

NEET-UG Biology Sample Paper-3

Duration: 1 Hour

Maximum Marks: 360

Instructions

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

- Q1.** Which of the following represents the correct sequence of taxonomic categories in increasing order of complexity and decreasing order of similarity?
- (A) Species → Genus → Family → Order → Class → Phylum → Kingdom
(B) Kingdom → Division → Class → Order → Family → Genus → Species
(C) Species → Genus → Order → Family → Class → Division → Kingdom
(D) Kingdom → Class → Order → Division → Family → Genus → Species
- Q2.** In Whittaker's five-kingdom classification, certain organisms like Chlamydomonas and Chlorella were moved from Algae to Protista. What was the primary criterion for this shift?
- (A) Presence of a well-defined nucleus
(B) Mode of nutrition (Autotrophic)
(C) Unicellular eukaryotic nature
(D) Presence of cellulosic cell walls
- Q3.** Consider a virus with a double-stranded DNA genome that replicates in the cytoplasm. Which of the following groups of viruses most likely matches this description?
- (A) Bacteriophages
(B) Poxviruses



(C) Retroviruses

(D) Reoviruses

Q4. Select the mismatched pair regarding the classification of Wheat (*Triticum aestivum*):

(A) Family: Poaceae

(B) Order: Sapindales

(C) Class: Monocotyledonae

(D) Division: Angiospermae

Q5. Which of the following statements is INCORRECT regarding the Diatoms?

(A) They are the chief producers in the oceans.

(B) Their cell walls are embedded with silica and are indestructible.

(C) They move actively in the water column using flagella.

(D) They leave behind large deposits of "Diatomaceous earth" over billions of years.

Q6. In the life cycle of Archegoniates, which of the following represents a common feature between Bryophytes and Pteridophytes?

(A) Dominant phase is the sporophyte.

(B) Requirement of water for fertilization of flagellated male gametes.

(C) Presence of a well-developed vascular system.

(D) Development of seeds within a fruit.

Q7. Which characteristic is unique to Phylum Ctenophora and distinguishes it from Cnidaria?

(A) Presence of Cnidoblasts for defense.

(B) Radial symmetry and tissue level of organization.

(C) Presence of eight external rows of ciliated comb plates.



(D) Extracellular and intracellular digestion.

Q8. Match the type of symmetry with the organism: (i) Echinodermata (Adult), (ii) Platyhelminthes, (iii) Porifera. Select the correct sequence:

(A) (i) Bilateral, (ii) Radial, (iii) Asymmetrical

(B) (i) Radial, (ii) Bilateral, (iii) Asymmetrical

(C) (i) Asymmetrical, (ii) Bilateral, (iii) Radial

(D) (i) Radial, (ii) Asymmetrical, (iii) Bilateral

Q9. A student observes a transverse section of a plant stem and notices "Conjoint, Collateral, and Closed" vascular bundles scattered in the ground tissue. This specimen is most likely:

(A) Dicotyledonous root

(B) Monocotyledonous stem

(C) Dicotyledonous stem

(D) Monocotyledonous leaf

Q10. In the secondary growth of a dicot stem, the heartwood differs from sapwood because heartwood:

(A) Conducts water and minerals efficiently.

(B) Contains active living parenchyma cells.

(C) Has deposition of tannins, resins, and oils, making it durable.

(D) Is located in the outer peripheral region of the secondary xylem.

Q11. Identify the tissue that provides mechanical support to the growing parts of a plant such as a young stem and the petiole of a leaf, and is characterized by thickened corners due to cellulose and pectin:

(A) Sclerenchyma

(B) Parenchyma

(C) Collenchyma



(D) Aerenchyma

Q12. The ciliated epithelium is found in the inner surface of hollow organs like fallopian tubes and bronchioles. Its primary function is to:

(A) Secretion of enzymes and mucus.

(B) Move particles or mucus in a specific direction over the epithelium.

(C) Provide protection against chemical and mechanical stresses.

(D) Absorption of nutrients through microvilli.

Q13. Which of the following junctions help to stop substances from leaking across a tissue, particularly in the epithelial lining of the stomach?

(A) Adhering junctions

(B) Gap junctions

(C) Tight junctions

(D) Desmosomes

Q14. A researcher treats a cell with a drug that inhibits the hydrolytic activity of the signal peptidase enzyme in the Rough Endoplasmic Reticulum. Which of the following would be the most immediate consequence?

(A) Ribosomes will fail to bind to the translocon.

(B) Secretory proteins will retain their N-terminal signal sequences.

(C) Glycosylation of proteins will be completely halted.

(D) mRNA will be unable to exit the nucleus.

Q15. During the G_2 phase of the cell cycle, a diploid cell has a DNA content of $4C$. What was the DNA content and chromosome number of this cell during the G_1 phase?

(A) $2C$ and n

(B) $4C$ and $2n$

(C) $2C$ and $2n$



(D) 1C and n

Q16. Which of the following statements correctly describes the behavior of the Synaptonemal Complex?

(A) It forms during Leptotene and dissolves during Zygotene.

(B) It facilitates the process of crossing over during Pachytene.

(C) It is composed primarily of RNA and non-histone proteins.

(D) Its dissolution marks the beginning of Diplotene, leading to Chiasmata visibility.

Q17. Identify the correct match regarding the Axoneme structure of a eukaryotic flagellum:

(A) Central sheath: Encloses the peripheral doublets.

(B) Radial spokes: Connect peripheral doublets to the central sheath.

(C) Interdoublet bridge: Connects the central microtubules to each other.

(D) Arrangement: 9+0 triplet pattern.

Q18. In the fluid mosaic model of the plasma membrane, the "flip-flop" movement is a rare event for lipids and almost non-existent for proteins because:

(A) The membrane is too fluid for such movement.

(B) The hydrophilic heads cannot easily pass through the hydrophobic core.

(C) Peripheral proteins block the path of integral proteins.

(D) Cholesterol molecules act as "spacers" preventing rotation.

Q19. Which organelle is responsible for the synthesis of steroidal hormones in animal cells and is also involved in the detoxification of drugs in the liver?

(A) Rough Endoplasmic Reticulum

(B) Smooth Endoplasmic Reticulum

(C) Golgi Apparatus

(D) Lysosomes



- Q20.** If a plant cell is placed in a solution where the external osmotic pressure is exactly equal to the osmotic pressure of the cytoplasm, the cell is said to be:
- (A) Plasmolysed
 - (B) Turgid
 - (C) Flaccid
 - (D) Fully expanded
- Q21.** Satellite DNA is important because it:
- (A) Codes for enzymes needed for DNA replication.
 - (B) Shows high degree of polymorphism and does not code for proteins.
 - (C) Forms the majority of the coding strand in eukaryotes.
 - (D) Is rich in Guanine and Cytosine only.
- Q22.** Match the following enzymes with their functions during the cell cycle: (i) Recombinase, (ii) Separase, (iii) Kinase. Select the correct functional sequence:
- (A) (i) Crossing over, (ii) Sister chromatid separation, (iii) Phosphorylation
 - (B) (i) DNA repair, (ii) Spindle formation, (iii) Dephosphorylation
 - (C) (i) Synapsis, (ii) Nuclear membrane reform, (iii) ATP synthesis
 - (D) (i) Cytokinesis, (ii) Segregation, (iii) Protein folding
- Q23.** Which of the following is the correct characteristic of the Mitochondrial Matrix?
- (A) It contains enzymes for Glycolysis.
 - (B) It possesses a single circular DNA molecule and 70S ribosomes.
 - (C) It is the site of the Electron Transport System (ETS).
 - (D) It has a higher proton concentration than the intermembrane space during ATP synthesis.
- Q24.** During C₄ photosynthesis, the decarboxylation of Malic acid to release CO₂ and Pyruvic acid occurs in which specific location?



- (A) Mesophyll chloroplasts
- (B) Bundle sheath cytosol
- (C) Bundle sheath chloroplasts
- (D) Mesophyll peroxisomes

Q25. In the Z-scheme of light reaction, the primary electron acceptor located towards the outer side of the thylakoid membrane transfers its electron to:

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

Q26. A plant is treated with a metabolic inhibitor that prevents the conversion of Phosphoenolpyruvate (PEP) to Pyruvate. Which of the following processes will be most directly affected?

- (A) Translocation of sugars in phloem
- (B) Substrate-level phosphorylation in Glycolysis
- (C) Photolysis of water in PS-II
- (D) Carbon fixation in C3 plants

Q27. The pigment phytochrome (P_{fr}) is considered the physiologically active form. What happens when P_{fr} absorbs Far-Red light?

- (A) It triggers flowering in Long Day Plants.
- (B) It is converted into the P_r form.
- (C) It moves from the cytoplasm into the vacuole.
- (D) It degrades immediately into amino acids.

Q28. If the Water Potential (Ψ_w) of a cell is -10 bars and its Pressure Potential (Ψ_p) is 5 bars, what is its Solute Potential (Ψ_s)?

- (A) -5 bars



- (B) –15 bars
- (C) +15 bars
- (D) +5 bars

Q29. The phenomenon of 'Guttation' is primarily driven by:

- (A) Negative hydrostatic pressure in xylem
- (B) Root pressure developed during low transpiration
- (C) High transpiration pull during the day
- (D) Active absorption of water by guard cells

Q30. Which mineral ion is required for the activation of the enzyme Rubisco and is also a constituent of the ring structure of Chlorophyll?

- (A) Manganese (Mn^{2+})
- (B) Magnesium (Mg^{2+})
- (C) Iron (Fe^{3+})
- (D) Calcium (Ca^{2+})

Q31. In the Krebs Cycle, the conversion of Succinyl-CoA to Succinic acid results in the synthesis of:

- (A) One molecule of $FADH_2$
- (B) One molecule of GTP (or ATP) via substrate-level phosphorylation
- (C) One molecule of $NADH + H^+$
- (D) One molecule of CO_2 through decarboxylation

Q32. A person is suffering from a condition where the parietal cells of the gastric mucosa are damaged. Which of the following is the most likely physiological consequence?

- (A) Inability to digest fats due to lack of steapsin
- (B) Failure to convert pepsinogen to pepsin and impaired B12 absorption



- (C) Increased secretion of enterogastrone and secretin
- (D) Rapid emptying of the stomach into the duodenum

Q33. During the transport of CO_2 in the blood, the 'Chloride Shift' (Hamburger phenomenon) occurs to maintain ionic balance. This involves the movement of:

- (A) Cl^- from plasma into RBCs in exchange for HCO_3^-
- (B) Cl^- from RBCs into plasma in exchange for Na^+
- (C) HCO_3^- from plasma into RBCs in exchange for K^+
- (D) Cl^- and HCO_3^- simultaneously into the plasma

Q34. A shift of the Oxygen-Dissociation curve to the right is observed under which of the following physiological conditions?

- (A) Low pCO_2 , High pH, and Low Temperature
- (B) High pCO_2 , Low pH, and High Temperature
- (C) Low pCO_2 , Low pH, and Low Temperature
- (D) High pO_2 , High pH, and High Temperature

Q35. Which of the following events occurs during the 'Atrial Systole' in a normal cardiac cycle?

- (A) Closing of the Semilunar valves
- (B) Flow of blood into the ventricles increases by about 30 percent
- (C) Generation of the second heart sound (Dub)
- (D) The Ventricular pressure exceeds the Aortic pressure

Q36. In the Counter-Current Mechanism of the kidney, the high osmolarity of the inner medullary interstitium is primarily maintained by:

- (A) Active transport of Na^+ in the descending limb of Henle's loop
- (B) Diffusion of Urea from the collecting duct and transport of $NaCl$ by the ascending limb
- (C) Selective permeability of the descending limb to electrolytes



(D) The action of Atrial Natriuretic Factor (ANF) on the DCT

Q37. A patient presents with hyperglycemia, glycosuria, and ketoacidosis. Upon testing, insulin levels are found to be normal, but target cells show a lack of response. This indicates:

- (A) Diabetes Insipidus
- (B) Type I Diabetes Mellitus
- (C) Type II Diabetes Mellitus
- (D) Cushing's Syndrome

Q38. During the 'Refractory Period' of a nerve impulse, the membrane is unable to respond to a second stimulus because:

- (A) Na^+ channels are already open or in an inactivated state
- (B) The membrane is highly permeable to Cl^- ions
- (C) K^+ channels are completely closed
- (D) The Sodium-Potassium pump has stopped working

Q39. The 'Organ of Corti' converts mechanical vibrations into nerve impulses. This is achieved when:

- (A) The basilar membrane strikes the tympanic membrane
- (B) Hair cells are pressed against the tectorial membrane
- (C) Perilymph flows into the Eustachian tube
- (D) The stapes vibrates against the round window

Q40. Which of the following is the correct matching of a hormone with its specific site of action and function?

- (A) PTH: Bone; Decreases blood calcium levels
- (B) CCK: Pancreas; Stimulates secretion of alkaline pancreatic juice
- (C) ADH: Distal convoluted tubule; Increases water reabsorption
- (D) Aldosterone: Glomerulus; Increases GFR through vasoconstriction



- Q41.** In the sliding filament theory of muscle contraction, the hydrolysis of ATP by the Myosin head leads to:
- (A) Binding of Myosin to the active site on Actin (Cross-bridge formation)
 - (B) The 'Power Stroke' which pulls Actin towards the M-line
 - (C) Disattachment of the Myosin head from the Actin filament
 - (D) Activation of the troponin-tropomyosin complex
- Q42.** Which part of the brain is responsible for the regulation of body temperature, hunger, and thirst?
- (A) Cerebellum
 - (B) Medulla Oblongata
 - (C) Hypothalamus
 - (D) Corpus Callosum
- Q43.** What is the correct sequence of the depolarization wave in the human heart?
- (A) SA Node → Purkinje fibers → AV Node → Bundle of His
 - (B) SA Node → AV Node → Bundle of His → Purkinje fibers
 - (C) AV Node → SA Node → Bundle of His → Purkinje fibers
 - (D) Bundle of His → SA Node → AV Node → Purkinje fibers
- Q44.** Emphysema is a chronic disorder characterized by the damage of alveolar walls. What is the major cause and the resulting physiological change?
- (A) Coal dust; Increased respiratory surface area
 - (B) Cigarette smoking; Decreased respiratory surface area
 - (C) Bacterial infection; Inflammation of bronchioles
 - (D) Vitamin deficiency; Thickening of the diffusion membrane
- Q45.** In Angiosperms, if the haploid number of a plant is 12, what will be the number of chromosomes in the cells of the Nucellus and the Endosperm respectively?



- (A) 12 and 36
- (B) 24 and 36
- (C) 24 and 24
- (D) 36 and 12

Q46. Which of the following ensures 'Xenogamy' (True Cross-pollination) in plants?

- (A) Cleistogamy
- (B) Dioecy (Unisexual plants)
- (C) Geitonogamy
- (D) Homogamy

Q47. During the development of the female gametophyte (Embryo sac), how many sequential mitotic divisions occur in the functional megaspore?

- (A) Two
- (B) Three
- (C) Four
- (D) One

Q48. The 'Filiform apparatus' is a characteristic feature of which cell in the embryo sac, and what is its role?

- (A) Egg cell; To facilitate fertilization
- (B) Central cell; To provide nutrition to the zygote
- (C) Synergid; To guide the entry of the pollen tube
- (D) Antipodal cell; To absorb nutrients from the nucellus

Q49. In human females, the 'LH surge' triggers which of the following events?

- (A) Growth of the primary follicle
- (B) Completion of Meiosis-II in the oocyte
- (C) Rupture of the Graafian follicle and release of the secondary oocyte



(D) Formation of the primary endosperm nucleus

Q50. Identify the correct sequence of the pathway of sperm transport in the human male reproductive system:

(A) Seminiferous tubules → Rete testis → Vasa efferentia → Epididymis → Vas deferens

(B) Rete testis → Epididymis → Vasa efferentia → Vas deferens

(C) Seminiferous tubules → Vas deferens → Epididymis → Vasa efferentia

(D) Vas deferens → Epididymis → Rete testis → Seminiferous tubules

Q51. What is the primary function of the 'Trophoblast' layer of the blastocyst during human embryonic development?

(A) It differentiates into the three germ layers

(B) It forms the embryo proper

(C) It attaches to the endometrium and helps form the placenta

(D) It produces the first blood cells of the fetus

Q52. The medical procedure 'GIFT' (Gamete Intra-Fallopian Transfer) is recommended for women who:

(A) Cannot produce an ovum but can provide a suitable environment for fertilization

(B) Have blocked fallopian tubes and require IVF

(C) Suffer from cervical mucus hostility

(D) Are unable to maintain a pregnancy due to low progesterone

Q53. Which of the following is a non-medicated IUD?

(A) CuT

(B) Lippes Loop

(C) LNG-20

(D) Multiload 375



- Q54.** During 'Spermiogenesis', which of the following transformations occurs?
- (A) Spermatogonia divide to form primary spermatocytes
 - (B) Secondary spermatocytes undergo Meiosis-II
 - (C) Spermatids are transformed into mature spermatozoa
 - (D) Spermatogonia are released into the lumen of the tubules
- Q55.** In a dihybrid cross involving two genes *A* and *B*, the parental combination was $AABB \times aabb$. The F_1 generation was test-crossed, resulting in 44% $AaBb$, 44% $aabb$, 6% $Aabb$, and 6% $aaBb$. What is the distance between the two genes on the chromosome?
- (A) 44 map units
 - (B) 12 map units
 - (C) 6 map units
 - (D) 88 map units
- Q56.** Which of the following describes the 'Lyon Hypothesis' regarding X-chromosome inactivation in human females?
- (A) Both X-chromosomes remain active to ensure double protein dosage.
 - (B) One of the two X-chromosomes is randomly inactivated into a Barr body during early embryonic development.
 - (C) Only the paternal X-chromosome is inactivated in all cells of the offspring.
 - (D) The Y-chromosome suppresses one X-chromosome in males.
- Q57.** A DNA molecule has 2000 base pairs. If the amount of Adenine is 20%, calculate the total number of hydrogen bonds present in this DNA molecule.
- (A) 4800
 - (B) 5200
 - (C) 4000
 - (D) 6000



- Q58.** During the process of translation, the "Wobble Hypothesis" suggests that:
- (A) The first base of the codon is not specific.
 - (B) A single tRNA can recognize more than one codon due to non-standard pairing at the third base.
 - (C) Ribosomes move in a jerky motion along the mRNA.
 - (D) The genetic code is overlapping in nature.
- Q59.** In the Lac Operon, if a mutation occurs in the *i* gene such that it cannot bind to the inducer, what will be the result?
- (A) Constitutive expression of structural genes.
 - (B) The operon will always be in the "off" state, even in the presence of lactose.
 - (C) Only the *z* gene will be expressed.
 - (D) RNA polymerase will bind more efficiently to the promoter.
- Q60.** According to the Hardy-Weinberg principle, if the frequency of a recessive allele in a population is 0.4, what is the frequency of the heterozygous individuals?
- (A) 0.16
 - (B) 0.36
 - (C) 0.48
 - (D) 0.24
- Q61.** Which of the following sets of structures represents 'Analogy' resulting from convergent evolution?
- (A) Forelimbs of whale and wings of bat.
 - (B) Flippers of penguins and flippers of dolphins.
 - (C) Thorns of Bougainvillea and tendrils of Cucurbita.
 - (D) Hearts of different vertebrates.
- Q62.** The "RNA World" hypothesis is supported by the discovery of:



- (A) DNA being more stable than RNA.
- (B) Ribozymes, which are RNA molecules with catalytic activity.
- (C) RNA having a double-helical structure in most viruses.
- (D) mRNA being translated into proteins in the nucleus.

Q63. Sickle-cell anemia is an example of 'Point Mutation' where:

- (A) Glutamic acid is replaced by Valine at the 6th position of the α -globin chain.
- (B) Valine is replaced by Glutamic acid at the 6th position of the β -globin chain.
- (C) Glutamic acid is replaced by Valine at the 6th position of the β -globin chain.
- (D) A frame-shift occurs due to deletion of a single base.

Q64. In a DNA fingerprinting experiment, the probe used for hybridization is:

- (A) Double-stranded non-radioactive DNA.
- (B) Radiolabelled VNTR (Variable Number Tandem Repeats) sequence.
- (C) Non-specific RNA sequence.
- (D) Restriction endonucleases.

Q65. The theory of 'Saltation' proposed by Hugo de Vries suggests that:

- (A) Evolution is a slow and gradual process.
- (B) Single-step large mutations cause speciation.
- (C) Small variations are the basis of evolution.
- (D) Acquired characters are inherited.

Q66. If a color-blind man marries a woman who is homozygous for normal vision, the probability of their son being color-blind is:

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



- Q67.** The classic experiment by Meselson and Stahl proved the semi-conservative replication of DNA by using which isotopes?
- (A) ^{14}C and ^{12}C
 - (B) ^{35}S and ^{32}P
 - (C) ^{15}N and ^{14}N
 - (D) ^3H and ^{14}C
- Q68.** Which of the following is NOT a characteristic of the genetic code?
- (A) Universal (with few exceptions).
 - (B) Ambiguous (one codon codes for multiple amino acids).
 - (C) Degenerate (one amino acid coded by multiple codons).
 - (D) Comma-less and non-overlapping.
- Q69.** The Miller-Urey experiment produced which of the following organic molecules in the simulated primitive atmosphere?
- (A) Nucleotides and ATP
 - (B) Amino acids like Glycine and Alanine
 - (C) Complex proteins and DNA
 - (D) Polysaccharides and Lipids
- Q70.** A person is diagnosed with a disease that has resulted in a severely depleted count of Helper T-lymphocytes. Which of the following is the causative agent and the diagnostic test for this condition?
- (A) *Salmonella typhi*; Widal test
 - (B) HIV; ELISA
 - (C) *Plasmodium vivax*; Blood smear
 - (D) Rhinovirus; PCR
- Q71.** In the treatment of sewage, the 'Activated Sludge' is:



- (A) The sedimented part of the primary settling tank.
- (B) The mass of bacteria and fungal filaments (flocs) that settle after secondary treatment.
- (C) The scum that floats on the surface of anaerobic digesters.
- (D) The effluent released directly into water bodies.

Q72. Which of the following is an example of 'Biofortification'?

- (A) Using *Bacillus thuringiensis* to control pests.
- (B) Developing Maize hybrids with twice the amount of amino acids like Lysine and Tryptophan.
- (C) Production of single-cell protein from *Spirulina*.
- (D) Using mycorrhiza to improve phosphorus absorption.

Q73. The 'Cyclosporin A' used as an immunosuppressive agent in organ-transplant patients is produced by:

- (A) *Monascus purpureus*
- (B) *Trichoderma polysporum*
- (C) *Aspergillus niger*
- (D) *Acetobacter aceti*

Q74. Which of the following is a 'Lymphoid organ' where immature lymphocytes differentiate into antigen-sensitive lymphocytes?

- (A) Spleen
- (B) Peyer's patches
- (C) Thymus
- (D) Lymph nodes

Q75. The 'Heroin' (Smack) is chemically Diacetylmorphine, which is extracted from the latex of:

- (A) *Cannabis sativa*



- (B) *Papaver somniferum*
- (C) *Atropa belladonna*
- (D) *Erythroxylum coca*

Q76. A researcher wants to insert a gene of interest into a plasmid vector at a site located within the gene for β -galactosidase (*lacZ*). After transformation, the recombinant colonies will appear:

- (A) Blue, because the gene for β -galactosidase is active.
- (B) White, due to insertional inactivation of the *lacZ* gene.
- (C) Red, because of the accumulation of X-gal.
- (D) Colorless, but only in the absence of ampicillin.

Q77. In the context of the Ti-plasmid of *Agrobacterium tumefaciens*, which of the following is responsible for the actual transfer and integration of the T-DNA into the plant genome?

- (A) *ori* region
- (B) *vir* (virulence) genes
- (C) Opine catabolism genes
- (D) Cytokinin biosynthetic genes

Q78. During the process of Gene Therapy for Adenosine Deaminase (ADA) deficiency, why do patients require periodic infusions of genetically engineered lymphocytes?

- (A) The retroviral vector used is unstable.
- (B) Lymphocytes are not immortal cells and eventually die.
- (C) The ADA gene is not integrated into the host genome.
- (D) The enzyme produced is rapidly degraded in the blood.

Q79. Which of the following represents the correct order of steps in a Polymerase Chain Reaction (PCR)?

- (A) Extension \rightarrow Denaturation \rightarrow Annealing



- (B) Annealing → Extension → Denaturation
- (C) Denaturation → Annealing → Extension
- (D) Denaturation → Extension → Annealing

Q80. RNA interference (RNAi) involves the silencing of a specific mRNA due to a complementary RNA molecule. In the development of *Meloidogyne incognita*-resistant tobacco plants, the source of this complementary RNA is:

- (A) A chemical mutagen applied to the soil.
- (B) An *Agrobacterium* vector carrying both sense and anti-sense DNA.
- (C) The parasite's own ribosomes.
- (D) High-intensity UV radiation.

Q81. What is the function of the "Stirrer" in a stirred-tank bioreactor?

- (A) To facilitate the filtration of the final product.
- (B) To maintain an anaerobic environment.
- (C) To ensure even oxygen availability and mixing of contents throughout the reactor.
- (D) To regulate the temperature of the culture medium.

Q82. The "Bt" in Bt-cotton refers to a toxin that is initially an inactive protoxin. It is converted into an active toxin in the insect gut due to:

- (A) Acidic pH of the stomach.
- (B) High temperature of the insect body.
- (C) Alkaline pH of the midgut.
- (D) Action of amylase enzymes.

Q83. In downstream processing, which of the following is NOT a step in the recovery of a recombinant protein?

- (A) Separation of the product.
- (B) Purification of the product.



- (C) Addition of preservatives for clinical trials.
- (D) Transformation of host cells.

Q84. In a stable ecosystem, if the Net Primary Productivity (NPP) is $1000 \text{ kcal/m}^2/\text{yr}$ and the Respiration (R) loss is $400 \text{ kcal/m}^2/\text{yr}$, what is the Gross Primary Productivity (GPP)?

- (A) $600 \text{ kcal/m}^2/\text{yr}$
- (B) $1400 \text{ kcal/m}^2/\text{yr}$
- (C) $400 \text{ kcal/m}^2/\text{yr}$
- (D) $2500 \text{ kcal/m}^2/\text{yr}$

Q85. According to the "Rivet Popper Hypothesis" by Paul Ehrlich, the extinction of a "key" species in an ecosystem is analogous to:

- (A) Removing a rivet from the seat of an airplane.
- (B) Removing a rivet from the wings of an airplane.
- (C) Adding a new rivet to the cockpit.
- (D) Changing the fuel of the airplane.

Q86. In an age pyramid, if the pre-reproductive population is much larger than the reproductive population, the population is:

- (A) Declining
- (B) Stable
- (C) Expanding
- (D) Fluctuating

Q87. Which of the following is an example of 'Ex-situ' conservation?

- (A) National Parks
- (B) Wildlife Sanctuaries
- (C) Biosphere Reserves



(D) Cryopreservation of gametes

Q88. The phenomenon where a high concentration of non-biodegradable pollutants (like DDT) accumulates at successive trophic levels is known as:

(A) Eutrophication

(B) Biomagnification

(C) Algal Bloom

(D) Bioremediation

Q89. In the equation for the Species-Area relationship, $\log S = \log C + Z \log A$, the value of Z (regression coefficient) for a very large area like an entire continent is typically:

(A) 0.1 to 0.2

(B) 0.6 to 1.2

(C) 1.0 to 2.0

(D) 0.01 to 0.05

Q90. The 'Montreal Protocol' (1987) was signed to control the emission of:

(A) Greenhouse gases causing global warming.

(B) Ozone-depleting substances (ODS).

(C) Industrial effluents into water bodies.

(D) Toxic gases from automobiles.



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

Concept: Biological classification follows a hierarchical system where organisms are grouped based on similarities and differences. As we move from lower to higher categories, complexity increases while similarity decreases. The standard taxonomic hierarchy progresses from species (most specific) to kingdom (most general).

Solution: The correct sequence of taxonomic categories in increasing order of complexity and decreasing similarity is: Species → Genus → Family → Order → Class → Phylum → Kingdom. Species is the basic unit where organisms share maximum similarity. As we move upward, groups become broader and include more diverse organisms. Genus groups similar species, family groups related genera, and so on until kingdom, which includes the largest diversity. Other options either reverse the order or incorrectly place categories. Hence, the correct hierarchical progression is clearly represented in option (A).

Final Answer: Species → Genus → Family → Order → Class → Phylum → Kingdom

Answer: (A)

Q2.**Solution**

Concept: Whittaker's five-kingdom classification system is based on criteria such as cell structure, body organization, mode of nutrition, and phylogenetic relationships. Protista includes unicellular eukaryotic organisms that do not fit into other kingdoms.

Solution: Organisms like Chlamydomonas and Chlorella were moved from Algae to Protista primarily because they are unicellular eukaryotes. Although they are autotrophic and possess chlorophyll, their simple unicellular organization distinguishes them from multicellular algae in Plantae. Whittaker emphasized cellular organization as a key criterion, placing all unicellular eukaryotes under Protista. The presence of a true nucleus is common to all eukaryotes, so it is not a distinguishing factor. Thus, their unicellular eukaryotic nature was the main reason for their classification under Protista.

Final Answer: Unicellular eukaryotic nature

Answer: (C)



Q3.

Solution

Concept: Viruses are classified based on their genetic material and replication strategies. Most DNA viruses replicate in the nucleus, but some unique viruses carry their own machinery to replicate in the cytoplasm.

Solution: Poxviruses are double-stranded DNA viruses that replicate in the cytoplasm of host cells. Unlike most DNA viruses, they do not rely on the host nucleus because they possess the necessary enzymes for transcription and replication. This makes them unique among DNA viruses. Bacteriophages typically infect bacteria and replicate differently, while retroviruses have RNA genomes and use reverse transcription. Reoviruses are double-stranded RNA viruses. Therefore, the description of a dsDNA virus replicating in the cytoplasm best matches poxviruses.

Final Answer: Poxviruses

Answer: (B)

Q4.

Solution

Concept: Taxonomic classification of plants is based on morphological and reproductive characteristics. Wheat (*Triticum aestivum*) belongs to a well-defined classification under the angiosperms.

Solution: Wheat belongs to the family Poaceae, class Monocotyledonae, and division Angiospermae. However, it does not belong to the order Sapindales. Instead, wheat is classified under the order Poales. Sapindales includes plants like citrus and neem, which are unrelated to grasses. Therefore, the pair “Order: Sapindales” is incorrect for wheat. All other options correctly match wheat’s classification. Thus, option (B) represents the mismatched pair.

Final Answer: Order: Sapindales

Answer: (B)

Q5.

Solution

Concept: Diatoms are unicellular algae found in aquatic environments and play a crucial role in global primary productivity. They have unique structural features, especially their silica-based cell walls.

Solution: The incorrect statement regarding diatoms is that they move actively using flagella. Diatoms generally lack flagella (except in some reproductive stages) and do not actively swim in water. Instead, they may drift passively or show limited gliding movement. They are indeed major producers in oceans, their silica walls are indestructible, and they form diatomaceous earth deposits over time. Therefore, the statement about flagellar movement is incorrect.

Final Answer: They move actively in the water column using flagella

Answer: (C)



Q6.

Solution

Concept: Bryophytes and pteridophytes are archegoniates that share certain reproductive features. Both require specific environmental conditions for successful fertilization.

Solution: A common feature between bryophytes and pteridophytes is the requirement of water for fertilization. In both groups, male gametes are flagellated and need a thin film of water to swim toward the female gamete (egg). This dependence on water limits their distribution to moist environments. Bryophytes have a dominant gametophyte, while pteridophytes have a dominant sporophyte, so dominance is not common. Vascular tissues are absent in bryophytes, and seeds are not formed in either group. Hence, water requirement for fertilization is the shared feature.

Final Answer: Requirement of water for fertilization of flagellated male gametes

Answer: (B)

Q7.

Solution

Concept: Ctenophores and cnidarians are both diploblastic and radially symmetrical animals, but they differ in certain unique features that distinguish their classification.

Solution: The presence of eight external rows of ciliated comb plates is a unique feature of phylum Ctenophora. These comb plates are used for locomotion and give the organisms a characteristic shimmering appearance. In contrast, cnidarians possess cnidoblasts (stinging cells) for defense and prey capture. Both groups share radial symmetry and tissue-level organization, so these are not distinguishing features. Therefore, the comb plates are the defining characteristic of ctenophores.

Final Answer: Presence of eight external rows of ciliated comb plates

Answer: (C)

Q8.

Solution

Concept: Symmetry in animals refers to the arrangement of body parts around an axis. Different phyla exhibit characteristic symmetry patterns based on their body organization and evolution.

Solution: Adult echinoderms exhibit radial symmetry, although their larvae are bilaterally symmetrical. Platyhelminthes show bilateral symmetry, which allows directional movement and cephalization. Porifera (sponges) are generally asymmetrical due to their simple body organization and lack of definite shape. Matching these correctly gives: (i) Radial, (ii) Bilateral, (iii) Asymmetrical. Therefore, option (B) is the correct sequence.

Final Answer: (i) Radial, (ii) Bilateral, (iii) Asymmetrical

Answer: (B)



Q9.

Solution

Concept: Monocot stems are characterized by scattered vascular bundles embedded in ground tissue. These bundles are conjoint, collateral, and closed, meaning xylem and phloem lie together without cambium, and secondary growth is absent. This arrangement is a key diagnostic feature distinguishing monocot stems from dicot stems.

Solution: In plant anatomy, vascular bundles provide important clues for identifying plant tissues. In monocotyledonous stems, such as maize or sugarcane, the vascular bundles are scattered throughout the ground tissue rather than arranged in a ring. These bundles are conjoint, meaning xylem and phloem are present together, collateral because xylem lies on the inner side and phloem on the outer side, and closed because cambium is absent. The absence of cambium prevents secondary growth in monocots. In contrast, dicot stems show open vascular bundles arranged in a ring, allowing secondary growth. Roots also have radial vascular bundles, and leaves show different organization. Thus, the presence of scattered, conjoint, collateral, and closed vascular bundles indicates a monocot stem.

Final Answer: Monocotyledonous stem

Answer: (B)

Q10.

Solution

Concept: Secondary growth in dicot stems leads to the formation of heartwood and sapwood. Heartwood is the older, non-functional xylem that becomes dark and durable due to deposition of organic substances, while sapwood remains active in conduction.

Solution: In dicot stems undergoing secondary growth, the secondary xylem differentiates into sapwood and heartwood. Sapwood is the outer, younger region that actively conducts water and minerals and contains living parenchyma cells. Heartwood, on the other hand, is the inner region of the secondary xylem that gradually loses its conducting function. It becomes filled with deposits such as tannins, resins, gums, and oils. These substances make heartwood darker, harder, and more resistant to decay and microbial attack. Heartwood does not conduct water and is composed of dead cells, while sapwood remains functional. It is not located at the periphery but in the central region of the stem. Thus, heartwood differs due to deposition of protective substances.

Final Answer: Has deposition of tannins, resins, and oils, making it durable

Answer: (C)



Q11.

Solution

Concept: Collenchyma is a living mechanical tissue in plants that provides flexible support to growing regions such as young stems and leaf petioles. It is characterized by uneven thickening of cell walls at the corners due to cellulose and pectin deposition.

Solution: Plant tissues are broadly classified into simple and complex tissues. Collenchyma is a simple permanent tissue that provides mechanical support to young, growing parts of the plant such as stems and leaf petioles. Its cells are living and elongated, and the cell walls show uneven thickening at the corners due to deposition of cellulose and pectin. This feature provides both strength and flexibility, allowing the plant to bend without breaking. Sclerenchyma, in contrast, consists of dead cells with lignified walls and provides rigid support. Parenchyma is a basic living tissue involved in storage and photosynthesis. Aerenchyma is found in aquatic plants and helps in buoyancy. Thus, collenchyma is responsible for flexible mechanical support.

Final Answer: Collenchyma

Answer: (C)

Q12.

Solution

Concept: Ciliated epithelium consists of cells bearing cilia that beat rhythmically to move substances like mucus or ova across epithelial surfaces. It is found in respiratory passages and reproductive tracts.

Solution: Ciliated epithelium is a specialized epithelial tissue in which cells possess hair-like projections called cilia. These cilia beat in coordinated movements to transport substances along the epithelial surface. In the respiratory tract, ciliated epithelium helps move mucus containing dust and microbes toward the throat for removal. In the fallopian tubes, it helps in the movement of the ovum toward the uterus. This movement is directional and essential for maintaining cleanliness and proper transport within hollow organs. It does not primarily function in secretion or absorption. Thus, the main function of ciliated epithelium is directional movement of particles or mucus.

Final Answer: Move particles or mucus in a specific direction over the epithelium

Answer: (B)



Q13.

Solution

Concept: Tight junctions are specialized cell junctions that seal adjacent epithelial cells, preventing leakage of substances through the intercellular space. They are especially important in organs like the stomach and intestines.

Solution: Cell junctions are structures that connect adjacent cells and maintain tissue integrity. Tight junctions are the most important for preventing leakage of substances between epithelial cells. They form a continuous belt-like seal around cells, blocking the passage of water, ions, and other molecules through intercellular spaces. This is particularly important in the stomach and intestines, where controlled movement of substances is necessary. Adhering junctions provide mechanical attachment between cells. Gap junctions allow communication through small molecules and ions. Desmosomes provide strong anchoring between cells. Thus, tight junctions are responsible for preventing leakage across epithelial tissues.

Final Answer: Tight junctions

Answer: (C)

Q14.

Solution

Concept: Signal peptidase is an enzyme in the rough endoplasmic reticulum that removes signal peptides from newly synthesized proteins destined for secretion or organelles. Inhibition of this enzyme affects protein processing.

Solution: During protein synthesis on ribosomes attached to the rough endoplasmic reticulum, secretory and membrane proteins are synthesized with an N-terminal signal peptide. This signal sequence directs the ribosome to the ER membrane and is essential for protein targeting. Once the protein enters the ER lumen, signal peptidase cleaves off the signal peptide, allowing proper folding and processing. If signal peptidase is inhibited, the signal sequence will not be removed. As a result, proteins will accumulate with their signal peptides still attached, leading to improper maturation and processing. Ribosome binding and transcription processes are unaffected, and glycosylation occurs independently of signal peptide removal. Thus, the immediate effect is retention of signal sequences.

Final Answer: Secretory proteins will retain their N-terminal signal sequences

Answer: (B)



Q15.

Solution

Concept: The cell cycle involves changes in DNA content while chromosome number remains constant in somatic cells.

Key Idea:

- DNA content doubles during S phase
- Chromosome number remains diploid ($2n$) in G_1 and G_2

Given:

- In G_2 phase: DNA content = $4C$

Understanding phases:

- G_1 phase: before DNA replication
- S phase: DNA replication occurs
- G_2 phase: post replication (DNA doubled)

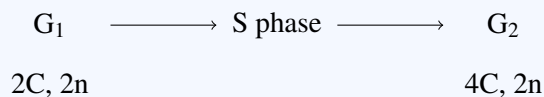
Relationship:

$$\text{If } G_2 = 4C \Rightarrow G_1 = 2C$$

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Chromosome number:

- Chromosome number does not change in G_1 or G_2
- Diploid condition remains: $2n$



Final Answer: $2C$ and $2n$

Answer: (C)



Q16.

Solution

Concept: The synaptonemal complex is a protein structure that forms between homologous chromosomes during prophase I of meiosis. It plays a crucial role in pairing homologs and facilitating genetic recombination (crossing over), especially during the pachytene stage. Its formation and dissolution are tightly regulated across leptotene, zygotene, pachytene, and diplotene stages.

Solution: During meiosis I, homologous chromosomes undergo pairing and recombination in prophase I. The synaptonemal complex is a highly organized proteinaceous structure that forms between homologous chromosomes during the zygotene stage. It acts like a zipper, bringing homologous chromosomes into close alignment, ensuring accurate pairing. Crossing over, which involves exchange of genetic material between non-sister chromatids, occurs during the pachytene stage while the synaptonemal complex is fully formed. This makes it essential for genetic recombination and variation. In diplotene, the synaptonemal complex begins to disassemble, and homologous chromosomes start separating but remain attached at chiasmata, which are the visible sites of crossover. Thus, chiasmata become clearly visible only after dissolution begins. The complex is primarily composed of proteins such as SYCP1, SYCP2, and SYCP3, not RNA. Therefore, statements about RNA composition are incorrect. Hence, the correct statement is that it facilitates crossing over during pachytene.

Final Answer: It facilitates the process of crossing over during Pachytene

Answer: (B)

Q17.

Solution

Concept: The axoneme is the structural core of eukaryotic cilia and flagella, typically arranged in a “9+2” pattern. It consists of nine peripheral microtubule doublets and two central singlet microtubules, connected by various protein structures.

Solution: In the axoneme, radial spokes connect the peripheral microtubule doublets to the central sheath surrounding the central pair of microtubules. This structural arrangement helps in coordinating movement. The central sheath encloses the central microtubules, not the peripheral ones. Interdoublet bridges connect adjacent peripheral doublets, not central microtubules. Also, the arrangement is 9+2, not 9+0. Therefore, the correct match is that radial spokes connect peripheral doublets to the central sheath.

Final Answer: Radial spokes connect peripheral doublets to the central sheath

Answer: (B)



Q18.

Solution

Concept: The fluid mosaic model explains the dynamic nature of the plasma membrane. Lipids and proteins can move laterally, but transverse (flip-flop) movement is rare due to structural constraints.

Solution: Flip-flop movement is rare because the hydrophilic heads of phospholipids cannot easily pass through the hydrophobic core of the membrane. This energetic barrier prevents spontaneous transverse movement. Proteins, being larger and more complex, almost never undergo such movement without assistance. Enzymes like flippases facilitate this process when required. Thus, the hydrophobic interior of the membrane restricts the passage of polar heads, making flip-flop movement extremely rare.

Final Answer: The hydrophilic heads cannot easily pass through the hydrophobic core

Answer: (B)

Q19.

Solution

Concept: Different cell organelles perform specialized metabolic functions. The smooth endoplasmic reticulum (SER) is particularly important in lipid metabolism and detoxification processes.

Solution: The smooth endoplasmic reticulum is responsible for the synthesis of steroidal hormones and detoxification of drugs, especially in liver cells. It lacks ribosomes and is involved in lipid synthesis, phospholipid production, and metabolism of xenobiotics. In hepatocytes, SER enzymes modify toxic substances to make them more water-soluble for excretion. Rough ER mainly synthesizes proteins, Golgi modifies and packages materials, and lysosomes are involved in digestion. Hence, SER performs both hormone synthesis and detoxification functions.

Final Answer: Smooth Endoplasmic Reticulum

Answer: (B)

Q20.

Solution

Concept: Osmosis in plant cells depends on the relative concentration of solutes inside and outside the cell. When both are equal, there is no net movement of water across the membrane.

Solution: When a plant cell is placed in an isotonic solution, where external osmotic pressure equals internal osmotic pressure, there is no net movement of water. The cell neither gains nor loses water and becomes flaccid. It is not turgid because no inward pressure develops, and not plasmolysed because no water is lost. This condition represents equilibrium in water movement, leading to a relaxed cell state. Therefore, the correct term describing the cell condition is flaccid.

Final Answer: Flaccid

Answer: (C)



Q21.

Solution

Concept: Satellite DNA consists of repetitive non-coding sequences in the genome. It is often used in genetic studies due to its variability among individuals.

Solution: Satellite DNA is important because it shows a high degree of polymorphism and does not code for proteins. These repetitive sequences are found in regions like centromeres and telomeres. Their variability makes them useful in DNA fingerprinting and forensic identification. They do not encode enzymes or structural proteins and are not the majority of coding DNA. Hence, their significance lies in genetic variation and identification rather than functional protein synthesis.

Final Answer: Shows high degree of polymorphism and does not code for proteins

Answer: (B)

Q22.

Solution

Concept: Enzymes regulate key events in the cell cycle such as recombination, chromatid separation, and phosphorylation, ensuring accurate DNA division and progression through phases.

Solution: Recombinase enzymes facilitate crossing over during meiosis by exchanging DNA segments between homologous chromosomes. Separase is responsible for cleaving cohesin proteins, allowing sister chromatids to separate during anaphase. Kinases catalyze phosphorylation reactions, which regulate cell cycle progression by activating or deactivating proteins. Hence, the correct matching is: Recombinase—crossing over, Separase—sister chromatid separation, and Kinase—phosphorylation.

Final Answer: (i) Crossing over, (ii) Sister chromatid separation, (iii) Phosphorylation

Answer: (A)

Q23.

Solution

Concept: The mitochondrial matrix is the innermost compartment containing genetic material and enzymes required for metabolic processes like the Krebs cycle.

Solution: The mitochondrial matrix contains circular DNA and 70S ribosomes, resembling prokaryotic features, supporting the endosymbiotic theory. Glycolysis occurs in the cytoplasm, and the electron transport system is located on the inner mitochondrial membrane. During ATP synthesis, the proton gradient is higher in the intermembrane space, not the matrix. Therefore, the correct characteristic is the presence of circular DNA and 70S ribosomes.

Final Answer: It possesses a single circular DNA molecule and 70S ribosomes

Answer: (B)



Q24.

Solution

Concept: C_4 photosynthesis involves spatial separation of initial CO_2 fixation and decarboxylation processes between mesophyll and bundle sheath cells.

Solution: In C_4 plants, malic acid formed in mesophyll cells is transported to bundle sheath cells. Here, it undergoes decarboxylation within the chloroplasts, releasing CO_2 for the Calvin cycle and producing pyruvate. This spatial separation reduces photorespiration and increases efficiency. Therefore, the decarboxylation of malic acid occurs in bundle sheath chloroplasts.

Final Answer: Bundle sheath chloroplasts

Answer: (C)

Q25.

Solution

Concept: The Z-scheme of photosynthesis illustrates the flow of electrons through photosystems and electron carriers in the thylakoid membrane.

Solution: The primary electron acceptor of Photosystem II transfers electrons to plastoquinone (PQ), which then carries them to the cytochrome b_6f complex. Plastocyanin and ferredoxin act later in the chain. Since PQ is the first stable carrier after the primary acceptor, it receives electrons directly.

Final Answer: Plastoquinone (PQ)

Answer: (B)

Q26.

Solution

Concept: Glycolysis includes substrate-level phosphorylation, where ATP is generated directly from metabolic intermediates.

Solution: The conversion of phosphoenolpyruvate (PEP) to pyruvate is catalyzed by pyruvate kinase and produces ATP via substrate-level phosphorylation. If this step is inhibited, ATP generation at this stage is blocked, directly affecting glycolysis. Other processes like photolysis or carbon fixation are unrelated. Therefore, substrate-level phosphorylation in glycolysis is most affected.

Final Answer: Substrate-level phosphorylation in Glycolysis

Answer: (B)



Q27.

Solution

Concept: Phytochrome exists in two interconvertible forms, P_r and P_{fr} , which regulate plant responses to light through photoreversibility.

Solution: The biologically active form P_{fr} absorbs far-red light and is converted back into the inactive P_r form. This reversible transformation allows plants to detect light conditions and regulate processes like flowering and germination. Red light converts P_r to P_{fr} , while far-red light reverses it. Hence, absorption of far-red light converts P_{fr} into P_r .

Final Answer: It is converted into the P_r form

Answer: (B)

Q28.

Solution

Concept: Water potential in plant cells is the sum of solute potential and pressure potential.

Fundamental Equation: $\Psi_w = \Psi_s + \Psi_p$

Given:

- Water potential, $\Psi_w = -10$ bars
- Pressure potential, $\Psi_p = +5$ bars

Step 1: Rearranging equation

$$\Psi_s = \Psi_w - \Psi_p$$

Step 2: Substituting values

$$\Psi_s = -10 - 5$$

Step 3: Calculation

$$\Psi_s = -15 \text{ bars}$$

$$\Psi_w = -10 \longrightarrow \Psi_p = +5$$

$$\Psi_s = -15$$

Final Answer: -15 bars

Answer: (B)



Q29.

Solution

Concept: Guttation is the exudation of liquid water from hydathodes due to internal root pressure when transpiration is minimal.

Solution: Guttation occurs mostly at night or early morning when transpiration is low. Roots actively absorb minerals, causing osmotic entry of water and development of positive root pressure in xylem vessels. This pressure pushes water upward and out through hydathodes. It is not driven by transpiration pull but by internal pressure generated in roots. Therefore, root pressure under low transpiration conditions causes guttation.

Final Answer: Root pressure developed during low transpiration

Answer: (B)

Q30.

Solution

Concept: Mineral nutrients serve structural and enzymatic roles in plants, especially in photosynthesis and enzyme activation.

Solution: Magnesium (Mg^{2+}) is a central component of the chlorophyll molecule and also acts as an activator of the enzyme Rubisco, which catalyzes carbon fixation in the Calvin cycle. Other ions like iron and manganese assist in electron transport but are not part of chlorophyll structure. Hence, magnesium fulfills both roles mentioned.

Final Answer: Magnesium (Mg^{2+})

Answer: (B)

Q31.

Solution

Concept: The Krebs cycle includes a step of substrate-level phosphorylation that generates energy directly in the form of GTP or ATP.

Solution: During the conversion of Succinyl-CoA to succinic acid, catalyzed by succinyl-CoA synthetase, a molecule of GTP (or ATP) is produced via substrate-level phosphorylation. This is one of the few direct energy-yielding steps in the cycle. Other steps produce NADH or $FADH_2$. Therefore, the correct product formed is GTP.

Final Answer: One molecule of GTP (or ATP)

Answer: (B)



Q32.

Solution

Concept: Parietal cells secrete hydrochloric acid and intrinsic factor, both essential for digestion and vitamin B₁₂ absorption.

Solution: Damage to parietal cells reduces HCl secretion, preventing activation of pepsinogen into pepsin, thereby impairing protein digestion. Additionally, intrinsic factor is not produced, leading to vitamin B₁₂ malabsorption and pernicious anemia. Thus, both digestive function and B₁₂ absorption are compromised due to parietal cell damage.

Final Answer: Failure to convert pepsinogen to pepsin and impaired B12 absorption

Answer: (B)

Q33.

Solution

Concept: The chloride shift maintains ionic balance during CO₂ transport in blood by exchanging ions between RBCs and plasma.

Solution: Inside RBCs, CO₂ is converted into bicarbonate (HCO_3^-), which diffuses into plasma. To maintain electrical neutrality, chloride ions (Cl^-) move from plasma into RBCs. This exchange is known as the chloride shift or Hamburger phenomenon and is essential for efficient CO₂ transport in blood.

Final Answer: Cl^- from plasma into RBCs in exchange for HCO_3^-

Answer: (A)

Q34.

Solution

Concept: The oxygen dissociation curve shifts based on physiological conditions that affect hemoglobin's affinity for oxygen.

Solution: A rightward shift occurs when hemoglobin releases oxygen more readily. This happens under conditions of high pCO_2 , low pH (acidic conditions), and high temperature. These factors are common in actively respiring tissues and enhance oxygen delivery. This phenomenon is known as the Bohr effect.

Final Answer: High pCO_2 , Low pH, and High Temperature

Answer: (B)



Q35.

Solution

Concept: Atrial systole is the phase of the cardiac cycle in which both atria contract, pushing additional blood into the ventricles. This phase ensures optimal ventricular filling before ventricular systole begins. It contributes a small but important fraction of ventricular filling, especially during increased heart rate conditions. Proper coordination between atrial and ventricular contractions is essential for efficient cardiac output.

Solution: During atrial systole, the atria contract and force blood into the ventricles. Although most ventricular filling occurs passively before this phase, atrial contraction contributes an additional volume of blood, commonly referred to as the “atrial kick.” This accounts for approximately 20–30% of the ventricular filling. This phase occurs just before ventricular systole begins, ensuring that the ventricles are filled to their maximum capacity for efficient pumping. The semilunar valves remain closed during this phase, so their closure is not associated specifically with atrial systole. The second heart sound (“dub”) is produced during the closure of semilunar valves at the beginning of ventricular diastole, not atrial systole. Similarly, ventricular pressure exceeding aortic pressure occurs during ventricular systole, not atrial contraction. Thus, the most appropriate event associated with atrial systole is the increase in blood flow into the ventricles due to atrial contraction.

Final Answer: Flow of blood into the ventricles increases by about 30 percent

Answer: (B)

Q36.

Solution

Concept: The counter-current mechanism in the kidney is responsible for maintaining a high osmolarity gradient in the medulla, which is crucial for water reabsorption. This mechanism involves the loop of Henle and the vasa recta. The descending limb is permeable to water, while the ascending limb actively transports ions, helping establish and maintain osmotic gradients.

Solution: The high osmolarity of the inner medullary interstitium is maintained through a combination of sodium chloride transport and urea recycling. The ascending limb of the loop of Henle actively transports NaCl into the interstitial fluid, increasing its osmolarity. Importantly, this segment is impermeable to water, which helps dilute the tubular fluid while concentrating the surrounding interstitium. Additionally, urea plays a crucial role in maintaining high osmolarity in the inner medulla. Urea diffuses out of the collecting duct into the interstitial space and enters the loop of Henle, contributing significantly to the osmotic gradient. This process is known as urea recycling. The descending limb is permeable to water but does not actively transport sodium. ANF acts on the distal convoluted tubule but is not involved in maintaining medullary osmolarity. Thus, the combined action of NaCl transport in the ascending limb and urea diffusion from the collecting duct is responsible for maintaining the high osmolarity.

Final Answer: Urea diffuses; NaCl is transported in loop of Henle

Answer: (B)



Q37.

Solution

Concept: Diabetes mellitus is characterized by impaired glucose metabolism due to insulin deficiency or resistance. In Type I diabetes, insulin production is insufficient, whereas in Type II diabetes, insulin is present but target cells fail to respond properly. Insulin resistance leads to elevated blood glucose levels despite normal or high insulin levels.

Solution: The patient described has hyperglycemia, glycosuria, and ketoacidosis, which are hallmark features of diabetes mellitus. However, the key detail is that insulin levels are normal, yet the target cells fail to respond appropriately. This indicates a condition where insulin is present but ineffective, known as insulin resistance. In Type I diabetes mellitus, insulin levels are typically low or absent due to destruction of pancreatic beta cells. Therefore, it does not match the given condition. Diabetes insipidus is related to ADH deficiency and does not involve glucose metabolism. Cushing's syndrome involves excess cortisol and does not primarily cause insulin resistance with normal insulin levels. In Type II diabetes mellitus, the body produces insulin, but cells do not respond effectively to it. This results in high blood glucose levels and associated complications. Therefore, the condition described is consistent with Type II diabetes mellitus.

Final Answer: Type II Diabetes Mellitus

Answer: (C)

Q38.

Solution

Concept: The refractory period is a phase during which a neuron is unable to generate another action potential immediately after one has occurred. This ensures unidirectional propagation of nerve impulses. It occurs due to changes in ion channel states, particularly sodium channel inactivation and potassium channel activity.

Solution: During the refractory period, the neuron temporarily loses its ability to respond to a new stimulus. This occurs mainly because voltage-gated sodium channels, which are responsible for depolarization, become inactivated after opening. While they may still be physically open, they cannot be immediately reopened until they return to their resting state. This inactivation prevents another action potential from being generated, even if a stimulus is applied. Meanwhile, potassium channels remain open, allowing potassium ions to exit the cell, helping restore the resting membrane potential. However, the key reason for the inability to respond is sodium channel inactivation. Chloride ion permeability is not the primary factor, and potassium channels are not completely closed during this phase. The sodium-potassium pump continues to function normally. Thus, the refractory period occurs because sodium channels are either open or inactivated and cannot initiate another impulse.

Final Answer: Na^+ channels are already open or in an inactivated state

Answer: (A)



Q39.

Solution

Concept: The organ of Corti is the sensory organ of hearing located within the cochlea. It contains hair cells that act as mechanoreceptors. These cells convert sound vibrations into electrical signals that are transmitted to the brain via auditory nerves.

Solution: The organ of Corti functions by converting mechanical vibrations into nerve impulses through the action of hair cells. When sound waves travel through the ear, they cause vibrations in the basilar membrane. These vibrations lead to the movement of hair cells against the tectorial membrane. As the hair cells bend due to this movement, ion channels open, leading to depolarization and the generation of nerve impulses. These signals are then transmitted to the brain via the auditory nerve for interpretation. The basilar membrane does not strike the tympanic membrane. The Eustachian tube is involved in pressure equalization, not hearing. The stapes vibrates against the oval window, not the round window. Thus, the correct mechanism involves hair cells being pressed against the tectorial membrane, enabling the conversion of vibrations into nerve impulses.

Final Answer: Hair cells are pressed against the tectorial membrane

Answer: (B)

Q40.

Solution

Concept: Hormones act on specific target organs to regulate physiological processes. Each hormone has a defined site of action and function. Understanding correct hormone-function relationships is essential in physiology, especially for homeostasis and digestion, osmoregulation, and calcium balance.

Solution: Among the given options, the correct match is CCK acting on the pancreas to stimulate secretion of alkaline pancreatic juice. Cholecystokinin (CCK) is released from the small intestine and stimulates the pancreas to release enzyme-rich pancreatic juice, which is alkaline in nature and helps neutralize acidic chyme from the stomach. Parathyroid hormone (PTH) actually increases blood calcium levels by stimulating bone resorption, so option A is incorrect. Antidiuretic hormone (ADH) acts mainly on the collecting ducts (and partially on DCT) to increase water reabsorption, but the most precise site is the collecting duct, making option C less accurate. Aldosterone acts on distal tubules and collecting ducts to increase sodium reabsorption, not on the glomerulus. Thus, the correct and most accurate hormone-function match is CCK stimulating pancreatic secretion.

Final Answer: CCK: Pancreas; Stimulates secretion of alkaline pancreatic juice

Answer: (B)



Q41.

Solution

Concept: The sliding filament theory explains muscle contraction through cyclic interaction between actin and myosin filaments. ATP plays a central role by enabling detachment, energizing the myosin head, and facilitating cross-bridge cycling. Hydrolysis of ATP provides energy that changes the conformation of the myosin head, preparing it for binding with actin and subsequent contraction processes.

Solution: In the sliding filament mechanism, ATP first binds to the myosin head, causing its detachment from the actin filament. This is followed by hydrolysis of ATP into ADP and inorganic phosphate. The energy released during this hydrolysis changes the conformation of the myosin head into a high-energy “cocked” position. This energized state allows the myosin head to bind to the exposed active sites on actin, forming a cross-bridge. Thus, ATP hydrolysis does not directly cause the power stroke but prepares the myosin head for attachment. The power stroke occurs later when ADP and phosphate are released. Activation of the troponin-tropomyosin complex is regulated by calcium ions, not ATP hydrolysis. Therefore, the most direct outcome of ATP hydrolysis is enabling cross-bridge formation.

Final Answer: Binding of Myosin to the active site on Actin (Cross-bridge formation)

Answer: (A)

Q42.

Solution

Concept: The hypothalamus is a crucial regulatory center in the brain responsible for maintaining homeostasis. It controls body temperature, hunger, thirst, circadian rhythms, and endocrine functions through its connection with the pituitary gland. It integrates neural and hormonal signals to maintain internal balance.

Solution: The hypothalamus plays a vital role in regulating essential body functions such as temperature, hunger, and thirst. It contains specialized centers like the thermoregulatory center, hunger center, and thirst center. These centers monitor internal conditions and initiate corrective responses, such as sweating, shivering, or increasing food and water intake. The cerebellum is involved in coordination and balance, while the medulla oblongata controls involuntary actions like respiration and heart rate. The corpus callosum connects the two hemispheres of the brain and has no direct role in regulating homeostasis. Thus, the hypothalamus is responsible for maintaining internal equilibrium and regulating key physiological drives.

Final Answer: Hypothalamus

Answer: (C)



Q43.

Solution

Concept: The cardiac conduction system ensures rhythmic contraction of the heart. The sinoatrial node acts as the pacemaker, initiating electrical impulses that spread through specialized conduction pathways to coordinate atrial and ventricular contractions efficiently.

Solution: The depolarization wave in the human heart originates from the sinoatrial (SA) node, located in the right atrium. This impulse spreads across the atria, causing atrial contraction. It then reaches the atrioventricular (AV) node, where a brief delay allows the ventricles to fill completely. From the AV node, the impulse travels through the Bundle of His, which divides into right and left bundle branches. These branches further conduct the impulse to the Purkinje fibers, which distribute it throughout the ventricular myocardium, causing synchronized ventricular contraction. Incorrect options either misplace the conduction order or disrupt the physiological sequence.

Final Answer: SA Node → AV Node → Bundle of His → Purkinje fibers

Answer: (B)

Q44.

Solution

Concept: Emphysema is a chronic respiratory disease involving destruction of alveolar walls. This leads to reduced surface area for gas exchange and decreased lung elasticity. It is most commonly associated with prolonged exposure to cigarette smoke, which damages lung tissues over time.

Solution: Emphysema primarily results from chronic cigarette smoking. The harmful chemicals in smoke damage alveolar walls, causing them to rupture and merge into larger air spaces. This reduces the total surface area available for gas exchange. As a result, oxygen diffusion into the bloodstream is impaired, leading to breathlessness and reduced oxygen supply to tissues. The loss of elasticity also affects normal exhalation. Coal dust exposure leads to pneumoconiosis, not emphysema. Bacterial infections cause inflammatory conditions like bronchitis or pneumonia. Vitamin deficiency does not directly cause alveolar destruction. Thus, cigarette smoking leading to decreased respiratory surface area is the correct explanation.

Final Answer: Cigarette smoking; Decreased respiratory surface area

Answer: (B)



Q45.

Solution

Concept: In angiosperms, different tissues of the seed and ovule have different ploidy levels depending on fertilization events.

Given:

- Haploid number (n) = 12

Key Concepts:

- Nucellus is a maternal tissue \rightarrow diploid ($2n$)
- Endosperm is formed after double fertilization \rightarrow triploid ($3n$)

Chromosome number calculation:

1. Nucellus:

- Diploid condition: $2n$
- $2n = 2 \times 12 = 24$

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2. Endosperm:

- Triploid condition: $3n$
- $3n = 3 \times 12 = 36$

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Nucellus ($2n$)	—————	Endosperm ($3n$)
24 chromosomes		36 chromosomes

Final Answer:

Answer: (B)



Q46.

Solution

Concept: Xenogamy refers to cross-pollination between flowers of different plants. Certain mechanisms prevent self-pollination and promote genetic diversity. Dioecy ensures separation of male and female reproductive organs in different plants.

Solution: Dioecy ensures true cross-pollination because male and female flowers are present on separate plants. This prevents self-pollination entirely and requires pollen transfer between different individuals. Cleistogamy promotes self-pollination, as flowers remain closed. Geitonogamy occurs between flowers of the same plant and is genetically similar to selfing. Homogamy allows simultaneous maturation of reproductive organs, often promoting self-pollination. Thus, dioecy guarantees xenogamy.

Final Answer: Dioecy (Unisexual plants)

Answer: (B)

Q47.

Solution

Concept: The female gametophyte develops from a functional megaspore through mitotic divisions. This process results in an eight-nucleate embryo sac with specialized cells for fertilization and development.

Solution: The functional megaspore undergoes three sequential mitotic divisions. The first division produces two nuclei, the second results in four nuclei, and the third yields eight nuclei. These nuclei are then organized into a structured embryo sac. The mature embryo sac consists of one egg cell, two synergids, three antipodal cells, and a central cell with two polar nuclei. Thus, three mitotic divisions are required.

Final Answer: Three

Answer: (B)

Q48.

Solution

Concept: The embryo sac contains specialized cells, including synergids, which play a role in guiding the pollen tube. The filiform apparatus is a unique structure aiding this process.

Solution: The filiform apparatus is present in synergid cells and consists of finger-like projections that guide the pollen tube into the embryo sac. It enhances absorption and directs the male gametes to the egg cell. Other cells like the egg, central cell, and antipodals have different roles and lack this structure. Thus, the filiform apparatus belongs to synergids and guides the pollen tube.

Final Answer: Synergid; To guide the entry of the pollen tube

Answer: (C)



Q49.

Solution

Concept: The menstrual cycle is regulated by hormones such as FSH and LH. A sudden increase in luteinizing hormone (LH), called the LH surge, plays a crucial role in ovulation by triggering the release of the secondary oocyte from the mature Graafian follicle.

Solution: During the mid-cycle phase of the menstrual cycle, a sharp rise in LH levels occurs, known as the LH surge. This hormonal spike induces several physiological changes in the ovary. Most importantly, it causes the rupture of the mature Graafian follicle. As a result of this rupture, the secondary oocyte is released from the ovary into the fallopian tube, a process known as ovulation. The LH surge also initiates luteinization of the follicle, leading to the formation of the corpus luteum, which secretes progesterone. Meiosis-II in the oocyte is not completed at this stage; it is completed only after fertilization. Growth of the primary follicle occurs earlier under the influence of FSH. Formation of endosperm is a plant process. Thus, LH surge triggers ovulation.

Final Answer: Rupture of the Graafian follicle and release of the secondary oocyte

Answer: (C)

Q50.

Solution

Concept: Sperm transport in the male reproductive system follows a specific anatomical pathway. It begins in the seminiferous tubules where spermatogenesis occurs and proceeds through a series of ducts for maturation, storage, and transport.

Solution: Sperms are produced in the seminiferous tubules of the testes. From there, they pass into the rete testis, a network of tubules that collects sperm. The sperm then move into the vasa efferentia, which transport them to the epididymis. In the epididymis, sperms mature and gain motility. After maturation, they are stored temporarily and then transported through the vas deferens during ejaculation. The vas deferens carries sperm to the ejaculatory duct, eventually leading to the urethra. Other sequences listed are incorrect because they either skip steps or present them in the wrong order. Thus, the correct pathway is seminiferous tubules → rete testis → vasa efferentia → epididymis → vas deferens.

Final Answer: Sperm path: tubules → rete testis → efferentia → epididymis → vas deferens

Answer: (A)



Q51.

Solution

Concept: The blastocyst consists of an inner cell mass and an outer trophoblast layer. The trophoblast is essential for implantation and formation of extraembryonic structures. It interacts with the maternal endometrium and plays a key role in establishing nutrient exchange between mother and developing embryo.

Solution: The trophoblast is the outer cell layer of the blastocyst and plays a crucial role during early embryonic development. Its primary function is to facilitate implantation by attaching the blastocyst to the endometrium of the uterus. After attachment, the trophoblast differentiates into specialized structures such as cytotrophoblast and syncytiotrophoblast, which invade the maternal tissue. This invasion helps establish the placenta, a vital organ for exchange of nutrients, gases, and wastes between the mother and embryo. The inner cell mass forms the embryo proper, while the trophoblast contributes to supporting structures rather than forming the embryo itself. Thus, the trophoblast is mainly responsible for implantation and placenta formation.

Final Answer: It attaches to the endometrium and helps form the placenta

Answer: (C)

Q52.

Solution

Concept: GIFT (Gamete Intra-Fallopian Transfer) is an assisted reproductive technique where gametes are transferred directly into the fallopian tube. It requires at least one functional fallopian tube and is used when fertilization can occur naturally but gamete availability is limited.

Solution: In GIFT, ova (from a donor if necessary) and sperms are placed directly into the fallopian tube, allowing fertilization to occur inside the body. This technique is suitable for women who cannot produce viable ova but have normal fallopian tubes and uterus capable of supporting fertilization and pregnancy. Women with blocked fallopian tubes are not candidates for GIFT, as the procedure requires a functional tube for fertilization. Cervical mucus issues are typically managed with intrauterine insemination (IUI). Low progesterone affects pregnancy maintenance, not fertilization. Thus, GIFT is recommended for women who cannot produce ova but can support fertilization internally.

Final Answer: Cannot produce an ovum but can provide a suitable environment for fertilization

Answer: (A)



Q53.

Solution

Concept: Intrauterine devices (IUDs) are contraceptive methods categorized as non-medicated, copper-releasing, and hormone-releasing. Non-medicated IUDs prevent implantation without releasing any chemical agents.

Solution: Among the given options, Lippes Loop is a non-medicated IUD. It acts as a foreign body in the uterus, inducing a local inflammatory response that prevents implantation. It does not release any copper or hormones. CuT and Multiload 375 are copper-releasing IUDs, which release copper ions that reduce sperm motility and fertilization capacity. LNG-20 is a hormone-releasing IUD that releases levonorgestrel. Thus, Lippes Loop is the correct example of a non-medicated IUD.

Final Answer: Lippes Loop

Answer: (B)

Q54.

Solution

Concept: Spermiogenesis is the final stage of spermatogenesis where spermatids transform into mature spermatozoa. This involves structural and functional changes, including development of the flagellum, acrosome formation, and condensation of the nucleus.

Solution: During spermiogenesis, round spermatids undergo morphological changes to become mature spermatozoa. This process includes formation of the acrosome from the Golgi apparatus, development of a flagellum for motility, condensation of nuclear material, and shedding of excess cytoplasm. Earlier stages include spermatogonia dividing to form primary spermatocytes and secondary spermatocytes undergoing meiosis-II. These steps occur before spermiogenesis. Thus, spermiogenesis specifically refers to transformation of spermatids into spermatozoa.

Final Answer: Spermatids are transformed into mature spermatozoa

Answer: (C)



Q55.

Solution

Concept: Gene linkage and recombination frequency are used to calculate map distance between two genes.

Given Cross:

- Parental: $AABB \times aabb$
- F_1 : $AaBb$
- Test cross progeny:
 - 44% $AaBb$ (parental type)
 - 44% $aabb$ (parental type)
 - 6% $Aabb$ (recombinant type)
 - 6% $aaBb$ (recombinant type)

Key Idea:

- Recombination frequency = sum of recombinant offspring

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Step 1: Identify recombinants

- $Aabb = 6\%$
- $aaBb = 6\%$

Step 2: Calculate recombination frequency

$$RF = 6\% + 6\% = 12\%$$

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Step 3: Map distance

- 1% recombination = 1 map unit (cM)

Map distance = 12 map units

Gene A \longleftrightarrow Gene B

12 cM

Final Answer: 12 map units

Answer: (B)



Q56.

Solution

Concept: The Lyon hypothesis explains X-chromosome inactivation in females to balance gene dosage between males and females. One X chromosome is randomly inactivated in each cell during early development, forming a Barr body.

Solution: According to the Lyon hypothesis, in females (XX), one of the two X chromosomes becomes inactive during early embryonic development. This inactivation is random and occurs independently in each cell, resulting in mosaic expression of X-linked genes. The inactive X condenses into a structure called the Barr body. This mechanism ensures dosage compensation so that females, like males, have only one functional copy of X-linked genes. Thus, random inactivation of one X chromosome is the correct explanation.

Final Answer: One X chromosome is inactivated (Barr body)

Answer: (B)



Q57.

Solution**Concept:** Hydrogen bonding in DNA depends on base pairing:

- Adenine (A) pairs with Thymine (T) → 2 hydrogen bonds
- Guanine (G) pairs with Cytosine (C) → 3 hydrogen bonds

Given:

- Total base pairs = 2000
- Adenine = 20%

Step 1: Total number of bases

$$\text{Total nucleotides} = 2000 \times 2 = 4000$$

Step 2: Number of A bases

$$A = 20\% \times 4000 = 800$$

Since A = T:

$$T = 800$$

Step 3: Remaining bases (G + C)

$$G + C = 4000 - (800 + 800) = 2400$$

Since G = C:

$$G = 1200, \quad C = 1200$$

A-T pairs → G-C pairs

800 pairs 1200 pairs

Step 4: Hydrogen bonds

- A-T bonds: $800 \times 2 = 1600$
- G-C bonds: $1200 \times 3 = 3600$

$$\text{Total H-bonds} = 1600 + 3600 = 5200$$

Final Answer: 5200**Answer: (B)**

Q58.

Solution

Concept: The wobble hypothesis explains flexibility in codon-anticodon pairing, particularly at the third position, allowing one tRNA to recognize multiple codons.

Solution: According to the wobble hypothesis, the first two bases of the codon pair strictly with the anticodon, but the third base allows non-standard pairing. This flexibility enables a single tRNA molecule to recognize more than one codon. This reduces the number of tRNA molecules required for protein synthesis. Thus, wobble occurs at the third base and allows multiple codon recognition.

Final Answer: One tRNA can read multiple codons (wobble)

Answer: (B)

Q59.

Solution

Concept: The lac operon is regulated by the repressor protein encoded by the *i* gene. Normally, the inducer (lactose/allolactose) binds to the repressor and inactivates it, allowing transcription of structural genes. If the repressor cannot bind the inducer, it remains active and continuously blocks transcription.

Solution: In the lac operon system of prokaryotes, the *i* gene codes for a repressor protein that binds to the operator region and prevents transcription of structural genes (*z*, *y*, and *a*). Under normal conditions, the presence of lactose leads to formation of allolactose, which acts as an inducer by binding to the repressor protein. This binding inactivates the repressor and allows RNA polymerase to transcribe structural genes.

If a mutation occurs in the *i* gene such that the repressor protein cannot bind to the inducer, the repressor remains in its active form permanently. As a result, it continuously binds to the operator region and blocks transcription regardless of the presence or absence of lactose. Therefore, the operon remains permanently switched off, and no enzymes for lactose metabolism are produced. Thus, the correct outcome is continuous repression of the operon.

Final Answer: The operon will always be in the "off" state, even in the presence of lactose

Answer: (B)



Q60.

Solution

Concept: Hardy-Weinberg principle describes genetic equilibrium in a population.

Formula:

- $p + q = 1$
- $p^2 + 2pq + q^2 = 1$

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Given:

- Frequency of recessive allele: $q = 0.4$
- Therefore, $p = 1 - q = 1 - 0.4 = 0.6$

Heterozygous frequency:

- $2pq = 2 \times 0.6 \times 0.4$

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Calculation:

$$2pq = 2 \times 0.6 \times 0.4 = 0.48$$

$$\text{Allele } q = 0.4 \text{ — Allele } p = 0.6$$

$$\text{Heterozygous} = 2pq = 0.48$$

Final Answer:

Answer: (C)

Q61.

Solution

Concept: Analogous structures arise from convergent evolution, where unrelated organisms evolve similar traits due to similar environmental pressures. These structures perform similar functions but differ in origin and internal structure.

Solution: Analogous structures are those that perform similar functions but have different evolutionary origins. In this case, flippers of penguins and dolphins serve the same function of swimming but evolved independently in birds and mammals, respectively. Forelimbs of whales and wings of bats are homologous structures as they share a common origin but differ in function. Thorns of Bougainvillea and tendrils of Cucurbita are also homologous as they originate from similar plant structures but perform different functions. Hearts of vertebrates are homologous structures. Thus, flippers of penguins and dolphins represent analogy due to convergent evolution.

Final Answer:

Answer: (B)



Q62.

Solution

Concept: The RNA World hypothesis suggests that RNA was the first genetic material, capable of both storing information and catalyzing chemical reactions. This theory is supported by the discovery of ribozymes, RNA molecules that possess enzymatic activity.

Solution: The RNA World hypothesis proposes that early life forms relied on RNA for both genetic information storage and catalytic functions before DNA and proteins evolved. This idea gained strong support with the discovery of ribozymes—RNA molecules that can catalyze biochemical reactions. Ribozymes demonstrate that RNA is not merely a passive carrier of genetic information but can also function as an enzyme. This dual capability makes RNA a strong candidate for the earliest biomolecule in the origin of life. DNA's stability does not support this hypothesis directly. RNA is generally single-stranded, and mRNA translation occurs in the cytoplasm, not the nucleus. Thus, the discovery of ribozymes provides key evidence for the RNA World hypothesis.

Final Answer: Ribozymes, which are RNA molecules with catalytic activity

Answer: (B)

Q63.

Solution

Concept: Sickle-cell anemia is a genetic disorder caused by a point mutation in the β -globin gene of hemoglobin. A single nucleotide substitution leads to an amino acid change, altering hemoglobin structure and function.

Solution: In sickle-cell anemia, a point mutation occurs in the gene coding for the β -globin chain of hemoglobin. Specifically, the sixth amino acid in the β -globin chain is changed from glutamic acid to valine due to substitution of a single nucleotide. This seemingly small change has significant effects, as valine is hydrophobic while glutamic acid is hydrophilic. This causes abnormal aggregation of hemoglobin molecules under low oxygen conditions, leading to the characteristic sickle shape of red blood cells. This deformation impairs oxygen transport and can block blood vessels, causing pain and organ damage. Thus, the mutation involves replacement of glutamic acid by valine at the sixth position of the β -globin chain.

Final Answer: Glutamic acid is replaced by Valine at the 6th position of the β -globin chain

Answer: (C)



Q64.

Solution

Concept: DNA fingerprinting relies on detecting highly variable regions of DNA such as VNTRs (Variable Number Tandem Repeats). Probes are short, labeled DNA sequences used to identify complementary DNA fragments through hybridization.

Solution: In DNA fingerprinting, DNA fragments are first separated using gel electrophoresis and then transferred onto a membrane through Southern blotting. To identify specific DNA sequences, probes are used. These probes are single-stranded DNA fragments that are complementary to VNTR regions and are usually radiolabelled or tagged for detection. When these probes are applied, they hybridize with complementary VNTR sequences on the membrane. The radiolabel allows visualization through autoradiography, producing a unique banding pattern for each individual. Double-stranded DNA cannot act effectively as a probe without denaturation. RNA probes are not typically used in this context, and restriction enzymes are used for cutting DNA, not detection. Thus, radiolabelled VNTR probes are used for hybridization.

Final Answer: Radiolabelled VNTR (Variable Number Tandem Repeats) sequence

Answer: (B)

Q65.

Solution

Concept: Hugo de Vries proposed the theory of mutation or saltation, suggesting that evolution can occur through sudden, large-scale changes rather than gradual accumulation of small variations.

Solution: According to the theory of saltation, new species arise through sudden, large mutations known as "sports." Hugo de Vries observed such mutations in the plant *Oenothera* and proposed that evolution does not always occur gradually, as suggested by Darwin, but can happen in leaps. These large mutations can produce significant phenotypic changes in a single generation, leading to speciation. This contrasts with Darwin's theory of gradualism, which emphasizes small variations over long periods. Acquired characters are associated with Lamarckism, not saltation. Thus, the correct explanation is that evolution can occur through single-step large mutations.

Final Answer: Single-step large mutations cause speciation

Answer: (B)



Q66.

Solution**Concept:** Color blindness is an **X-linked recessive disorder**.

- Gene is located on X chromosome
- Males (XY) express the trait if they inherit one affected X
- Females (XX) require two affected alleles to express the trait

Given:

- Color-blind man: X^cY
- Homozygous normal woman: $X^C X^C$

Gametes:

- Male produces: X^c and Y
- Female produces: X^C only

Cross (Punnett Square):

	X^C	X^C
X^c	$X^C X^c$	$X^C X^c$
Y	$X^C Y$	$X^C Y$

Result:

- All daughters: $X^C X^c$ (carriers, not color-blind)
- All sons: $X^C Y$ (normal vision)

Conclusion:

- No son receives the affected X chromosome
- Therefore, probability of color-blind son = 0%

Final Answer: **Answer: (A)**

Q67.

Solution

Concept: The *Meselson and Stahl experiment* demonstrated the semi-conservative mode of DNA replication using isotopic labeling.

Experimental Design:

- Bacteria (*E. coli*) were first grown in medium containing heavy nitrogen isotope (^{15}N)
- DNA became labeled with ^{15}N (heavy DNA)
- Cells were then transferred to medium containing light nitrogen isotope (^{14}N)
- DNA samples were extracted after each generation

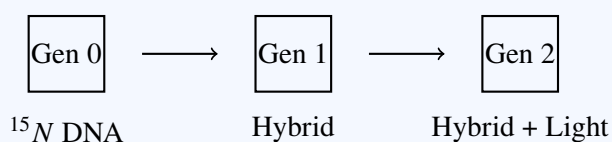
Observations:

- After one generation: DNA showed intermediate density (hybrid $^{15}N-^{14}N$)
- After two generations: mixture of hybrid and light DNA
- This ruled out conservative and dispersive models

Conclusion:

- Each daughter DNA molecule contains one parental strand and one newly synthesized strand
- This confirms

semi-conservative replication



Key Insight:

- Nitrogen isotopes (^{15}N and ^{14}N) were used because nitrogen is a key component of DNA bases

Final Answer: ^{15}N and ^{14}N

Answer: (C)



Q68.

Solution

Concept: The genetic code is a set of rules defining how nucleotide sequences are translated into amino acids. It has key properties such as being universal, degenerate, non-overlapping, and unambiguous.

Solution: The genetic code is universal across most organisms, meaning the same codon codes for the same amino acid in different species. It is degenerate, as multiple codons can code for the same amino acid. It is also comma-less and non-overlapping, meaning codons are read continuously without gaps. However, the genetic code is unambiguous, meaning each codon specifies only one amino acid. It is not ambiguous; a codon does not code for multiple amino acids. Thus, the statement that the genetic code is ambiguous is incorrect.

Final Answer: Ambiguous (one codon codes for multiple amino acids)

Answer: (B)

Q69.

Solution

Concept: The Miller-Urey experiment simulated primitive Earth conditions to study the origin of life. It demonstrated that organic molecules could be synthesized from inorganic compounds under specific conditions.

Solution: In the Miller-Urey experiment, a mixture of gases like methane, ammonia, hydrogen, and water vapor was subjected to electric sparks to simulate lightning. After several days, the mixture was analyzed and found to contain organic molecules such as amino acids. These included simple amino acids like glycine and alanine, which are building blocks of proteins. This experiment provided strong evidence that organic compounds necessary for life could form under prebiotic conditions. The experiment did not produce complex molecules like proteins, DNA, or polysaccharides. Thus, amino acids were formed in the experiment.

Final Answer: Amino acids like Glycine and Alanine

Answer: (B)



Q70.

Solution

Concept: HIV (Human Immunodeficiency Virus) targets helper T-lymphocytes, weakening the immune system and leading to AIDS. ELISA is a commonly used diagnostic test to detect HIV infection.

Solution: HIV infects and destroys CD4+ helper T-lymphocytes, leading to a weakened immune system. A severe decrease in these cells is a hallmark of AIDS. The virus spreads through bodily fluids and progressively impairs immune function. The ELISA (Enzyme-Linked Immunosorbent Assay) test is commonly used for initial screening of HIV infection. It detects antibodies against HIV in the blood. Positive results are often confirmed by additional tests like Western blot. Other options correspond to different diseases: Salmonella typhi causes typhoid (Widal test), Plasmodium causes malaria (blood smear), and rhinovirus causes common cold. Thus, HIV infection diagnosed by ELISA is correct.

Final Answer: HIV; ELISA

Answer: (B)

Q71.

Solution

Concept: Sewage treatment involves primary and secondary stages. In secondary treatment, microorganisms form flocs that degrade organic matter. These microbial aggregates settle down and form what is known as activated sludge, which plays a crucial role in further treatment processes.

Solution: During secondary treatment of sewage, aerobic microorganisms such as bacteria and fungi grow rapidly and form clusters known as flocs. These flocs consume organic matter present in the sewage, reducing biochemical oxygen demand (BOD). After sufficient microbial activity, the mixture is transferred to a settling tank where these flocs settle at the bottom. This settled biomass is called activated sludge. A portion of this sludge is recycled back into the aeration tank to maintain microbial population, while the remaining is sent to anaerobic digesters. The sediment in the primary tank is different and is not called activated sludge. Scum refers to floating material, and effluent is treated water. Thus, activated sludge consists of microbial flocs formed during secondary treatment.

Final Answer: Settled microbial biomass (flocs)

Answer: (B)



Q72.

Solution

Concept: Biofortification is the process of increasing the nutritional value of crops through conventional breeding or biotechnology. It focuses on enhancing essential nutrients like proteins, vitamins, and minerals in food crops.

Solution: Biofortification aims to improve the nutritional quality of crops to combat deficiencies in human populations. One example is the development of maize hybrids enriched with essential amino acids such as lysine and tryptophan. These amino acids are often deficient in staple crops. Using *Bacillus thuringiensis* for pest control is an example of genetic pest resistance, not biofortification. Production of single-cell protein is related to alternative food sources. Mycorrhiza improves nutrient absorption but does not directly increase nutrient content in edible parts. Thus, developing nutrient-rich crop varieties is a clear example of biofortification.

Final Answer: High-lysine, high-tryptophan maize hybrids

Answer: (B)

Q73.

Solution

Concept: Cyclosporin A is an immunosuppressive drug used in organ transplantation to prevent rejection. It is produced by certain fungi and has the ability to suppress T-cell activity.

Solution: Cyclosporin A is produced by the fungus *Trichoderma polysporum*. It is widely used in organ transplant patients to suppress immune responses and prevent rejection of transplanted organs. *Monascus purpureus* produces statins used for lowering cholesterol. *Aspergillus niger* is used for citric acid production. *Acetobacter aceti* is involved in vinegar production. Thus, the correct organism producing cyclosporin A is *Trichoderma polysporum*.

Final Answer: *Trichoderma polysporum*

Answer: (B)

Q74.

Solution

Concept: Primary lymphoid organs are sites where lymphocytes mature and become antigen-sensitive. In humans, these include bone marrow and thymus. Secondary lymphoid organs are sites where immune responses are initiated.

Solution: The thymus is a primary lymphoid organ where immature T-lymphocytes differentiate and mature into antigen-sensitive T cells. This process involves selection mechanisms that ensure self-tolerance and proper immune function. The spleen, lymph nodes, and Peyer's patches are secondary lymphoid organs where mature lymphocytes encounter antigens and initiate immune responses. Thus, thymus is responsible for maturation of lymphocytes.

Final Answer: Thymus

Answer: (C)



Q75.

Solution

Concept: Heroin is an opioid drug derived from morphine, which is extracted from the latex of the opium poppy plant. It is chemically known as diacetylmorphine and acts as a depressant on the central nervous system.

Solution: Heroin, also called smack, is obtained from morphine, which is extracted from the latex of *Papaver somniferum* (opium poppy). The latex contains alkaloids such as morphine and codeine. Morphine is chemically modified to produce heroin. *Cannabis sativa* produces cannabinoids like marijuana. *Atropa belladonna* contains atropine, and *Erythroxylum coca* produces cocaine. Thus, heroin is derived from *Papaver somniferum*.

Final Answer:

Answer: (B)

Q76.

Solution

Concept: In recombinant DNA technology, insertion of a gene into the *lacZ* gene disrupts its function. This is known as insertional inactivation and is used in blue-white screening to identify recombinant colonies.

Solution: The *lacZ* gene codes for β -galactosidase, which breaks down X-gal to produce a blue color. When a foreign gene is inserted into the *lacZ* gene, it disrupts its function, preventing the enzyme from being produced. As a result, colonies with recombinant plasmids cannot metabolize X-gal and appear white. Non-recombinant colonies retain functional *lacZ* and appear blue. Thus, recombinant colonies are identified as white due to insertional inactivation.

Final Answer:

Answer: (B)



Q77.

Solution

Concept: The Ti-plasmid of *Agrobacterium tumefaciens* is widely used in plant genetic engineering. It contains T-DNA and virulence (*vir*) genes. While T-DNA is transferred into the plant genome, the *vir* genes play a crucial role in processing and mediating the transfer of T-DNA into host cells.

Solution: In *Agrobacterium tumefaciens*, the Ti-plasmid contains T-DNA, which is the segment that gets integrated into the plant genome. However, the actual process of transfer and integration is controlled by the *vir* (virulence) genes. These genes encode proteins responsible for excision of T-DNA from the plasmid, formation of a transfer complex, and movement of T-DNA into the plant cell. The *ori* region is involved in replication of plasmid DNA, not transfer. Opine catabolism genes help the bacterium utilize compounds produced in infected plants. Cytokinin biosynthetic genes are involved in tumor formation. Thus, *vir* genes are responsible for T-DNA transfer and integration.

Final Answer: *vir* (virulence) genes

Answer: (B)

Q78.

Solution

Concept: Gene therapy for ADA deficiency involves introducing functional ADA genes into lymphocytes. However, lymphocytes have a limited lifespan, which affects the longevity of therapeutic effects.

Solution: In ADA deficiency, gene therapy is performed by introducing a functional ADA gene into a patient's lymphocytes using a retroviral vector. These modified lymphocytes produce the ADA enzyme and temporarily restore immune function. However, lymphocytes are not immortal cells; they have a limited lifespan and eventually die. As a result, the therapeutic effect diminishes over time. To maintain adequate levels of ADA enzyme, patients require repeated infusions of genetically engineered lymphocytes. The gene is integrated into the host genome, and the vector is generally stable. The issue lies in the limited lifespan of the modified cells. Thus, periodic infusions are needed because lymphocytes are short-lived.

Final Answer: Lymphocytes are not immortal cells and eventually die

Answer: (B)



Q79.

Solution

Concept: Polymerase Chain Reaction (PCR) is a technique used to amplify DNA. It involves three main steps: denaturation, annealing, and extension, repeated cyclically to produce multiple copies of DNA.

Solution: PCR begins with denaturation, where double-stranded DNA is heated to separate into single strands. This is followed by annealing, where primers bind to complementary sequences on the single-stranded DNA at a lower temperature. The final step is extension, where DNA polymerase synthesizes new DNA strands by adding nucleotides complementary to the template strand. This cycle is repeated multiple times to exponentially amplify the DNA. Incorrect sequences disrupt the logical progression of the process. Thus, the correct order is denaturation → annealing → extension.

Final Answer: Denaturation → Annealing → Extension

Answer: (C)

Q80.

Solution

Concept: RNA interference (RNAi) is a gene-silencing mechanism where double-stranded RNA leads to degradation of complementary mRNA. It is used in genetic engineering to confer resistance against pathogens.

Solution: In developing *Meloidogyne incognita*-resistant tobacco plants, scientists introduced genes that produce both sense and antisense RNA corresponding to nematode genes. This is achieved using an *Agrobacterium* vector. When these RNAs are expressed, they form double-stranded RNA (dsRNA), which triggers RNA interference. The dsRNA is processed into small interfering RNAs (siRNAs) that bind to complementary mRNA of the nematode and degrade it, preventing expression of essential genes. Thus, the source of complementary RNA is an *Agrobacterium* vector carrying both sense and antisense DNA.

Final Answer: An *Agrobacterium* vector carrying both sense and anti-sense DNA

Answer: (B)



Q81.

Solution

Concept: A stirred-tank bioreactor is used for large-scale cultivation of microorganisms. Proper mixing and oxygen supply are essential for optimal growth and product formation.

Solution: The stirrer in a stirred-tank bioreactor ensures uniform mixing of the culture medium and maintains even distribution of nutrients and oxygen throughout the vessel. This is especially important for aerobic microorganisms, which require sufficient oxygen for metabolism. The stirrer also prevents settling of cells and maintains homogeneity in temperature and pH conditions. It does not directly regulate temperature or filtration processes. Thus, the primary function of the stirrer is to ensure proper mixing and oxygen availability.

Final Answer: To ensure even oxygen availability and mixing of contents throughout the reactor

Answer: (C)

Q82.

Solution

Concept: Bt toxin produced by *Bacillus thuringiensis* is initially in an inactive protoxin form. It becomes active in the alkaline environment of the insect gut, leading to cell damage and death of the insect.

Solution: The Bt toxin is ingested by insect larvae feeding on Bt-cotton plants. Inside the insect gut, the alkaline pH conditions activate the protoxin by converting it into its active form. The activated toxin binds to epithelial cells of the gut and creates pores, leading to cell lysis and death of the insect. In contrast, the human stomach is acidic, which does not activate the toxin, making it safe for human consumption. Thus, the alkaline pH of the insect midgut is responsible for activation of the Bt toxin.

Final Answer: Alkaline pH of the midgut

Answer: (C)



Q83.

Solution

Concept: Downstream processing involves recovery and purification of products after biosynthesis. It includes steps like separation, purification, and formulation, but does not involve genetic manipulation steps such as transformation of host cells.

Solution: Downstream processing begins after the desired product has been synthesized in a bioreactor. The first step is separation of biomass and recovery of the product from the culture medium. This is followed by purification using techniques such as chromatography to obtain a high-quality product. Finally, the product is formulated by adding preservatives or stabilizers, especially for pharmaceutical use. These steps ensure the product is safe, stable, and suitable for clinical or commercial use. Transformation of host cells is part of upstream processing, where recombinant DNA is introduced into cells before production begins. It is not involved in recovery or purification. Thus, transformation is not a step in downstream processing.

Final Answer: Transformation of host cells

Answer: (D)

Q84.

Solution

Concept: Gross Primary Productivity (GPP) is related to Net Primary Productivity (NPP) and respiration (R) by:

Given:

- NPP = 1000 kcal/m²/yr
- R = 400 kcal/m²/yr

Calculation:

$$GPP = 1000 + 400 = 1400 \text{ kcal/m}^2/\text{yr}$$

NPP	—————→	GPP
1000		1400

Final Answer: 1400 kcal/m²/yr

Answer: (B)



Q85.

Solution

Concept: The Rivet Popper Hypothesis by Paul Ehrlich compares species in an ecosystem to rivets in an airplane. Loss of species weakens ecosystem stability, and loss of key species can cause sudden collapse.

Solution: According to the Rivet Popper Hypothesis, each species in an ecosystem plays a role similar to a rivet in an airplane. Removing a few rivets may not immediately affect the plane, but continuous removal weakens its structure. If rivets are removed from critical parts like the wings, the entire system may collapse suddenly. Similarly, the extinction of a key species, which has a disproportionately large impact on ecosystem functioning, can lead to instability or collapse. Thus, removal of a key species is analogous to removing a rivet from the wings of an airplane.

Final Answer: Removing a rivet from the wings of an airplane

Answer: (B)

Q86.

Solution

Concept: Age pyramids represent the distribution of individuals in different age groups. A larger pre-reproductive population indicates a higher number of individuals entering reproductive age, leading to population growth.

Solution: In an age pyramid, populations are divided into pre-reproductive, reproductive, and post-reproductive groups. If the pre-reproductive group is much larger than the reproductive group, it indicates that many individuals will soon enter the reproductive phase. This leads to an increase in birth rate and overall population size in the future. Such a population is termed expanding, as it shows a broad base in the pyramid. Stable populations have similar proportions in pre-reproductive and reproductive groups, while declining populations have fewer young individuals. Thus, a larger pre-reproductive population indicates an expanding population.

Final Answer: Expanding

Answer: (C)



Q87.

Solution

Concept: Conservation strategies are classified as in-situ and ex-situ. In-situ conservation protects species in their natural habitats, while ex-situ conservation involves preserving species outside their natural environment.

Solution: Ex-situ conservation includes methods such as zoos, botanical gardens, and cryopreservation, where organisms or their genetic material are conserved outside their natural habitats. Cryopreservation involves storing gametes, embryos, or seeds at very low temperatures to preserve them for future use. National parks, wildlife sanctuaries, and biosphere reserves are examples of in-situ conservation, as they protect organisms within their natural ecosystems. Thus, cryopreservation of gametes is an example of ex-situ conservation.

Final Answer: Cryopreservation of gametes

Answer: (D)

Q88.

Solution

Concept: Biomagnification refers to the progressive increase in concentration of non-biodegradable pollutants at successive trophic levels in a food chain. These substances accumulate because they are not easily metabolized or excreted.

Solution: Non-biodegradable pollutants like DDT enter ecosystems through water or soil and are absorbed by producers. When herbivores consume these producers, the pollutants accumulate in their tissues. As carnivores feed on herbivores, the concentration further increases. At each trophic level, the concentration of these substances becomes higher, reaching maximum levels in top predators. This process is called biomagnification. Eutrophication involves nutrient enrichment, algal blooms refer to excessive growth of algae, and bioremediation uses organisms to remove pollutants. Thus, the accumulation of pollutants across trophic levels is called biomagnification.

Final Answer: Biomagnification

Answer: (B)



Q89.

Solution

Concept: The species-area relationship describes how species richness increases with area. It is expressed as $S = CA^Z$ or in logarithmic form $\log S = \log C + Z \log A$. The value of Z varies with scale, being smaller for small areas and larger for extensive regions like continents.

Solution: The species-area relationship shows that as the area increases, the number of species also increases. When plotted on a log-log scale, it forms a straight line with slope Z . For smaller areas such as local habitats, Z typically ranges from 0.1 to 0.2, indicating a gradual increase in species number. However, when very large areas such as continents are considered, species diversity increases more steeply due to greater habitat heterogeneity, evolutionary history, and geographic isolation. In such cases, the value of Z is much higher, generally ranging between 0.6 and 1.2. Thus, for very large areas, the regression coefficient Z falls within the range of 0.6 to 1.2.

Final Answer: 0.6 to 1.2

Answer: (B)

Q90.

Solution

Concept: The Montreal Protocol is an international environmental agreement aimed at protecting the ozone layer by controlling substances that deplete it, such as chlorofluorocarbons (CFCs).

Solution: The Montreal Protocol was signed in 1987 as a global effort to address the depletion of the ozone layer caused by certain man-made chemicals. These substances, known as ozone-depleting substances (ODS), include chlorofluorocarbons (CFCs), halons, and other related compounds. These chemicals release chlorine and bromine atoms in the stratosphere, which break down ozone molecules. The depletion of ozone increases harmful ultraviolet (UV) radiation reaching the Earth's surface, leading to health issues and ecological damage. The protocol mandated the gradual reduction and eventual elimination of ODS production and use. It has been one of the most successful international environmental agreements. Thus, the Montreal Protocol specifically targets ozone-depleting substances.

Final Answer: Ozone-depleting substances (ODS)

Answer: (B)



Answer Key

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

