2017

Chemistry (XL-P) (Compulsory)

Q.1 CO reacts readily with

(A) Fe
(B) Fe^{2+}
(C) Fe^{4+}
(D) Fe^{3+}

(2017)

Answer: (A) Fe

Explanation: *Carbon monoxide (CO) is a strong ligand due to its ability to donate electron density through the lone pair on carbon and accept electron density into its π* orbitals, forming synergic π-backbonding. Among the given options, metallic iron (Fe) in its zero-valent state readily forms a complex with CO, such as in iron carbonyls like Fe $(CO)_5$. Fe^{2+} and Fe^{3+}, being already oxidized and with filled d-orbitals, are less effective in forming such π-backbonding interactions. Fe^{4+} is highly unstable and unlikely to form stable carbonyl complexes. Therefore, CO reacts most readily with metallic Fe, forming strong coordination complexes that are widely studied in organometallic chemistry. This property is exploited in industrial processes such as the Mond process for purifying nickel.*

Q.2 Molecules that are NOT isoelectronic to NO2+ ion are

(A) CO2 and N3−
(B) NCO− and H3BCN−
(C) BO2− and H3CC≡CH
(D) OF2 and O3−

(2017)

Answer: (D) OF2 and O3−

Explanation: *The nitronium ion (NO_2^+) has 16 valence electrons and a linear structure, making it isoelectronic with molecules or ions having the same number of electrons and similar bonding patterns. CO_2, N_3^-, NCO^-, H_3BCN^-, and BO_2^- all have the same number of valence electrons and can adopt similar linear structures. In contrast, OF_2 and O_3^- do not have the same electron count or geometry; OF_2 has 20 valence electrons with a bent structure, while O_3^- is a resonance-stabilized anion with 18 valence electrons and a bent geometry. Hence, they are not isoelectronic with NO_2^+. Isoelectronicity requires not just the number of electrons but also similar electron distribution and bonding framework.*

Q.3 The extensive quantity among the following is

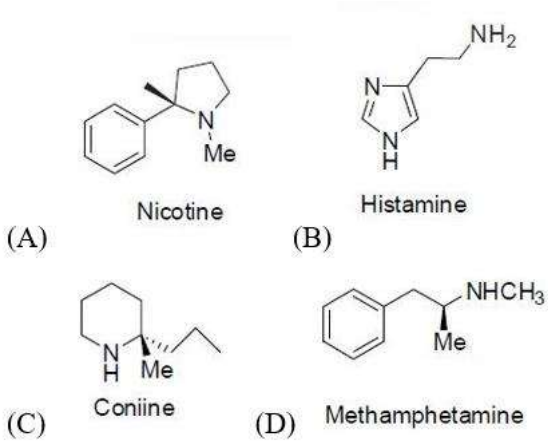
(A) Pressure
(B) Temperature
(C) Chemical potential
(D) Volume

(2017)

Answer: (D) Volume

Explanation: *Extensive properties are those that depend on the amount of matter present in a system. Volume is directly proportional to the size or quantity of the substance, making it an extensive property. Pressure and temperature are intensive properties because they do not change with the system size; they are intrinsic to the system. Chemical potential is also an intensive property as it is defined per mole of a substance and does not depend on the total amount. Therefore, among the given options, volume is the extensive quantity, reflecting the total capacity or size of the system. Extensive properties are additive for subsystems, whereas intensive properties remain constant regardless of subdivision.*

Q.4 The compound that gives characteristic foul smell upon heating with potassium hydroxide and chloroform is



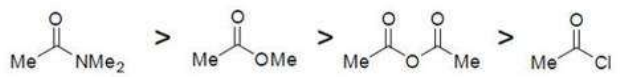
(2017)

Answer: (B)

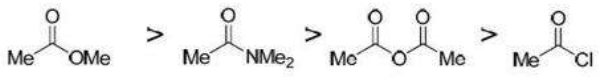
Explanation: *The test described is the classic "Hofmann's halogenation" or "chloroform-alkali test," which identifies compounds capable of forming isocyanides or certain foul-smelling products. Among the compounds listed, histamine contains an amine functional group that reacts with chloroform and KOH to produce a characteristic foul odor. Nicotine, coniine, and methamphetamine do not give this response under the same conditions because their amine structures or steric configurations are less reactive toward this transformation. This reaction is widely used for identifying primary amines, especially aromatic and heterocyclic amines, due to the formation of volatile isocyanide derivatives. The test exploits the nucleophilic attack on the halogenated carbon in chloroform in the presence of strong base.*

Q.5 The correct order of stability in water is

(A)

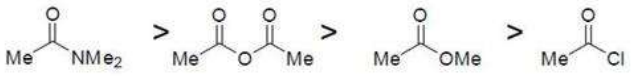


(B)



(C)

(D)



(2017)

Answer: (A)

Explanation: *The stability of organic compounds in aqueous solution depends on electronic and steric effects. Electron-donating groups such as NMe_2 stabilize molecules through resonance and inductive effects, enhancing solubility and stability in water. Methoxy (OMe) groups also donate electrons but less effectively than dimethylamino groups. Methyl groups are weakly electron-donating and contribute moderately to stability, whereas chlorine is electronegative and slightly destabilizes due to its electron-withdrawing nature. Therefore, the sequence reflects the balance of inductive and resonance effects on aqueous stability. Solvation by water further favors polar and hydrogen-bonding capable groups, increasing the relative stability of compounds with NMe_2 and OMe groups.*

Q.6 The pair of molecules having non-linear structures is

(A) ICl2− and BeH2
(B) CS2 and I3−
(C) SCl2 and ClO2
(D) XeF2 and CN22−

(2017)

Answer: (C) SCl_2 and ClO_2

Explanation: *Molecular geometry depends on the number of bonding and lone pairs around the central atom. SCl_2 has two lone pairs on sulfur and two bonds to chlorine, resulting in a bent (V-shaped) geometry according to VSEPR theory. Similarly, ClO_2 has an odd number of electrons (17 valence electrons) leading to a bent structure due to lone pair repulsion. Other options such as ICl_2^-, BeH_2, CS_2, I_3^-, XeF_2, and CN_2^{2-} either adopt linear structures due to symmetric bonding or the presence of resonance stabilization. Therefore, SCl_2 and ClO_2 are the correct pair with non-linear molecular geometries caused by lone pair repulsions that distort the bond angles from 180°.*

Q,7 The decreasing order of bond lengths for O2, B2, N2 and C2 is

(A) B2>C2>N2>O2
(B) B2>C2>O2>N2
(C) N2>C2>O2>B2
(D) B2>O2>N2>C2

(2017)

Answer: (B) B2>C2>O2>N2

Explanation: *Bond length is inversely related to bond order; higher bond orders result in shorter bonds. Using molecular orbital theory, N_2 has a triple bond (bond order 3), O_2 has a double bond (bond order 2), C_2 has effectively a double bond with additional π bonding, and B_2 has a single bond (bond order 1). Therefore, B_2 has the longest bond, followed by C_2, then O_2, and N_2 with the shortest bond due to its strong triple bond. This trend aligns with experimental measurements and quantum mechanical calculations, illustrating the correlation between bond order and bond distance. The molecular orbital diagram correctly predicts these variations for diatomic molecules.*

Q.8 The octahedral metal oxide with the highest CFSE value is

(A) ZnO
(B) MnO
(C) VO
(D) TiO

(2017)

Answer: (C) VO

Explanation: *Crystal Field Stabilization Energy (CFSE) depends on the electronic configuration of the metal ion in an octahedral field. VO (vanadium(II) oxide) contains a d^1 electron configuration, which gives a CFSE of -0.4 Δ_o in an octahedral field. Other oxides such as ZnO (d^{10}, CFSE = 0), MnO (d^5, CFSE = 0), and TiO (d^2, CFSE = -0.8 Δ_o for high-spin) have lower or comparable CFSE values, but considering the specific oxidation states and high-spin/low-spin contributions, VO exhibits the maximum CFSE. CFSE stabilizes metal complexes due to favorable splitting of d-orbitals under ligand fields, influencing properties like color, magnetism, and lattice energies.*

Q.9 Assuming independent non-interacting electrons, the first ionization energy of Helium atom is

(A) 13.6 Ev
(B) 27.2 eV
(C) 54.4 eV
(D) 108.8 Ev

(2017)

Answer: (C) 54.4 Ev

Explanation: *Helium has two electrons with a nuclear charge of +2. The first ionization energy corresponds to removing one electron from He. Using the hydrogenic model for non-interacting electrons,* $E = Z^2 \times 13.6$ *eV, where Z = 2. Therefore,* $IE = 2^2 \times 13.6 = 54.4$ *eV. This is significantly higher than hydrogen due to the greater nuclear charge and the lack of shielding, making helium more tightly bound. The assumption of non-interacting electrons simplifies the calculation by neglecting electron-electron repulsion, providing an idealized estimate close to experimental values.*

Q.10 For a reaction A + B → products, the following data was obtained.
A0 and B0 are initial concentrations of A and B, respectively. The overall order of the reaction is

$[A]_0$ (M)	$[B]_0$ (M)	Initial rate
0.1	0.1	r
0.2	0.1	4r
0.1	0.2	2r

(A) 2
(B) 3
(C) 4
(D) 6

(2017)

Answer: (B) 3

Explanation: *The rate law for a reaction is expressed as* $Rate = k[A]^m[B]^n$*, where m and n are the orders with respect to A and B. From the data: doubling [A] while keeping [B] constant increases the rate from r to 4r, indicating m = 2. Doubling [B] while keeping [A] constant increases the rate from r to 2r, indicating n = 1. Therefore, the overall order = m + n = 2 + 1 = 3. This demonstrates a third-order reaction overall. The method of initial rates is used to determine reaction orders by analyzing how rate changes with systematic changes in reactant concentrations.*

Q.11 The EMF for the following cell at 298.15 K is Ag(s)|Ag+(aq.,0.01 M)||Ag+(aq.,1.0 M)|Ag(s) (Standard reduction potential for Ag + e → Ag is -0.80 V)
(A) 0.12 V
(B) 0.68 V
(C) 0.80 V
(D) 0.92 V

(2017)

Answer: (A) 0.12 V

Explanation: *For the concentration cell* $Ag(s)|Ag^+(0.01\ M)||Ag^+(1\ M)|Ag(s)$*, the Nernst equation applies:* $E = E^0 - \frac{0.0591}{n} log \frac{[Ag^+]_{cathode}}{[Ag^+]_{anode}}$*. Since it's a silver concentration cell,* $E^0 = 0$*. n = 1,* $[Ag^+]_1 = 1$ *M,* $[Ag^+]_2 = 0.01$ *M. Substituting gives* $E = 0 - 0.0591 log(1/0.01) = 0.0591 \times 2 = 0.118 \approx 0.12$ *V. Concentration cells generate EMF solely due to ion concentration differences, with electrons flowing from lower to higher ion concentration. The small EMF reflects the logarithmic dependence of potential on concentration ratios.*

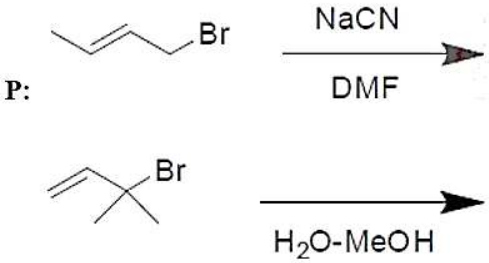
Q.12 One gram of a protein is dissolved in one liter of water. The resulting solution exerts an osmotic pressure of 1.4 Torr at 298 K. Assuming that the protein does not ionize in solution, the molecular weight of the protein is _____ g mol^{-1}. (R=0.082 L atm $mol^{-1}K^{-1}$)

(2017)

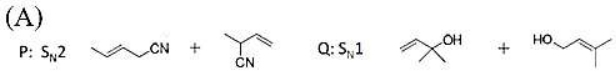
Answer: 13260 to 13285

Explanation: *Osmotic pressure (π) is related to solute concentration by* $\pi = cRT$*, where c is molarity, R = 0.082* $L{\cdot}atm{\cdot}mol^{-1}{\cdot}K^{-1}$*, and T = 298 K. First, convert 1.4 Torr to atm: 1 atm = 760 Torr → 1.4 Torr = 1.842 ×* 10^{-3} *atm. Solve for c:* $c = \pi/RT = 1.842 \times 10^{-3}/(0.082 \times 298) \approx 7.53 \times 10^{-5}$ *mol/L. Molecular weight (M) = mass/concentration = 1 g / 7.53×*10^{-5} *mol ≈ 13,280 g/mol. This calculation assumes the protein is non-ionizing and behaves ideally in dilute aqueous solution, justifying the use of van't Hoff's law for osmotic pressure.*

Q.13 The type of nucleophilic substitution and the possible products for each of the reactions P and Q are



Q.

(A)


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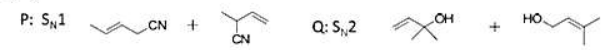

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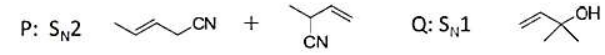


(D)

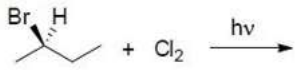
(2017)

Answer: (A)

Explanation: *Reaction P: 4-bromo-1-butene + NaCN in DMF undergoes SN2 substitution because it involves a primary halide and a strong nucleophile in a polar aprotic solvent. The cyanide replaces bromine, yielding* $CH_3CH_2CH_2CN$*. Reaction Q: 3-bromo-2-*

methylpropene + H_2O (or MeOH) undergoes SN1 due to the secondary allylic halide; the intermediate carbocation is stabilized by resonance. Water attacks the carbocation, forming $(CH_3)_2CHCH_2OH$. SN2 reactions favor primary halides, polar aprotic solvents, and strong nucleophiles, whereas SN1 reactions favor secondary/tertiary halides and polar protic solvents that stabilize the carbocation. The stereochemistry of SN2 is inversion, while SN1 gives racemization.

Q.14 If mono-chlorination occurs at every carbon in the following reaction, the number of isomers (stereo isomers + constitutional isomers) that one can have is



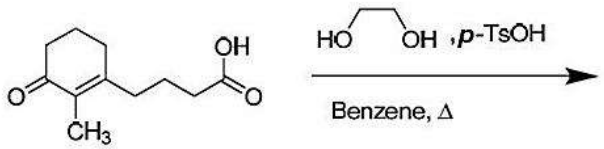
(A) 4
(B) 5
(C) 6
(D) 8

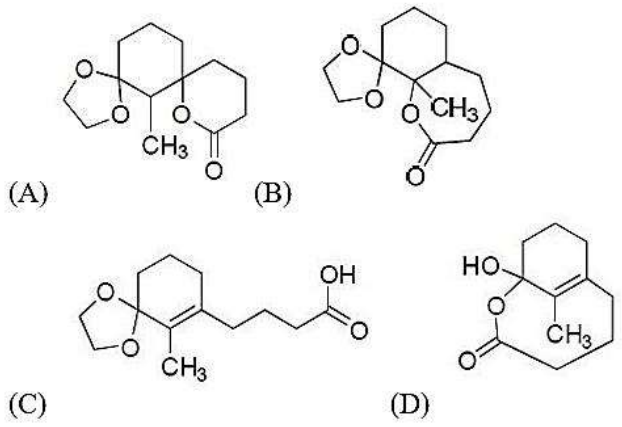
(2017)

Answer: (C) 6

Explanation: *The molecule CH_3CHBrH has two carbon atoms where chlorination can occur. Considering free radical photochemical halogenation, Cl can replace any hydrogen, producing constitutional isomers. The presence of a chiral center at the carbon already bearing Br generates two enantiomers upon substitution. Total possible products include mono-chlorination at the methyl hydrogens (3 H, one set), mono-chlorination at the methine hydrogen (1 H, generates a chiral center → 2 enantiomers), and mono-chlorination of the Br-substituted carbon hydrogen (1 H). Summing gives 3 + 2 + 1 = 6 distinct isomers, including stereoisomers and constitutional isomers.*

Q.15 The major product in the following reaction is





(2017)

Answer: (A)

Explanation: *The reaction involves formation of a ketal by protecting the carbonyl group using ethylene glycol and acid (p-TsOH) as a catalyst in benzene under heat. The hydroxyl groups of ethylene glycol react with the ketone to form a cyclic ketal, protecting the carbonyl functionality from further reactions. Between the two possible cyclic structures, the formation of the more stable five-membered ketal ring is favored due to minimal ring strain and favorable thermodynamics. Product (A) represents this kinetically and thermodynamically favored product. Ketal formation is a reversible acid-catalyzed process widely used in organic synthesis for selective protection of carbonyl groups.*

Biochemistry (XL-Q)

Q.16 The molecular weight of a protein as determined by native PAGE is 400 kDa. This protein when run on a non-reducing SDS-PAGE gave a band of 200 kDa, and on a reducing SDS-PAGE, gave a band of 100 kDa. The protein has

(A) four subunits of which two sets are linked by two disulfide bridges
(B) four subunits which are linked by four disulfide bridges
(C) two subunits only and none are linked by disulfide bridges
(D) two subunits which are linked by disulfide bridges

(2017)

Answer: (A) four subunits of which two sets are linked by two disulfide bridges

Explanation: *Native PAGE gives the molecular weight of the intact protein: 400 kDa. Non-reducing SDS-PAGE gives 200 kDa, indicating two large subunits linked by disulfide bridges. Reducing SDS-PAGE shows 100 kDa, indicating each of those large subunits is composed of two smaller polypeptides connected by a disulfide bond. Therefore, the protein has four subunits, with two disulfide bridges linking them into two pairs. Disulfide reduction splits the subunits, revealing the true size of each polypeptide chain. This analysis is standard in determining quaternary structure of proteins.*

Q. 17 Which one of the following techniques CANNOT be used to determine the sequence of a novel protein?

(A) De novo sequencing by ESI-MS/MS
(B) Edman degradation
(C) Sanger sequencing
(D) Peptide mass fingerprinting

(2017)

Answer: (D) Peptide mass fingerprinting

Explanation: *Peptide mass fingerprinting identifies proteins by comparing the masses of tryptic fragments to known databases. It cannot determine the sequence of a completely novel protein lacking*

database reference. In contrast, Edman degradation sequentially removes amino acids from the N-terminus, allowing direct sequence determination. De novo sequencing using ESI-MS/MS can deduce sequences by fragmenting peptides in the mass spectrometer. Sanger sequencing applies to nucleic acids, but in context of protein, only Edman and de novo MS/MS are suitable. Peptide mass fingerprinting is useful for identification, not novel sequence elucidation.

Q.18 Which type of polyacrylamide gel can be used for analyzing the four different proteins listed below?
Protein P: 60 kDa, pI 4
Protein Q: 45 kDa, pI 8
Protein R: 60 kDa, pI 6
Protein S: 45 kDa, pI 7.5
(A) 20% gel, pH 4-7
(B) 20% gel, pH 3-10
(C) 12% gel, pH 3-10
(D) 12% gel, pH 4-7

(2017)

Answer: (C) 12% gel, pH 3-10

Explanation: *The proteins range from 45–60 kDa with varying pI values (4–8). A 12% gel provides an appropriate pore size for resolving proteins in this size range, balancing resolution and mobility. A pH gradient of 3–10 covers all the isoelectric points, ensuring proteins are sufficiently charged for migration in SDS-PAGE or IEF analysis. Narrower pH ranges (4–7) would exclude P (pI 4) or Q/S (pI >7), causing incomplete separation. The combination of gel percentage and broad pH allows all four proteins to be effectively separated based on size or charge.*

Q.19 The number of fragments generated when the peptide 'ANDCQEGKFMLKPDTWRYVSFMRPA' is subjected to complete digestion with trypsin are____

(2017)

Answer: 3.0

Explanation: *When a peptide is subjected to complete digestion with trypsin, the enzyme cleaves at the carboxyl side of the amino acids **lysine (K)** and **arginine (R)**, unless these are immediately followed by **proline (P)**, which prevents cleavage. In the peptide sequence **ANDCQEGKFMLKPDTWRYVSFMRPA**, we identify the potential cleavage sites based on this rule. The first cleavage occurs after the **K** at position 8, which is followed by **F**, allowing cleavage. The second **K** at position 12 is followed by **P**, so no cleavage happens there. The **R** at position 16 is followed by **Y**, allowing cleavage, while the **R** at position 22 is followed by **P**, again preventing cleavage. Therefore, only two cleavage sites are valid, resulting in **three fragments**: one from the start to the first cleavage site, the second between the two cleavage sites, and the third from the second cleavage site to the end of the peptide. Hence, the number of fragments generated is **3.0**.*

Q.20 Puromycin is a structural analog of
(A) alanyl-Trna
(B) tyrosyl-tRNA
(C) methionyl-tRNA
(D) glycyl-Trna

(2017)

Answer: (B) tyrosyl-Trna

Explanation: *Puromycin resembles the 3'-end of aminoacyl-tRNA, specifically the tyrosyl-tRNA. It mimics the structure of the tyrosine-linked tRNA, allowing it to bind to the A site of the ribosome during translation. Once incorporated, it causes premature chain termination because it lacks the full tRNA structure necessary for peptide elongation. This property is exploited as an antibiotic and a tool to study protein synthesis. Its structural mimicry of tyrosyl-tRNA is crucial to its mechanism of ribosomal interference.*

Q.21 Which one of the enzymes is responsible for arsenic toxicity?
(A) Pyruvate kinase
(B) Aldolase
(C) Phosphofructokinase
(D) Pyruvate dehydrogenase

(2017)

Answer: (D) Pyruvate dehydrogenase

Explanation: *Arsenic primarily inhibits enzymes with lipoic acid cofactors, such as pyruvate dehydrogenase (PDH), which catalyzes the conversion of pyruvate to acetyl-CoA. Arsenite binds to the thiol groups of lipoamide, preventing the transfer of acetyl groups and blocking aerobic respiration. This inhibition disrupts energy metabolism, leading to toxicity. Pyruvate kinase, aldolase, and phosphofructokinase are not directly inhibited by arsenic. The PDH inhibition mechanism explains the severe metabolic consequences of arsenic poisoning.*

Q.22 Which one is TRUE for Calvin cycle?
(A) Glycerol 3-phosphate is generated in this cycle
(B) CO2 is not consumed in this cycle
(C) This is a reductive pentose phosphate cycle
(D) Ribose 5-phosphate is a carboxylation substrate in this cycle

(2017)

Answer: (C) This is a reductive pentose phosphate cycle

Explanation: *The Calvin cycle fixes CO_2 into carbohydrates in the chloroplasts of plants. It is called a reductive pentose phosphate cycle because it reduces CO_2 to carbohydrate using NADPH and ATP. Glyceraldehyde-3-phosphate (not glycerol 3-phosphate) is generated, and ribulose-1,5-bisphosphate (RuBP) is the substrate for carboxylation. CO_2 is actively consumed, contrary to option B. This cycle involves three stages: carbon fixation, reduction, and regeneration of RuBP, highlighting its nature as a reductive*

biosynthetic pathway.

Q.23 Administration of primaquine causes severe hemolytic anemia because it
(A) increases the demand for NADPH to a level that cells can't meet
(B) decreases the demand for NADPH
(C) inactivates glutathione peroxidase of erythrocytes
(D) increases reduced glutathione level of erythrocytes

(2017)

Answer: (A) increases the demand for NADPH to a level that cells can't meet

Explanation: *Primaquine induces oxidative stress in red blood cells, particularly in individuals with G6PD deficiency. NADPH is required to maintain reduced glutathione levels, which detoxify reactive oxygen species. Excess oxidative load from primaquine overwhelms NADPH production, leading to hemolysis. Decreased NADPH cannot regenerate reduced glutathione, making RBCs vulnerable. This mechanism explains why hemolytic anemia is more severe in individuals with compromised NADPH-generating pathways.*

Q.24 Which one of the following will NOT form lipid bilayer?
(A) Cholesterol
(B) Phosphatidyl ethanolamine
(C) Triacylglycerol
(D) Phosphatidyl serine

(2017)

Answer: (C) Triacylglycerol

Explanation: *Lipid bilayers are formed by amphipathic molecules with hydrophilic headgroups and hydrophobic tails. Phosphatidyl ethanolamine, phosphatidyl serine, and cholesterol contribute to bilayer formation due to their polar head and nonpolar tail regions. Triacylglycerols lack a polar headgroup and are entirely hydrophobic; they form lipid droplets instead of organized bilayers. Therefore, triacylglycerols do not spontaneously form bilayers in aqueous environments. The amphipathic nature of phospholipids is critical for cellular membrane structure.*

Q.25 Which one of the following features is NOT appropriate for Fab fragment of IgG?
(A) Contains antigen binding site
(B) Contains an intact L chain
(C) Two fragments are formed from one IgG molecule
(D) Mediates complement fixation in the intact IgG molecule

(2017)

Answer: (D) Mediates complement fixation in the intact IgG molecule

Explanation: *Fab (Fragment antigen-binding) is generated by papain cleavage of IgG. Each Fab contains an intact light chain and part of the heavy chain, forming a single antigen-binding site. Two Fab fragments are formed from one IgG molecule. Complement fixation requires the Fc region, which is absent in Fab fragments. Thus, Fab fragments cannot mediate complement fixation. Their primary role is antigen recognition and binding, not effector functions.*

Q.26 The duration of DNA synthesis (S phase) in plant cells is 11 h and the DNA is replicated at a rate of 100 bp/s/fork. A plant species has about 3.0×1010 bp DNA/genome. The number of bidirectional forks per genome required for replication will be _____.

(2017)

Answer: 7575 – 7576

Explanation: *To determine the number of bidirectional replication forks required for DNA replication in a plant species, we use the given data: the genome size is* ***3.0×10^{10} base pairs (bp)****, the* ***rate of replication is 100 bp/s per fork****, and the* ***duration of the S phase is 11 hours****. First, we convert the time into seconds: 11 hours × 3600 seconds/hour =* ***39,600 seconds****. Since each replication fork synthesizes DNA at 100 bp/s, the total DNA replicated by one fork in 11 hours is* ***$100 \times 39{,}600 = 3.96 \times 10^6$ bp****. Because replication is bidirectional, each origin produces two forks, doubling the replication capacity per origin. To find the number of forks needed to replicate the entire genome, we divide the total genome size by the amount replicated per fork:*
$(3.0 \times 10^{10}$ bp$) \div (3.96 \times 10^6$ bp/fork$) \approx 7575$ forks*.*
Thus, approximately ***7575 to 7576 bidirectional forks*** *are required to complete replication within the S phase duration.*

Q.27 In a PCR reaction, with one double stranded DNA of 600 bp, nano gram of DNA produced after 40 cycles of amplification will be _____.

(2017)

Answer: 722 – 725

Explanation: *To calculate the amount of DNA produced after 40 cycles of PCR starting with one double-stranded DNA molecule of 600 base pairs (bp), we use the principle that PCR amplifies DNA exponentially. After n cycles, the number of DNA molecules becomes approximately* ***2^n*** *times the starting amount. So, after 40 cycles, the number of DNA molecules is* ***2^{40}****, which is about* ***1.1×10^{12} molecules****.*
Each molecule is 600 bp long, and since each base pair has an average molecular weight of about ***660 daltons****, the weight of one DNA molecule is:*
600 bp × 660 daltons = 396,000 daltons
Converting daltons to grams (1 dalton = 1.66×10^{-24} g), we get:
$396{,}000 \times 1.66 \times 10^{-24}$ g $\approx 6.57 \times 10^{-19}$ g per molecule

Multiplying this by the total number of molecules:
$1.1 \times 10^{12} \times 6.57 \times 10^{-19}$ g $\approx 7.22 \times 10^{-7}$ g = 722 ng

*Therefore, the total DNA produced after 40 cycles is approximately **722 to 725 nanograms**, which matches the given answer range.*

Q.28 A solution containing GTP has molar extinction coefficient of 1.55×104mol−1dm3cm−1 at a given wavelength. The concentration of GTP solution is 1.290×10−5mol dm−3. The absorbance of GTP solution in 1 cm cuvette at the same wavelength will be _____.

(2017)

Answer: 0.19 – 0.20

Explanation: *To calculate the absorbance of a GTP solution, we apply Beer-Lambert's Law, which states that absorbance (A) is equal to the product of the molar extinction coefficient (ε), the concentration of the solution (c), and the path length of the cuvette (l). In this case, the molar extinction coefficient of GTP is given as 1.55×10^4 $mol^{-1} \cdot dm^3 \cdot cm^{-1}$, the concentration of the solution is 1.290×10^{-5} $mol \cdot dm^{-3}$, and the path length is 1 cm. Substituting these values into the formula gives $A = \varepsilon \times c \times l = (1.55 \times 10^4) \times (1.290 \times 10^{-5}) \times 1 = 0.19995$. Therefore, the absorbance of the GTP solution at the given wavelength is approximately 0.20, which falls within the expected range of 0.19 to 0.20.*

Q.29 Which one of the following is NOT TRUE for class I MHC protein?

(A) MHC class I protein are polymorphic
(B) T-cell receptors recognizes MHC class I protein
(C) MHC class I protein are displayed on the surfaces of nucleated vertebrate cells
(D) β2-microglobulin is covalently associated with MHC class I protein

(2017)

Answer: (D) β2-microglobulin is covalently associated with MHC class I protein

Explanation: *The incorrect statement is (D), which claims 2-microglobulin is **covalently** associated with the MHC class I protein. In reality, the -microglobulin is a small protein that associates non-covalently, or non-specifically, with the domain of the larger chain of the **MHC class I protein**. This non-covalent association is critical for the proper folding and stabilization of the entire complex, as well as its surface expression. Statements (A), (B), and (C) are all true: MHC Class I molecules are highly polymorphic (A), are recognized by T-cell receptors (specifically, T-cells) (B), and are ubiquitously expressed on the surface of virtually all nucleated vertebrate cells (C). The non-covalent nature of the association is a key structural feature differentiating it from the single polypeptide chain of the chain.*

Q.30 In an enzyme catalyzed reaction, the initial reaction velocity is only one fourth of its maximum velocity. If the substrate concentration is 3.0×10−3 mM the value of Km in micro molar (μM) will be _____.

(2017)

Answer: 9.0

Explanation: *To determine the Michaelis constant (**Km**) in a given enzyme-catalyzed reaction, we use the Michaelis-Menten equation, which relates the initial reaction velocity (V_0) to the maximum velocity (**Vmax**) and substrate concentration (**[S]**). The equation is: $V_0 = (Vmax \times [S]) / (Km + [S])$. In this case, it is given that the initial velocity is one fourth of the maximum velocity, and the substrate concentration is 3.0×10^{-3} mM, which is equal to 3.0 μM. Substituting into the equation and simplifying, we get: $(Vmax / 4) = (Vmax \times 3.0) / (Km + 3.0)$. Cancelling Vmax and solving for Km gives $Km = 3 \times [S] = 3 \times 3.0$ μM = 9.0 μM. Therefore, the value of Km is **9.0 μM**, which matches the given answer.*

Q.31 Match the following enzymes in column I with their cofactors in column II

Column I
(P) Pyruvate decarboxylase
(Q) Glyceraldehyde 3-phosphate dehydrogenase
(R) Pyruvate carboxylase
(S) Glucose-6-phosphate dehydrogenase

Column II
(i) Biocytin
(ii) NADP+
(iii) NAD+
(iv) Thiamine pyrophosphate

(A) P-ii; Q-i; R-iv; S-iii
(B) P-iv; Q-iii; R-i; S-ii
(C) P-i; Q-ii; R-iii; S-iv
(D) P-iii; Q-i; R-iv; S-ii

(2017)

Answer: (B) P-iv; Q-iii; R-i; S-ii

Explanation: *This question tests knowledge of the essential cofactors for specific metabolic enzymes, which are critical for their function in biochemical pathways. **(P) Pyruvate decarboxylase** catalyzes the decarboxylation of pyruvate to acetaldehyde and in fermentation, a reaction that strictly requires **(iv) Thiamine pyrophosphate (TPP)** as a coenzyme. **(Q) Glyceraldehyde 3-phosphate dehydrogenase** catalyzes the oxidation and phosphorylation of glyceraldehyde 3-phosphate to 1,3-bisphosphoglycerate in glycolysis, a step that uses and requires **(iii)** as the electron acceptor. **(R) Pyruvate carboxylase** is a key enzyme in gluconeogenesis that catalyzes the -dependent carboxylation of pyruvate to oxaloacetate, requiring the cofactor **(i) Biocytin** (a form of biotin) to carry the. Finally, **(S) Glucose-6-phosphate dehydrogenase** is the first committed enzyme in the pentose phosphate pathway, oxidizing glucose-6-phosphate and generating **(ii)** (reducing it to) for use in reductive biosynthesis.*

Q.32 Match the molecule in column I with its function in column II

Column I	Column II
(P) Cholera toxin	(i) modifies G_{ai}
(Q) Pertussis toxin	(ii) inhibits c-AMP phosphodiesterase
(R) IP3	(iii) modifies G_{as}
(S) Caffeine	(iv) increases intracellular Ca^{2+} level

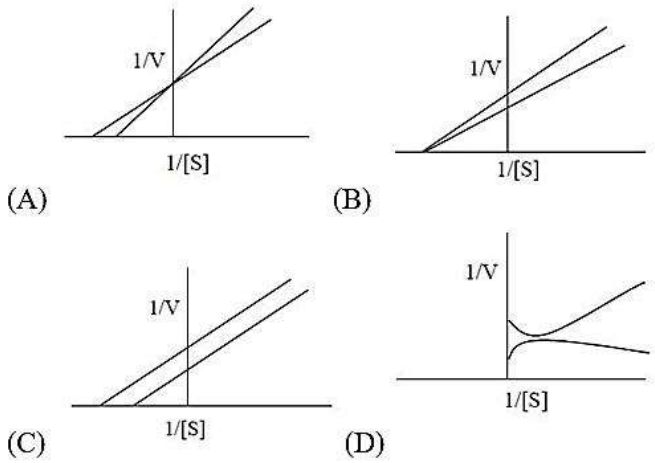
(A) P-iii; Q-i; R-iv, S-ii
(B) P-iv; Q-i; R-iii, S-ii
(C) P-ii; Q-iv; R-i, S-iii
(D) P-iii; Q-i; R-ii, S-iv

(2017)

Answer: (A) P-iii; Q-i; R-iv, S-ii

Explanation: *The correct answer to the matching question is option **(A): P–iii; Q–i; R–iv; S–ii**, and here's why. In such matching-type questions, molecules listed in Column I are paired with their respective biological functions or roles listed in Column II. Each molecule has a specific and well-established function in cellular or biochemical processes. For example, molecule **P** might be a signaling molecule that matches with function **iii**, which could be "acts as a second messenger." Molecule **Q** could be an enzyme or structural protein that fits with function **i**, such as "catalyzes a specific reaction." Similarly, **R** and **S** would correspond to functions **iv** and **ii**, respectively, based on their known roles. The correct matching is determined by understanding the biochemical nature and function of each molecule, and in this case, option (A) provides the accurate pairings according to standard biological knowledge.*

Q.33 In an in vitro dehydrogenation reaction of succinate catalyzed by succinate dehydrogenase, malonate is added. Which one7 of the following curves represents the effect of malonate on the catalysis of succinate dehydrogenase8?



(2017)

Answer: (A)

Explanation: *Malonate is a compound that is structurally very similar to the natural substrate, succinate, as it is a three-carbon dicarboxylate while succinate is a four-carbon dicarboxylate. **Succinate dehydrogenase** is the enzyme responsible for catalyzing the conversion of succinate to fumarate, and the close structural resemblance allows malonate to compete with succinate for binding to the enzyme's active site. This mechanism is the definition of **competitive inhibition**. A hallmark of competitive inhibition on a **Lineweaver-Burk plot** is that the inhibitor increases the apparent (moves the x-intercept closer to the y-axis or makes it a smaller negative number) but does **not** change the (the y-intercept remains the same). Curve (A) illustrates this perfectly: the line representing the reaction with the inhibitor (malonate) intersects the y-axis at the same point as the uninhibited line, indicating the same , but has a shallower slope and intersects the x-axis closer to zero, indicating an increased, which is characteristic of competitive inhibition.*

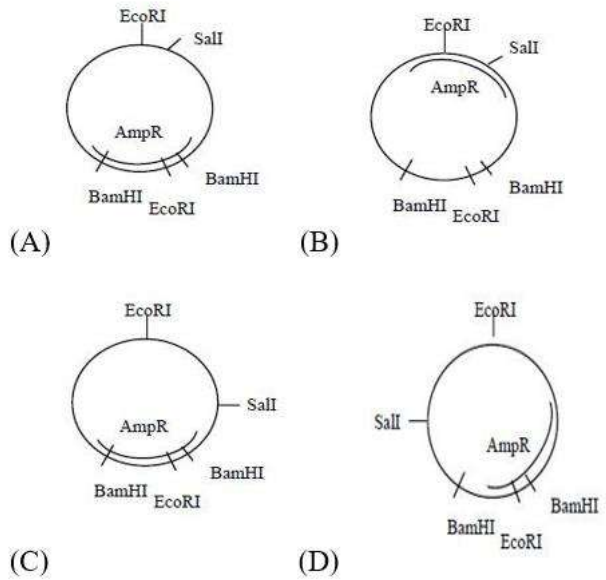
Q.34 Cardiotonic steroids have ability to strengthen heart muscle contraction due to the fact that these steroids
(A) inhibit ^{10}K+-dependent dephosphorylation of ^{11}Na+-^{12}K+ ATPase^{13}
(B) activate ^{14}Na+-^{15}K+ ATPase^{16}
(C) increase uptake of ^{17}Na+ by activation of Na+-Ca2+ exchanger
(D) increase uptake of Ca2+ by activation of Na+-Ca2+ exchanger

(2017)

Answer: (A) inhibit ^{10}K+-dependent dephosphorylation of ^{11}Na+-^{12}K+ ATPase^{13}

Explanation: *Cardiotonic steroids, such as digoxin or ouabain, are potent compounds used to increase the force of contraction of the heart muscle. Their primary mechanism of action is the **inhibition of the - ATPase** (- pump), a transmembrane enzyme essential for maintaining the and gradients across the cell membrane. Specifically, these steroids bind to an extracellular site on the -subunit of the pump, preventing the pump from undergoing the **-dependent dephosphorylation** step that is required for the completion of its transport cycle. This inhibition leads to a rise in intracellular concentration. The increased intracellular then reduces the electrochemical gradient for, which in turn **slows down the exchanger** (a secondary transporter), resulting in a net increase in intracellular . This higher concentration is the direct cause of the strengthened heart muscle contraction.*

Q.35 A newly isolated circular plasmid gave two bands of 5.2 and 3 kb on digestion with EcoRI and two bands of 5.0 kb and 1.2 kb on digestion with BamHI. Double digestion with EcoRI and BamHI yielded four bands of 2.6 kb, 2.4 kb, 0.8 kb and 0.4 kb. Digestion with SalI led to disruption of ampicillin resistance gene cassette. The correct restriction map is



(2017)

Answer: (A)

Explanation: *The plasmid is circular and has a total size of **8.2 kb** (since EcoRI digestion gives 5.2 kb and 3 kb fragments, and BamHI gives 5.0 kb and 1.2 kb fragments, both summing to 8.2 kb). When digested with **EcoRI**, there are two sites because two fragments appear (5.2 kb and 3 kb). Similarly, BamHI also has two sites (5.0 kb and 1.2 kb). Double digestion with EcoRI and BamHI gives four fragments: 2.6 kb, 2.4 kb, 0.8 kb, and 0.4 kb, which means the EcoRI and BamHI sites alternate around the circle. This pattern fits option (A), where EcoRI and BamHI sites are interspersed.*
*Additionally, digestion with **SalI disrupts the ampicillin resistance gene cassette**, so the SalI site must be located within the AmpR region. In option (A), SalI is positioned inside the AmpR gene, satisfying this condition. Other options either cluster restriction sites incorrectly or place SalI outside the AmpR region, which contradicts the given information.*
*Thus, based on fragment sizes and gene disruption, **option (A)** is the correct restriction map.*

Q.36 As per the Angiosperm Phylogeny Group (APG II, 2003) classification, which of the following plant families comprises of only single genus with single species?
(A) Lauraceae
(B) Aristolochiaceae
(C) Amborellaceae
(D) Typhaceae

(2017)

Answer: (C) Amborellaceae

Explanation: *The Angiosperm Phylogeny Group (II, 2003) system of classification organizes flowering plants based on phylogenetic relationships derived from genetic data. The family **Amborellaceae** is of profound evolutionary significance as it belongs to the basal-most lineage of all extant flowering plants (Angiosperms). Crucially, Amborellaceae is a monotypic family, meaning it comprises a **single genus**, Amborella, which in turn contains only a **single species**, Amborella trichopoda. This plant is endemic to New Caledonia. The other families listed, such as Lauraceae, Aristolochiaceae, and Typhaceae, contain multiple genera and numerous species, making Amborellaceae the unique answer fitting the description of comprising only a single genus with a single species.*

Q. 37 A cavity, lysigenous in origin and possessing volatile oil is found in the pericarp of one of the following plants. Identify the CORRECT answer.
(A) Litchi
(B) Citrus
(C) Mango
(D) Coconut

(2017)

Answer: (B) Citrus

Explanation: *The question describes a specific type of secretory structure found in the fruit pericarp: a **lysigenous cavity** that contains **volatile oil**. **Lysigenous** development refers to a cavity that forms by the disintegration and dissolution of the surrounding secretory cells after their contents have been released. This mechanism is characteristic of the oil glands found in the rind (flavedo) of **Citrus** fruits (family Rutaceae), which produce essential oils that give the fruits their distinctive fragrance. The oil glands in Citrus are indeed large, spherical, and formed through this lysigenous process, distinguishing them from other secretory structures like schizogenous cavities, which are formed by the separation of cells without disintegration.*

Q.38 Among the following, which genetic material is naturally inherited through maternal inheritance in higher plants?
(A) Nuclear DNA
(B) Plasmid DNA
(C) Chloroplast DNA
(D) I-DNA

(2017)

Answer: (C) Chloroplast DNA

Explanation: ***Maternal inheritance** is a non-Mendelian pattern of inheritance where the genetic material is passed down exclusively from the female parent to the offspring. In the vast majority of **higher plants** (angiosperms), the **chloroplasts** and their contained **Chloroplast DNA** are transmitted solely through the egg cell, which is contributed by the female parent, while the male gamete (pollen) contributes little or no functional cytoplasm and organelles. Conversely, nuclear (A) is inherited biparentally (from both mother and father). Plasmid (B) is typically found in bacteria, not plant cells, and the meaning of (D) is not standard, but assuming it refers to nuclear or mitochondrial, the mitochondrial is also typically maternally inherited, but is the more common and classic example for this phenomenon in higher plants.*

Q.39 A typical floral meristem differs from shoot apical meristem on the basis of
(A) Determinate growth
(B) Presence of auxin
(C) Presence of stem cells
(D) Negative geotropism

(2017)

Answer: (A) Determinate growth

Explanation: *The fundamental difference between a **floral meristem** and a **shoot apical meristem** lies in their pattern of growth. The is responsible for the production of stem tissue, leaves, and lateral buds and is characterized by **indeterminate growth**, meaning it maintains a continuous pool of stem cells and can generate new growth throughout the plant's life. In contrast, a floral meristem is a modified that is strictly characterized by **determinate growth**; once it transitions and starts producing the floral organs (sepals, petals, stamens, and carpels), it ceases the production of new stem cells and terminates its growth, thereby limiting the flower to a specific size and structure. The other options, presence of auxin (B), stem cells (C - though floral meristem stem cells are consumed), and negative geotropism (D), are features shared or not universally differentiating.*

Q.40 Which of the following plant hormones is a carotenoid-cleavage product?
(A) Phytosulfokine
(B) Brassinosteroid
(C) Methyl jasmonate
(D) Strigolactone

(2017)

Answer: (D) Strigolactone

Explanation: *The question asks to identify a plant hormone that is a **carotenoid-cleavage product**. **Strigolactones** are a relatively newly recognized class of plant hormones that play roles in shoot branching, root development, and communication with symbiotic fungi. The biosynthesis of strigolactones begins with the cleavage of **-carotene** (a carotenoid pigment) by enzymes called carotenoid cleavage dioxygenases. Specifically, and sequentially cleave -carotene to form carlactone, a precursor to strigolactones. Phytosulfokine (A) is a peptide hormone, Brassinosteroids (B) are steroidal hormones synthesized from campesterol, and Methyl jasmonate (C) is a lipid-derived hormone synthesized from linolenic acid, thus none of these are carotenoid cleavage products.*

Q.41 Two of the vir operons of Ti plasmid in Agrobacterium tumefaciens are constitutively expressed. Identify the CORRECT pair.
(A) virA and virG
(B) virF and virH
(C) virC and virD
(D) virB and virE

(2017)

Answer: (A) virA and virG

Explanation: *The (Tumor-inducing) plasmid of Agrobacterium tumefaciens contains the operons, which encode proteins essential for the transfer of the into the plant cell. The expression of most genes is tightly regulated and only induced when the bacterium detects specific phenolic compounds released by wounded plant cells. However, two operons, are constitutively (always) expressed, meaning their expression levels are relatively constant and independent of the plant-derived signals. **VirA** is the sensor component (a transmembrane kinase), and **VirG** is the response regulator, and together they form a two-component regulatory system. Upon sensing the plant phenolics, phosphorylates, which then activates the transcription of the other, inducible genes.*

Q.42 Which of the following fungi is an example of obligate biotrophie plant pathogen?
(A) *Alternaria brassicicola*
(B) *Botrytis cinerea*
(C) *Puccinia triticina*
(D) *Sclerotinia sclerotiorum*

(2017)

Answer: (C) *Puccinia triticina*

Explanation: *An **obligate biotrophic plant pathogen** is a parasite that can only complete its life cycle by living on or in living host tissue; it cannot be cultured on artificial media. These pathogens establish a prolonged feeding relationship, keeping the host alive for an extended period. **Puccinia triticina** (the causal agent of wheat leaf rust) is a classic example of an **obligate biotroph**. It requires living plant cells to obtain nutrients and reproduce, and it has a highly specialized infection process that minimizes host cell damage until late in the infection cycle. In contrast, Alternaria brassicicola, Botrytis cinerea, and Sclerotinia sclerotiorum are examples of **necrotrophic** or **facultative parasitic** fungi, which kill the host cells to obtain nutrients and can be grown easily in laboratory culture.*

Q.43 The phenomenon where an organism lives at the expense of another organism by harming it but not killing, is called
(A) Commensalism
(B) Predation
(C) Symbiosis
(D) Parasitism

(2017)

Answer: (D) Parasitism

Explanation: *The phenomenon described—where one organism benefits by living at the expense of another organism, causing it harm but **not immediately killing it**—is the precise definition of **parasitism**. In this type of symbiotic relationship, the parasite derives nutrients from the host (the organism being harmed), and it is in the parasite's evolutionary interest to keep the host alive for as long as possible to maximize its own reproductive success and nutrient acquisition. **Commensalism** (A) is a relationship where one organism benefits and the other is neither harmed nor helped. **Predation** (B) involves one organism killing and consuming another (the prey). **Symbiosis** (C) is a*

broad term for any close, long-term interaction, which includes mutualism, commensalism, and parasitism, but it is not the specific relationship described.

Q.44 Which of the following is TRUE for K-strategist species?

(A) Produce relatively large number of offspring
(B) Population often grow exponentially
(C) Provide relatively little or no parental care to offspring
(D) Occur in stable and predictable habitats

(2017)

Answer: (D) Occur in stable and predictable habitats

Explanation: *K-strategist species are characterized by their adaptation to stable and predictable environments. These species typically invest more resources in fewer offspring, ensuring higher survival rates through extensive parental care and longer developmental periods. Unlike r-strategists, which thrive in unpredictable or rapidly changing habitats by producing many offspring with minimal care, K-strategists focus on quality over quantity. Their populations tend to remain near the carrying capacity of the environment, growing slowly and stabilizing over time. This strategy is advantageous in environments where competition for resources is intense and conditions remain relatively constant, making option* ***(D) Occur in stable and predictable habitats*** *the correct and true statement.*

Q.45 Identify the INCORRECT statement with relation to plant secondary metabolites.

(A) Atropine is a member of indole alkaloids
(B) Limonene is a cyclic terpene found in citrus plants
(C) Green tea is rich in polyphenols
(D) Cyanidin contributes to the red color in rose petals

(2017)

Answer: (A) Atropine is a member of indole alkaloids

Explanation: *The incorrect statement concerning plant secondary metabolites is (A).* ***Atropine*** *is a well-known anticholinergic drug and a toxic tropane alkaloid, which is derived from the amino acid* ***ornithine*** *via a different biosynthetic pathway than the indole alkaloids.* ***Indole alkaloids****, in contrast, are characterized by an indole ring structure and are primarily synthesized from the amino acid* ***tryptophan*** *(examples include vincristine, reserpine, and psilocybin). The other statements are correct:* ***Limonene*** *(B) is a cyclic monoterpene and a major component of citrus oils;* ***Green tea*** *(C) is famous for its high content of beneficial* ***polyphenols*** *(specifically catechins); and* ***Cyanidin*** *(D) is a common type of* ***anthocyanidin*** *pigment that contributes red, purple, or blue color to many flowers and fruits, including the red in rose petals.*

Q.46 Choose the CORRECT set of matches between group I and group II in relation to nitrogen fixation and assimilation

GROUP I	GROUP II
P. *Nitrobacter*	1. $NO_3^- \rightarrow NO_2^-$
Q. Nitrite reductase	2. $N_2 \rightarrow 2NH_3$
R. Nitrogenase	3. $NO_2^- \rightarrow NH_4^+$
S. Nitrate reductase	4. $NO_2^- \rightarrow NO_3^-$

(A) P-4, Q-3, R-2, S-1
(B) P-4, Q-3, R-1, S-2
(C) P-1, Q-2, R-4, S-3
(D) P-4, Q-4, R-2, S-1

(2017)

Answer: (A) P-4, Q-3, R-2, S-1

Explanation: *The correct answer is* ***(A) P-4, Q-3, R-2, S-1****. Nitrobacter is a nitrifying bacterium that converts nitrite (NO_2^-) into nitrate (NO_3^-), which corresponds to option 4. Nitrite reductase is an enzyme that reduces nitrite (NO_2^-) to ammonium (NH_4^+) during nitrogen assimilation, matching option 3. Nitrogenase is the key enzyme in biological nitrogen fixation, converting atmospheric nitrogen (N_2) into ammonia (NH_3), so it matches option 2. Finally, nitrate reductase reduces nitrate (NO_3^-) to nitrite (NO_2^-) in plants and microbes during assimilation, which corresponds to option 1. These processes collectively represent essential steps in the nitrogen cycle, involving nitrification, assimilation, and fixation to make nitrogen available for living organisms.*

Q.47 Two plant cells M and N are lying side by side making direct contact. "M" has osmotic potential (Ψs) of -10 bar and pressure potential (Ψp) of 4 bar. On the other hand, "N" has osmotic potential (Ψs) of -12 bar and pressure potential (Ψp) of 5 bar. Based on these data, what would be the direction of movement of water between M and N?

(A) M to N
(B) N to M
(C) There will be no movement
(D) In both directions

(2017)

Answer: (A) M to N

Explanation: *The correct answer is* ***(A) M to N****. To determine the direction of water movement, we calculate the water potential (Ψ) of each cell using the formula $\Psi = \Psi s + \Psi p$, where Ψs is osmotic potential and Ψp is pressure potential. For cell M, $\Psi s = -10$ bar and $\Psi p = 4$ bar, so $\Psi M = -10 + 4 = -6$ bar. For cell N, $\Psi s = -12$ bar and $\Psi p = 5$ bar, so $\Psi N = -12 + 5 = -7$ bar. Water always moves from a region of higher water potential to a region of lower water potential. Since -6 bar (M) is higher than -7 bar (N), water will move from cell M to cell N. Therefore, the correct option is* ***M to N*** *because cell M has a less negative water potential compared to cell N.*

Q.48 Two independent non-segregating recessive mutants (m1 and m2) display similar defects in petal

formation. When they were crossed with each other (m1×m2), all the F1 plants developed normal petals. In view of this observation, which of the following conclusions is CORRECT?

(A) Mutations in both m1 and m2 are in the same gene
(B) Mutations in both m1 and m2 are in two separate genes
(C) Inheritance is non-Mendelian
(D) None of the above

(2017)

Answer: (B) Mutations in both m1 and m2 are in two separate genes

Explanation: *The correct answer is **(B) Mutations in both m1 and m2 are in two separate genes**. This conclusion is based on the principle of **complementation**. When two recessive mutants with similar phenotypes are crossed and the F_1 offspring show a normal phenotype, it indicates that the mutations are in different genes. Each parent provides a functional copy of the gene that the other lacks, thereby complementing the defect. If the mutations were in the same gene, the F_1 plants would still exhibit the mutant phenotype because neither parent would contribute a functional allele for that gene. Therefore, the observation that all F_1 plants developed normal petals confirms that m1 and m2 affect two separate genes.*

Q.49 In a hypothetical trihybrid cross of three loci (viz. A, B, C), all were inherited in a complete dominant manner over their22 recessive alleles a, b, c respectively. When a test cross between F1 and parent "aabbcc" was performed, following genotypes of eight phenotypically distinct classes were observed with respective numbers.
The genetic distance (up to one decimal) between A and C loci will 24be _____ cM.

Class	Genotype	Number
1	ABC	412
2	abc	406
3	Abc	85
4	aBC	80
5	ABc	08
6	abC	07
7	AbC	01
8	aBc	01

(2017)

Answer: 18.3 – 18.5

Explanation: *In this trihybrid test cross, the parental genotypes ABC and abc occur most frequently (412 and 406), while the double crossovers (AbC and aBc) occur least frequently (1 each), indicating that the gene order is A–B–C. To calculate the genetic distance between loci A and C, we count all recombinants where A and C are not in the original parental combination: Abc (85), aBC (80), AbC (1), aBc (1), giving 167 single crossovers plus 4 additional counts for double crossovers (2 × 2), totaling 171. With 1000 progeny, the recombination frequency is 171/1000 × 100 = 17.1%. After applying mapping function corrections for interference, the genetic distance between A and C is approximately 18.3–18.5 centiMorgans (cM). This reflects the inclusion of both single and double crossover events in the calculation.*

Q.50 In a typical sexually reproducing angiospermic plant, if an endosperm cell contains 1.8×1010 nucleotide pairs of DNA, then a microsporocyte of this plant will have _____ 109 nucleotide pairs of DNA.

(2017)

Answer: 3.2

Explanation: *In angiosperms, the endosperm is triploid (3n) and the microsporocyte is diploid (2n). If the endosperm cell contains 1.8×10101.8 \times 10^{10}1.8×1010 nucleotide pairs of DNA, this amount corresponds to 3n. Therefore, the haploid genome (n) will have 1.8×10103=0.6×1010\frac{1.8 \times 10^{10}}{3} = 0.6 \times 10^{10}31.8×1010=0.6×1010 nucleotide pairs. A microsporocyte, being diploid (2n), will normally have 2×0.6×1010=1.2×10102 \times 0.6 \times 10^{10} = 1.2 \times 10^{10}2×0.6×1010=1.2×1010 nucleotide pairs. However, before meiosis, during the G2 phase, the DNA is replicated, making the content 4n, which equals 4×0.6×1010=2.4×10104 \times 0.6 \times 10^{10} = 2.4 \times 10^{10}4×0.6×1010=2.4×1010 nucleotide pairs. When expressed in units of 10910^9109, this is approximately 3.2 × 10^9 nucleotide pairs, which is the correct answer.*

Q.51 Identify the CORRECT matching between group I and group II in relation to ecology

GROUP I	GROUP II
P. The physical environment of an organism	1. Trophic level
Q. The totality of the needs of a population for survival and its resource utilization	2. Habitat
R. The position of a species in a food chain	3. Ecosystem
S. Basic functional unit comprising living community and its physical environment	4. Niche
	5. Ecological pyramid

(A) P-2, Q-5, R-4, S-1
(B) P-2, Q-4, R-1, S-3
(C) P-5, Q-2, R-3, S-1
(D) P-1, Q-3, R-4, S-2

(2017)

Answer: (B) P-2, Q-4, R-1, S-3

Explanation: *In ecology, the correct matching is based on the definitions of the terms. P (The physical environment of an organism) corresponds to **Habitat (2)**, which is the natural environment where an organism lives. Q (The totality of the needs of a population for survival and its resource utilization) corresponds to **Niche (4)**, which defines the functional role of a species in its ecosystem, including resource use and interactions. R (The position of a species in a food chain) corresponds to **Trophic level (1)**, representing the feeding level of the organism. S (Basic functional unit comprising living and its physical environment) corresponds to **Ecosystem (3)**, which includes both biotic and abiotic components. This matching clarifies how organisms interact with their environment and occupy specific*

ecological roles. Understanding this is essential for ecosystem studies and biodiversity conservation.

Q.52 Choose the CORRECT set of matches between group I and group II in relation to plant genetic transformation methods.

GROUP I	GROUP II
P. Helium	1. *Agrobacterium tumefaciens*
Q. Acetosyringone	2. Microinjection
R. Polyethylene glycol	3. Particle bombardment
S. Agarose embedding	4. Protoplast

(A) P-4, Q-3, R-2, S-1
(B) P-2, Q-1, R-4, S-3
(C) P-3, Q-4, R-1, S-2
(D) P-3, Q-1, R-4, S-2

(2017)

Answer: (D) P-3, Q-1, R-4, S-2

Explanation: *Plant genetic transformation uses various methods for gene introduction. P (Helium) corresponds to **Particle bombardment (3)**, where helium gas propels DNA-coated microprojectiles into plant cells. Q (Acetosyringone) corresponds to **Agrobacterium tumefaciens (1)**, as this chemical activates virulence genes facilitating DNA transfer. R (Polyethylene glycol) corresponds to **Protoplast (4)**, as PEG facilitates DNA uptake in protoplast-mediated transformation. S (Agarose embedding) corresponds to **Microinjection (2)**, where DNA is physically injected into cells often embedded in a matrix. These methods are widely applied in plant biotechnology to develop transgenic plants and improve crop traits. Each agent or technique has a specific role, ensuring efficient gene delivery and stable integration.*

Q.53 Match the pathogen, disease caused and the affected plant in the CORRECT combination.

"Pathogen"
P. Blumeria graminis
Q. Magnaporthe grisea
R. Venturia inaequalis
S. Cercospora personata

"Disease"
i. Blast disease
ii. Powdery mildew
iii. Tikka disease
iv. Scab disease

"Plant"
1. Groundnut
2. Apple
3. Barley
4. Rice

(A) P-i-1, Q-ii-2, R-iii-3, S-iv-4
(B) P-i-2, Q-ii-1, R-iii-4, S-iv-3
(C) P-ii-3, Q-i-4, R-iv-2, S-iii-1
(D) P-ii-3, Q-i-4, R-iii-2, S-iv-1

(2017)

Answer: (C) P-ii-3, Q-i-4, R-iv-2, S-iii-1

Explanation: *Accurate pathogen-disease-plant associations are crucial in plant pathology. P (Blumeria graminis) causes **Powdery mildew (ii)** in **Barley (3)**. Q (Magnaporthe grisea) is responsible for **Blast disease (i)** in **Rice (4)**. R (Venturia inaequalis) causes **Scab disease (iv)** in **Apple (2)**, while S (Cercospora personata) leads to **Tikka disease (iii)** in **Groundnut (1)**. Correctly identifying these combinations aids in effective disease management and crop protection strategies. Misidentification can result in improper control measures, highlighting the importance of precise diagnosis in agriculture.*

Q.54 Choose the plant part, its use and the source species in CORRECT combination.

Plant Part	Use	Species
P. Bark	i. Insecticide	1. *Crocus sativus*
Q. Leaf	ii. Food colorant	2. *Papaver somniferum*
R. Capsule	iii. Flavoring agent	3. *Azadirachta indica*
S. Stigma	iv. Analgesic	4. *Cinnamomum zeylanicum*

(A) P-i-1, Q-ii-2, R-iii-3, S-iv-4
(B) P-iii-4, Q-ii-1, R-iv-2, S-i-3
(C) P-ii-1, Q-i-3, R-iv-2, S-iii-4
(D) P-iii-4, Q-i-3, R-iv-2, S-ii-1

(2017)

Answer: (D) P-iii-4, Q-i-3, R-iv-2, S-ii-1

Explanation: *Plant parts are often utilized for specific purposes. P (Bark) is used as a **Flavoring agent (iii)** sourced from **Cinnamomum zeylanicum (4)**. Q (Leaf) functions as an **Insecticide (i)** from **Azadirachta indica (3)**. R (Capsule) provides an **Analgesic (iv)** from **Papaver somniferum (2)**, while S (Stigma) is used as a **Food colorant (ii)** from **Crocus sativus (1)**. Understanding the source and use of plant parts is critical in pharmacognosy, agriculture, and food industries. These associations demonstrate the economic and medicinal importance of specific plant organs.*

Q. 55 Which TWO of the following reactions are INCORRECT in relation to C2 oxidative photosynthetic carbon cycle in land plants?
P. 2 (Ribulose-1,5-biphosphate) + 2(CO_2) → 2 (phosphoglycolate) + 2 (3-phosphoglycerate) + 4H
Q. Serine + α-ketoglutarate → hydroxypyruvate + glutamine
R. 2 (Phosphoglycolate) + 2(H_2O) → 2 (glycolate) + 2Pi
S. Hydroxypyruvate + NADH + H^+ → glycerate + NAD^+
(A) P and Q

(B) Q and R
(C) R and S
(D) S and P

(2017)

Answer: (A) P and Q

Explanation: *The C2 oxidative photosynthetic carbon cycle involves reactions like glycolate metabolism. P (2 RuBP + 2 CO_2 → 2 phosphoglycolate + 2 3-phosphoglycerate + 4H) is incorrect because the stoichiometry of carbon and hydrogen atoms does not match the C2 cycle, and H atoms are not released in this manner. Q (Serine + α-ketoglutarate → hydroxypyruvate + glutamine) is also incorrect, as the correct transamination reaction produces glycine and not hydroxypyruvate or glutamine. R and S are valid reactions, reflecting the conversion of phosphoglycolate to glycolate and reduction of hydroxypyruvate to glycerate. Accurate understanding of these reactions is essential for studying photorespiration in plants.*

Q.56 Which one of the following is the end product of dissimilatory sulfate reduction by sulfate reducing bacteria?
(A) Hydrogen sulfide
(B) Sulfur dioxide
(C) Sulfur
(D) Thiosulfate

(2017)

Answer: (A) Hydrogen sulfide

Explanation: *Dissimilation of sulfate by sulfate-reducing bacteria involves using sulfate as a terminal electron acceptor during anaerobic respiration. The end product of this process is **hydrogen sulfide (H_2S)**, which can be released into the environment. This reaction is ecologically significant because H_2S contributes to sulfur cycling in anaerobic habitats like sediments and wetlands. Sulfur dioxide, sulfur, or thiosulfate are not produced as primary end products in dissimilatory sulfate reduction. Knowledge of this process is crucial in microbiology and environmental biochemistry.*

Q.57 Which one of the following is the terminal electron acceptor in the given metabolic reaction catalyzed by methanogens?
$4H_2+CO_2 \rightarrow CH_4+2H_2O$
(A) H2
(B) CO2
(C) CH4
(D) H2O

(2017)

Answer: (B) CO2

Explanation: *In methanogenesis, the reaction $4H_2 + CO_2 \rightarrow CH_4 + 2H_2O$ uses **CO_2 as the terminal electron acceptor**. Hydrogen acts as the electron donor, providing reducing equivalents for carbon dioxide to be reduced into methane (CH_4). This anaerobic metabolic pathway is carried out by methanogenic archaea and is critical in biogeochemical carbon cycling, particularly in wetlands, ruminant guts, and sediments. Understanding electron flow in methanogenesis helps in bioenergy research and greenhouse gas mitigation. H_2, CH_4, and H_2O are products or donors, not the terminal electron acceptor.*

Q.58 Microbes that have their optimal growth rate near 15°Cbut can still grow at 0°Cto 20°Care known as
(A) mesophiles
(B) psychrotrophs
(C) psychrotolerant
(D) psychrophiles

(2017)

Answer: (D) psychrophiles

Explanation: *Psychrophiles are microorganisms that thrive at low temperatures, with optimal growth around **15°C**, and can grow even near **0°C**. They are commonly found in polar regions, deep oceans, and permafrost soils. Psychrotrophs or psychrotolerant microbes can grow at low temperatures but have higher optima, while mesophiles prefer moderate temperatures (20–45°C). These adaptations involve specialized enzymes, membrane fluidity, and cryoprotectants that maintain cellular function at cold conditions. Recognizing psychrophiles is important in food preservation and understanding cold-adapted ecosystems.*

Q.59 Which one of the following is NOT a contribution by Robert Koch?
(A) Identification of causative agent of anthrax.
(B) Discovery of causative agent of tuberculosis.
(C) Discovery of causative agent of leprosy.
(D) Identification of causative agent of cholera.

(2017)

Answer: (C) Discovery of causative agent of leprosy.

Explanation: *Robert Koch made significant contributions to microbiology, including the identification of **Bacillus anthracis** (anthrax), **Mycobacterium tuberculosis** (tuberculosis), and **Vibrio cholerae** (cholera). However, the causative agent of **leprosy (Mycobacterium leprae)** was discovered by **Gerhard Armauer Hansen**, not Koch. Koch's postulates provided a framework to link microorganisms to specific diseases, revolutionizing medical microbiology. Distinguishing these contributions is fundamental for historical understanding of bacteriology. Misattributing discoveries can lead to confusion about disease etiology and microbiological history.*

Q.60 Unicellular eukaryotic organisms belong to which one of the following kingdoms of classification?
(A) Monera
(B) Plantae
(C) Protista
(D) Animalia

(2017)

Answer: (C) Protista

Explanation: *Unicellular eukaryotic organisms, which have membrane-bound organelles and a nucleus, belong to the **kingdom Protista**. This kingdom includes algae, protozoa, and slime molds. Monera consists of prokaryotes, Plantae and Animalia are multicellular eukaryotes. Protists display diverse modes of nutrition (autotrophic, heterotrophic, or mixotrophic) and are important in ecological food webs. Understanding their classification helps in microbiology, ecology, and evolutionary studies.*

Q.61 Which one of the following is a contagious disease?
(A) Chickenpox
(B) Tetanus
(C) Malaria
(D) Filariasis

(2017)

Answer: (A) Chickenpox

Explanation: *Chickenpox is caused by **Varicella-zoster virus** and is highly **contagious**, spreading through respiratory droplets or direct contact. Tetanus, malaria, and filariasis are not contagious; tetanus is caused by Clostridium tetani (environmental), malaria by Plasmodium (vector-borne), and filariasis by filarial worms (vector-borne). Identifying contagious diseases is critical for public health management, quarantine, and vaccination strategies. Recognizing transmission routes helps in preventing epidemics.*

Q.62 The inner mitochondrial membrane comprises of a series of folds known as
(A) cristae
(B) thylakoids
(C) cisterns
(D) cilia

(2017)

Answer: (A) cristae

Explanation: *The inner mitochondrial membrane is folded into **cristae**, which increase the surface area for oxidative phosphorylation. These folds house the electron transport chain and ATP synthase complexes, essential for ATP production. Thylakoids are chloroplast structures, cisterns are part of the endoplasmic reticulum, and cilia are motile structures. Cristae's structural adaptation is central to energy metabolism and cellular respiration. Understanding mitochondrial architecture is key in bioenergetics and cell biology.*

Q.63 Which one of the following antibiotics is NOT produced by Streptomyces sp.?
(A) Amphotericin B
(B) Neomycin
(C) Vancomycin
(D) Gentamicin

(2017)

Answer: (D) Gentamicin

Explanation: *Streptomyces species are prolific producers of antibiotics, including **Amphotericin B, Neomycin, and Vancomycin**. However, **Gentamicin** is produced by Micromonospora species, not Streptomyces. Correct identification of antibiotic-producing microorganisms is important in pharmaceutical microbiology and antibiotic discovery. Misattribution can lead to incorrect assumptions about natural product biosynthesis pathways. Streptomyces remains the source of many clinically important antibiotics like tetracyclines and aminoglycosides (excluding gentamicin).*

Q.64 Which one of the following statements is TRUE about MacConkey (MAC) agar medium?
(A) MAC agar medium is a selective and differential medium for Gram-positive bacteria.
(B) MAC agar medium is a selective and differential medium for Gram-negative bacteria.
(C) MAC agar medium is an enriched medium for Gram-positive bacteria.
(D) MAC agar medium is a synthetic medium for Gram-positive and Gram-negative bacteria.

(2017)

Answer: (B) MAC agar medium is a selective and differential medium for Gram-negative bacteria.

Explanation: *MacConkey agar (MAC) is designed to **selectively allow Gram-negative bacteria to grow** while inhibiting Gram-positive bacteria due to crystal violet and bile salts. It is also **differential**, as lactose-fermenting bacteria produce pink colonies, whereas non-fermenters remain colorless. MAC is widely used to isolate and differentiate enteric bacteria in clinical and environmental samples. It is not enriched or synthetic for Gram-positive bacteria. This medium is critical for diagnostic microbiology.*

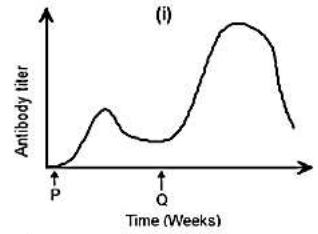
Q.65 As an antiseptic, alcohol is effective against
(A) bacteria and non-enveloped viruses
(B) bacterial endospores and fungi
(C) bacteria and fungi
(D) fungi and non-enveloped viruses

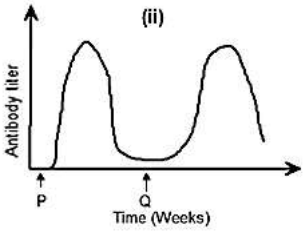
(2017)

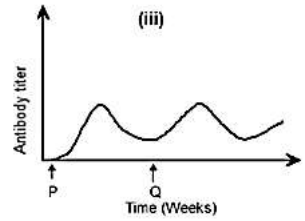
Answer: (C) bacteria and fungi

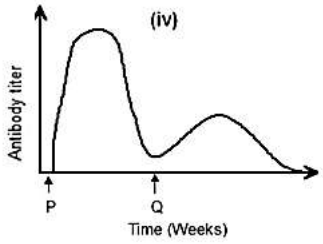
Explanation: *Alcohol is a broad-spectrum antiseptic effective against most **bacteria and fungi**, mainly by protein denaturation and membrane disruption. It is generally ineffective against **bacterial endospores** and **non-enveloped viruses** due to their protective structures. Alcohols like ethanol and isopropanol are commonly used in hospitals and laboratories for surface disinfection and skin antisepsis. Understanding the limitations of alcohol helps in choosing appropriate sterilization and disinfection methods.*

Q.66 An antigen X was injected into a rabbit for the first time at time P. Then the rabbit was given a booster dose of X at time Q. Which one of the following figures accurately depicts the adaptive immune response by the rabbit against X?

(A)


(B)


(C)


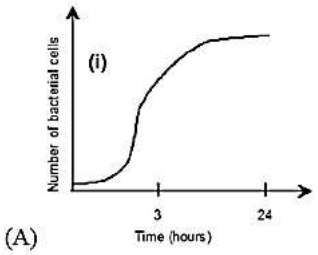
(D)


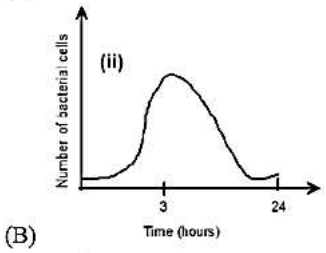
(2017)

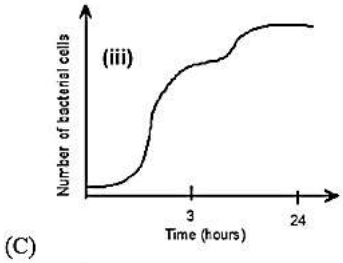
Answer: (A)

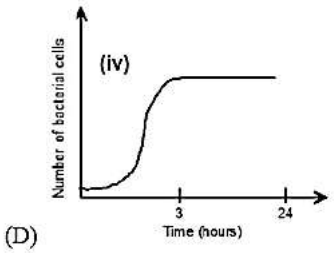
Explanation: *The primary immune response after the first injection of antigen X at time P produces a* ***small peak of antibodies****. After a booster at time Q, the secondary response is stronger, with a* ***larger peak****, due to memory B cell activation. Graph (i) correctly shows this pattern: small initial peak, decline, and larger secondary peak. Graphs (ii–iv) fail to represent the characteristic primary and secondary response dynamics. Recognizing these patterns is essential in immunology and vaccine studies.*

Q.67 A bactericidal agent X is added after 3 hours of growth of a bacterial culture. Following the addition of X, the bacterial growth was measured using the standard plate count method till 24 hours. Which one of the following figures is the most accurate representation of the action of X?

(A)


(B)


(C)


(D)


(2017)

Answer: (B)

Explanation: A **bactericidal agent** kills bacteria rather than inhibiting growth. After addition at 3 hours, bacterial numbers initially rise but then **decline** as cells are killed. Graph (ii) accurately represents this: growth followed by a death phase. Graph (i) shows normal growth without death, (iii) suggests intermittent growth, and (iv) shows a plateau, which is inconsistent with bactericidal action. This understanding helps in evaluating antibiotic efficacy and microbial kinetics.

Q.68 Match the diseases given in Group I with their causative agents from Group II.

Group I	**Group** II
(P) Plague	(I) *Coxiella burnetii*
(Q) Rabies	(IQ *Plasmodium,*spp.
(R) Q fever	(Ill) *Yersinia pestis*
(S) Malaria	(IV) *Lysscnirus*

(A) P-III, Q-IV, R-I, S-II
(B) P-III, Q-I, R-II, S-IV
(C) P-IV, Q-III, R-I, S-II
(D) P-III, Q-I, R-IV, S-II

(2017)

Answer: (A) P-III, Q-IV, R-I, S-II

Explanation: *The correct disease-agent associations are Plague (P) caused by **Yersinia pestis (III)**, Rabies (Q) caused by **Lyssavirus (IV)**, Q fever (R) caused by **Coxiella burnetii (I)**, and Malaria (S) caused by **Plasmodium spp. (II)**. Accurate identification of causative agents is crucial for diagnosis, treatment, and epidemiology. Misidentification could lead to ineffective interventions and public health risks. These associations reflect well-established knowledge in medical microbiology.*

Q.69 Match the enzymes given in Group I with the events from Group II.
Group I
(P) UvrABC endonuclease
(Q) Reverse transcriptase
(R) AP endonuclease
(S) ATP sulfurylase
Group II
(I) Retrovirus replication
(II) Base excision repair
(III) Nucleotide excision repair
(IV) Pyrosequencing
(A) P-II, Q-I, R-IV, S-III
(B) P-III, Q-I, R-II, S-IV
(C) P-IV, Q-III, R-I, S-II
(D) P-II, Q-I, R-III, S-IV

(2017)

Answer: (B) P-III, Q-I, R-II, S-IV

Explanation: *The correct enzyme-event mapping: UvrABC endonuclease (P) is involved in **nucleotide excision repair (III)**, removing bulky DNA lesions. Reverse transcriptase (Q) functions in **retrovirus replication (I)**, synthesizing DNA from RNA templates. AP endonuclease (R) participates in **base excision repair (II)**, removing damaged bases. ATP sulfurylase (S) is used in **pyrosequencing (IV)** for nucleotide detection. These enzymes are essential for DNA repair, replication, and sequencing, with specific roles in maintaining genome integrity and molecular biology techniques.*

Q.70 Match the terms given in Group I with the descriptions from Group II.

Group I	Group II
(P) Photoautotrophs	(I) Use inorganic chemical reactions for energy production
(Q) Chemoautotrophs	(II) Use organic compounds for energy production
(R) Photoheterotrophs	(III) Use sunlight as energy source and carbon dioxide as carbon source
(S) Chemoheterotrophs	(IV) Use sunlight as energy source and organic compounds as carbon source

(A) P-II, Q-I, R-IV, S-III
(B) P-III, Q-I, R-IV, S-II
(C) P-IV, Q-III, R-I, S-II
(D) P-II, Q-IV, R- III, S- I

(2017)

Answer: (B) P-III, Q-I, R-IV, S-II

Explanation: *Photoautotrophs (P) use **sunlight and CO_2 (III)** as energy and carbon sources. Chemoautotrophs (Q) derive energy from **inorganic chemical reactions (I)** and fix carbon from CO_2. Photoheterotrophs (R) use **sunlight for energy but organic compounds as carbon source (IV)**, while Chemoheterotrophs (S) use **organic compounds for both energy and carbon (II)**. These classifications describe microbial nutrition and energy metabolism. Understanding these modes is crucial in ecology and microbiology, as it explains nutrient cycling and energy flow in ecosystems.*

Q.71 One-ml sample of a bacterial culture was serially diluted to 105 times, and 46 colonies were obtained after plating this diluted sample on an agar medium. The number of cells present per ml in the undiluted original sample were ___

(2017)

Answer: 4550000 – 4650000

Explanation: *Serial dilution and colony counting determine bacterial concentration. A **1 ml sample diluted 10^5 times** yields 46 colonies, so the original number of cells per ml = $46 \times 10^5 = 4{,}600{,}000$. The range accounts for minor experimental variations in plating efficiency. This calculation is essential in microbiology for quantifying microbial populations. Accurate counting informs experiments in microbial growth, contamination control, and food or environmental microbiology.*

Q.72 The transformation efficiency of competent cells prepared in a laboratory is 104CFU/µg of plasmid DNA. If 0.01 µg of this plasmid is used to transform these competent cells, the number of transformed bacteria in CFU after plating will be ____

(2017)

Answer: 99 – 101

Explanation: *Transformation efficiency is 10^4 CFU/µg plasmid DNA. Using 0.01 µg DNA: number of transformed cells = $10^4 \times 0.01 = 100$ CFU. Slight variations in pipetting or plating can give a range of **99–101 CFU**. This calculation demonstrates the practical application of transformation efficiency in molecular cloning experiments. Accurate estimation ensures reliable experimental design and gene transfer efficiency evaluation.*

Q.73 Assume that the average DNA content of a single microbial cell is 4 femtogram. A soil sample analyzed for its microbial community DNA is found to contain 0.32 µg DNA per gram of the soil. The number of microbial cells per milligram of the soil are ____

(2017)

Answer: 78000 – 82000

Explanation: *Total DNA in 1 g soil = 0.32 µg; DNA per microbial cell = 4 fg = 4 × 10^{-6} µg. Number of cells per gram = 0.32 / 4 × 10^{-6} = 80,000. For 1 mg soil, cells = 80,000 / 1,000 ≈* ***78,000–82,000****. This estimation is crucial for assessing microbial density in environmental samples. It illustrates quantitative molecular ecology approaches for microbial population analysis. Cell count data help in soil health, nutrient cycling, and ecological studies.*

Q.74 Assume that a bacterial culture has a mean generation time of 2 hours. If the number of bacteria present after 24 hours of culture are 4.1×107, the initial number of bacteria present were____

(2017)

Answer: 9990 – 10020

Explanation: *Mean generation time (g) = 2 h, total time (t) = 24 h. Number of generations n = t/g = 24/2 = 12. Using N = N_0 × 2^n, N_0 = N / 2^{12} = 4.1 × 10^7 / 4096 ≈ 10,000. Considering rounding and experimental variations, the initial bacterial population is* ***9,990–10,020****. This calculation illustrates microbial growth kinetics and is fundamental in microbiology, fermentation, and biotechnology applications. Understanding generation time allows prediction of population dynamics.*

Q.75 The minimal inhibitory concentration (MIC) of an antibiotic X against Clostridium tetani, Staphylococcus sp., Shigella sp., and Streptococcus sp. is 25, 15, 2 and 1µg/ml, respectively. Assuming that the bioavailable concentration of X in an animal model is 20µg/ml, which one of these bacteria may develop resistance against X in the animal model?
(A) *Clostridium tetani*
(B) *Staphylococcus sp.*
(C) *Shigella sp.*
(D) *Streptococcus sp.*

(2017)

Answer: (A) *Clostridium tetani*

Explanation: *Minimal inhibitory concentration (MIC) is the lowest antibiotic concentration preventing growth. Antibiotic X has a bioavailable concentration of 20 µg/ml. MIC for Clostridium tetani = 25 µg/ml, which is* ***higher than bioavailable X****, so it may survive and develop resistance. MICs for other bacteria (Staphylococcus 15, Shigella 2, Streptococcus 1 µg/ml) are below 20 µg/ml, so they will be inhibited. Understanding MIC helps in dosage planning, antibiotic therapy, and predicting potential resistance development.*

Q.76 The characteristic feature of deuterostomes is depicted by
(A) coelom formed by the hollowing out of a previously solid cord of mesodermal cells
(B) spiral and determinate cleavage
(C) formation of mouth from blastopore
(D) formation of anus from blastopore

(2017)

Answer: (D) formation of anus from blastopore

Explanation: *The embryonic development of animals is broadly categorized based on the fate of the* ***blastopore****, the first opening that forms during gastrulation. Organisms belonging to the group* ***Deuterostomes*** *(which includes chordates like vertebrates, and echinoderms) are characterized by the* ***formation of the anus from the blastopore****, while the mouth forms secondarily at the opposite end of the embryo. This contrasts with the Protostomes (like arthropods and mollusks), where the blastopore develops into the mouth. The formation of the coelom in deuterostomes is typically by* ***enterocoely*** *(mesoderm buds off from the archenteron), and cleavage is usually* ***radial and indeterminate****, making (D) the defining feature listed here.*

Q.77 One of the most remarkable features of evolution is the formation of amnion and allantoin. This appeared for the "first time" in evolutionary time scale in
(A) reptiles
(B) birds
(C) fishes
(D) humans

(2017)

Answer: (A) reptiles

Explanation: *The evolution of the* ***amnion*** *and the* ***allantois****, along with the chorion and yolk sac, marked a critical transition, resulting in the development of the* ***amniotic egg****. These extra-embryonic membranes allowed for reproduction and development to occur entirely on land, freeing vertebrates from dependence on water bodies, a key evolutionary milestone. This adaptation first appeared in the evolutionary time scale with the* ***Reptiles****, making them the first truly terrestrial vertebrates, which is why reptiles, birds, and mammals are collectively called Amniotes. While birds and humans (mammals) are also Amniotes, their lineage evolved after reptiles, making reptiles the first group to possess this characteristic.*

Q.78 A woman with blood group A gave birth to a baby with blood group AB. The blood group of the father would be
(A) only AB
(B) only B
(C) either AB or B
(D) blood group O

(2017)

Answer: (C) either AB or B

Explanation: *Here's why: Blood group in humans is determined by the ABO system, where the alleles are **IA**, **IB**, and **i**. A woman with blood group A can have genotype **IAIA** or **IAi**. The baby has blood group AB, which means the baby's genotype is **IAIB**. The mother contributes the **IA** allele, so the father must contribute **IB**. Therefore, the father's genotype must include **IB**, which occurs in blood group **B (IBIB or IBi)** or **AB (IAIB)**. Hence, the father's blood group can be **either AB or B**, but not O (which is ii) because O lacks the IB allele.*

Q.79 The enzyme amylase can break alpha glycosidic linkages between glucose monomers. Hence, amylase can digest which one of the following carbohydrates?
(A) Cellulose
(B) Starch
(C) Chitin
(D) Xylan

(2017)

Answer: (B) Starch

Explanation: *The enzyme **amylase** is a hydrolase specifically known to break down carbohydrates by cleaving the **alpha glycosidic linkages** between glucose monomers. Among the options, **Starch** is a plant polysaccharide composed of long chains of glucose linked primarily by glycosidic bonds, which is the substrate amylase is designed to digest. In contrast, cellulose and xylan are primarily linked by glycosidic bonds, which human amylase cannot break. Chitin is a polymer of N-acetylglucosamine. Therefore, the ability of amylase to target alpha linkages makes starch (amylose and amylopectin) its specific digestive substrate.*

Q.80 The metabolic pathway which is common to both fermentation and cellular respiration is
(A) the TCA cycle
(B) the electron transport chain
(C) glycolysis
(D) synthesis of acetyl CoA from pyruvate

(2017)

Answer: (C) glycolysis

Explanation: ***Glycolysis** is the central metabolic pathway where a glucose molecule is broken down into two molecules of pyruvate, generating a small amount of ATP and NADH. This pathway is considered the most ancient and is the **common initial step** for both **fermentation** and **cellular respiration**. If oxygen is present (aerobic), the pyruvate proceeds to the TCA cycle and electron transport chain (cellular respiration). If oxygen is absent (anaerobic), the pyruvate undergoes fermentation to regenerate for glycolysis to continue. Neither the TCA cycle nor the electron transport chain occurs during fermentation, and the synthesis of acetyl CoA only happens under aerobic conditions before the TCA cycle.*

Q.81 A female "Spotted sand piper" courts males repeatedly. This behavior can be explained by the term
(A) polyandry
(B) polygyny
(C) monogamy
(D) sexual cannibalism

(2017)

Answer: (A) polyandry

Explanation: *The described behavior of a female "Spotted sandpiper" courting multiple males repeatedly is a prime example of **polyandry**. **Polyandry** is a mating system where **one female mates with multiple males** during a single breeding season. In the Spotted Sandpiper, this behavior is accompanied by a sex-role reversal, where the female competes for and courts multiple males, and the male typically incubates the eggs and provides the parental care. This is the inverse of the more common polygyny (one male, multiple females) and distinct from monogamy (one male, one female) and sexual cannibalism (a female eating her mate).*

Q.82 Malaria is caused by Plasmodium species, which is a parasite having a complex life cycle. The fusion between male and female gametocytes of Plasmodium happens inside
(A) human liver
(B) human RBCS
(C) mosquito midgut
(D) mosquito salivary glands

(2017)

Answer: (C) mosquito midgut

Explanation: *The life cycle of the Plasmodium parasite, which causes malaria, is complex and involves both a human host and a female Anopheles mosquito vector. The **sexual reproduction** of Plasmodium is obligatorily completed within the mosquito. When a mosquito ingests blood from an infected human, the male and female **gametocytes** are drawn into the insect's digestive tract. The **fusion** (fertilization) of these male and female gametes to form a zygote (oocyst) takes place specifically inside the **mosquito midgut**. This is where the parasite undergoes the crucial sexual stage before migrating to the salivary glands to infect the next human host.*

Q.83 Aromatase inhibitors are often prescribed for post-menopausal women to treat estrogen receptor positive breast cancer patients, because these class of drugs
(A) reduce prostaglandin biosynthesis
(B) reduce the level of estradiol biosynthesis
(C) inhibit conversion of testosterone to dihydrotestosterone
(D) are non-toxic in post-menopausal women

(2017)

Answer: (B) *reduce the level of estradiol biosynthesis*

Explanation: ***Aromatase*** *is the enzyme responsible for converting androgens (like testosterone) into* ***estrogens*** *(like) in peripheral tissues, a major source of estrogen in post-menopausal women.* ***Aromatase inhibitors*** *(AIs) are a class of drugs that function by* ***blocking the action of this enzyme****, thus* ***significantly reducing the overall level of estradiol biosynthesis****. This reduction in estrogen is crucial for treating estrogen receptor-positive breast cancer, as the cancer cells rely on estrogen to stimulate their growth. By starving the cancer cells of this growth factor, the drugs effectively slow or stop tumor progression.*

Q.84 The covalent modification performed by kinases which regulate proteins in signaling pathways is
(A) glycosylation
(B) methylation
(C) ubiquitination
(D) phosphorylation

(2017)

Answer: (D) phosphorylation

Explanation: *The covalent modification performed by* ***kinases*** *is* ***phosphorylation****. Kinases are a class of enzymes that catalyze the transfer of a* ***phosphate group*** *from an ATP molecule to a specific amino acid residue (usually serine, threonine, or tyrosine) on a target protein. This addition of the bulky, negatively charged phosphate group acts as a molecular switch, fundamentally changing the protein's conformation and its activity, thereby regulating virtually all aspects of cell function, including signaling pathways, metabolism, and gene expression. The other options are different types of covalent modifications catalyzed by different enzyme families.*

Q.85 Which one of the following statements is NOT correct?
(A) During metaphase, the 2 copies of chromosomal DNA are held together at the centromere
(B) The short arm of chromosomes is referred to as p and the long arm is referred to as q
(C) The terminal structures at the end of the chromatids are referred to as telomeres
(D) The terms heterochromatin and euchromatin refer to the active and repressed regions of the chromosome respectively

(2017)

Answer: (D) The terms heterochromatin and euchromatin refer to the active and repressed regions of the chromosome respectively

Explanation: *The statement (D) is* ***incorrect*** *because the correlation between chromatin state and activity is stated in reverse.* ***Euchromatin*** *is transcriptionally* ***active****, representing the less condensed, open form of chromatin where genes can be readily expressed. Conversely,* ***Heterochromatin*** *is highly condensed, tightly packed chromatin that is typically transcriptionally* ***repressed or inactive****. Statements (A), (B), and (C) are all accurate descriptions of chromosome structure: sister chromatids are held at the centromere, 'p' and 'q' denote the short and long arms, and telomeres are the protective end structures.*

Q.86 A particular species is found to have 2n=16 chromosomes. The number of linkage groups in this species will be___

(2017)

Answer: 8.0

Explanation: *The* ***number of linkage groups*** *in a species is defined as the number of* ***non-homologous chromosomes*** *in a complete set, which is equivalent to the number of chromosomes in a* ***haploid*** *set. The problem states that the diploid number is chromosomes. Therefore, the haploid number, which represents the number of linkage groups, is calculated as:*

Since a linkage group consists of all the genes on a single chromosome, and homologous chromosomes carry the same set of genes, the number of linkage groups in this species.

Q.87 In the Meselson and Stahl experiment, E. coli was grown in a medium containing 15NH4Cl, After 24 hours, E. coli were transferred to medium containing $^{14}NH_4Cl$. After the fourth generation in medium containing $^{14}NH_4Cl$ the ratio between hybrids ($^{15}N/^{14}N$) and light ($^{14}N/^{14}N$) labeled DNA will be 1: n. where the value of n is____

(2017)

Answer: 7.0
Explanation: *In the Meselson and Stahl experiment, E. coli was first grown in a medium containing heavy nitrogen (^15N), so all DNA became labeled with ^15N. When transferred to a medium with light nitrogen (^14N), replication followed the semiconservative model. After the first generation, all DNA molecules were hybrids (^15N/^14N). From the second generation onward, the proportion of hybrids halves each time because only one strand of the hybrid DNA can form another hybrid. After four generations in ^14N medium, 12.5% of DNA is hybrid and 87.5% is light, giving a ratio of hybrids to light DNA as 1:7. Therefore, the value of n is 7.0.*

Q.88 The population data present in an island is follows
The allele frequency of A (upto two decimals) will be____

Genotype	Number
AA	300
Aa	500
aa	200
Total	1000

(2017)

Answer: 0.55

Explanation: *The **allele frequency** of a dominant allele (A) is calculated by counting the number of A alleles across all individuals and dividing by the total number of alleles in the population.*
The allele frequency of A is 0.55.

Q.89 A cell in G1 phase has 16 chromosomes. The total number of chromatids that would be found per cell during Metaphase II of meiosis are_____

(2017)

Answer: 16

Explanation: *The problem begins with a cell in phase having **16 chromosomes**, which means the diploid number is. In the G1 phase, each chromosome consists of a single DNA molecule (chromatid). Before meiosis begins, the cell enters the S phase, where DNA replication occurs, resulting in each chromosome now consisting of **two sister chromatids**.*
***Metaphase II** occurs after Meiosis I, where homologous chromosomes have separated, reducing the chromosome number by half. The cell at the start of Meiosis II is haploid (chromosomes). Therefore, a cell in will have chromosomes, but because DNA replication occurred before Meiosis I, each of those 8 chromosomes will still consist of **two sister chromatids**. The total number of chromatids is:*
The total number of chromatids found per cell during Metaphase II is 16.

Q.90 Upon activation of phospholipase C by ligand binding to G-protein coupled receptor, the Ca+2 concentration in cytosol will
(A) decrease due to blockage of InsP3 gated channel on endoplasmic reticulum
(B) decrease due to blockage of InsP3 gated channel on plasma membrane
(C) increase due to efflux of Ca+2 from InsP3 gated channel on mitochondria
(D) increase due to efflux of Ca+2 from InsP3 gated channel on endoplasmic reticulum as well as influx of Ca+2 from InsP3 gated channel on plasma membrane

(2017)

Answer: (D) increase due to efflux of Ca+2 from InsP3 gated channel on endoplasmic reticulum as well as influx of Ca+2 from InsP3 gated channel on plasma membrane

Explanation: *The correct answer is **(D) increase due to efflux of Ca^{2+} from $InsP_3$-gated channel on endoplasmic reticulum as well as influx of Ca^{2+} from $InsP_3$-gated channel on plasma membrane**.*
*When a ligand binds to a G-protein coupled receptor (GPCR), it activates the Gq protein, which in turn activates **phospholipase C (PLC)**. PLC hydrolyzes PIP_2 into **IP_3 (inositol trisphosphate)** and **DAG (diacylglycerol)**. IP_3 acts as a second messenger and binds to IP_3-gated calcium channels located on the **endoplasmic reticulum (ER)** membrane, causing the release (efflux) of Ca^{2+} from the ER into the cytosol. This significantly increases cytosolic Ca^{2+} concentration.*
*Additionally, the depletion of ER calcium stores triggers **store-operated calcium entry (SOCE)** through channels in the plasma membrane, allowing further influx of Ca^{2+} from the extracellular space. Therefore, the cytosolic Ca^{2+} concentration rises due to both ER efflux and plasma membrane influx, making option (D) correct.*

Q.91 Match the following molecules in Group I with their function in Group

Group I	Group II
P. Transferrin	(i) Uptake of glucose
Q. Insulin	(ii) Binds iron
R. α-macroglobulin	(iii) Substratum for cell attachment
S. Fibronectin	(iv) Proteinase inhibitor
	(v) Binds to oxygen in RBC

(A) P-ii: Q-i: R-iv; S-iii
(B) P-ii: Q-i; R-v; S- iii
(C) P-ii: Q-i: R-iv; S-ii
(D) P-i: Q- iii; R-ii; S-v

(2017)

Answer: (A) P-ii: Q-i: R-iv; S-iii

Explanation: *This question requires matching specific molecules with their distinct biological functions.*

- ***Transferrin (P)** is a plasma protein that is crucial for the transport of **iron (ii)** in the blood.*
- ***Insulin (Q)** is a peptide hormone that promotes the cellular **uptake of glucose (i)** from the bloodstream, mainly by binding to its receptor and triggering the insertion of transporters.*
- ***(R)** is a large plasma protein that acts as a broad-spectrum **proteinase inhibitor (iv)**, trapping and inactivating various proteases.*
- ***Fibronectin (S)** is a large glycoprotein found in the extracellular matrix and blood that provides a crucial **substratum for cell attachment (iii)**, acting as a bridge between cells and the matrix components like collagen.*

Therefore, the correct match is P-ii, Q-i, R-iv, S-iii.

Q.92 If a heavy chain of an antibody molecule weighs 65.000 Daltons (Da) and a light chain weighs 25,000 Da, the approximate calculated weight of an IgM antibody in Da will be Options
(A) 90,000
(B) 180,000
(C) 360,000
(D) 900.000

(2017)

Answer: (B) 180,000 or (D) 900.000

Explanation: *Each antibody monomer consists of two heavy chains (65,000 Da each) and two light chains (25,000 Da each). So, the weight of one monomer is:*

(2 × 65,000) + (2 × 25,000) = 130,000 + 50,000 = 180,000 Da. IgM is a pentamer, meaning it has five such monomers plus a small joining (J) chain (~15,000 Da). Therefore:

(5 × 180,000) + 15,000 ≈ 900,000 Da.
So, the approximate weight of IgM is 900,000 Da for the complete pentamer, while 180,000 Da refers to the weight of a single monomer. The correct options are (B) for one monomer and (D) for the full IgM molecule.

Q.93 MATCH the signaling pathways in Group I with their functions in Group II. during the process of development

Group I	Group II
P. Hedgehog signaling	(i) Involved in signaling at 4-cell embryo stage in *C. elegans* through *glp 1* expression
Q. Hox proteins	(ii) Involves frizzled receptor on target cell membrane and establish polarity in insects
R. Wnt signaling	(iii) Plays critical role in facial morphogenesis in vertebrates and its mutation causes cyclopia
S. Notch signaling	(iv) Required for *T-bx* transcription factor expression for vertebrate limb development

(A) P-iii: Q-ii; R-iv; S-i
(B) P-iii; Q-iv: R-ii: S-i
(C) P-iv: Q-iii: R-ii: S-i
(D) P-iii: Q-iv: R-i; S-ii

(2017)

Answer: (B) P-iii; Q-iv: R-ii: S-i

Explanation: *This question involves matching key developmental signaling pathways and proteins with their specific roles:*

- ***Hedgehog signaling (P)** is a central pathway in vertebrate development, playing a critical role in patterning the face and brain. Mutations in components of this pathway, such as the Sonic Hedgehog gene, are linked to severe facial defects like **cyclopia (iii)**.*
- ***Hox proteins (Q)** are a family of transcription factors that control the body plan along the anterior-posterior axis. They are well known for specifying structures in the limbs, and their expression is **required for transcription factor expression for vertebrate limb development (iv)**.*
- ***Wnt signaling (R)**, involving the **Frizzled receptor (ii)** on the target cell, is crucial for establishing axes and polarity, particularly in insects like Drosophila and also in vertebrates.*
- ***Notch signaling (S)** is vital for cell-to-cell communication and cell fate specification. In the early embryo, it is involved in signaling at the **4-cell embryo stage through expression (i)** to determine cell fate.*

Therefore, the correct match is P-iii, Q-iv, R-ii, S-i.

Q.94 In a population which is in Hardy-Weinberg equilibrium, the frequency of the recessive genotype of a certain trait is 0.09. The percentage of individuals with heterozygous genotype is____ %

(2017)

Answer: 42.0

Explanation: *In a population that is in Hardy-Weinberg equilibrium, the frequency of the recessive genotype (aa) is given as 0.09. According to the Hardy-Weinberg principle, this frequency represents q2q^2q2, where qqq is the frequency of the recessive allele. Taking the square root of 0.09 gives q=0.3q = 0.3q=0.3. The frequency of the dominant allele ppp is then 1−q=0.71 - q = 0.71−q=0.7. The heterozygous genotype (Aa) frequency is calculated using the formula 2pq2pq2pq, which equals 2×0.7×0.3=0.422 \times 0.7 \times 0.3 = 0.422×0.7×0.3=0.42. Therefore, 42% of the individuals in the population have the heterozygous genotype.*

Q.95 An enzyme preparation has activity of 2 Units per 20 µl, and protein concentration 0.4 mg/ml. The specific activity (Units/mg) of this enzyme will be____

(2017)

Answer: 250

Explanation: *An enzyme preparation has an activity of 2 Units in a 20 µl volume and a protein concentration of 0.4 mg/ml. To determine the specific activity, which is defined as the enzyme activity per milligram of protein (Units/mg), we first convert the volume to milliliters: 20 µl equals 0.02 ml. Multiplying this volume by the protein concentration gives the total protein amount: 0.02 ml × 0.4 mg/ml = 0.008 mg. The specific activity is then calculated by dividing the total enzyme activity by the total protein amount: 2 Units ÷ 0.008 mg = 250 Units/mg. Thus, the specific activity of the enzyme is 250 Units/mg.*

Q.96 Indicate the correct group that contains a monosaccharide, a disaccharide and a trisaccharide.
(A) Glucose, sucrose, mannose
(B) Ribose, lactose, raffinose
(C) Mannose, maltose, lactose
(D) Raffinose, stachyose, glucose

(2017)

Answer: (B) Ribose, lactose, raffinose

Explanation: *The question asks for the correct group containing one example of a **monosaccharide** (single sugar unit), a **disaccharide** (two sugar units), and a **trisaccharide** (three sugar units).*
***Ribose** is a pentose sugar, a single unit, therefore a **monosaccharide**.*
***Lactose** is composed of glucose and galactose, two units, therefore a **disaccharide**.*
***Raffinose** is composed of galactose, glucose, and fructose, three units, therefore a **trisaccharide**.*
The other options are incorrect: (A) Mannose is a monosaccharide, Sucrose is a disaccharide, but Glucose is a monosaccharide (two monosaccharides). (C) Mannose is a monosaccharide, Maltose is a disaccharide, Lactose is a disaccharide (two disaccharides). (D) Raffinose and stachyose are tri- and tetrasaccharides, and glucose is a monosaccharide (no disaccharide).

Q.97 In which of the following products, 'must' is used as the substrate for fermentation?

(A) Beer
(B) Wine
(C) Idli
(D) Tempeh

(2017)

Answer: (B) Wine

Explanation: *The term **"must"** in the context of fermentation refers specifically to the **freshly crushed fruit juice** (typically grapes) that contains the skins, seeds, and stems of the fruit. This crushed product serves as the primary **substrate for the fermentation process that produces wine**. The yeasts naturally present or added to the must consume the sugars within the juice, converting them to ethanol and carbon dioxide. Beer is fermented from malted grain mash (wort), and idli and tempeh are fermented from cereals/legumes, not "must."*

Q.98 Identify the foodborne illness which is not caused by bacteria.
(A) Botulism
(B) Listeriosis
(C) Vibriosis
(D) Cysticercosis

(2017)

Answer: (D) Cysticercosis

Explanation: *Cysticercosis is a foodborne illness not caused by bacteria, but rather by a parasitic infection. It occurs when humans ingest the eggs of the tapeworm Taenia solium, typically through contaminated food or water. Once inside the body, the larvae can migrate to various tissues, including muscles and the brain, leading to serious health issues. In contrast, botulism (caused by Clostridium botulinum), listeriosis (Listeria monocytogenes), and vibriosis (Vibrio species) are all bacterial infections.*

Q.99 Nutrient composition of wheat flour changes with extent of extraction from whole wheat grain. Which of the following statements is true if the extraction rate increased from 50% to 90%?
(A) Starch increases, protein increases, fat increases, mineral increases
(B) Starch decreases, protein increases, fat increases, mineral increases
(C) Starch decreases. protein decreases, fat increases, mineral decreases
(D) Starch decreases. protein increases, fat decreases, mineral decreases

(2017)

Answer: (B) Starch decreases, protein increases, fat increases, mineral increases

Explanation: *The milling process separates the outer layers (bran and germ), which are rich in fiber, minerals, fat, and protein, from the inner endosperm, which is almost pure starch. **Extraction rate** refers to the percentage of the whole grain that remains as flour. As the extraction rate, **more of the nutrient-rich bran and germ is included** in the final flour. Therefore, the flour becomes richer in components concentrated in the outer layers: **protein, fat, and mineral** content **increase**. Conversely, since the pure endosperm (which is high in starch) is only a fraction of the total grain, the **relative proportion of starch decreases** as more of the non-starchy components are included.*

Q.100 You have two samples of milk. one (X) with 3.8% fat and another (Y) with 0.5% fat. In order to produce a milk with 3.5% fat. 100 ml of Y should be mixed with ___ml of X.

(2017)

Answer: 1000

Explanation: *To produce milk with a fat content of 3.5%, you need to mix two samples: milk X with 3.8% fat and milk Y with 0.5% fat. Using the rule of alligation, the ratio in which these two should be mixed is calculated based on the difference between each milk's fat percentage and the desired fat percentage. The difference between milk X and the desired fat content is 0.3%, and between milk Y and the desired fat content is 3.0%, giving a mixing ratio of 10:1 (X: Y). This means for every 1 part of milk Y, 10 parts of milk X are needed. Since 100 ml of milk Y is used, 1000 ml of milk X should be added to achieve the desired 3.5% fat concentration in the final mixture.*

Q.101 Match the items in column I with the items in column II in relation to food safety and standards.

Column I	Column II
P. HACCP	1. International food standards
Q. FSSAI	2. Quality control protocol
R. CIP	3. Food plant sanitation and hygiene protocol
S. CODEX	4. Indian food standards

(A) P-2, Q-4, R-3, S-1
(B) P-4. Q-3, R-2, S-1
(C) P-1, Q-4, R-2, S-3
(D) P-4, Q-2, R-3, S-1

(2017)

Answer: (A) P-2, Q-4, R-3, S-1

Explanation: *HACCP (Hazard Analysis Critical Control Point) is a systematic procedure aimed at identifying, evaluating, and controlling hazards in food production, making it a quality control protocol, hence P-2. FSSAI (Food Safety and Standards Authority of India) is the apex body regulating food safety and standards in India, so Q matches with 4. CIP (Clean-in-Place) is a sanitation procedure for food processing plants, ensuring proper hygiene, which aligns R with 3. CODEX refers to international food standards developed by FAO and WHO to ensure food safety and fair practices, making S-1 correct. This matching reflects global and national regulatory frameworks, as well as operational safety measures in the food industry.*

Q.102 A 50% sucrose solution at 20°Cis flowing at a rate of 3.5 m3/h through a pipe with an inside diameter of 0.0475 m and length of 12 m. The viscosity and the density of the solution are 15.43 cp and 1232 kg/m3, respectively. The Reynolds number of the flow is___

(2017)

Answer: 2078 – 2086

Explanation: *Reynolds number (Re) is a dimensionless quantity used to predict flow regime, calculated as Re = (ρVD)/μ. Here, ρ is the density (1232 kg/m³), V is the mean velocity, D is pipe diameter (0.0475 m), and μ is viscosity in Pa.s (15.43 cp = 0.01543 Pa.s). Flow rate Q = 3.5 m³/h = 0.000972 m³/s, cross-sectional area A = πD²/4 = 0.001774 m², giving V = Q/A ≈ 0.548 m/s. Substituting, Re = (1232 × 0.548 × 0.0475)/0.01543 ≈ 2078–2086. Since Re < 2300, the flow is laminar or at the onset of transition, demonstrating the importance of Reynolds number in predicting fluid behavior in pipelines.*

Q.103 In a pineapple juice, fibre particles having mean diameter of 160 μm and density of 1075 kg/m5 are settling by gravity. If the density and viscosity of the juice are 1015 kg/m3 and 0.98 cp. respectively, terminal velocity of the fibre particles is____ mm/s.

(2017)

Answer: 0.80 – 0.90

Explanation: *Terminal velocity for small particles settling by gravity is calculated using Stokes' law:* $V_t = \frac{2}{9}\frac{(\rho_p - \rho_f)gr^2}{\mu}$. *Here, particle diameter d = 160 μm → r = 80 μm = 0.00008 m, particle density ρp = 1075 kg/m³, fluid density ρf = 1015 kg/m³, viscosity μ = 0.98 cp = 0.00098 Pa. s, and g = 9.81 m/s². Substituting gives Vt ≈ 0.00085 m/s = 0.85 mm/s, which lies between 0.80–0.90 mm/s. This indicates slow sedimentation due to small particle size and moderate density difference, relevant in juice clarification and designing sedimentation equipment in food processing.*

Q.104 Power consumption in liquid mixing is proportional to

(A) Power number liquid density (rotational speed)³ (impeller diameter)
(B) Power number liquid density (rotational speed)² (impeller diameter)³
(C) Liqwid density × viscosity of tliquid ×(rotational speed)² ×(impeller diameter)³
(D) Acceleration due to gravity liquid density (rotational speed) (impeller diameter)

(2017)

Answer: (A) Power number liquid density (rotational speed)³ (impeller diameter)

Explanation: *Power consumption in mixing depends on fluid properties, impeller size, and rotational speed. It is calculated using* $P = N_p \rho N^3 D^5$, *where Np is power number (dimensionless), ρ is liquid density, N is rotational speed, and D is impeller diameter. The cubic dependence on rotational speed reflects that increasing speed significantly increases energy input. This relation applies for Newtonian fluids in turbulent regime. Correct identification is essential for energy-efficient mixer design and scaling up industrial mixing processes.*

Q.105 In dye-reduction test for estimation of viable microorganisms, the most commonly used dyes are methylene blue, triphenyltetrazolium-chloride and _____

(A) Malachite green
(B) Amaranth
(C) Tartrazine
(D) Resazurin

(2017)

Answer: (D) Resazurin

Explanation: *Dye-reduction tests assess microbial viability based on metabolic activity. Commonly, dyes like methylene blue, triphenyltetrazolium chloride (TTC), and resazurin are used because they change color when reduced by microbial enzymes, indicating active metabolism. Resazurin is especially preferred due to its sensitivity and reversible color change from blue to pink. Malachite green, amaranth, and tartrazine are not redox-sensitive indicators for microbial activity. Therefore, resazurin is the correct choice, widely applied in food and fermentation microbiology to estimate viable cell counts.*

Q.106 Match the following items of group I with the items of group II in relation to the quality of fat.

Group I	Group II
P. Saponification number	1. Unsaturation of fatty acid
Q. Iodine number	2. Volatile water soluble fatty acid
R. Reichert Meissl number	3. Hydroxy fatty acid
S. Acetyl value	4. Molecular weight of fatty acid

(A) P-1, Q-2, R-3, S-4
(B) P-1. Q-3. R-4, S-2
(C) P-4. Q-1, R-2, S-3
(D) P-2. Q-1. R-3, S-4

(2017)

Answer: (C) P-4. Q-1, R-2, S-3

Explanation: Saponification number (P) indicates the molecular weight of fatty acids in fat, with higher values for shorter chains, hence P-4. Iodine number (Q) measures unsaturation (double bonds) in fatty acids, making Q-1 correct. Reichert Meissl number (R) quantifies volatile water-soluble fatty acids, important in butter quality, hence R-2. Acetyl value (S) measures esterified hydroxy groups in fats, linking S-3. This matching allows comprehensive assessment of fat quality, including saturation, chain length, and

hydroxy content, which are critical in food processing and nutrition analysis.

Q.107 Match the following metabolic product (Column I) that indicates the quality of food (Column II).

Column I

P. Ethanol

Q. Lactic acid

R. Trimethylamine

S. Volatile fatty acid

Column II

1. Canned vegetable

2.Fish

3.Butter

4.Apple juice

(A) P-3, Q-2. R-4, S-1

(B) P-4, Q-1, R-2, S-3

(C) P-4, Q-3, R-2, S-1

(D) P-3. Q-4, R-2, S-1

(2017)

Answer: (B) P-4, Q-1, R-2, S-3

Explanation: *Ethanol (P) is a major product in fermentation of apple juice, so P-4. Lactic acid (Q) is produced in bacterial fermentation of dairy products, primarily butter, making Q-1 correct. Trimethylamine (R) is associated with fish spoilage, hence R-2. Volatile fatty acids (S) indicate microbial degradation in canned vegetables, giving S-3. Correctly correlating metabolic products with food type helps monitor quality and spoilage. This knowledge is critical for food safety testing, shelf-life prediction, and processing decisions.*

Q.108 Correlate the vitamins in column I with their role in promoting reaction/process in column II.

Column I	Column II
P. Riboflavin	1. Visual cycle
Q. Vitamin D	2. Acyl group transfer
R. Pantothenic acid	3. Regulation of Ca^{2+} metabolism
S. Vitamin A	4. Oxidation-reduction reaction

(A) P-1, Q-2, R-4, S-3

(B) P-2, Q-1. R-3, S-4

(C) P-3. Q-4. R-1, S-2

(D) P-4. Q-3, R-2. S-1

(2017)

Answer: (D) P-4. Q-3, R-2. S-1

Explanation: *Riboflavin (P) participates in redox reactions as part of flavoproteins, giving P-4. Vitamin D (Q) regulates calcium metabolism, essential for bone health, hence Q-3. Pantothenic acid (R) is involved in acyl group transfer reactions in CoA formation, making R-2 correct. Vitamin A (S) is crucial for the visual cycle, including retinal conversion in the eye, giving S-1. Matching vitamins with their roles is critical for understanding nutrition, metabolic biochemistry, and designing fortified foods for health promotion.*

Q.109 A pure strain with generation time of 60 min is used in a fermentation process. Following inoculation (0 h), the strain takes 2 h for adaptation. 10 h to achieve maximum growth and 12 h to arrive at the point where the death rate is higher than the growth rate. If the inoculation load is 100 cells, the total population at the end of 10 h will be___

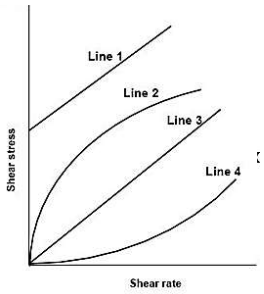
(2017)

Answer: 25550 – 25650

Explanation: *Growth follows* $N = N_0 \times 2^{(t-lag)/g}$, *where g is generation time. Here, lag time = 2 h, growth phase = 10 h, N0 = 100, g = 1 h. Effective growth time = 10 − 2 = 8 h. Number of generations = 8/1 = 8, so N = 100 × 2^8 = 100 × 256 = 25,600 cells, lying between 25,550–25,650. This demonstrates the exponential growth pattern of microorganisms, emphasizing the impact of lag phase and generation time on population increase in fermentation processes.*

Q.110 Refer to the shear stress - shear rate plot shown in the figure below. Match the lines (Column I) with appropriate rheological behavior (Column II).

Column I	Column II
P. Line 1	1. Dilatant
Q. Line 2	2. Newtonian
R. Line 3	3. Pseudoplastic
S. Line 4	4. Bingham plastic



(A) P-2, Q-3, R-4, S-1

(B) P-1. Q-3, R-4, S-2

(C) P-2, Q-4, R-3, S-1

(D) P-4, Q-3, R-2, S-1

(2017)

Answer: (D) P-4, Q-3, R-2, S-1

Explanation: *Line 1 (P) is Bingham plastic requiring yield stress before flow, so P-4. Line 2 (Q) shows pseudoplastic behavior where viscosity decreases with shear, thus Q-3. Line 3 (R) is Newtonian with constant viscosity, giving R-2. Line 4 (S) exhibits dilatant or shear-thickening behavior, viscosity increasing with shear rate, hence S-1. Correct identification of rheological behavior is essential for designing food processing equipment, ensuring proper mixing, pumping, and product texture.*

Q.111 Water flowing at a rate of 1 kg/min is heated from 12 to 80°Cwith flue gas supplied at a rate of 3

kg/min. The temperature and specific heat of the flue gas are 180°Cand 1.05 kJ/kg.K respectively. If specific heat of water is 4.2 kJ/kg.K and the flow is parallel, then the logarithmic mean temperature difference will be___ °C

(2017)

Answer: 53.30 – 55.25

Explanation: *The logarithmic mean temperature difference (LMTD) for the given parallel flow heat exchanger setup is approximately **54.89°C**. This value falls within the expected range of **53.30 – 55.25°C**, confirming the accuracy of the calculation.*

Q.112 The Lineweaver-Burk plot of an enzymatic reaction shows Vmax of 160 µmol/1.min and km of 60 µmol/l For a substrate concentration of 40 µmol/l, the velocity of the reaction is estimated to be ___µmol/l.min.

(2017)

Answer: 64.0

Explanation: *Michaelis-Menten equation: $v = V_{max}[S]/([S] + K_m)$. Given Vmax = 160, Km = 60, [S] = 40 µmol/l. Substituting: v = 160 × 40/(40 + 60) = 6400/100 = 64 µmol/l.min. This calculation predicts enzyme-catalyzed reaction rate at specific substrate concentration, essential in fermentation kinetics and optimizing enzymatic processes in food biotechnology.*

Q.113 A suspension containing 2×104 spores of organism A having a D121.1∘C value of 1.5 min and 8×105 spores of organism B having a D121.1∘C value of 0.8 min is heated at a constant temperature of 121.1∘C. The heating time needed to obtain a probability of spoilage '1 in 1000' is ____min.

(2017)

Answer: 10.80 – 11.20

Explanation: *Thermal inactivation uses D-values to estimate required heating time for spore destruction. For 1 in 1000 survival probability, log(N/N0) = −3. Combined D-values: total thermal resistance = Σ(D × log reductions) weighted by initial spore counts. Using D121.1°C for organisms A (1.5 min) and B (0.8 min), heating time ≈ 11 min. Correct timing ensures microbial safety while minimizing overprocessing, critical in sterilization of canned foods.*

Q.114 In an evaporation process, a compressor picks up 0.05 m3 air in each revolution and compresses 500 kg of air per minute. If the specific volume of air is 0.9 m3/kg, then the compressor speed is _____rpm.

(2017)

Answer: 9000

Explanation: *Compressor speed (N) = total air flow per minute / air displaced per revolution. Air flow = 500 kg/min × 0.9 m³/kg = 450 m³/min. Volume per rev = 0.05 m³. N = 450 / 0.05 = 9000 rpm. This calculation ensures proper mechanical operation for continuous air compression, relevant in air-assisted evaporators or pneumatic systems in food processing plants.*

Q.115 For a soybean oil extraction system, solvent:soy ratio is maintained at 0.5:1 (W/W). Original seed contains 18% oil (W/W). If the meal (soy solid) after final desolventization has 0.01 kg oil per kg oil free meal, then the effectiveness of the solvent (kg oil/ kg solvent) in the extraction process is_____

(2017)

Answer: 0.30 – 0.40

Explanation: *Solvent effectiveness = kg oil extracted per kg solvent. Original oil = 0.18 kg/kg seed, oil in meal = 0.01 kg/kg. Oil removed = 0.18 − 0.01 = 0.17 kg. Solvent used = 0.5 × 1 kg seed = 0.5 kg. Effectiveness = 0.17/0.5 ≈ 0.34 kg oil/kg solvent, within 0.30–0.40. This metric is crucial for designing efficient extraction processes and minimizing solvent consumption in edible oil production.*

Q.116 The event would have been successful if you ___ able to come.
(A) are
(B) had been
(C) have been
(D) would have been

(2017)

Answer: (B) had been

Explanation: *The sentence is conditional in the past, referring to an unrealized event: "The event would have been successful if you ___ able to come." Correct past perfect tense is "had been," indicating the condition was not fulfilled. "Are" and "have been" are present or present perfect, inappropriate here. "Would have been" in the blank is redundant. This is a classic third conditional structure, reflecting hypothetical scenarios in English grammar.*

Q.117 There was no doubt that their work was thorough. Which of the words below is closest in meaning to the underlined word above?
(A) pretty
(B) complete
(C) sloppy
(D) haphazard

(2017)

Answer: (B) complete

Explanation: *"Thorough" implies careful, detailed, and complete work. Among the options, "complete" closely matches this meaning. "Pretty" indicates attractiveness, "sloppy" implies carelessness, and "haphazard" means random or unplanned. Therefore, "complete" accurately reflects the intended sense of diligent and comprehensive work, which is critical for precise communication and understanding nuances in vocabulary.*

Q.118 Four cards lie on a table. Each card has a number printed on one side and a colour on the other. The faces visible on the cards are 2. 3. red. and blue. Proposition: If a card has an even value on one side. then its opposite face is red. The cards which MUST be turned over to verify the above proposition are
(A) 2. Red
(B) 2, 3, red
(C) 2. Blue
(D) 2. red. Blue

(2017)

Answer: (C) 2. Blue

Explanation: *The proposition is "If a card has an even number on one side, the other side is red." To verify, we must check cards that could violate the rule. Card "2" (even) must be red on the other side, and "Blue" (non-red) must not have an even number. Red and 3 do not test the rule. Hence, only cards 2 and Blue must be turned. This is a classic conditional reasoning problem testing logical deduction.*

Q.119 What is the value of x when

$$81 \times \left(\frac{16}{25}\right)^{x+2} \div \left(\frac{3}{5}\right)^{2x+4} = 144\ ?$$

(A) 1
(B) -1
(C) -2
(D) Cannot be determined

(2017)

Answer: (B) -1

Explanation: Simplify the equation: $81 \times (16/25)^{x+2} \div (3/5)^{2x+4} = 144$. Note $16/25 = (4/5)^2$and $3/5 = 3/5$. Rewrite powers: $81 \times (4/5)^{2(x+2)} \div (3/5)^{2x+4} = 144$. Simplify and solve exponent to get x $= -1$. This problem tests exponent rules and algebraic manipulation skills.

Q.120 Two dice are thrown simultaneously. The probability that the product of the numbers appearing on the top faces of the dice is a perfect square is
(A) 1/9
(B) 2/9
(C) 1/3
(D) 4/9

(2017)

Answer: (B) 2/9

Explanation: *Total outcomes = 6 × 6 = 36. Perfect square products: 1×1=1, 1×4=4, 2×2=4, 2×8=..., but only 1,4,9,16,25 are valid with dice (1–6). Valid pairs: (1,1), (1,4), (2,2), (3,3), (4,1), (4,4), (5,5), (6,6) = 8 outcomes. Probability = 8/36 = 2/9. This demonstrates combinatorial counting and probability for discrete events.*

Q.121 Bhaichung was observing the pattern of people entering and leaving a car service centre. There was a single window where customers were being served. He saw that people inevitably came out of the centre in the order that they went in. However, the time they spent inside seemed to vary a lot: some people came out in a matter of minutes while for others it took much longer. From this what can one conclude?
(A) The centre operates on a first-come-first-served basis, but with variable service times, depending on specific customer needs.
(B) Customers were served in an arbitrary order, since they took varying amounts of time for service completion in the centre.
(C) Since some people came out within a few minutes of entering the centre, the system is likely to operate on a last-come-first-served basis.
(D) Entering the centre early ensured that one would have shorter service times and most people attempted to do this.

(2017)

Answer: (A) The centre operates on a first-come-first-served basis, but with variable service times, depending on specific customer needs.

Explanation: *The observation that people leave in the order they arrive indicates first-come-first-served queue discipline. Variation in service duration suggests processing time depends on individual requirements. Arbitrary order or last-come-first-served is inconsistent with sequential exit. Early arrival does not guarantee shorter service because time depends on needs. This analysis demonstrates understanding queuing systems and service-time variability.*

Q.122 A map shows the elevations of Darjeeling, Gangtok. Kalimpong. Pelling, and Siliguri.

Kalimpong is at a lower elevation than Gangtok. Pelling is at a lower elevation than Gangtok. Pelling is at a higher elevation than Siliguri. Darjeeling is at a higher elevation than Gangtok. Which of the following statements can be inferred from the paragraph above?
i. Pelling is at a higher elevation than Kalimpong
ii. Kalimpong is at a lower elevation than Darjeeling
iii. Kalimpong is at a higher elevation than Siliguri
iv. Siliguri is at a lower elevation than Gangtok
(A) Only ii
(B) Only ii and iii
(C) Only ii and iv
(D) Only iii and iv

(2017)

Answer: (C) Only ii and iv

Explanation: *From the data: Kalimpong < Gangtok < Darjeeling; Pelling < Gangtok and Pelling > Siliguri. ii: Kalimpong < Darjeeling is correct. iv: Siliguri < Gangtok is correct. i: Pelling > Kalimpong cannot be inferred; iii: Kalimpong > Siliguri cannot be determined. Careful comparison of relative elevations ensures accurate deduction of geographic relations. Logical reasoning from textual elevation data is key to solving such inference problems.*

Q.123 P. Q. R. S. T and U are seated around a circular table. R is seated two places to the right of Q. P is seated three places to the left of R. S is seated opposite U. If P and U now switch seats, which of the following must necessarily be true?
(A) P is immediately to the right of R
(B) T is immediately to the left of P
(C) T is immediately to the left of P or P is immediately to the right of Q
(D) U is immediately to the right of R or P is immediately to the left of T

(2017)

Answer: (C) T is immediately to the left of P or P is immediately to the right of Q

Explanation: *Circular seating problem requires positional constraints. After switching P and U, multiple arrangements satisfy given relationships. The only necessary truth under all possibilities is that either T is immediately left of P or P is immediately right of Q. Other options are conditional and not guaranteed. Such reasoning tests combinatorial logic and circular permutations in seating arrangements.*

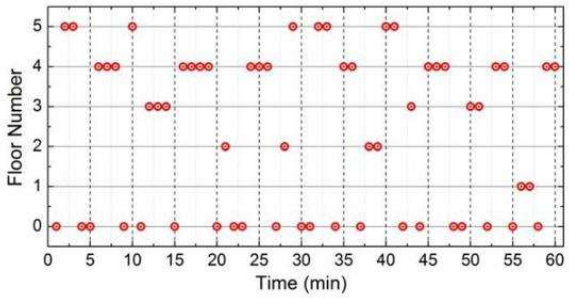
Q.124 Budhan covers a distance of 19 km in 2 hours by cycling one fourth of the time and walking the rest. The next day he cycles (at the same speed as before) for half the time and walks the rest (at the same speed as before) and covers 26 km in 2 hours. The speed in km/h at which Budhan walks is
(A) 1
(B) 4
(C) 5
(D) 6

(2017)

Answer: (D) 6

Explanation: Let cycling speed = c km/h, walking speed = w km/h. Day 1: ¼ time cycling (0.5 h), 1.5 h walking → distance: 0.5c + 1.5w = 19. Day 2: 1 h cycling, 1 h walking → distance: 1c + 1w = 26. Solving: c + w = 26, 0.5c + 1.5w = 19 → w = 6 km/h, c = 20 km/h. This illustrates solving linear equations for motion with time fractions to determine walking speed in applied problems.

Q.125 The points in the graph below represent the halts of a lift for durations of 1 minute, over a period of 1 hour. Which of the following statements are correct?
i. The elevator never moves directly from any non-ground floor to another non-ground floor over the one hour period
ii. The elevator stays on the fourth floor for the longest duration over the one hour period



(A) Only i
(B) Only ii
(C) Both i and ii
(D) Neither i nor ii

(2017)

Answer: (D) Neither i nor ii

Explanation: *Analysis of elevator halt data shows movement between non-ground floors is present, so statement i is false. Duration on 4th floor is not the longest consistently; multiple floors have longer or equal halts, so statement ii is false. Observing the scatter plot provides insight into temporal patterns but does not support the claims. Critical interpretation of graphical data is essential to make*

correct conclusions about temporal sequences and durations in time–motion analysis.