troponin is a complex of three regulatory subunits bound at intervals along the tropomyosin strand.

Step 5: When calcium binds to troponin, it shifts the position of the attached tropomyosin strand, uncovering the active binding sites for contraction to begin.

Final Answer:

Answer: (B)

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Q26.

Solution**Concept:**

Plant hormones, or phytohormones, regulate growth, development, and physiological responses. Different classes of hormones often act antagonistically to coordinate life cycle transitions like seed dormancy.

Solution:

Step 1: Seed dormancy is maintained by high internal levels of abscisic acid (ABA), preventing premature germination under unfavorable conditions.

Step 2: Gibberellic acid (GA), a growth-promoting phytohormone, acts as a direct antagonist to abscisic acid to break seed dormancy.

Step 3: When a dormant seed absorbs water, gibberellin synthesis is triggered within the embryo.

Step 4: The gibberellins diffuse to the outer aleurone layer of the seed, where they activate gene transcription for hydrolytic enzymes.

Step 5: This induces the synthesis of α -amylase, an enzyme that hydrolyzes stored starch into soluble sugars to nourish the growing embryo.

Final Answer:

Answer: (C)

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Q27.

Solution**Concept:**

Pulmonary ventilation parameters can be quantified by measuring specific lung volumes and capacities using a spirometer, reflecting the mechanical properties of thoracic expansion and lung elasticity.

Solution:

Step 1: Tidal volume is the air volume moved during a normal, quiet breath. Expiratory reserve volume is the extra air that can be forcefully exhaled after a normal breath.

Step 2: Even during a maximum, forceful expiration, the human lungs can never be completely deflated or emptied of air.

Step 3: The permanent volume of air trapped within the alveoli and non-collapsible conducting airways is defined as the Residual Volume (RV).

Step 4: RV functions to prevent alveolar collapse at low transpulmonary pressures and ensures continuous gas exchange between breaths. It cannot be measured directly by basic spirometry.

Final Answer:

Answer: (C)

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Q28.

Solution**Concept:**

DNA fingerprinting relies on identifying unique variations within non-coding regions of the human genome. These regions vary in length between individuals due to differences in the number of repeating sequence units.

Solution:

Step 1: The human genome contains satellite DNA regions consisting of short nucleotide sequences repeated multiple times in tandem.

Step 2: The number of tandem repetitions at specific chromosomal loci varies from person to person, creating high genetic polymorphism.

Step 3: These hypervariable genetic loci are termed Variable Number of Tandem Repeats (VNTRs).

Step 4: In Southern blot hybridization workflows, radiolabeled VNTR sequences are used as probes to bind to matching fragments, creating an individual-specific pattern of bands on film.

Final Answer:

Answer: (C)

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Q29.

Solution**Concept:**

Translation involves the polymerization of amino acids to form a protein chain. While most cellular enzymes are proteins, the formation of peptide bonds is catalyzed by an RNA molecule within the ribosome structure.

Solution:

Step 1: The large ribosomal subunit acts as the peptidyl transferase enzyme responsible for linking amino acids together during elongation.

Step 2: In prokaryotes, the large ribosomal subunit (50S) contains two distinct structural rRNA molecules: the 5S rRNA and the larger 23S rRNA.

Step 3: Structural and biochemical studies demonstrated that the catalytic peptidyl transferase activity resides within the 23S rRNA molecule itself.

Step 4: Because an RNA molecule is performing enzymatic catalysis, it is classified as a ribozyme. The 16S rRNA component is found in the small subunit and manages mRNA alignment.

Final Answer:

Answer: (B)

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Q30.

Solution**Concept:**

Cell division occurs via mitosis or meiosis. Mitosis preserves chromosome number to create identical somatic cells, while meiosis halves the chromosome number through two divisions to produce genetically diverse haploid gametes.

Solution:

Step 1: During mitotic metaphase, individual chromosomes align single-file at the equator, and their sister chromatids separate during anaphase.

Step 2: In prophase-I of meiosis-I, homologous chromosomes pair up (synapsis) to form bivalents and exchange genetic material during crossing over.

Step 3: During anaphase-I of meiosis, the homologous chromosome pairs separate and move toward opposite poles of the cell, while the sister chromatids remain attached at their centromeres.

Step 4: In contrast, mitotic anaphase involves the splitting of the centromere and the separation of individual sister chromatids. This distinguishes the two mechanical processes.

Final Answer: Homologous chromosomes separate during anaphase-I, while sister chromatids separate during mitotic anaphase.

Answer: (C)

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Q31.

Solution**Concept:**

Anthropogenic pollution can destabilize aquatic environments. Runoff containing agricultural fertilizers or domestic sewage introduces high concentrations of limiting nutrients into bodies of water.

Solution:

Step 1: The introduction of nitrogen and phosphorus compounds fertilizes an aquatic ecosystem like a lake, a process known as nutrient enrichment.

Step 2: This surplus of nutrients triggers an explosive population growth of planktonic algae, a phenomenon called an algal bloom.

Step 3: The dense layer of algae blocks sunlight from reaching submerged aquatic plants, causing them to die.

Step 4: Aerobic decomposers (bacteria) multiply rapidly to break down the dead organic matter, consuming vast amounts of dissolved oxygen.

Step 5: The resulting oxygen depletion leads to the suffocation and death of fish and other aquatic organisms. This entire ecological process is defined as eutrophication.

Final Answer:

Answer: (B)

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Q32.

Solution**Concept:**

Taxonomic classification groups organisms into distinct classes based on shared structural, anatomical, physiological, and reproductive traits that reveal evolutionary relationships.

Solution:

Step 1: Analyze the specific diagnostic traits provided in the question: warm-blooded (homeothermic) metabolism, a four-chambered heart, pneumatic bones, and an oviparous reproductive strategy.

Step 2: Reptiles are cold-blooded (poikilothermic), typically possess a three-chambered heart (except crocodilians), and lack pneumatic bones.

Step 3: Mammals are warm-blooded and have a four-chambered heart, but they are generally viviparous and do not have hollow pneumatic bones.

Step 4: Members of the class Aves (birds) possess pneumatic or hollow bones containing air cavities to reduce body weight for flight. They are homeothermic, have a complete four-chambered heart, and lay hard-shelled eggs (oviparous).

Final Answer:

Answer: (C)

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Q33.

Solution**Concept:**

The female gametophyte of angiosperms is an embryo sac, typically containing seven cells and eight nuclei. The micropylar end houses the egg apparatus, which consists of a single egg cell and two flanking synergid cells.

Solution:

Step 1: The synergid cells feature specialized, finger-like cellular invaginations at their micropylar tips, collectively called the filiform apparatus.

Step 2: This structure synthesizes and secretes chemical attractants, such as calcium ions, to establish a chemotropic gradient.

Step 3: When a pollen tube reaches the ovule, it follows this chemical gradient toward the micropyle.

Step 4: The filiform apparatus physically guides the tip of the growing pollen tube, directing its entry into one of the synergids to release the male gametes for fertilization.

Final Answer:

Answer: (A)

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Q34.

Solution**Concept:**

Biotechnology utilizes specialized vectors to deliver functional foreign genes into host genomes. Choosing a vector depends on the size of the gene insert and the biological kingdom of the target organism.

Solution:

Step 1: The soil-dwelling bacterium *Agrobacterium tumefaciens* naturally infects dicotyledonous plants, causing crown gall disease by transferring a segment of its plasmid into the host plant's genome.

Step 2: This naturally occurring plasmid is called the Tumor-inducing (Ti) plasmid.

Step 3: Genetic engineers modify the Ti plasmid by removing the disease-causing oncogenes while preserving its transfer mechanism.

Step 4: This disarmed Ti plasmid is used as a vector to deliver beneficial genes, such as pest resistance or drought tolerance, into dicotyledonous crop plants.

Final Answer:

Answer: (B)

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Q35.

Solution**Concept:**

Cellular respiration extracts chemical energy from organic substrates. Adenosine Triphosphate (ATP) is generated either through an electrochemical gradient in oxidative phosphorylation or directly via substrate-level phosphorylation (SLP).

Solution:

Step 1: The Krebs cycle (tricarboxylic acid cycle) processes acetyl-CoA within the mitochondrial matrix.

Step 2: During a single turn of the cycle, a 5-carbon intermediate (α -ketoglutarate) is converted to a 4-carbon compound (succinyl-CoA).

Step 3: In the next step, succinyl-CoA is converted to succinate by the enzyme succinyl-CoA synthetase.

Step 4: This reaction releases energy to couple inorganic phosphate to GDP, forming GTP (which is energetically equivalent to ATP in animal cells) or directly forming ATP in plant systems.

Step 5: Because this high-energy phosphate bond is synthesized directly from a substrate intermediate without the electron transport chain, it represents substrate-level phosphorylation, yielding exactly 1 ATP molecule per turn.

Final Answer:

Answer: (A)

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Q36.

Solution**Concept:**

The exchange and transport of respiratory gases are driven by partial pressure gradients across semipermeable cellular membranes. Gases spontaneously diffuse from regions of higher partial pressure to regions of lower partial pressure.

Solution:

Step 1: Atmospheric air has the highest partial pressure of oxygen (pO_2), measuring approximately 159 mmHg at sea level.

Step 2: As air enters the lungs and mixes with residual air in the alveoli, the pO_2 within the alveolar spaces drops to roughly 104 mmHg.

Step 3: Oxygen diffuses across the respiratory membrane into the blood. Once oxygenated, the blood leaving the pulmonary capillaries has a pO_2 of about 95 mmHg.

Step 4: Tissue cells constantly consume oxygen during cellular respiration, maintaining a low internal pO_2 of around 40 mmHg.

Step 5: Therefore, the correct descending gradient that drives oxygen diffusion into the body is: Atmospheric air > Alveoli > Oxygenated blood.

Final Answer: Atmospheric air > Alveoli > Oxygenated blood

Answer: (C)

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Q37.

Solution**Concept:**

Chromosomal disorders arise from errors during meiosis, such as non-disjunction, where homologous chromosomes or sister chromatids fail to separate properly, leading to an abnormal chromosome count (aneuploidy) in the gametes.

Solution:

Step 1: A normal human somatic cell contains 46 chromosomes, arranged as 22 pairs of autosomes and one pair of sex chromosomes (XX or XY).

Step 2: Klinefelter syndrome is a genetic condition caused by the non-disjunction of sex chromosomes during gametogenesis.

Step 3: This error results in an individual receiving an extra X chromosome alongside a standard male chromosomal complement.

Step 4: The total chromosome count becomes 47, and the specific sex chromosome configuration is written as XXY. This condition presents as a phenotypically male individual with certain feminized traits.

Final Answer:

Answer: (B)

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Q38.

Solution**Concept:**

The inner mitochondrial membrane contains the electron transport chain (ETC), an organized series of multi-protein complexes that transfer electrons from reduced coenzymes (NADH and FADH₂) to oxygen to generate a proton gradient.

Solution:

Step 1: Complex I is known as NADH dehydrogenase, and Complex II is succinate dehydrogenase.

Step 2: Complex III is the cytochrome *bc*₁ complex, which transfers electrons from ubiquinone to the mobile carrier cytochrome *c*.

Step 3: Cytochrome *c* delivers those electrons to Complex IV, which is structurally identified as Cytochrome *c* oxidase.

Step 4: Complex IV contains copper centers and cytochromes *a* and *a*₃. It performs the final step of the chain, transferring electrons directly to elemental oxygen (O₂) to form water molecules.

Final Answer:

Answer: (D)

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Q39.

Solution**Concept:**

Singer and Nicolson's fluid mosaic model describes biological membranes as a fluid bilayer of amphipathic lipids interspersed with a mosaic pattern of proteins, allowing for dynamic structural rearrangements.

Solution:

Step 1: Membrane fluidity depends primarily on the chemical composition of the hydrophobic fatty acid tails within the lipid bilayer.

Step 2: Saturated fatty acids have straight hydrocarbon chains that pack tightly together, increasing membrane rigidity and reducing fluidity.

Step 3: Polyunsaturated fatty acids contain one or more double bonds in their hydrocarbon chains. These double bonds introduce sharp kinks or bends in the tails.

Step 4: These kinks prevent the lipid molecules from packing tightly together, lowering the melting point of the lipid bilayer and significantly increasing membrane fluidity.

Final Answer:

Answer: (B)

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Q40.

Solution**Concept:**

International environmental treaties establish frameworks for global cooperation to protect critical habitats, preserve biodiversity, and manage ecological resources sustainably.

Solution:

Step 1: The Ramsar Convention is an intergovernmental environmental treaty adopted on February 2, 1971, in the Iranian city of Ramsar.

Step 2: This convention provides a framework for national action and international cooperation regarding habitat conservation.

Step 3: The scope of the treaty is focused on the preservation and sustainable utilization of wetlands worldwide.

Step 4: It aims to halt the global loss of wetlands and safeguard these ecosystems because of their critical roles in water purification, flood control, and supporting diverse migratory bird populations.

Final Answer:

Answer: (B)

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Q41.

Solution**Concept:**

Plant taxonomy utilizes specific morphological characteristics of the fruit, flower, and seed to differentiate and classify families within the angiosperms. Fruit types are highly conserved evolutionary traits.

Solution:

Step 1: The family Cruciferae, also commonly known as Brassicaceae or the mustard family, possesses a characteristic syncarpous gynoecium that develops into a specialized simple dry dehiscent fruit.

Step 2: This specific fruit type is called a siliqua.

Step 3: A siliqua develops from a bicarpellary, superior ovary which is initially unilocular but becomes bilocular due to the formation of a false internal septum known as the replum.

Step 4: During dehiscence, the outer walls break away from the base upward, leaving the seeds attached to the central replum framework. A shorter variant of this fruit is called a silicula.

Final Answer:

Answer: (B)

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Q42.

Solution**Concept:**

Hormonal contraceptive methods alter systemic endocrine pathways within the female reproductive system to disrupt normal follicle maturation, ovulation schedules, and the physiological environment of the reproductive tract.

Solution:

Step 1: Oral contraceptive pills contain synthetic combinations of estrogen and progesterone, or progesterone alone (progestin).

Step 2: The continuous exogenous administration of these hormones provides negative feedback to the hypothalamus and anterior pituitary gland.

Step 3: This negative feedback suppresses the secretion of Follicle-Stimulating Hormone (FSH) and Luteinizing Hormone (LH), thereby preventing follicular development and the mid-cycle LH surge required for ovulation.

Step 4: Additionally, these hormones alter the biochemical composition and physical thickness of the cervical mucus, making it highly viscous to prevent sperm penetration.

Final Answer:

Answer: (B)

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Q43.

Solution**Concept:**

The Polymerase Chain Reaction (PCR) is an *in-vitro* enzymatic technique used to exponentially amplify specific target sequences of DNA. The process relies on a thermostable enzyme and cyclical temperature variations.

Solution:

Step 1: PCR requires a sequence-specific DNA template, oligonucleotide primers, free dNTPs, and a heat-stable polymerase enzyme such as *Taq* polymerase.

Step 2: The automated instrument used to conduct this reaction is a thermal cycler, which adjusts temperatures through precise cycles.

Step 3: Each cycle consists of three distinct phases: Denaturation at high temperature ($\sim 94^{\circ}\text{C}$) to separate the double strands, Annealing at a lower temperature ($\sim 54^{\circ}\text{C}$) to allow primers to bind, and Extension at an intermediate temperature ($\sim 72^{\circ}\text{C}$) for synthesis.

Step 4: Therefore, the fundamental principle of the machine is to repeatedly change temperatures to permit these distinct thermodynamic phases.

Final Answer:

To repeatedly change temperatures to permit denaturation, annealing, and extension phases

Answer: (B)[Go Back to Question 43](#)

Q44.

Solution**Concept:**

The anatomical organization of vascular bundles in angiosperm stems varies across plant groups. Bundles are characterized based on the relative positioning of xylem and phloem, and the presence or absence of meristematic tissue.

Solution:

Step 1: In a typical dicotyledonous stem, the xylem and phloem are arranged along the same radius, which classifies the vascular bundle structurally as conjoint.

Step 2: The primary xylem is oriented such that the oldest elements (protoxylem) face inward toward the center pith, while the metaxylem faces outward. This developmental orientation is called endarch.

Step 3: A strip of actively dividing lateral meristematic tissue, known as the intrafascicular cambium, is physically positioned between the inner xylem and outer phloem.

Step 4: The presence of this cambium layer gives the bundle the capacity for secondary growth, which classifies it as an open vascular bundle. Therefore, it is conjoint, open, and endarch.

Final Answer:

Answer: (B)

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Q45.

Solution**Concept:**

Nitrogenous waste management in uricotelic and ureotelic organisms requires converting highly toxic metabolic byproducts into less toxic compounds for safe elimination from the body.

Solution:

Step 1: The catabolism of amino acids generates toxic ammonia (NH_3) as a direct byproduct, which must be immediately diluted or converted.

Step 2: In humans, who are ureotelic organisms, this toxic ammonia is transported via the blood to the liver.

Step 3: Hepatocytes contain the biochemical machinery for the ornithine cycle, also widely known as the urea cycle.

Step 4: This cyclic pathway combines two molecules of ammonia with one molecule of carbon dioxide (CO_2), utilizing metabolic energy (ATP) to synthesize urea (NH_2CONH_2).

Step 5: The highly soluble and less toxic urea is then released back into the bloodstream and later filtered out by the kidneys.

Final Answer:

Answer: (B)

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Q46.

Solution**Concept:**

The structural model of B-DNA deduced by Watson and Crick describes a right-handed double helix held together by hydrogen bonds between complementary purine and pyrimidine base pairs.

Solution:

Step 1: The helical structure of a standard B-DNA molecule features regular, repeating spatial parameters along its longitudinal axis.

Step 2: The distance required for the double helix to complete one full 360° turn is defined as the helical pitch.

Step 3: In a classic B-DNA configuration, one complete turn spans a longitudinal distance of exactly 3.4 nm (or 34 Å).

Step 4: Each helical turn contains approximately 10 base pairs. This structural arrangement results in a vertical distance of 0.34 nm (or 3.4 Å) between two consecutive base pairs along the helix.

Final Answer:

Answer: (A)

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Q47.

Solution**Concept:**

Plant tissue culture techniques rely on the principles of totipotency and organogenesis. Morphological differentiation from an unorganized mass of cells (callus) is controlled by the ratio of specific phytohormones.

Solution:

Step 1: In plant tissue culture workflows, the primary plant growth regulators used to guide development are auxins and cytokinins.

Step 2: The absolute and relative concentrations of these two hormones determine whether the cells remain as a callus or differentiate into specific organs.

Step 3: When an unorganized explant or callus is exposed to a hormone formulation with a very high ratio of auxin to cytokinin, it triggers rhizogenesis.

Step 4: This high-auxin chemical environment induces the specific differentiation and growth of roots from the callus cells. Conversely, a high cytokinin-to-auxin ratio promotes shoot development.

Final Answer:

Answer: (B)

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Q48.

Solution**Concept:**

The endosymbiotic theory posits that certain eukaryotic organelles evolved from free-living prokaryotes that were engulfed by ancestral host cells, retaining structural features like autonomous genomes and prokaryotic ribosomes.

Solution:

Step 1: Both mitochondria and chloroplasts contain their own circular DNA molecules and 70S ribosomes, allowing them to replicate semi-autonomously via a binary fission mechanism.

Step 2: The question specifies an organelle that cooperates with peroxisomes and chloroplasts during the metabolic process of photorespiration.

Step 3: Photorespiration, or the C_2 cycle, requires a metabolic pathway distributed across three distinct organelles in a precise sequence.

Step 4: This pathway begins in the chloroplast, moves through the peroxisome, and completes a structural decarboxylation step within the mitochondrion. Therefore, the mitochondrion matches all the specified autonomous and metabolic criteria.

Final Answer:

Answer: (A)

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Q49.

Solution**Concept:**

Decomposition is an essential ecosystem process that breaks down dead organic detritus into simpler inorganic nutrients. The rate of this process is regulated by the chemical composition of the substrate and environmental conditions.

Solution:

Step 1: Decomposition is primarily an oxygen-requiring process carried out by aerobic soil microorganisms like bacteria and fungi.

Step 2: Environmental factors such as soil moisture, temperature, and aeration significantly influence the metabolic activity of these decomposers.

Step 3: Low temperatures inhibit microbial enzyme kinetics, slowing down the breakdown of organic bonds.

Step 4: Anaerobic environments, characterized by a lack of oxygen, suppress aerobic microflora and force decomposition to proceed via slower, less efficient anaerobic pathways.

Step 5: Therefore, a combination of low temperature and anaerobic conditions significantly reduces the overall rate of decomposition.

Final Answer:

Answer: (C)

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Q50.

Solution**Concept:**

Organisms exhibit varying ranges of physiological tolerance toward fluctuations in environmental parameters. Special ecological terms describe their capacity to adapt to changes in temperature and salinity.

Solution:

Step 1: Salinity refers to the concentration of dissolved salts in an aquatic environment or soil solution.

Step 2: Organisms that can tolerate and thrive across a wide range of environmental salinity concentrations are classified as euryhaline.

Step 3: Organisms that are highly sensitive to osmotic fluctuations and are strictly restricted to a narrow range of salinity are classified as stenohaline.

Step 4: Similarly, the terms eurythermal and stenothermal describe wide and narrow tolerance ranges for ambient temperature, respectively. Thus, restriction to narrow salinity matches the definition of a stenohaline organism.

Final Answer:

Answer: (B)

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Q51.

Solution**Concept:**

Placentation refers to the structural arrangement and distribution of placentae and ovules within the ovary wall of a flower, serving as a key diagnostic trait for identifying plant families.

Solution:

Step 1: The family Fabaceae, commonly known as the legume or pea family, features a characteristic monocarpellary gynoecium.

Step 2: The ovary is superior, elongated, and unilocular, meaning it contains a single internal cavity or locule.

Step 3: The ovules are attached along the ventral suture of the ovary wall in a double row, forming a single longitudinal placenta.

Step 4: This specific architectural arrangement is defined as marginal placentation. It is typical of leguminous pods where the seeds line one edge of the opened fruit.

Final Answer:

Answer: (C)

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Q52.

Solution**Concept:**

The human menstrual cycle is regulated by a complex feedback loop involving hypothalamic, anterior pituitary, and ovarian hormones that coordinate follicle maturation and uterine preparation.

Solution:

Step 1: During the follicular phase, developing ovarian follicles secrete increasing amounts of estrogen.

Step 2: Around the midpoint of a typical 28-day cycle (day 14), high systemic levels of estrogen trigger a positive feedback response in the anterior pituitary.

Step 3: This positive feedback causes a sudden, rapid increase in the secretion of gonadotropic hormones, particularly Luteinizing Hormone (LH).

Step 4: This sharp peak is known as the LH surge. The high concentration of LH induces enzymatic rupture of the mature Graafian follicle wall, releasing the secondary oocyte into the fallopian tube, a process called ovulation.

Final Answer:

Answer: (C)

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Q53.

Solution**Concept:**

Biotechnology and molecular biology use specialized analytical techniques to separate, visualize, and isolate nucleic acids based on their physical properties like electric charge and molecular weight.

Solution:

Step 1: DNA molecules carry a net negative electrical charge along their sugar-phosphate backbone due to the presence of ionized phosphate groups.

Step 2: When DNA fragments are loaded into a matrix like an agarose gel and exposed to an electric field, they migrate away from the negative cathode toward the positive anode.

Step 3: The porous agarose gel matrix acts as a molecular sieve. Smaller DNA fragments move through the pores more easily and migrate faster than larger fragments.

Step 4: This differential migration separates the fragmented DNA into distinct bands based strictly on their nucleotide length. This technique is called Agarose Gel Electrophoresis.

Final Answer:

Answer: (B)

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Q54.

Solution**Concept:**

Glycolysis is a conserved metabolic pathway that breaks down a six-carbon glucose molecule into two molecules of three-carbon pyruvate, utilizing specific enzymes to regulate individual steps.

Solution:

Step 1: The initial phases of glycolysis involve preparatory steps that invest energy (ATP) to phosphorylate hexose sugars.

Step 2: In the third step of glycolysis, Fructose-6-phosphate is converted into Fructose-1,6-bisphosphate.

Step 3: This reaction requires the transfer of a phosphate group from a molecule of ATP to the first carbon position of the fructose sugar.

Step 4: The enzyme that catalyzes this highly regulated, irreversible rate-limiting step is Phosphofructokinase (PFK). This enzyme serves as a key metabolic sensor for cellular energy status.

Final Answer:

Answer: (B)

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Q55.

Solution**Concept:**

The internal anatomy of primary plant organs features a concentric cellular organization. The layers are arranged sequentially from the outermost protective barrier to the innermost vascular core.

Solution:

Step 1: The outermost cell layer of a primary root is the epiblema (or piliferous layer), which lacks a thick cuticle and bears unicellular root hairs for absorption.

Step 2: Beneath the epiblema lies the cortex, a broad zone composed of loosely arranged parenchymatous cells with prominent intercellular spaces.

Step 3: The innermost boundary of the cortex forms a single, tightly packed layer of barrel-shaped cells called the endodermis, which features suberized Casparian strips.

Step 4: Directly inside the endodermis lies the pericycle, a layer of parenchymatous or sclerenchymatous cells that surrounds the central vascular cylinder. Thus, the sequence is Epiblema → Cortex → Endodermis → Pericycle.

Final Answer:

Answer: (A)

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Q56.

Solution**Concept:**

Neurons are classified structurally based on the number of cytoplasmic extensions or processes (axons and dendrites) that originate directly from the central cell body (soma).

Solution:

Step 1: Multipolar neurons possess one long axon and multiple branching dendrites, making up the majority of neurons in the central nervous system.

Step 2: Unipolar neurons have a single process extending from the cell body and are typically found in embryonic stages.

Step 3: Bipolar neurons possess exactly two distinct cellular processes extending from opposite poles of the cell body: a single dendritic structure at one end and a single axon at the other.

Step 4: These highly specialized sensory neurons are localized within specific sensory structures, most notably forming the intermediate signal processing layer within the retina of the human eye.

Final Answer:

Answer: (B)

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Q57.

Solution**Concept:**

In 1952, Alfred Hershey and Martha Chase conducted experiments using T₂ bacteriophages to provide definitive proof that DNA, rather than protein, is the hereditary material that transmits genetic information.

Solution:

Step 1: Bacteriophages are viruses composed entirely of an outer protein capsule enclosing an inner molecule of double-stranded DNA.

Step 2: To differentiate between these two components, Hershey and Chase grew separate phage populations in media containing distinct radioactive isotopes.

Step 3: DNA contains phosphorus atoms but completely lacks sulfur. Therefore, the phage DNA was selectively labeled using radioactive phosphorus-32 (³²P).

Step 4: Viral proteins contain sulfur amino acids (cysteine and methionine) but lack phosphorus. Thus, the protein coat was selectively labeled using radioactive sulfur-35 (³⁵S). This experimental design allowed them to track which molecule entered the host bacteria.

Final Answer:

Answer: (B)

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Q58.

Solution**Concept:**

Prophase-I of meiosis-I is a prolonged and complex stage subdivided into five sequential substages, during which homologous chromosomes pair up and exchange genetic material.

Solution:

Step 1: The substages occur in the following order: Leptotene, Zygotene, Pachytene, Diplotene, and Diakinesis.

Step 2: During the pachytene stage, homologous chromosomes undergo crossing over, where non-sister chromatids physically break and exchange genetic segments.

Step 3: Following this, the cell enters the diplotene stage, which is characterized by the dissolution of the proteinaceous synaptonemal complex that held the homologous pairs together.

Step 4: As the homologous chromosomes begin to separate from one another, they remain held together at the exact sites where crossing over occurred. These X-shaped physical connection points are called chiasmata, and they become clearly visible during diplotene.

Final Answer:

Answer: (B)

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Q59.

Solution**Concept:**

International environmental protocols are legally binding treaties designed to coordinate global action against specific ecological threats to the biosphere.

Solution:

Step 1: The Montreal Protocol on Substances that Deplete the Ozone Layer is an international treaty that was opened for signature in September 1987.

Step 2: The agreement was driven by scientific discoveries showing that synthetic industrial chemicals were reacting with and destroying stratospheric ozone molecules.

Step 3: The primary objective of the protocol is to phase out the production, consumption, and global emission of Ozone-Depleting Substances (ODS).

Step 4: These targeted chemicals include chlorofluorocarbons (CFCs), halons, and carbon tetrachloride, helping to safeguard the protective stratospheric ozone layer.

Final Answer:

Answer: (B)

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Q60.

Solution**Concept:**

The Five-Kingdom system of biological classification proposed by R.H. Whittaker in 1969 groups organisms based on cell structure complexity, body organization, mode of nutrition, and phylogenetic relationships.

Solution:

Step 1: Kingdom Monera is reserved for all prokaryotic organisms, such as bacteria and cyanobacteria, which lack a nuclear membrane.

Step 2: Kingdom Plantae, Fungi, and Animalia are established to accommodate multicellular eukaryotic organisms with distinct nutritional strategies.

Step 3: Whittaker created the Kingdom Protista specifically to group all unicellular eukaryotic organisms into a single taxonomic category.

Step 4: Even though organisms like *Amoeba* show animal-like heterotrophy and certain cells like *Chlamydomonas* possess plant-like chloroplasts, their unicellular eukaryotic structure places them taxonomically within Kingdom Protista.

Final Answer:

Answer: (B)

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Q61.

Solution**Concept:**

Following fertilization, the single-celled diploid zygote undergoes rapid mitotic divisions called cleavage as it travels down the fallopian tube toward the uterine cavity.

Solution:

Step 1: The first cleavage division produces a two-celled embryo, which continues to divide into 4, 8, and 16 daughter cells called blastomeres.

Step 2: As these divisions proceed, the embryo forms a solid, spherical cluster of cells that resembles a mulberry.

Step 3: This solid, 8-to-16-celled embryonic stage is specifically termed a morula.

Step 4: The morula continues to divide and reorganizes its internal structure by forming a fluid-filled cavity, transitioning into a hollow blastocyst before implanting into the endometrium.

Final Answer:

Answer: (B)

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Q62.

Solution**Concept:**

Bioreactors are large vessels used in industrial biotechnology to cultivate microorganisms or animal cells under optimized environmental conditions to mass-produce biological products.

Solution:

Step 1: Aerobic bioprocesses require a continuous and reliable supply of dissolved oxygen to support the metabolic activity of growing cells.

Step 2: A standard stirred-tank bioreactor uses an impellor system to mix the broth, but agitation alone is insufficient to dissolve enough oxygen into thick cultures.

Step 3: To address this, a specialized component called a sparger is integrated into the base of the bioreactor.

Step 4: The sparger consists of a perforated metal ring or nozzle that injects sterile compressed air into the medium as a stream of microscopic bubbles.

Step 5: These small bubbles dramatically increase the surface area available for gas exchange, maximizing oxygen transfer throughout the culture.

Final Answer:

Answer: (C)

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Q63.

Solution**Concept:**

C₄ plants have evolved a metabolic pathway to bypass photorespiration by using an alternative enzyme to fix carbon dioxide in the mesophyll cells before delivering it to the Calvin cycle.

Solution:

Step 1: In the mesophyll cells of a C₄ leaf, atmospheric carbon dioxide (CO₂) dissolves to form bicarbonate (HCO₃⁻) ions.

Step 2: The initial substrate that reacts with and accepts this carbon molecule is a three-carbon compound called Phosphoenolpyruvate (PEP).

Step 3: This initial fixation reaction is catalyzed by the enzyme PEP carboxylase (PEPcase), which has a high affinity for carbon dioxide and is not inhibited by oxygen.

Step 4: The reaction produces the four-carbon compound Oxaloacetic acid (OAA), which gives the pathway its name. Ribulose-1,5-bisphosphate (RuBP) acts as the primary acceptor later in the bundle sheath cells.

Final Answer:

Answer: (B)

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Q64.

Solution**Concept:**

The gastric mucosa lining the stomach wall contains specialized gastric glands composed of different secretory cell types that coordinate chemical digestion.

Solution:

Step 1: Gastric glands contain parietal (or oxyntic) cells that secrete hydrochloric acid (HCl) and intrinsic factor. They also contain goblet cells that secrete protective mucus.

Step 2: The glands feature specialized proteolytic cells known as chief cells, peptic cells, or zymogen cells.

Step 3: These chief cells synthesize and secrete the inactive proenzyme pepsinogen into the stomach lumen.

Step 4: When pepsinogen comes into contact with the highly acidic environment created by HCl, it undergoes conformational cleavage to become the active proteolytic enzyme pepsin, which breaks down proteins.

Final Answer:

Answer: (C)

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Q65.

Solution**Concept:**

Erwin Chargaff formulated specific base-pairing rules for double-stranded DNA molecules, stating that the total amount of purines equals the total amount of pyrimidines: %A = %T and %G = %C.

Solution:

Step 1: The question states that a double-stranded DNA segment contains 30% Adenine (A).

Step 2: According to Chargaff's rules, Adenine pairs exclusively with Thymine (T), meaning their percentages must be equal:

$$\%T = \%A = 30\%$$

Step 2: Summing the percentages of Adenine and Thymine gives:

$$\%A + \%T = 30\% + 30\% = 60\%$$

Step 3: The remaining percentage of the DNA molecule must consist of Guanine (G) and Cytosine (C):

$$\%G + \%C = 100\% - 60\% = 40\%$$

Step 4: Since Guanine pairs equally with Cytosine, this remaining amount is divided equally between them:

$$\%G = \frac{40\%}{2} = 20\%$$

Final Answer:

Answer: (B)

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Q66.

Solution**Concept:**

The structural composition of the cell wall varies across biological kingdoms, providing unique chemical characteristics that serve as key criteria for phylogenetic classification.

Solution:

Step 1: Plant cell walls are primarily composed of cellulose, hemicellulose, and pectin polymers to provide mechanical rigidity.

Step 2: Bacterial cell walls utilize a cross-linked mesh of peptidoglycan (murein) to withstand osmotic pressures.

Step 3: The cell walls of true fungi lack cellulose. Instead, they are composed of a tough, structural homopolysaccharide known as chitin.

Step 4: Chitin is a long-chain polymer of N-acetylglucosamine, an amino derivative of glucose. This same polymer forms the exoskeleton of arthropods, highlighting an evolutionary link.

Final Answer:

Answer: (C)

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Q67.

Solution**Concept:**

Biodiversity conservation strategies are broadly categorized into two approaches based on whether the endangered species is protected inside or outside its natural habitat.

Solution:

Step 1: *Ex-situ* conservation involves removing threatened animals or plants from their vulnerable natural habitats and placing them in human-managed facilities for protection and breeding. Examples include botanical gardens, zoological parks, and gene banks.

Step 2: *In-situ* conservation focuses on protecting the entire natural ecosystem, allowing wild populations to grow and interact within their native habitats.

Step 3: Wildlife Sanctuaries, National Parks, and Biosphere Reserves are legally designated geographic areas established for *in-situ* conservation.

Step 4: Therefore, among the choices provided, Wildlife Sanctuaries represent the only *in-situ* conservation approach.

Final Answer:

Answer: (B)

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Q68.

Solution**Concept:**

The arrangement of xylem and phloem tissues within primary vascular cylinders varies characteristically between roots and stems, serving as a reliable anatomical diagnostic feature.

Solution:

Step 1: Conjoint vascular bundles feature xylem and phloem positioned together along the same radius, which is typical of stems and leaves.

Step 2: Radial vascular bundles are characterized by an arrangement where distinct strands of xylem and phloem are located on separate, alternating radii.

Step 3: This radial organization is a conserved anatomical feature found across all primary roots, including both monocotyledonous and dicotyledonous root systems.

Step 4: This arrangement facilitates the direct radial absorption and lateral transport of water from the root hairs into the central xylem vessels.

Final Answer:

Answer: (C)

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Q69.

Solution**Concept:**

The ovarian cycle is synchronized with endocrine transitions. Following ovulation, the structural remnants of the ruptured follicle undergo cellular remodeling to form a temporary endocrine gland.

Solution:

Step 1: Under the influence of a mid-cycle Luteinizing Hormone (LH) surge, a mature Graafian follicle ruptures to release its secondary oocyte.

Step 2: The follicular cells remaining within the ovary undergo luteinization, accumulating lipids and yellow lutein pigment.

Step 3: This cellular transformation converts the ruptured follicle into a vascularized, temporary endocrine structure called the corpus luteum.

Step 4: The corpus luteum secretes high levels of progesterone, which is essential for maintaining the thick uterine endometrium required for potential embryo implantation. If fertilization does not occur, it degenerates into a fibrous scar called the corpus albicans.

Final Answer:

Answer: (C)

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Q70.

Solution**Concept:**

Recombinant DNA workflows use molecular tools to cut, manipulate, and join nucleic acid fragments from different sources to create functional chimeric molecules.

Solution:

Step 1: Restriction endonucleases like *EcoRI* act as molecular scissors to cut DNA strands at specific palindromic recognition sequences.

Step 2: Once the target foreign gene and the plasmid vector backbone have been cut, their complementary ends must be joined together.

Step 3: The enzyme responsible for catalyzing this joining process is DNA ligase.

Step 4: DNA ligase catalyzes the formation of a covalent phosphodiester bond between the 3'-hydroxyl end of one nucleotide and the 5'-phosphate end of the adjacent nucleotide, sealing the structural nicks in the sugar-phosphate backbone.

Final Answer:

Answer: (C)

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Q71.

Solution**Concept:**

The enzyme RuBisCO can bind both carbon dioxide and oxygen. When oxygen concentrations are high and carbon dioxide levels are low, RuBisCO acts as an oxygenase, initiating the photorespiratory pathway.

Solution:

Step 1: In the standard Calvin cycle, RuBisCO fixes CO_2 to Ribulose-1,5-bisphosphate (RuBP), a five-carbon sugar, yielding two molecules of the three-carbon compound 3-phosphoglyceric acid (3-PGA).

Step 2: In the oxygenase reaction (photorespiration), RuBisCO binds a molecule of O_2 to the five-carbon RuBP instead of CO_2 .

Step 3: This oxygenation causes the unstable intermediate to split abnormally into two smaller products.

Step 4: It yields exactly one molecule of the three-carbon compound 3-phosphoglyceric acid (3-PGA) and one molecule of a two-carbon byproduct called 2-phosphoglycolate. The phosphoglycolate must then be recycled through the C_2 pathway.

Final Answer:

Answer: (B)

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Q72.

Solution**Concept:**

The central nervous system contains specialized regions that process sensory input and coordinate homeostatic, involuntary visceral functions necessary for survival.

Solution:

Step 1: The cerebrum manages higher cognitive processing, memory, and voluntary motor control, while the cerebellum coordinates balance and complex muscle movements.

Step 2: The hypothalamus regulates body temperature, hunger, thirst, and the endocrine system.

Step 3: The medulla oblongata is the lowermost structural component of the brainstem, connecting the brain to the spinal cord.

Step 4: The medulla contains highly specialized autonomic reflex centers, including the respiratory rhythm center, the cardiovascular center (controlling heart rate and blood pressure), and centers for gastric secretions, swallowing, and vomiting.

Final Answer:

Answer: (C)

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Q73.

Solution**Concept:**

Eukaryotic gene expression involves transcription within the nucleus to produce a primary RNA transcript (*hnRNA*) that must undergo post-transcriptional processing to become functional mRNA.

Solution:

Step 1: Eukaryotic genes are organized as split genes, containing alternating coding and non-coding nucleotide sequences.

Step 2: The coding sequences that contain the information for synthesizing a protein chain are called exons.

Step 3: The intervening, non-coding sequences that disrupt this genetic message are called introns.

Step 4: During post-transcriptional modifications, a large molecular complex called a spliceosome removes these non-coding introns from the primary *hnRNA* transcript and ligates the coding exons together to form mature mRNA.

Final Answer:

Answer: (B)

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Q74.

Solution**Concept:**

Enzyme activity can be regulated or inhibited by specific molecules. Competitive inhibition occurs when a compound structurally resembles the natural substrate and competes for binding at the active site.

Solution:

Step 1: The enzyme succinate dehydrogenase is an essential membrane-bound component of both the Krebs cycle and Complex II of the electron transport chain.

Step 2: Under normal conditions, this enzyme binds its natural substrate, succinate, and oxidizes it into fumarate.

Step 3: Malonate is a dicarboxylic acid that shares a highly similar chemical structure and spatial geometry with succinate.

Step 4: Due to this structural similarity, malonate binds reversibly to the active site of succinate dehydrogenase, blocking the natural substrate from entering. This serves as a classic textbook example of competitive inhibition.

Final Answer:

Answer: (A)

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Q75.

Solution**Concept:**

Ecological succession describes the predictable, directional process of community development and replacement within an ecosystem over time. Succession is categorized based on the initial state of the habitat.

Solution:

Step 1: Succession that occurs in an area where an ecosystem existed previously but was cleared by a disturbance (such as an abandoned agricultural field or a burned forest) is called secondary succession.

Step 2: Secondary succession proceeds relatively quickly because developed soil and organic matter are already present.

Step 3: Succession that takes place on a completely sterile, bare substrate where no living community or organic soil has ever existed before is defined as primary succession.

Step 4: Examples of primary substrates include newly formed volcanic lava flows, cooled sand dunes, or bare rock exposed by a retreating glacier. Pioneer species like lichens must break down the rock to form the initial soil layer.

Final Answer:

Answer: (A)

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Q76.

Solution**Concept:**

Taxonomic identification of angiosperm families relies on characterizing specific vegetative systems and the structural organization of floral organs.

Solution:

Step 1: The family Liliaceae, commonly known as the lily family, is a representative group of monocotyledonous plants.

Step 2: The perianth of these flowers is undifferentiated, meaning distinct sepals and petals are absent. Instead, they possess six tepals arranged in two whorls of three, often fused into a tube.

Step 3: The androecium contains six stamens that are often epitepalous, meaning their filaments are physically attached to the surrounding tepals.

Step 4: The gynoecium is characterized by a tricarpeal, syncarpous, superior ovary containing three distinct locules with axile placentation. This combination of traits is highly diagnostic for Liliaceae.

Final Answer: Tricarpeal syncarpous ovary, superior, with epitepalous stamens

Answer: (A)

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Q77.

Solution**Concept:**

During fertilization, mechanisms must operate quickly to prevent polyspermy, which is the entry of multiple sperm cells into a single oocyte. This ensures the embryo maintains a normal diploid chromosome count.

Solution:

Step 1: When a sperm cell makes physical contact with the oocyte plasma membrane, it triggers a two-phase block to prevent additional sperm entry.

Step 2: The immediate, temporary response is called the fast block to polyspermy.

Step 3: Binding of the first sperm cell opens ion channels in the oocyte membrane, causing a rapid influx of sodium (Na^+) ions from the extracellular environment.

Step 4: This ion influx depolarizes the oocyte plasma membrane from its resting potential of -70 mV to a positive electrical potential. This shift in membrane potential prevents additional sperm from fusing.

Step 5: This fast block is followed by a permanent, calcium-dependent slow block known as the cortical reaction.

Final Answer: Depolarization of the oocyte plasma membrane by sodium influx

Answer: (A)

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Q78.

Solution**Concept:**

RNA interference (RNAi) is a conserved post-transcriptional gene silencing mechanism in eukaryotic cells, utilizing double-stranded RNA molecules to trigger the targeted degradation of matching transcripts.

Solution:

Step 1: The parasitic nematode *Meloidogyne incognita* infects the roots of tobacco plants, significantly reducing crop yields.

Step 2: To engineer resistance, researchers introduce nematode-specific genes into the host plant using *Agrobacterium* vectors.

Step 3: The transgene is designed to express both sense and antisense RNA strands within the plant cells, which hybridize to form double-stranded RNA (dsRNA).

Step 4: When the nematode feeds on the transgenic plant tissue, it ingests these dsRNA molecules.

Step 5: Inside the parasite's cells, the dsRNA enters the RISC complex and targets the matching nematode mRNA for degradation. This silences an essential viral gene and prevents the parasite from surviving.

Final Answer:

Silencing of specific mRNA due to a complementary dsRNA molecule

Answer: (B)

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Q79.

Solution**Concept:**

Plant hormones coordinates diverse physiological growth phases and senescence processes. Certain phytohormones exist as volatile gases that can influence neighboring tissues.

Solution:

Step 1: Phytohormones are classified into growth promoters (like auxins, gibberellins, and cytokinins) and growth inhibitors or stress managers.

Step 2: Ethylene is a simple gaseous hydrocarbon plant hormone synthesized in high amounts by aging tissues and ripening fruits.

Step 3: Ethylene acts as a powerful promoter of fruit ripening, driving metabolic changes such as starch hydrolysis into sugars and chlorophyll degradation.

Step 4: Additionally, ethylene induces a classic morphological seedling response known as the triple response, characterized by inhibition of stem elongation, promotion of lateral swelling, and horizontal growth.

Final Answer:

Answer: (B)

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Q80.

Solution**Concept:**

An electrocardiogram (ECG) records the electrical activity generated by the depolarization and repolarization of cardiac muscle chambers over time, using specific waveforms to track distinct mechanical phases.

Solution:

Step 1: The baseline standard ECG tracer features a sequence of labeled electrical waves: P, QRS, and T.

Step 2: The P-wave represents atrial depolarization, which spreads from the sinoatrial node across the atria to trigger atrial contraction.

Step 3: The complex waveform known as the QRS complex is driven by the rapid spread of electrical activation through the ventricular myocardium.

Step 4: This electrical signal represents ventricular depolarization, which initiates ventricular systole and elevates intraventricular pressures.

Step 5: The subsequent T-wave represents ventricular repolarization, marking the transition into ventricular diastole. Atrial repolarization is masked by the larger QRS electrical signal.

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

