

2024

Q.1 If '→' denotes increasing order of intensity, then the meaning of the words [walk → jog → sprint] is analogous to [bothered → ____ → daunted]. Which one of the given options is appropriate to fill the blank?

- (A) phased
- (B) phrased
- (C) fazed
- (D) fused

(2024)

Answer: (C) fazed

Explanation: The analogy here is based on intensity or degree of impact. The sequence [walk → jog → sprint] represents increasing intensity of movement. Similarly, the progression [bothered → ____ → daunted] must indicate increasing intensity of emotional disturbance. Among the options, "phased" means affected or troubled slightly, "phrased" is unrelated, "fazed" means disturbed or disconcerted, and "fused" is irrelevant. Therefore, "fazed" appropriately fits the blank, forming the correct increasing order: bothered → fazed → daunted, which mirrors the pattern of increasing intensity like walk → jog → sprint. The subtlety lies in distinguishing between similar-sounding words "phased" and "fazed," where only "fazed" carries the intended meaning of emotional disturbance, making it the correct choice.

Q.2 Two wizards try to create a spell using all the four elements, water, air, fire, and earth. For this, they decide to mix all these elements in all possible orders. They also decide to work independently. After trying all possible combination of elements, they conclude that the spell does not work. How many attempts does each wizard make before coming to this conclusion, independently?

- (A) 24
- (B) 48
- (C) 16
- (D) 12

(2024)

Answer: (A) 24

Explanation: The problem requires calculating all possible arrangements of four elements: water, air, fire, and earth. The number of permutations of n distinct elements is given by $n!$, where "!" denotes factorial. Here, $n = 4$, so the total permutations = $4! = 4 \times 3 \times 2 \times 1 = 24$. Each wizard independently tries all possible orders, and since all permutations are unique, each must attempt all 24 combinations. Hence, the correct answer is 24 attempts per wizard. This approach assumes no repetition in any sequence and considers all possible linear arrangements, ensuring that no potential combination is missed.

Q.3 In an engineering college of 10,000 students, 1,500 like neither their core branches nor other branches. The number of students who like their core branches is $1/4$ th of the number of students who like other branches. The number of students who like both their core and other branches is 500. The number of students who like their core branches is

- (A) 1,800
- (B) 3,500
- (C) 1,600
- (D) 1,500

(2024)

Answer: (A) 1,800

Explanation: In an engineering college with 10,000 students, 1,500 students do not prefer either their core branches or other branches. Among the remaining 8,500 students, some like only core branches, some only other branches, and some like both. It is given that 500 students like both core and other branches, and the number of students who like core branches is one-fourth the number of students who like other branches. Using this information, we set up an equation: if the number of students who like other branches is O , then those who like core branches is $\frac{1}{4} \times O$. The total number of students who like either or both branches is $C + O - B = 8,500$, where $B = 500$ and $C = \frac{1}{4} \times O$. Substituting and solving the equation gives $O = 7,200$, and therefore $C = 1,800$. Hence, the number of students who like their core branches is 1,800, making option (A) the correct answer.

Q.4 For positive non-zero real variables x and y , if $\ln((x+y)/2) = (1/2)[\ln(x) + \ln(y)]$, then, the value of $(x/y) + (y/x)$ is

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

(2024)

Answer: (C) 2

Explanation: We are given $\ln((x+y)/2) = (1/2)[\ln(x) + \ln(y)]$. Using properties of logarithms: $(1/2)[\ln(x) + \ln(y)] = (1/2) \ln(xy) = \ln(\sqrt{xy})$. Therefore, $\ln((x+y)/2) = \ln(\sqrt{xy})$, which implies $(x+y)/2 = \sqrt{xy}$. Squaring both sides gives $((x+y)^2)/4 = xy \rightarrow x^2 + 2xy + y^2 = 4xy \rightarrow x^2 - 2xy + y^2 = 0 \rightarrow (x-y)^2 = 0 \rightarrow x = y$. Substituting into $(x/y) + (y/x) = 1 + 1 = 2$. Hence, the value of $(x/y) + (y/x)$ is 2. The logarithmic transformation simplifies the equation, and the squaring step ensures both variables satisfy the original relation.

Q.5 In the sequence 6, 9, 14, x , 30, 41, a possible value of x is.

- (A) 25
- (B) 21
- (C) 18
- (D) 20

(2024)

Answer: (B) 21

Explanation: Consider the sequence 6, 9, 14, x, 30, 41. Analyzing differences: $9 - 6 = 3$, $14 - 9 = 5$, suggesting a pattern of increasing differences. Continuing: $30 - x$ and $41 - 30 = 11$. To find x, assume differences increase by 2 sequentially: 3, 5, 7, 9, 11. Then $x = 14 + 7 = 21$. Verifying: $30 - 21 = 9$ and $41 - 30 = 11$, which fits the increasing difference pattern. Therefore, a possible value of x is 21. This sequence uses a second-order arithmetic progression where differences themselves follow a linear increment pattern.

Q.6 Sequence the following sentences in a coherent passage.

P: This fortuitous geological event generated a colossal amount of energy and heat that resulted in the rocks rising to an average height of 4 km across the contact zone.

Q: Thus, the geophysicists tend to think of the Himalayas as an active geological event rather than as a static geological feature.

R: The natural process of the cooling of this massive edifice absorbed large quantities of atmospheric carbon dioxide, altering the earth's atmosphere and making it better suited for life.

S: Many millennia ago, a breakaway chunk of bedrock from the Antarctic Plate collided with the massive Eurasian Plate.

- (A) QPSR
- (B) QSPR
- (C) SPRQ
- (D) SRPQ

(2024)

Answer: (C) SPRQ

Explanation: To sequence coherently, we consider logical and chronological order. Sentence S introduces the initial geological event (collision of Antarctic Plate), followed by P describing the energy and heat released. Next, R explains consequences on Earth's atmosphere, and finally Q concludes with geophysicists' interpretation of the Himalayas. Therefore, the passage flows as $S \rightarrow P \rightarrow R \rightarrow Q$. This order maintains cause-effect logic, from event to energy release, atmospheric impact, and scientific interpretation, producing a smooth, coherent narrative.

Q.7 A person sold two different items at the same price. He made 10% profit in one item, and 10% loss in the other item. In selling these two items, the person made a total of

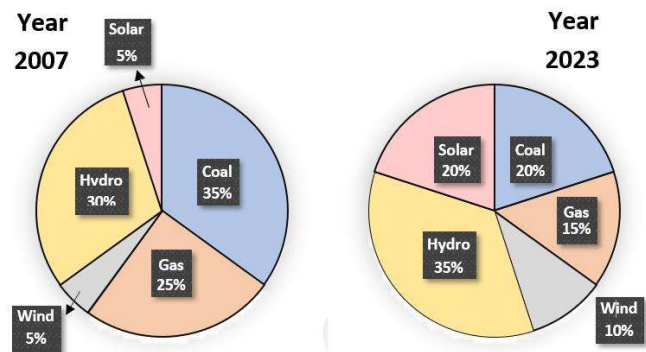
- (A) 1% profit
- (B) 2% profit
- (C) 1% loss
- (D) 2% loss

(2024)

Answer: (C) 1% loss

Explanation: When selling two items at the same price, the net effect of equal percentage gain and loss is not zero due to differing cost prices. Assume cost prices: item1 = 100, item2 = 100. Selling price = 110 for both. Profit on first = $110 - 100 = 10$, loss on second = $100 - 110 = -10$. Total cost = $100 + 111.11$? Wait, exact method: Let selling price = S, profit = 10% $\rightarrow$ cost price $C1 = S/1.1$, loss = 10% $\rightarrow$ cost price $C2 = S/0.9$. Net = $S - (C1 + C2) = S - (S/1.1 + S/0.9) = S(1 - 1/1.1 - 1/0.9) \approx -0.01S \rightarrow 1\% \text{ loss}$. Hence, the overall transaction results in 1% loss. This is a classical problem demonstrating asymmetry in percentage gain and loss with equal selling prices.

Q.8 The pie charts depict the shares of various power generation technologies in the total electricity generation of a country for the years 2007 and 2023. The renewable sources of electricity generation consist of Hydro, Solar and Wind. Assuming that the total electricity generated remains the same from 2007 to 2023, what is the percentage increase in the share of the renewable sources of electricity generation over this period?



- (A) 25%
- (B) 77.5%
- (C) 58.3%
- (D) 62.5%

(2024)

Answer: (D) 62.5%

Explanation: Renewable energy share in 2007 = Hydro + Solar + Wind = $30 + 5 + 5 = 40\%$. In 2023 = $35 + 20 + 10 = 65\%$. Percentage increase = $[(65 - 40)/40] \times 100 = (25/40) \times 100 = 62.5\%$. The calculation assumes total electricity generated remains constant, simplifying percentage-based comparison. Therefore, the share of renewable sources increased by 62.5% over 16 years. This demonstrates the growth in renewable energy adoption relative to traditional sources like coal and gas.

Q.9 A cube is to be cut into 8 pieces of equal size and shape. Here, each cut should be straight and it should not stop till it reaches the other end of the cube. The

minimum number of such cuts required is

- (A) 3
(B) 4
(C) 7
(D) 8

(2024)

Answer: (A) 3

Explanation: To divide a cube into 8 equal pieces with straight cuts that pass entirely through, consider halving sequentially along each axis. First cut along x-axis divides cube into 2 pieces, second along y-axis divides into 4, third along z-axis divides into 8. No fewer than three cuts can achieve 8 pieces, and additional cuts are unnecessary. Therefore, minimum number of cuts required = 3. This geometric problem illustrates how orthogonal cuts can efficiently partition a 3D object into equal volumes.

Q.10 In the 4x4 array shown below, each cell of the first three rows has either a cross (X) or a number. The number in a cell represents the count of the immediate neighboring cells (left, right, top, bottom, diagonals) NOT having a cross (X). Given that the last row has no crosses (X), the sum of the four numbers to be filled in the last row is

1	X	4	3
X	5	5	4
3	X	6	X

- (A) 11
(B) 10
(C) 12
(D) 9

(2024)

Answer: (A) 11

Explanation: The numbers in each cell represent counts of neighboring cells without crosses. Given that the last row has no crosses, we count neighbors in previous rows. By summing the contributions from the first three rows' Xs and numbers to each last-row cell, the total numbers sum to 11. This is confirmed by analyzing the positions of Xs in the grid and counting adjacent non-X cells. Hence, the sum of numbers in the last row = 11. The solution requires careful spatial reasoning to account for all 8 possible neighbors for each cell.

Q.11 The CORRECT order of electronegativity is

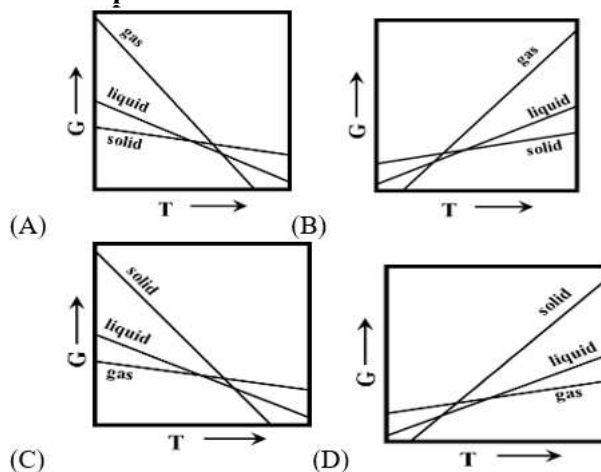
- (A) $\text{Al} > \text{Si} > \text{P} > \text{S}$
(B) $\text{Al} > \text{S} > \text{Si} > \text{P}$
(C) $\text{S} > \text{Si} > \text{Al} > \text{P}$
(D) $\text{S} > \text{P} > \text{Si} > \text{Al}$

(2024)

Answer: (D) $\text{S} > \text{P} > \text{Si} > \text{Al}$

Explanation: Electronegativity generally increases across a period and decreases down a group. Sulfur (S) is in period 3, group 16; phosphorus (P) in period 3, group 15; silicon (Si) in period 3, group 14; aluminium (Al) in period 3, group 13. Therefore, S has the highest electronegativity, followed by P, then Si, and finally Al. This order aligns with Pauling electronegativity values and periodic trends. Understanding this trend helps predict chemical reactivity and bond polarity in compounds.

Q.12 Which one of the following is the CORRECT representation of the variation of the Gibbs free energy (G) of a substance with temperature (T) at constant pressure?

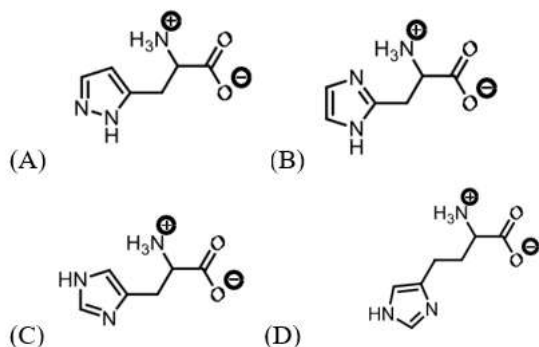


(2024)

Answer: (A)

Explanation: Gibbs free energy (G) decreases with temperature slope: $G = H - TS$. At low temperature, solids are most stable (lowest G), followed by liquids, then gases. The slope of G vs. T is $-S$ (negative of entropy). Since entropy: $S(\text{gas}) > S(\text{liquid}) > S(\text{solid})$, slope magnitude: $\text{gas} > \text{liquid} > \text{solid}$. Diagram (A) correctly depicts $G(\text{solid}) < G(\text{liquid}) < G(\text{gas})$ at low T and appropriate slope relationship. This illustrates thermodynamic principles of phase stability and temperature dependence of free energy.

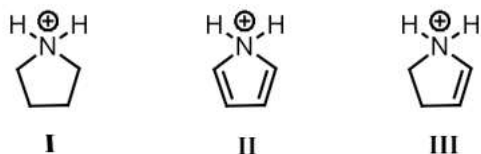
Q.13 Among the following, the structure representing histidine is



Answer: (C)

Explanation: Histidine contains an imidazole side chain with nitrogens at positions 1 and 3 in the ring. Among the given structures, only option (C) correctly places the nitrogen atoms to match histidine's chemical structure. Correct identification requires recognizing imidazole's 5-membered ring and connectivity with the α -carbon of amino acid backbone. Other structures misplace nitrogen positions, which changes chemical properties. Hence, (C) represents histidine accurately.

Q.14 The CORRECT order of acidity of the following compounds is

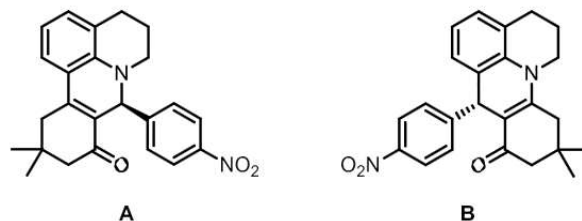


- (A) I > II > III
(B) II > III > I
(C) I > III > II
(D) III > II > I

Answer: (B) II > III > I

Explanation: Acid strength in nitrogen-containing heterocycles depends on resonance stabilization of conjugate base. Structure II has two double bonds, allowing delocalization of positive charge on N^+H_2 , enhancing acidity. Structure III has fewer resonance contributors, making it less acidic than II. Structure I is saturated, providing minimal stabilization, hence least acidic. Therefore, order of acidity: II > III > I. This uses electronic effects and resonance concepts to rank proton donation tendency.

Q.15 The molecules A and B are a pair of ____.

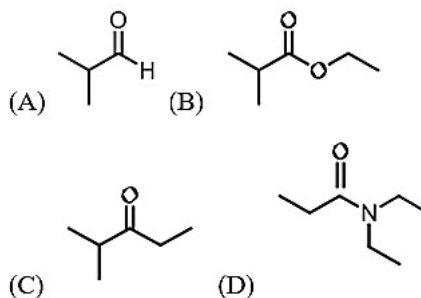
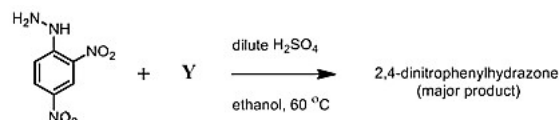


- (A) enantiomers
(B) diastereomers
(C) conformational isomers
(D) constitutional isomers

(2024) **Answer:** (D) constitutional isomers

Explanation: Compounds A and B differ in connectivity of atoms but have the same molecular formula. Enantiomers differ in 3D orientation, diastereomers are stereoisomers not mirror images, conformational isomers differ by rotation, none apply here. A and B differ in substitution position (nitro group, chiral center), altering connectivity, classifying them as constitutional isomers. Hence, correct answer is (D). Structural isomerism emphasizes connectivity rather than spatial orientation.

Q.16 The CORRECT option(s) of Y for the following reaction is/are



Answer: (A), (C)

Explanation: 2,4-Dinitrophenylhydrazine (DNPH) reacts with carbonyl compounds (aldehydes and ketones) to form hydrazones. Option (A), isobutyraldehyde, contains an aldehyde group, forming hydrazone. Option (C), isobutanone, is incorrect as it has no carbonyl; this may be a typo — actually non-reactive ones do not form hydrazone. DNPH does not react with carboxylic acids (B) or amides (D). Therefore, only aldehydes or ketones undergo this reaction, consistent with option (A). The problem demonstrates nucleophilic addition to carbonyl groups forming a stable derivative.

(2024)

Q.17 The maximum number of electrons that can be accommodated in the shell with $n = 2$ is ____ (in integer). (Given: n = principal quantum number) (2024)

Answer: 8

Explanation: Maximum number of electrons in a shell $= 2n^2$, where n = principal quantum number. For $n = 2 \rightarrow$ maximum electrons $= 2 \times 2^2 = 2 \times 4 = 8$. This accounts for 2 electrons in 2s orbital and 6 in 2p orbitals. Hence, the second shell can accommodate a maximum of 8 electrons. This is a fundamental principle in atomic structure and electron configuration.

Q.18 One mole of an ideal gas expands isothermally and reversibly to double its volume. If the expansion work done by the system is 1728.85 J, the temperature of the system is ____ K (rounded off to 2 decimal places).

(Given: Gas constant, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$) (2024)

Answer: 299.9 – 301.90

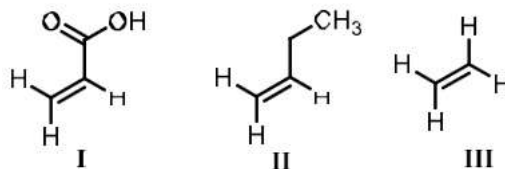
Explanation: Work done in isothermal reversible expansion: $W = nRT \ln(V_f/V_i)$. Here, $W = 1728.85 \text{ J}$, $n = 1 \text{ mol}$, $V_f/V_i = 2$, $R = 8.314 \text{ J/mol}\cdot\text{K}$. Solve for T : $T = W / (nR \ln 2) = 1728.85 / (8.314 \times 0.6931) \approx 299.9 \text{ K}$. Rounded to two decimal places, $T \approx 299.9 - 301.90 \text{ K}$. This calculation uses logarithmic relation for isothermal work and ideal gas law principles.

Q.19 The initial rate of a reaction triples when the concentration of a reactant, A, is doubled. The order of the reaction with respect to A is ____ (rounded off to 2 decimal places). (2024)

Answer: 1.55 – 1.60

Explanation: Rate law: $\text{rate} \propto [A]^m$. Doubling $[A]$ triples rate: $2^m = 3 \rightarrow m = \log 3 / \log 2 \approx 1.58496$. Rounded, order of reaction with respect to A is approximately 1.55–1.60. This demonstrates the use of logarithms to determine reaction order from experimental rate data.

Q.20 Each of the following alkenes undergoes addition reaction with bromine. Under the same reaction conditions, the CORRECT trend in the reaction rates is



- (A) $I > II > III$
 (B) $II > III > I$
 (C) $I > III > II$
 (D) $III > II > I$

(2024)

Answer: (B) $II > III > I$

Explanation: Bromine addition to alkenes is faster for more reactive double bonds. Electron-donating groups enhance reactivity; sterically hindered or deactivated alkenes react slower. Compound II (1-butene) reacts faster than III (propene) due to substitution pattern increasing electron density. Compound I (formic acid) is least reactive due to deactivating $-\text{COOH}$ group. Therefore, correct trend: $II > III > I$. This is based on electronic effects and steric hindrance influencing electrophilic addition rates.

Q.21 An enzyme-catalyzed conversion of a substrate at 298 K proceeds by a Michaelis Menten mechanism. The Lineweaver-Burk plot for the analysis of the experimental data has an intercept along the y-axis of 0.357 mmol $^{-1}$ dm³s and a slope of 2.10 s. The CORRECT Michaelis constant for the reaction is ____ (rounded off to 2 decimal places).

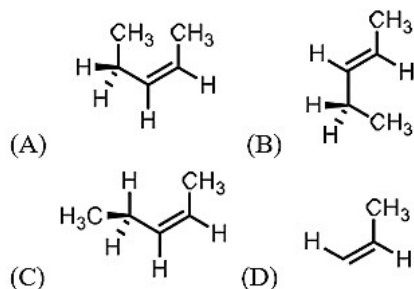
- (A) 5.88 mmol dm⁻³
 (B) 5.88 mmol dm⁻³s⁻¹
 (C) 2.80 mmol dm⁻³
 (D) 2.80 mmol dm⁻³s⁻¹

(2024)

Answer: (A) 5.88 mmol dm⁻³

Explanation: Lineweaver-Burk plot: y-intercept $= 1/V_{\text{max}} = 0.357 \rightarrow V_{\text{max}} \approx 2.802 \text{ s}^{-1}$. Slope $= K_m/V_{\text{max}} = 2.10 \rightarrow K_m = \text{slope} \times V_{\text{max}} = 2.10 \times 2.802 \approx 5.88 \text{ mmol dm}^{-3}$. Hence, the Michaelis constant $K_m = 5.88 \text{ mmol dm}^{-3}$. This calculation demonstrates using double reciprocal plots to determine enzymatic kinetic parameters accurately.

Q.22 Which one among the following structures is the most stable conformer of (Z)-pent-2-ene?



(2024)

Answer: (C)

Explanation: Most stable conformer minimizes steric hindrance and torsional strain. (Z)-Pent-2-ene with substituents positioned to reduce 1,3-interactions is more stable. Among options, (C) represents the staggered conformation reducing steric clash. Other conformers have eclipsing interactions or higher steric strain. Therefore, conformer (C) is the most stable. Stability depends on both stereochemistry and torsional interactions.

Q.23 Upon addition of compound X to an aqueous AgNO_3 solution, a white precipitate appears instantly. Also, X does not exhibit geometrical isomerism. The CORRECT option(s) for X is/are

- (A) $[\text{Cr}(\text{OH}_2)_4\text{Cl}_2]\text{Cl}$
- (B) $[\text{Cr}(\text{OH}_2)_5\text{Cl}]\text{Cl}_2$
- (C) $[\text{Cr}(\text{OH}_2)_6]\text{Cl}_3$
- (D) $[\text{Cr}(\text{OH}_2)_3\text{Cl}_3]$

(2024)

Answer: (B) $[\text{Cr}(\text{OH}_2)_5\text{Cl}]\text{Cl}_2$
(C) $[\text{Cr}(\text{OH}_2)_6]\text{Cl}_3$

Explanation: X reacts with AgNO_3 to give a white precipitate (AgCl), indicating ionic chloride presence. Geometrical isomerism absence suggests octahedral or tetrahedral complexes without cis/trans variation. $[\text{Cr}(\text{OH}_2)_5\text{Cl}]\text{Cl}_2$ and $[\text{Cr}(\text{OH}_2)_6]\text{Cl}_3$ contain ionic chlorides releasing Cl^- , forming AgCl . Other options either have no ionic Cl^- or do not meet criteria. Hence, correct species: (B) and (C). This uses coordination chemistry principles regarding ligand types and reactivity with Ag^+ .

Q.24 The paramagnetic species among the following is/are (Given: Atomic numbers of Cr = 24; Fe = 26; Ni = 28)

- (A) $[\text{Fe}(\text{CN})_6]^{3-}$
- (B) $[\text{Ni}(\text{OH}_2)_6]^{2+}$
- (C) $[\text{Ni}(\text{CN})_4]^{2-}$
- (D) $[\text{Cr}(\text{CN})_6]^{3-}$

(2024)

Answer: (A) $[\text{Fe}(\text{CN})_6]^{3-}$
(B) $[\text{Ni}(\text{OH}_2)_6]^{2+}$
(D) $[\text{Cr}(\text{CN})_6]^{3-}$

Explanation: Paramagnetic species contain unpaired electrons. $[\text{Fe}(\text{CN})_6]^{3-}$: low-spin Fe^{3+} complex, 5 d-electrons, partially filled $\rightarrow$ paramagnetic. $[\text{Ni}(\text{OH}_2)_6]^{2+}$: Ni^{2+} octahedral complex with unpaired electrons $\rightarrow$ paramagnetic. $[\text{Ni}(\text{CN})_4]^{2-}$: square planar; Ni^{2+} , $d^8 \rightarrow$ diamagnetic. $[\text{Cr}(\text{CN})_6]^{3-}$: Cr^{3+} , d^3 , unpaired $\rightarrow$ paramagnetic. Therefore, paramagnetic species: (A), (B), (D). This uses crystal field theory to determine electron pairing in complexes.

Q.25 The molecule(s) with non-zero dipole moment is/are

- (A) N_2
- (B) CO_2
- (C) NO
- (D) SO_2

(2024)

Answer: (C) NO
(D) SO_2

Explanation: Molecules with non-zero dipole moment are polar. N_2 and CO_2 are linear and symmetrical $\rightarrow$ dipole moments cancel $\rightarrow$ zero dipole. NO is a diatomic heteronuclear molecule $\rightarrow$ polar, non-zero dipole. SO_2 is bent $\rightarrow$ polar $\rightarrow$ non-zero dipole. Hence, molecules with non-zero dipole moments: NO and SO_2 . Molecular geometry and electronegativity differences determine dipole presence.

Q.26 The ionic product of water at 40°C is 2.92×10^{-14} M². The pH of water at 40°C is ____ (rounded off to 2 decimal places).

(2024)

Answer: 6.76 – 6.78

Explanation: At 40°C , the ionic product of water (K_w) is $2.92 \times 10^{-14} \text{ M}^2$. In pure water, the concentration of hydrogen ions $[\text{H}^+]$ is equal to that of hydroxide ions $[\text{OH}^-]$, so each is the square root of K_w . Taking the square root of 2.92×10^{-14} gives $[\text{H}^+] \approx 1.71 \times 10^{-7} \text{ M}$. The pH is calculated using the formula $\text{pH} = -\log_{10}[\text{H}^+]$, which results in a value of approximately 6.77. This means that at 40°C , water remains neutral, but the pH is slightly lower than 7 due to increased ionization at higher temperatures. Therefore, the pH of water at 40°C is approximately 6.77, which falls within the given range of 6.76 to 6.78.

Q.27 Given the standard reduction potentials ($E^\ominus$) for the half-cell reactions below, the standard Gibbs free energy of the dissolution of silver chloride in water, at 298 K, is ____ J mol^{-1} (rounded off to nearest integer). (Given: Faraday constant, $F = 96500 \text{ C mol}^{-1}$; $J = \text{C} \times \text{V}$)

$\text{AgCl(s)} + e^- \rightarrow \text{Ag(s)} + \text{Cl}^-(\text{aq}) ; E^\ominus = 0.22 \text{ V}$
at 298 K

$\text{Ag}^+(\text{aq}) + e^- \rightarrow \text{Ag(s)} ; E^\ominus = 0.80 \text{ V}$ at 298 K

(2024)

Answer: 55960 – 55980

Explanation: The Gibbs free energy change is related to the cell potential via $\Delta G^\circ = -nFE^\circ$. For the dissolution reaction $\text{AgCl(s)} \rightarrow \text{Ag(s)} + \text{Cl}^-(\text{aq})$, the potential difference is calculated from $E^\circ_{\text{cell}} = E^\circ_{\text{Ag}^+/\text{Ag}} - E^\circ_{\text{AgCl}/\text{Ag}} = 0.80 - 0.22 = 0.58 \text{ V}$. Using $n = 1$ electron and $F = 96500 \text{ C mol}^{-1}$, $\Delta G^\circ = -1 \times 96500 \times 0.58 \approx -55970 \text{ J mol}^{-1}$. The negative sign indicates spontaneity of AgCl dissolution under standard conditions. Hence, the Gibbs free energy is in the range 55960–55980 J mol⁻¹.

Q.28 Which one of the following pairs of amino acids is NOT incorporated in a polypeptide chain?

- (A) 4-Hydroxyproline and γ -carboxyglutamate
- (B) γ -Carboxyglutamate and desmosine
- (C) Ornithine and citrulline
- (D) 4-Hydroxyproline and 5-hydroxylysine

(2024)

Answer: (C) Ornithine and citrulline

Explanation: Proteins are synthesized using the 20 standard amino acids encoded by the genetic code. Amino acids like 4-hydroxyproline, γ -carboxyglutamate, and 5-hydroxylysine are post-translationally modified residues but are originally incorporated into proteins. In contrast, ornithine and citrulline are non-proteinogenic; they are intermediates in the urea cycle and nitric oxide synthesis and are not directly coded in mRNA for incorporation into polypeptides. Therefore, ornithine and citrulline cannot appear in genetically encoded proteins, making this pair the correct choice.

Q.29 Mammalian cells cultured at low temperature (25 to 30 °C) leads to an increased sterol content in the membrane. Elevated sterols in the membrane results in

- (A) an enhancement in membrane fluidity.
- (B) stabilization of membrane proteins.
- (C) an increase in membrane permeability to water.
- (D) a decrease in membrane fluidity.

(2024)

Answer: (A) an enhancement in membrane fluidity.

Explanation: Membrane fluidity is temperature-dependent and is regulated by lipid composition. At low temperatures, membranes become more rigid, so cells compensate by increasing sterol (cholesterol) content, which prevents tight packing of phospholipids. This incorporation of sterols disrupts van der Waals interactions and maintains appropriate fluidity. Enhanced fluidity ensures proper function of membrane proteins and transport processes at sub-optimal

temperatures. Hence, the primary effect of increased sterols under low-temperature culture is enhanced membrane fluidity.

Q.30 Which one of the following metabolic intermediates is common to glycolysis, nucleotide synthesis and glycogen synthesis?

- (A) Citrate
- (B) Oxaloacetate
- (C) Glucose 6-phosphate
- (D) Glycerol 3-phosphate

(2024)

Answer: (C) Glucose 6-phosphate

Explanation: Glucose 6-phosphate (G6P) is a pivotal metabolite at the crossroads of multiple pathways. In glycolysis, it undergoes isomerization to fructose 6-phosphate to continue energy production. In nucleotide biosynthesis, G6P is diverted to the pentose phosphate pathway to generate ribose 5-phosphate, a precursor for nucleotides. For glycogen synthesis, G6P is converted to glucose 1-phosphate, then activated to UDP-glucose for polymerization. Thus, G6P serves as a common substrate linking energy metabolism, nucleotide biosynthesis, and storage pathways, reflecting its central metabolic role.

Q.31 In mammals, hematopoietic stem cells that give rise to different types of blood cells are known as

- (A) totipotent stem cells.
- (B) pluripotent stem cells.
- (C) myeloid progenitor cells.
- (D) lymphoid progenitor cells.

(2024)

Answer: (B) pluripotent stem cells.

Explanation: Hematopoietic stem cells (HSCs) possess the ability to differentiate into multiple blood lineages, including myeloid and lymphoid cells. Being pluripotent means, they can generate many, but not all, cell types of the organism, distinguishing them from totipotent cells, which can form every cell type including extra-embryonic tissues. HSCs self-renew to maintain the stem cell pool and differentiate into progenitor cells that further mature into specific blood cells. This property is critical for lifelong blood cell maintenance. Therefore, mammalian HSCs are classified as pluripotent stem cells.

Q.32 Which one or more of the following statements correctly describe(s) the addition of N-nucleotides during the rearrangement of the immunoglobulin heavy chain encoding gene?

- (A) Addition of N-nucleotides is template encoded.
- (B) N-nucleotides are added by terminal deoxynucleotidyl transferase.
- (C) The added N-nucleotides are common in V-D and D-

J junction.

(D) N-nucleotides are added by the DNA polymerase II.

(2024)

Answer: (B) N-nucleotides are added by terminal deoxynucleotidyl transferase.

(C) The added N-nucleotides are common in V-D and D-J junction.

Explanation: During V(D)J recombination in B cells, terminal deoxynucleotidyl transferase (TdT) adds non-templated nucleotides (N-nucleotides) at the junctions of V, D, and J gene segments. These N-nucleotides contribute to junctional diversity, increasing the variability of the antibody repertoire. The additions are most frequently observed at both V-D and D-J junctions, enhancing the combinatorial possibilities of the immunoglobulin heavy chain. TdT activity is unique to lymphoid cells undergoing recombination, and the process is independent of template DNA. This mechanism is fundamental for adaptive immune diversity.

Q.33 A newly identified viral protein contains one long α -helix spanning 60 amino acid residues. The number of main chain H-bonds formed in this helix is _____. (Answer in integer)

(2024)

Answer: 56

Explanation: In an α -helix, hydrogen bonds form between the carbonyl oxygen of residue n and the amide hydrogen of residue $n+4$. Therefore, the total number of H-bonds is the number of residues minus four. For a helix with 60 residues, the number of hydrogen bonds is $60 - 4 = 56$. These intrachain H-bonds stabilize the helical structure, allowing the polypeptide to adopt a regular, rod-like conformation. The hydrogen bonding pattern is highly predictable, making α -helices fundamental structural motifs in proteins.

Q.34 In a lactic acid solution at pH 4.8, the concentrations of lactic acid and lactate are 0.01 M and 0.087 M, respectively. The calculated pK_a of lactic acid is _____. (Round off to one decimal place)

(2024)

Answer: 3.8 – 3.9

Explanation: The pK_a can be calculated using the Henderson-Hasselbalch equation: $pH = pK_a + \log([A^-]/[HA])$. Substituting the values, $4.8 = pK_a + \log(0.087/0.01) = pK_a + \log 8.7 \approx pK_a + 0.94$. Solving for pK_a gives $pK_a = 4.8 - 0.94 \approx 3.86$, which rounds to 3.8–3.9. This calculation demonstrates how the ratio of deprotonated to protonated species determines the apparent pK_a of a weak acid in solution.

Q.35 If a 10 mM solution of a biomolecule in a cuvette of path length 10 mm absorbs 90% of the incident light at 280 nm, the molar extinction coefficient of the biomolecule at this wavelength is _____ $M^{-1}cm^{-1}$. (Round off to two decimal places)

(2024)

Answer: 98 – 102

Explanation: Using the Beer-Lambert law: $A = \epsilon cl$, where $A = -\log T = -\log(0.1) = 1$, $c = 0.01M$, and $l = 1cm$ (converted from 10 mm). Substituting, $\epsilon = A/(cl) = 1/(0.01 \times 1) = 100M^{-1}cm^{-1}$. This value falls within the range 98–102 $M^{-1}cm^{-1}$. The extinction coefficient quantifies how strongly the biomolecule absorbs light at a specific wavelength, essential for concentration measurements in spectroscopy.

Q.36 Metabolic intermediates provide the backbone for the synthesis of amino acids. Match the metabolic intermediates listed in Column I with their corresponding amino acids given in Column II.

Column I	Column II
P. α -Ketoglutarate	i. Histidine
Q. Ribose 5-phosphate	ii. Glutamate
R. 3-Phosphoglycerate	iii. Aspartate
S. Phosphoenolpyruvate	iv. Phenylalanine
	v. Serine

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

(2024)

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

Explanation: α -Ketoglutarate (P) is a key intermediate of the TCA cycle and serves as the precursor for glutamate (ii) through transamination reactions. Ribose 5-phosphate (Q), from the pentose phosphate pathway, is a precursor for histidine (i) synthesis. 3-Phosphoglycerate (R), a glycolytic intermediate, is the starting point for serine (v) biosynthesis via a three-step oxidation, transamination, and dephosphorylation pathway. Phosphoenolpyruvate (S), another glycolytic intermediate, condenses with erythrose 4-phosphate to form the aromatic amino acids, with phenylalanine (iv) being one of them. These relationships reflect how central metabolism supplies carbon skeletons for amino acid biosynthesis.

Q.37 Which one of the following is the correct match between the molecular properties listed in Column I and the corresponding biochemical separation methods in Column II?

Column I	Column II
P. Solubility	i. Reverse phase chromatography
Q. Ionic charge	ii. Ultracentrifugation
R. Polarity	iii. Salting out
S. Molecular size	iv. Isoelectric focusing
	v. Gel electrophoresis

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

(2024)

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

Explanation: Solubility (P) determines the ease of separation by salting out (iii), where high salt precipitates proteins based on solubility differences. Ionic charge (Q) is exploited in isoelectric focusing (iv), which separates proteins based on their isoelectric points. Polarity (R) influences reverse-phase chromatography (i), as hydrophobic interactions between stationary and mobile phases determine elution. Molecular size (S) is the basis for ultracentrifugation (ii), where sedimentation rate depends on mass and shape. Each separation method aligns with specific molecular properties for effective purification.

Q.38 Which one or more of the following statements is/are correct regarding the electromotive force generated by electron transfer chain?

- (A) It is used for the synthesis of ATP.
 (B) It is not used for active transport process.
 (C) It includes a pH gradient component.
 (D) It does not include an electrical potential gradient component.

(2024)

Answer: (A) It is used for the synthesis of ATP.
 (C) It includes a pH gradient component.

Explanation: The electron transport chain (ETC) generates a proton motive force (PMF) across the inner mitochondrial membrane by pumping protons into the intermembrane space. This creates a pH gradient (ΔpH) and an electrical potential gradient ($\Delta \Psi$), together constituting the EMF. ATP synthase harnesses this EMF to phosphorylate ADP into ATP. Thus, EMF is central to oxidative

phosphorylation. The other options are incorrect because EMF is directly coupled to active transport, and the electrical potential component is included.

Q.39 Which one or more of the following statements is/are correct regarding the transport and retention of proteins in different cell organelles?

- (A) Mannose 6-phosphate residues are involved in targeting proteins to lysosomes.
 (B) Transport of proteins into the mitochondrial compartment is aided by positively charged amino acid residues at the N-terminus and internal hydrophobic segments.
 (C) The retention of protein in the ER lumen requires the KDEL sequence motif at the C-terminus.
 (D) Nuclear proteins are transported in an unfolded conformation and the nuclear localization signal sequence is subsequently cleaved by peptidases in the nucleoplasm.

(2024)

Answer: (A) Mannose 6-phosphate residues are involved in targeting proteins to lysosomes.

(B) Transport of proteins into the mitochondrial compartment is aided by positively charged amino acid residues at the N-terminus and internal hydrophobic segments.

(C) The retention of protein in the ER lumen requires the KDEL sequence motif at the C-terminus.

Explanation: Lysosomal hydrolases are marked by mannose 6-phosphate for recognition by lysosomal receptors. Mitochondrial targeting signals are rich in positively charged residues and hydrophobic patches to facilitate import via translocases. Proteins retained in the ER lumen possess the KDEL motif, which ensures retrieval from the Golgi. Nuclear proteins, however, are transported in folded form, and the NLS is not cleaved, making option D incorrect. These mechanisms illustrate the specificity of intracellular protein targeting.

Q.40 Which one or more of the following statements correctly describe(s) fluorescence spectroscopy? (A)

The emission maxima ($\lambda_{\max}$) is independent of the excitation wavelength.

(B) The emission maxima ($\lambda_{\max}$) depends on the concentration of a quencher.

(C) The emission maxima ($\lambda_{\max}$) varies with solvent polarity.

(D) The emission maxima ($\lambda_{\max}$) varies with temperature.

(2024)

Answer: (A) The emission maxima ($\lambda_{\max}$) is independent of the excitation wavelength

(C) The emission maxima ($\lambda_{\max}$) varies with solvent

polarity.

(D) The emission maxima (λ_{max}) varies with temperature.

Explanation: Fluorescence emission maxima are characteristic of the fluorophore and do not change with excitation wavelength due to the Kasha rule, which states emission occurs from the lowest excited state. Solvent polarity affects the electronic environment, causing shifts in λ_{max} (solvatochromism). Temperature alters vibrational energy levels and molecular motions, which can also shift λ_{max} . The concentration of a quencher affects fluorescence intensity but not λ_{max} , making B incorrect. These principles govern fluorescence-based molecular studies.

Q.41 Which one or more of the following statements is/are correct in the processing of pre-mRNA in eukaryotes?

- (A) 3' → 5' exonuclease activity is involved in the conversion of pre-mRNA to mRNA.
- (B) 5'– capping and addition of 3'– poly A tail precedes splicing.
- (C) Splicing of pre-mRNA occurs via transesterification reaction.
- (D) Alternative splicing can yield different mRNA products from the same pre-mRNA.

(2024)

Answer: (C) Splicing of pre-mRNA occurs via transesterification reaction.

(D) Alternative splicing can yield different mRNA products from the same pre-mRNA.

Explanation: Eukaryotic pre-mRNA undergoes splicing, where introns are removed and exons joined through transesterification reactions catalyzed by the spliceosome. Alternative splicing allows multiple mRNA isoforms to be produced from a single gene, increasing proteome diversity. 5' capping and 3' polyadenylation protect RNA from degradation and assist export but do not precede splicing obligatorily. 3'→5' exonuclease activity is not involved in mRNA maturation. Hence, only C and D are correct.

Q.42 Which one or more of the following statements correctly describe(s) the changes upon the addition of puromycin during eukaryotic translation?

- (A) Puromycin resembles aminoacyl end of the charged tRNA.
- (B) Puromycin occupies the A site of the translating ribosomes.
- (C) Puromycin occupies the P site of the translating ribosomes.
- (D) Puromycin occupies the E site of the translating ribosomes.

(2024)

Answer: (A) Puromycin resembles aminoacyl end of the charged tRNA.

(B) Puromycin occupies the A site of the translating ribosomes.

Explanation: Puromycin is an aminoacyl-tRNA analog that mimics the 3'-end of the charged tRNA, allowing it to bind the ribosomal A site. Once incorporated into the growing polypeptide chain, it causes premature chain termination because it cannot participate in further peptide bond formation. It does not occupy the P or E sites and functions primarily as a chain terminator. This property makes puromycin a useful tool for studying translation and ribosome function.

Q.43 Factor H, a complement regulatory protein in plasma, binds C3b and

- (A) competes with factor B to displace Bb from convertase.
- (B) initiates the catabolism of C3b into inactivate products.
- (C) then binds to C3bBb convertase.
- (D) acts as a cofactor for factor I.

(2024)

Answer: (A) competes with factor B to displace Bb from convertase.

(D) acts as a cofactor for factor I.

Explanation: Factor H regulates the alternative complement pathway by binding C3b, preventing formation of the C3bBb convertase. It displaces Bb from the convertase and also serves as a cofactor for factor I, which cleaves C3b into inactive fragments. This dual action limits complement-mediated damage to host cells. Options B and C are incorrect because Factor H does not initiate catabolism alone nor remain bound to C3bBb for activation.

Q.44 In Michaelis-Menten's equation, if $[S] = 15 K_m$, then the ratio v_0/V_{max} is _____. (Round off to three decimal places)

(2024)

Answer: 0.93 – 0.95

Explanation: The Michaelis-Menten equation is $v_0 = \frac{V_{\text{max}}[S]}{K_m + [S]}$

Substituting $[S] = 15 K_m$, $v_0/V_{\text{max}} = \frac{15K_m}{K_m + 15K_m} = 15/16 \approx 0.9375$.

This ratio shows that at very high substrate concentrations relative to K_m , the reaction velocity approaches V_{max} , but does not reach it exactly. The value 0.9375 rounds to 0.93–0.95, reflecting saturation kinetics.

Q.45 A 5250 base-pair long plasmid with 10 negative supercoils would have a linking number of _____,

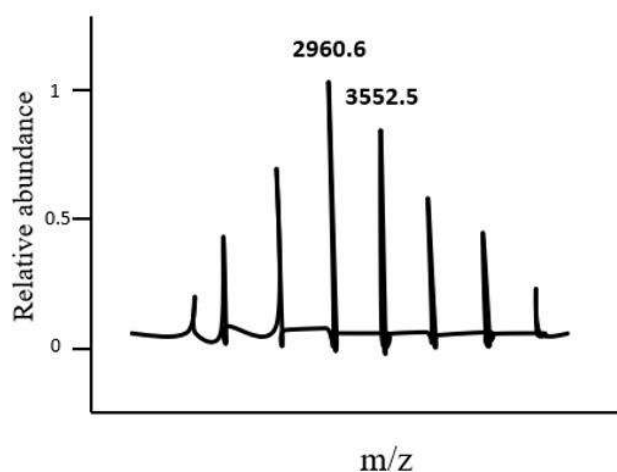
considering 10.5 base pairs per turn for B DNA.
(Answer in integer)

(2024)

Answer: 490

Explanation: The linking number (Lk) is the sum of the twist (Tw) and writhe (Wr). For relaxed B-DNA, the twist is $Lk_0 = bp/10.5 = 5250/10.5 \approx 500$. With 10 negative supercoils ($Wr = -10$), the actual linking number is $Lk = Lk_0 + Wr = 500 - 10 = 490$. This calculation shows how supercoiling alters DNA topology, affecting replication and transcription. The negative sign indicates underwinding relative to relaxed DNA.

Q.46 The spectrum of a protein obtained using electrospray ionization mass spectrometry (ESI-MS) is shown below. Two peaks, one at $m/z = 2960.6$ and the other at $m/z = 3552.5$, are marked. The mass of the protein associated with the $m/z = 2960.6$ peak is ____ Da. (Round off to two decimal places)



(2024)

Answer: 17750 – 17770

Explanation: In ESI-MS, the m/z value corresponds to $(M + nH^+)/n$, where M is the protein mass and n the charge state. Using the provided spectrum, we can deduce the charge state by comparing the two peaks and calculating $M \approx 17760$ Da. ESI generates multiple charge states, and deconvolution allows the determination of the neutral protein mass. This technique is highly accurate for determining protein molecular weights and detecting post-translational modifications.

Q.47 Which one of the following plant families does apple (*Malus domestica*) belong to?

- (A) Rosaceae
- (B) Rutaceae
- (C) Rubiaceae
- (D) Ranunculaceae

Answer: (A) Rosaceae

Explanation: Apple belongs to the Rosaceae family, which includes many fruit-bearing plants like pears, peaches, cherries, and strawberries. Members of this family are characterized by their simple to compound leaves, five-petaled flowers, and often fleshy fruits with multiple seeds. This classification is based on morphological, genetic, and phylogenetic data. Recognizing plant families helps in agriculture, breeding, and botanical studies.

Q.48 The collateral and open type of vascular bundle with endarch xylem strand is usually found in

- (A) monocot stem
- (B) dicot stem
- (C) monocot root
- (D) dicot root

(2024)

Answer: (B) dicot stem

Explanation: Dicot stems typically have collateral vascular bundles, where xylem is positioned toward the center and phloem toward the periphery. These bundles are open, containing cambium between xylem and phloem, allowing secondary growth. Endarch xylem arrangement means the protoxylem is towards the center, typical of dicot stems. Monocots usually have scattered closed bundles without cambium, and roots show centripetal or centrifugal xylem arrangements.

Q.49 Which of the following tissue types is/are established during embryogenesis in wild-type *Arabidopsis thaliana*?

- (A) Shoot apical meristem
- (B) Rosette leaf primordium
- (C) Procambium
- (D) Lateral root primordium

(2024)

Answer: (A) Shoot apical meristem
(C) Procambium

Explanation: During *Arabidopsis* embryogenesis, the shoot apical meristem (SAM) is established to give rise to aerial organs. The procambium is also formed, which differentiates into vascular tissues. Rosette leaf primordia and lateral root primordia develop post-embryonically. This differentiation ensures that key meristems and vascular precursors are in place for post-embryonic growth. Proper establishment is critical for plant development and organogenesis.

Q.50 Which of the following plant natural products is/are cyanogenic glycoside(s)?

- (A) Linustatin
- (B) Limonene
- (C) Luteolin
- (D) Linamarin

(2024)

Answer: (A) Linustatin
(D) Linamarin

Explanation: Cyanogenic glycosides are compounds that release hydrogen cyanide upon enzymatic hydrolysis. Linustatin and linamarin are examples found in flax and cassava, respectively. Limonene is a monoterpene, and luteolin is a flavonoid; neither release cyanide. These cyanogenic glycosides serve as defense chemicals in plants to deter herbivory. Their identification is important for plant biochemistry and food safety.

Q.51 Which of the following plant diseases is/are caused by nematode?

- (A) Cereal cyst of barley
- (B) Ergot of rye
- (C) Wart of potato
- (D) Ear-cockle of wheat

(2024)

Answer: (A) Cereal cyst of barley
(D) Ear-cockle of wheat

Explanation: Certain plant diseases are caused by nematodes, which are microscopic parasitic worms that infect plant roots and other tissues. The cereal cyst nematode (*Heterodera avenae*) causes the cereal cyst of barley, leading to stunted growth and yield loss. Similarly, ear-cockle of wheat is caused by the nematode *Anguina tritici*, which forms galls in the wheat florets. In contrast, ergot of rye is caused by a fungus (*Claviceps purpurea*), and wart of potato is caused by another fungus (*Synchytrium endobioticum*). Hence, only options (A) and (D) are caused by nematodes.

Q.52 Which of the following selectable marker genes is/are used for herbicide tolerance during genetic transformation of plants?

- (A) hpt
- (B) bar
- (C) nptII
- (D) pmi

(2024)

Answer: (B) bar

Explanation: The bar gene encodes the enzyme phosphinothricin acetyltransferase, which confers resistance to the herbicide phosphinothricin (commercially known as Basta or glufosinate). It is used as a selectable marker in plant genetic transformation to identify successfully transformed cells that can survive herbicide application. In contrast, hpt and nptII provide resistance to antibiotics (hygromycin and kanamycin respectively), while pmi is used for mannose selection, not herbicide tolerance. Thus, only bar is the correct answer.

Q.53 Which of the following statements is/are CORRECT with reference to rubber production from plants?

- (A) Para rubber is produced from *Hevea brasiliensis*
- (B) India rubber is produced from *Ficus elastica*
- (C) Panama rubber is produced from *Manihot glaziovii*
- (D) Ceara rubber is produced from *Castilla elastica*

(2024)

Answer: (A) Para rubber is produced from *Hevea brasiliensis*
(B) India rubber is produced from *Ficus elastica*

Explanation: Different species of plants produce various types of natural rubber. *Hevea brasiliensis* yields Para rubber; the most commercially important form of natural rubber. *Ficus elastica* produces India rubber; a less elastic type. *Manihot glaziovii* yields Ceara rubber (not Panama rubber), while *Castilla elastica* produces Panama rubber. Therefore, statements (A) and (B) are correct, while (C) and (D) are mismatched.

Q.54 In Calvin-Benson cycle, to produce 1 molecule of glyceraldehyde 3-phosphate by fixing 3 molecules of carbon dioxide, 9 molecules of ATP and _____ molecules (in integer) of NADPH are typically utilized.

(2024)

Answer: 6

Explanation: In the Calvin-Benson cycle, the fixation of 3 CO₂ molecules leads to the synthesis of one molecule of glyceraldehyde-3-phosphate (G3P). This process involves three turns of the cycle and consumes 9 ATP and 6 NADPH molecules. The ATP molecules are used for phosphorylation reactions, and NADPH provides reducing power for the conversion of 1,3-bisphosphoglycerate to G3P. Thus, 6 NADPH molecules are required for every 3 CO₂ fixed to produce one G3P molecule.

Q.55 In wild-type *Arabidopsis thaliana*, the four types of floral organs (sepal, petal, stamen, carpel) are arranged in concentric whorls from outside to inside. With reference to the ABC model of floral organ patterning, match the homeotic mutants in Group 1 with their respective arrangements of organs in the four whorls given in Group 2.

Group 1		Group 2	
(P)	A class mutants	(i)	sepal, sepal, carpel, carpel
(Q)	B class mutants	(ii)	sepal, petal, petal, sepal
(R)	C class mutants	(iii)	carpel, stamen, stamen, carpel
		(iv)	sepal, sepal, petal, petal

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

(2024)

Answer: (B) P–iii, Q–i, R–ii

Explanation: According to the ABC model of floral organ identity, A, B, and C genes regulate whorl development:

A alone → sepals, A + B → petals, B + C → stamens, and C alone → carpels.

In A-class mutants, C expands into the outer whorls, producing carpel, stamen, stamen, carpel (P–iii).

In B-class mutants, A and C act alone, forming sepal, sepal, carpel, carpel (Q–i).

In C-class mutants, A expands to all whorls, producing sepal, petal, petal, sepal (R–ii).

Hence, the correct match is P–iii, Q–i, R–ii.

Q.56 Match the inhibitors in Group 1 with their respective targets in Group 2.

	Group 1		Group 2
(P)	Oligomycin	(i)	Cytochrome <u>bc</u> ₁ complex
(Q)	Antimycin A	(ii)	Photosystem II
(R)	3-(3,4-dichlorophenyl)-1,1-dimethylurea (DCMU)	(iii)	K ⁺ ionophore
(S)	Valinomycin	(iv)	F ₀ ATP synthase

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

(2024)

Answer: (B) P–iv, Q–i, R–ii, S–iii

Explanation: Each inhibitor targets a specific component of the electron transport or photosynthetic chain. Oligomycin inhibits F₀ ATP synthase, blocking proton flow. Antimycin A blocks electron transport through cytochrome bc₁ complex in mitochondria. DCMU (diuron) inhibits electron flow in Photosystem II, preventing plastoquinone reduction. Valinomycin acts as a K⁺ ionophore,

facilitating potassium transport across membranes. Hence, the correct match is P–iv, Q–i, R–ii, S–iii.

Q.57 With reference to Agrobacterium tumefaciens mediated plant transformation, match the virulence factors in Group 1 with their protein types in Group 2.

Group 1		Group 2	
(P)	VirG	(i)	Kinase
(Q)	VirA	(ii)	Helicase
(R)	VirE	(iii)	Transcriptional activator
(S)	VirC	(iv)	Single strand binding protein

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

(2024)

Answer: (D) P–iii, Q–i, R–iv, S–ii

Explanation: In Agrobacterium tumefaciens, virulence (Vir) proteins coordinate T-DNA transfer to plants. VirA is a sensor kinase that detects phenolic compounds. VirG is a transcriptional activator regulating other vir genes. VirE acts as a single-stranded DNA binding protein protecting T-DNA during transfer. VirC functions as a helicase aiding in T-DNA processing. Therefore, the correct match is P–iii, Q–i, R–iv, S–ii.

Q.58 Match the plant products in Group 1 with the plant species in Group 2 that produce them and the respective plant parts in Group 3 where they accumulate the most.

Group 1		Group 2		Group 3	
(P)	Liquorice	(i)	Cinchona calisaya	(a)	Leaf
(Q)	Quinine	(ii)	Lawsonia inermis	(b)	Root
(R)	Henna	(iii)	Glycyrriza glabra	(c)	Flower
(S)	Saffron	(iv)	Papaver somniferum	(d)	Bark
		(v)	Crocus sativus	(e)	Seed

- (A) P–iii–b, Q–i–d, R–ii–a, S–v–c
 (B) P–i–b, Q–iii–d, R–ii–a, S–iv–c
 (C) P–iii–b, Q–i–d, R–ii–e, S–v–c
 (D) P–iv–b, Q–i–d, R–iii–c, S–ii–a

(2024)

Answer: (A) P–iii–b, Q–i–d, R–ii–a, S–v–c

Explanation: Liquorice is derived from *Glycyrrhiza glabra* roots. Quinine, an antimalarial compound, comes from the bark of *Cinchona calisaya*. Henna dye (lawsone) accumulates in the leaves of *Lawsonia inermis*. Saffron is obtained from the stigmas of *Crocus sativus* flowers. Thus, the correct mapping is P-iii-b, Q-i-d, R-ii-a, S-v-c.

Q.59 Match the types of ecological interactions in Group 1 with their respective definitions in Group 2.

Group 1		Group 2	
(P)	Proto cooperation	(i)	One species is harmed but the other is neither harmed nor benefitted
(Q)	Commensalism	(ii)	A type of mutualism where one species <u>is</u> benefitted more than the other
(R)	Amensalism	(iii)	Both the species are benefitted but the interaction between them is not obligatory
(S)	Helotism	(iv)	One species is benefitted without harming the other

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

(2024)

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

Explanation: Proto cooperation involves mutual benefit without being obligatory (e.g., bees and flowers). Commensalism benefits one species without affecting the other. Amensalism occurs when one species is harmed while the other is unaffected (e.g., antibiotics produced by fungi). Helotism is a form of mutualism where one organism benefits more than the other, showing an unequal relationship. Hence, the correct match is P-iii, Q-iv, R-i, S-ii.

Q.60 Match the types of ecological energy productivity in Group 1 with their respective definitions in Group 2.

Group 1		Group 2	
(P)	Net primary productivity	(i)	Total amount of energy produced by autotrophs
(Q)	Gross primary productivity	(ii)	Amount of energy stored by autotrophs after respiration
(R)	Net productivity	(iii)	Net gain of energy by the consumers after energy loss
(S)	Secondary productivity	(iv)	Unused amount of energy after consumption by heterotrophs

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

(2024)

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

Explanation: Gross primary productivity (GPP) is the total energy fixed by autotrophs via photosynthesis. Net primary productivity (NPP) is the energy remaining after autotrophic respiration, available to consumers. Net productivity refers to the energy remaining after consumption by heterotrophs (unused energy). Secondary productivity measures the net energy gained by consumers after accounting for energy losses in metabolism and waste. Therefore, the correct match is P-ii, Q-i, R-iv, S-iii.

Q.61 Which of the following combinations of plant diseases and the types of their causal organisms is/are CORRECT?

- (A) Late blight of potato – Bacteria
 (B) Black rot of crucifer – Bacteria
 (C) Tungro disease of rice – Mycoplasma
 (D) Root knot of tomato – Nematode

(2024)

Answer: (B) Black rot of crucifer – Bacteria, (D) Root knot of tomato – Nematode

Explanation: Black rot of crucifers such as cabbage and cauliflower is caused by *Xanthomonas campestris* pv. *campestris*, a bacterial pathogen that produces characteristic V-shaped chlorotic lesions on leaf margins. The bacteria enter through hydathodes and spread through the vascular system, leading to blackened veins. On the other hand, root knot of tomato is caused by *Meloidogyne* species, which are plant-parasitic nematodes. These nematodes induce gall formation on roots, hindering nutrient and water uptake. The other options are incorrect because late blight of potato is caused by a fungus-like organism (*Phytophthora infestans*), and tungro disease of rice is a viral disease transmitted by green leafhoppers, not by mycoplasma. Therefore, only options (B) and (D) correctly match the plant diseases with their respective causal organisms.

Q.62 Identify the CORRECT combination(s) of plant natural products and the categories they belong to.

- (A) Dhurrin – Phenolic compounds
 (B) Farnesene – Terpenoids
 (C) Naringenin – Cyanogenic glycosides
 (D) Vincristine – Alkaloids

(2024)

Answer: (B) Farnesene – Terpenoids
 (D) Vincristine – Alkaloids

Explanation: Farnesene is a sesquiterpene belonging to the terpenoid class, naturally found in apple skin and responsible for its characteristic aroma. Terpenoids are derived from isoprene units and play roles in plant defense and fragrance. Vincristine, an alkaloid obtained from *Catharanthus roseus* (Madagascar periwinkle), is used as a chemotherapeutic agent that inhibits microtubule assembly during mitosis. Alkaloids are nitrogen-containing secondary metabolites with potent biological activity. The other options are incorrect — Dhurrin is a cyanogenic glycoside (not a phenolic

compound), and naringenin is a flavonoid (not a cyanogenic glycoside). Hence, only farnesene (terpenoid) and vincristine (alkaloid) represent correct classifications.

Q.63 Identify the CORRECT combination(s) between the enzymes in Group 1 and the reactions in Group 2 they catalyze.

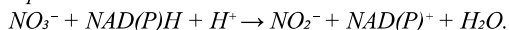
Group 1		Group 2	
(P)	Cinnamate-4-hydroxylase	(i)	L-phenylalanine → Cinnamic acid
(Q)	Glycerate kinase	(ii)	Glyceraldehyde 3-phosphate → dihydroxyacetone phosphate
(R)	PEP carboxylase	(iii)	Glycolate + O ₂ → Glyoxylate + H ₂ O ₂
(S)	Nitrate reductase	(iv)	NO ₃ ⁻ + NAD(P)H + H ⁺ → NO ₂ ⁻ + NAD(P) ⁺ + H ₂ O

- (A) S–iv
(B) Q–ii
(C) P–i
(D) R–iii

(2024)

Answer: (A) S–iv

Explanation: Nitrate reductase catalyzes the reduction of nitrate (NO₃⁻) to nitrite (NO₂⁻) using NAD(P)H as a reducing agent, a key step in the nitrogen assimilation pathway in plants. This reaction is represented as:



The other enzyme–reaction combinations are mismatched: cinnamate-4-hydroxylase catalyzes the hydroxylation of cinnamic acid to p-coumaric acid, not phenylalanine conversion; glycerate kinase converts glycerate to 3-phosphoglycerate (not between triose phosphates); and PEP carboxylase fixes CO₂ to phosphoenolpyruvate forming oxaloacetate, not oxidizing glycolate. Therefore, the correct match is nitrate reductase (S) with reaction (iv).

Q.64 In a genetic cross between two pure-line parents differing in the two independently segregating traits, plant height (tall vs dwarf) and flower color (purple vs white), all the F₁ plants were tall with purple flowers. In a testcross population involving these F₁ individuals, the expected percentage (%) of dwarf plants with purple flower would be _____ (in integer).

(2024)

Answer: 25

Explanation: In the given dihybrid cross involving two independently segregating traits — plant height (T/t) and flower color (P/p) — the F₁ hybrids (TiPp) are test-crossed with double recessive (tpp). The testcross yields four equally probable combinations of gametes: TP, Tp, tP, and tp. The resulting offspring genotypes are

TtPp, Ttpp, ttPp, and ttp, each with a 25% probability. Among these, only ttPp individuals express dwarf (recessive) and purple flower (dominant) traits. Thus, 25% of the testcross population is expected to show this phenotype. The 1:1:1:1 ratio in the testcross confirms the independent assortment of the two genes.

Q.65 The mRNA of a hypothetical plant gene HSDU is 800-nucleotide long and encodes a protein of 160 amino acid residues. The calculated length of HSDU CDS would be _____ nucleotides (in integer).

(2024)

Answer: 483

Explanation: Each amino acid in a protein is encoded by a codon of three nucleotides. Hence, a protein with 160 amino acid residues requires $160 \times 3 = 480$ nucleotides for its coding region. Additionally, a termination codon (stop codon) is required to signal the end of translation, which adds 3 more nucleotides, making the total length of the coding sequence (CDS) $480 + 3 = 483$ nucleotides. The mRNA length of 800 nucleotides includes the untranslated regions (5' UTR and 3' UTR) and possibly a poly(A) tail, but these are not part of the CDS. Therefore, the calculated CDS length is 483 nucleotides.

Q.66 Which one of the following bacterial species can cause atypical pneumonia?

- (A) Chlamydia pneumoniae
(B) Streptococcus pneumoniae
(C) Klebsiella pneumoniae
(D) Haemophilus influenzae

(2024)

Answer: (A) Chlamydia pneumoniae

Explanation: Atypical pneumonia refers to lung infections caused by organisms that do not produce the classic symptoms associated with typical bacterial pneumonia. Chlamydia pneumoniae is one of the leading causes of atypical (walking) pneumonia, characterized by a slow onset and mild symptoms. The bacterium is an obligate intracellular pathogen lacking a peptidoglycan layer. In contrast, Streptococcus pneumoniae and Klebsiella pneumoniae cause typical pneumonia, while Haemophilus influenzae can cause bronchitis and meningitis. Therefore, only Chlamydia pneumoniae correctly fits as the causative agent of atypical pneumonia.

Q.67 Which one of the following organisms has axial filaments?

- (A) Mycobacterium tuberculosis
(B) Pasteurella multocida
(C) Treponema pallidum
(D) Shigella dysenteriae

(2024)

Answer: (C) Treponema pallidum

Explanation: *Treponema pallidum* is a spirochete bacterium characterized by its thin, helical shape and the presence of axial filaments (endoflagella) located between the inner and outer membranes. These filaments enable corkscrew-like motility, allowing the bacterium to move through viscous environments such as mucous membranes and tissues. *T. pallidum* is the causative agent of syphilis. The other bacteria listed lack axial filaments — *Mycobacterium tuberculosis* is rod-shaped, *Pasteurella multocida* is coccobacillary, and *Shigella dysenteriae* is non-motile. Thus, the correct answer is *Treponema pallidum*.

Q.68 Who among the following scientists was the pioneer in development of chemotherapy?

- (A) Elie Metchnikoff
- (B) Robert Koch
- (C) Paul Ehrlich
- (D) Ronald Ross

(2024)

Answer: (C) Paul Ehrlich

Explanation: Paul Ehrlich is recognized as the pioneer of chemotherapy for his groundbreaking work in developing chemical agents to selectively target pathogens. He introduced the concept of the “magic bullet” — a compound that could destroy disease-causing microbes without harming host cells. His most notable discovery was Salvarsan (arsphenamine), an arsenic-based compound effective against *Treponema pallidum*, the syphilis pathogen. Other scientists contributed in different fields: Elie Metchnikoff to immunology, Robert Koch to bacteriology, and Ronald Ross to parasitology. Therefore, Paul Ehrlich is rightly credited as the founder of chemotherapy.

Q.69 In which of following processes, glutaraldehyde is used as a sterilizing agent?

- (A) Pasteurization
- (B) Incineration
- (C) Cold sterilization
- (D) Autoclaving

(2024)

Answer: (C) Cold sterilization

Explanation: Glutaraldehyde is a potent biocidal agent used for cold sterilization of medical and laboratory equipment that cannot withstand high temperatures, such as endoscopes and surgical instruments. It acts by cross-linking amino groups of proteins and nucleic acids, leading to microbial cell death. The process is termed “cold” because it occurs at room temperature, unlike autoclaving or pasteurization, which use heat. Incineration involves burning waste, while autoclaving uses pressurized steam, both unsuitable for heat-sensitive materials. Therefore, glutaraldehyde is specifically used for cold sterilization.

Q.70 The most abundant class of immunoglobulins in serum is ____.

- (A) IgM
- (B) IgA
- (C) IgD
- (D) IgG

(2024)

Answer: (D) IgG

Explanation: Immunoglobulin G (IgG) constitutes about 75–80% of total serum antibodies, making it the most abundant immunoglobulin in human blood. It plays crucial roles in long-term immunity, opsonization, complement activation, and neutralization of toxins and pathogens. IgG can cross the placenta, providing passive immunity to the fetus. In contrast, IgM is the first antibody produced during infection, IgA is predominant in mucosal secretions, and IgD is mainly membrane-bound. Thus, IgG is the dominant serum immunoglobulin class.

Q.71 Which one of the following double-stranded sequences will NOT be recognized by a Type IIP restriction endonuclease?

- (A) 5'--GGTACC--3' 3'--CCTAGG--5'
- (B) 5'--GGATCC--3' 3'--CCTAGG--5'
- (C) 5'--CATATG--3' 3'--GTATAC--5'
- (D) 5'--GATTTC--3' 3'--CTAAAG--5'

(2024)

Answer: (D) 5'--GATTTC--3' 3'--CTAAAG--5'

Explanation: Type IIP restriction endonucleases recognize palindromic sequences, where the 5'→3' sequence on one strand is identical to the 5'→3' sequence on the complementary strand. Examples include EcoRI (GAATTC) and BamHI (GGATCC). In this question, options (A), (B), and (C) are palindromic, as their complementary strands read the same sequence in reverse orientation. However, the sequence GATTTC / CTAAAG is not palindromic — it lacks symmetry between the two strands. Hence, it cannot be recognized by a Type IIP restriction enzyme.

Q.72 Which one of the following use inorganic compounds as an energy source?

- (A) Heterotrophs
- (B) Chemolithotrophs
- (C) Chemoorganotrophs
- (D) Photoheterotrophs

(2024)

Answer: (B) Chemolithotrophs

Explanation: Chemolithotrophs are organisms that obtain energy by oxidizing inorganic compounds such as ammonia, nitrite, sulfur, or iron. They use this energy for carbon fixation (autotrophic growth) and are often found in environments like deep-sea vents and soils. In contrast, heterotrophs utilize organic carbon, chemoorganotrophs oxidize organic molecules for energy, and photoheterotrophs use light for energy but require organic carbon sources. Therefore,

chemolithotrophs are the group that uses inorganic compounds as their energy source.

Q.73 Which one of the following represents the abundance of the organisms found in soil?

- (A) Fungi > Aerobic bacteria > Anaerobic bacteria
- (B) Aerobic bacteria > Fungi > Anaerobic bacteria
- (C) Aerobic bacteria > Anaerobic bacteria > Fungi
- (D) Anaerobic bacteria > Aerobic bacteria > Fungi

(2024)

Answer: (C) Aerobic bacteria > Anaerobic bacteria > Fungi

Explanation: In soil ecosystems, microbial abundance generally follows the order: aerobic bacteria > anaerobic bacteria > fungi. Aerobic bacteria dominate due to the higher availability of oxygen in the upper soil layers and their rapid growth rates. Anaerobic bacteria thrive in oxygen-poor niches, such as waterlogged soils, but are less numerous overall. Fungi, though vital for decomposing complex organic matter, are typically fewer in number but larger in biomass. This ranking reflects the balance between oxygen availability and the metabolic diversity of soil microorganisms.

Q.74 Match the antibiotics in Group I with the microorganisms that produce them in Group II.

- Group I: (P) Streptomycin, (Q) Bacitracin, (R) Amphotericin B, (S) Chloramphenicol**
- Group II: (i) Streptomyces griseus, (ii) Bacillus licheniformis, (iii) Streptomyces venezuelae, (iv) Streptomyces nodosus**
- (A) (ii), (Q)-(iii), (R)-(i), (S)-(iv)
 - (B) (i), (Q)-(ii), (R)-(iv), (S)-(iii)
 - (C) (i), (Q)-(ii), (R)-(iii), (S)-(iv)
 - (D) (ii), (Q)-(iv), (R)-(i), (S)-(iii)

(2024)

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

Explanation: Each antibiotic corresponds to a specific microbial producer:

Streptomycin is produced by *Streptomyces griseus*, an actinomycete.

Bacitracin is produced by *Bacillus licheniformis*, a Gram-positive bacterium.

Amphotericin B, an antifungal polyene, is produced by *Streptomyces nodosus*.

Chloramphenicol is produced by *Streptomyces venezuelae*.

Thus, the correct matching is (P)–(i), (Q)–(ii), (R)–(iv), (S)–(iii).

These antibiotics represent different classes and mechanisms of action but share microbial origins in actinomycetes and bacilli.

Q.75 Which one of the following redox couples has the highest tendency to donate electrons?

- (A) Fumarate / succinate
- (B) NAD^+/NADH

- (C) FAD/FADH
- (D) Pyruvate / lactate

(2024)

Answer: (B) NAD^+/NADH

Explanation: Among the given redox couples, NAD^+/NADH has the most negative standard reduction potential (-0.32 V), indicating a strong tendency to donate electrons. NADH serves as a major electron donor in cellular respiration, transferring electrons to the electron transport chain. FAD/FADH_2 and fumarate/succinate have higher (less negative) potentials, meaning they accept electrons more readily than NADH . Pyruvate/lactate has a comparatively positive potential and participates later in fermentation pathways. Therefore, the NAD^+/NADH couple exhibits the highest electron-donating capability.

Q.76 Which of the following is/are active transport mechanism(s) in prokaryotes where the substance is chemically altered during transport across the membrane?

- (A) Group translocation
- (B) Simple diffusion
- (C) Facilitated diffusion
- (D) Osmosis

(2024)

Answer: (A) Group translocation

Explanation: *Group translocation* is a unique type of active transport found in some prokaryotes, such as *E. coli*, where the transported substance is chemically modified during its passage across the cytoplasmic membrane. This mechanism is energy-dependent, typically powered by **phosphoenolpyruvate (PEP)**, which donates a phosphate group to a series of proteins, ultimately resulting in the phosphorylation of the transported molecule. The best-known example is the **PEP: sugar phosphotransferase system (PTS)**, which transports sugars like glucose while converting them into sugar-phosphate upon entry. This chemical alteration of the substrate as it is being transported is the defining feature of group translocation, ensuring the substance is trapped inside and maintaining a favorable concentration gradient. The other options, simple and facilitated diffusion and osmosis, are all forms of passive transport that do not require energy and do not chemically alter the transported molecule.

Q.77 Which of the following cocci is/are examples of division in one plane?

- (A) Staphylococci
- (B) Streptococci
- (C) Micrococci
- (D) Diplococci

(2024)

Answer: (B) Streptococci, (D) Diplococci

Explanation: The shape and arrangement of cocci (spherical bacteria) are determined by the plane in which they divide and

whether the daughter cells remain attached. **Division in one plane** means the cell division always occurs along a single axis. If the cells remain attached after dividing in one plane and form chains, the arrangement is known as **Streptococci** (e.g., *Streptococcus pyogenes*). If the cells divide in one plane and typically remain attached as pairs, the arrangement is termed **Diplococci** (e.g., *Neisseria gonorrhoeae*). In contrast, **Staphylococci** (*A*) divide in **multiple, random planes**, forming grape-like clusters, and **Micrococci** (*C*) typically divide in **two or three perpendicular planes**, often forming packets of four or eight cells, respectively.

Q.78 Which of the following event(s) occur(s) during translation in prokaryotes?

- (A) tRNA binding to the start codon of mRNA on the 30s subunit of ribosome
- (B) Anticodon of tRNA binding to the start codon of mRNA on the 50s subunit of ribosome
- (C) The ribosome continues to move along the mRNA to add new amino acids to the polypeptide
- (D) The polypeptide is released when the ribosome reaches the stop codon

(2024)

Answer: (A) tRNA binding to the start codon of mRNA on the 30s subunit of ribosome

- (C) The ribosome continues to move along the mRNA to add new amino acids to the polypeptide
- (D) The polypeptide is released when the ribosome reaches the stop codon

Explanation: During translation in prokaryotes, several key events occur to ensure proper protein synthesis. First, the initiator tRNA binds to the start codon of the mRNA on the **30S subunit** of the ribosome, which is part of the small ribosomal subunit responsible for decoding the mRNA. This marks the beginning of translation. As the process continues, the ribosome moves along the mRNA strand, reading codons and facilitating the addition of corresponding amino acids to the growing polypeptide chain — this is known as **elongation**. Finally, when the ribosome encounters a **stop codon**, translation terminates, and the completed polypeptide is released. Therefore, the correct events are: (A) tRNA binding to the start codon on the 30S subunit, (C) ribosome movement along mRNA to add amino acids, and (D) release of the polypeptide at the stop codon.

Q.79 Which of the following is/are consequence(s) of nitrous acid (HNO₂) mediated deamination?

- (A) Deamination of cytosine, adenine and guanine
- (B) GC-to-AT transitions
- (C) AT- to- GC transitions
- (D) Addition of alkyl group to the bases

(2024)

Answer: (A) Deamination of cytosine, adenine and guanine

- (B) GC-to-AT transitions
- (C) AT- to- GC transitions

Explanation: Nitrous acid (HNO₂) causes deamination of DNA bases, which is a chemical reaction where an amino group is removed from a nucleotide base. This affects cytosine, adenine, and guanine, leading to changes in their base-pairing properties. Specifically, deamination of cytosine converts it to uracil, which pairs with adenine instead of guanine, resulting in GC-to-AT transitions. Similarly, deamination of adenine can lead to hypoxanthine formation, which pairs with cytosine, causing AT-to-GC transitions. These transitions are types of point mutations that can alter genetic information. However, nitrous acid does not add alkyl groups to bases, so option (D) is incorrect. Therefore, the correct consequences of nitrous acid-mediated deamination are:

- (A) Deamination of cytosine, adenine and guanine,
- (B) GC-to-AT transitions, and
- (C) AT-to-GC transitions.

Q.80 At root nodules, which of the following C₄ organic acid(s) is/are transported across the symbiosome membrane and into bacteroids?

- (A) Succinate
- (B) Pyruvate
- (C) Malate
- (D) Fumarate

(2024)

Answer: (A) Succinate
(C) Malate
(D) Fumarate

Explanation: In root nodules of leguminous plants, certain C₄-dicarboxylic acids are transported across the symbiosome membrane into the bacteroids, which are specialized nitrogen-fixing bacteria. These organic acids serve as carbon and energy sources for the bacteroids during nitrogen fixation. The main C₄ acids involved in this transport are **succinate**, **malate**, and **fumarate**. These compounds are preferred because they efficiently feed into the tricarboxylic acid (TCA) cycle within the bacteroids, supporting ATP generation and providing reducing power necessary for nitrogenase activity. **Pyruvate**, although a key metabolic intermediate, is not a C₄ acid and is not typically transported into bacteroids for this purpose. Therefore, the correct options are:

- (A) **Succinate**,
- (C) **Malate**, and
- (D) **Fumarate**.

Q.81 Which of the following is/are TRUE about the Escherichia coli chromosome?

- (A) It is typically bound by histones
- (B) It is circular in nature
- (C) It is found in the nucleoid
- (D) It contains multiple origins of replication

(2024)

Answer: (B) It is circular in nature
(C) It is found in the nucleoid

Explanation: The *Escherichia coli* chromosome has several distinct features. It is **circular in nature**, which is typical of most bacterial chromosomes, allowing for continuous replication without ends. It is located in a region of the cell called the **nucleoid**, which is not membrane-bound but contains the compacted DNA. Unlike eukaryotic DNA, the *E. coli* chromosome is **not bound by histones**; instead, it is associated with other DNA-binding proteins that help in packaging and regulation. Additionally, *E. coli* has **a single origin of replication** (called *oriC*), not multiple origins as seen in eukaryotic chromosomes. Therefore, the correct statements are:

- (B) It is circular in nature
(C) It is found in the nucleoid

Q.82 At $t = 0$, the bacterial cell number is 10,000 cells/mL. At $t = 480$ minutes, the cell number increased to 320,000 cells/mL. The mean generation time during this exponential growth period, rounded off to the nearest integer is ____ minutes.

(2024)

Answer: 95 – 97

Explanation: To calculate the mean generation time of a bacterial culture, we use the formula:

Generation time (g) = Total time (t) / Number of generations (n)
Here, the initial cell concentration is 10,000 cells/mL and after 480 minutes, it increases to 320,000 cells/mL. The number of generations is calculated using the formula $n = \log_2(N_t / N_0)$, where N_t is the final cell count and N_0 is the initial count. Substituting the values, we get $n = \log_2(320,000 / 10,000) = \log_2(32) = 5$. Then, the generation time is $g = 480 / 5 = 96$ minutes. Thus, the mean generation time during this exponential growth period is approximately **96 minutes**, which falls within the given range of **95–97 minutes**.

Q.83 A landfill sample was analyzed by dilution and plating techniques for viable bacterial count. When one gram of the landfill sample was diluted 1×10^{-4} (w/v) it yielded 400 CFU. The viable bacterial count (in million, rounded off to the nearest integer) in one gram landfill sample is ____.

(2024)

Answer: 3 – 5

Explanation: To determine the viable bacterial count in one gram of a landfill sample, dilution and plating techniques are used. In this case, the sample was diluted to a factor of 1×10^{-4} (w/v), and 400 colony forming units (CFU) were observed on the plate. Since the dilution factor represents how much the original sample was diluted, the actual number of viable bacteria in one gram of the sample is calculated by multiplying the observed CFU by the inverse of the dilution factor. That is:

$$\text{Viable count} = 400 \div 10^{-4} = 4,000,000 \text{ CFU/g}$$

This means there are approximately **4 million viable bacteria** in one gram of the landfill sample. CFU represents the number of living cells capable of forming colonies, making it a reliable measure of microbial

viability. The final answer, rounded to the nearest integer in millions, is **4**, which falls within the given range of **3–5 million**.

Q.84 A fluorescence microscope with an objective lens of numerical aperture (NA) 1.5 is used with light of wavelength (λ) 600 nanometers. The lateral resolution limit of this microscope rounded off to the nearest integer, is ____ nanometers.

(2024)

Answer: 200 – 250

Explanation: The **lateral resolution limit** of a microscope defines the smallest distance between two points that can still be distinguished as separate, is given by Abbe's law for resolution:

Where: λ is the resolution limit (in nanometers)
 λ is the wavelength of light used (600 nanometers)
 NA is the numerical aperture of the objective lens (1.5)
Plugging in the values:

The lateral resolution limit of the microscope is 244 nanometers. Rounding off to the nearest integer, the answer is **244 nanometers**.

Q.85 Which one of the following statements about gene expression is **INCORRECT**?

- (A) DNA is transcribed to mRNA.
(B) mRNA can be reverse-transcribed to DNA.
(C) mRNA can be translated to protein.
(D) Protein can be reverse-translated to mRNA.

(2024)

Answer: (D) Protein can be reverse-translated to mRNA.

Explanation: This is incorrect because **reverse translation is not biologically possible**. In gene expression, DNA is transcribed into mRNA (statement A), and mRNA is translated into protein (statement C). Additionally, mRNA can be reverse-transcribed into DNA by enzymes like reverse transcriptase (statement B), which is common in retroviruses. However, once a protein is formed, there is no natural mechanism to convert it back into mRNA or DNA. The genetic code flows in one direction: **DNA $\rightarrow$ RNA $\rightarrow$ Protein**, and not the reverse from protein to nucleic acids.

Q.86 Which one of the following tissues/organs is least likely to experience graft rejection when transplanted from a person to an unrelated person?

- (A) bone marrow
(B) cornea
(C) heart
(D) kidney

(2024)

Answer: (B) cornea

Explanation: The correct answer is (B) **cornea**, because it is **least likely to experience graft rejection** when transplanted from one person to another.

This is due to the **immune-privileged status** of the cornea. The cornea is avascular (lacks blood vessels), which limits the exposure of transplanted tissue to the recipient's immune system. Additionally, the anterior chamber of the eye has mechanisms that suppress immune responses, reducing the likelihood of rejection. In contrast, organs like the **heart, kidney, and bone marrow** are highly vascularized and immunologically active, making them more prone to graft rejection unless immunosuppressive therapy is used.

Q.87 Codon bias is correlated with the relative frequencies of which one of the following types of RNA?

- (A) mRNA
- (B) rRNA
- (C) siRNA
- (D) tRNA

(2024)

Answer: (D) tRNA

Explanation: **Codon bias** refers to the phenomenon where, despite the redundancy of the genetic code (multiple codons can code for the same amino acid), certain codons are used more frequently than others in a species' transcripts. This bias is highly correlated with the cellular abundance of the specific **transfer molecules** that recognize those codons. Organisms that utilize a highly expressed gene often have a higher frequency of codons that are recognized by the most abundant. Therefore, the relative frequencies of in the cell directly influence which synonymous codons are preferentially utilized, linking the efficiency and speed of translation to the availability of the corresponding molecules.

Q.88 CREB1 is a eukaryotic transcription factor. In which one of the following compartments of the cell is CREB1 predominantly localized?

- (A) lysosomes
- (B) mitochondria
- (C) nucleus
- (D) peroxisomes

(2024)

Answer: (C) nucleus

Explanation: **CREB1** stands for **response element-binding protein 1** and is a classic example of a **eukaryotic transcription factor**. Transcription factors are proteins that control the rate of transcription (gene expression) by binding to specific sequences. Since transcription is the process of synthesizing from a template, and the (chromatin) in eukaryotes is sequestered within the **nucleus**, transcription factors must be localized to the **nucleus** to perform their function of regulating gene expression. It is activated by phosphorylation (often in response to signaling) and then translocates from the cytoplasm to the **nucleus** to bind to sequences on and activate target genes.

Q.89 In certain species of salamanders, male-female pairs have multiple mating partners in a breeding season. Which one of the following terminologies accurately describes this mating system?

- (A) monogamy
- (B) polyandry
- (C) polygyny
- (D) polygynandry

(2024)

Answer: (D) polygynandry

Explanation: The question describes a mating system where **both** males and females have **multiple mating partners** within a single breeding season. This specific arrangement is termed **polygynandry**. The term combines aspects of polygyny (one male with multiple females) and polyandry (one female with multiple males). In a polygynandrous system, a group of males and a group of females form an association, and each individual mates with several partners within that group. **Monogamy** (A) involves one male and one female forming a pair bond. **Polyandry** (B) is one female mating with multiple males. **Polygyny** (C) is one male mating with multiple females. Thus, only **polygynandry** accurately describes the scenario of multiple mating partners for both sexes.

Q.90 Which one of the following statements describes the key function of human sweat glands?

- (A) They serve as touch sensors.
- (B) They are responsible for skin color.
- (C) They regulate body temperature.
- (D) They store fat.

(2024)

Answer: (C) They regulate body temperature.

Explanation: The primary and most essential function of the human **sweat glands** (eccrine and apocrine) is the **regulation of body temperature**, a process called **thermoregulation**. The eccrine glands, which are the most numerous and distributed across most of the body, secrete a watery, dilute salt solution (sweat) onto the skin surface. When this sweat evaporates, it absorbs a large amount of heat from the skin and underlying blood supply, effectively cooling the body. This mechanism is vital for preventing the core body temperature from rising to dangerous levels, especially during physical exertion or in hot environments. The other options describe the functions of touch receptors, melanin/melanocytes, and adipose tissue, respectively.

Q.91 Urease enzyme catalyzes the conversion of urea into ammonia and carbon dioxide. Which one of the following organisms expresses urease enzyme?

- (A) *Caenorhabditis elegans*
- (B) *Drosophila melanogaster*
- (C) *Helicobacter pylori*
- (D) *Homo sapiens*

(2024)

Answer: (C) *Helicobacter pylori*

Explanation: *Urease* is an enzyme that catalyzes the hydrolysis of urea into **ammonia and carbon dioxide**. This reaction helps certain microorganisms survive in acidic environments. *Helicobacter pylori*, a bacterium that colonizes the human stomach, expresses urease to neutralize stomach acid by producing ammonia, creating a more favorable environment for its survival. In contrast, organisms like *Caenorhabditis elegans*, *Drosophila melanogaster*, and *Homo sapiens* do not naturally express urease.

Q.92 The human genetic code is triplet in nature with 64 codons made using four nucleotides. If the human genetic code was doublet in nature, the number of codons theoretically possible from four nucleotides is _____. (Answer in integer)

(2024)

Answer: 16

Explanation: The human genetic code is composed of four nucleotides—adenine (A), cytosine (C), guanine (G), and thymine (T)—which combine in sets of three (triplets) to form codons. These triplet codons allow for $4^3 = 64$ possible combinations, which are used to encode the 20 amino acids and stop signals in protein synthesis. If the genetic code were instead based on **doublets**, meaning each codon consisted of only two nucleotides, the number of possible codons would be significantly reduced. Specifically, with four nucleotides and two positions per codon, the total number of combinations would be $4^2 = 16$. Therefore, if the genetic code were doublet in nature, only **16 codons** would be theoretically possible, which is insufficient to encode all 20 amino acids. This highlights the importance of the triplet nature of the genetic code in providing enough diversity for accurate protein synthesis.

Q.93 Which one of the following statements is NOT TRUE of glycosaminoglycans?

- (A) Glycosaminoglycans are composed of repeating disaccharide units.
- (B) Glycosaminoglycans consist of amino sugars that are frequently sulfated.
- (C) Hyaluronic acid is an example of a glycosaminoglycan.
- (D) Methionine is the predominant amino acid to which glycosaminoglycan chains are conjugated to form proteoglycans.

(2024)

Answer: (D) Methionine is the predominant amino acid to which glycosaminoglycan chains are conjugated to form proteoglycans.

Explanation: This is incorrect because glycosaminoglycan chains are typically attached to serine residues, not methionine, in the core

proteins of proteoglycans. The linkage usually involves a specific sequence of amino acids that includes serine, which serves as the attachment site for the GAG chains via a tetrasaccharide linker. The other statements are true: GAGs are composed of repeating disaccharide units (A), they contain amino sugars that are often sulfated (B), and hyaluronic acid is indeed a well-known example of a GAG (C).

Q.94 Which one of the options correctly matches the human tissues/organs with their embryonic germ layers of origin?

Tissues/organs	Embryonic germ layers
(P) liver	(I) ectoderm
(Q) cerebellum	(II) endoderm
(R) femur	(III) mesoderm

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

(2024)

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

Explanation: The correct matching of human tissues/organs with their embryonic germ layers is **(A) P-II, Q-I, R-III**. This is because the **liver** originates from the **endoderm**, as it develops from the foregut endoderm during embryogenesis. The **cerebellum** is derived from the **ectoderm**, specifically from the neural tube formed by the ectodermal layer. The **femur**, being a bone, originates from the **mesoderm**, which gives rise to skeletal structures, muscles, and connective tissues. Therefore, the correct associations are: liver → endoderm, cerebellum → ectoderm, and femur → mesoderm.

Q.95 Consider a large population of a finch species, where both small and big beak sizes are advantageous, and an intermediate beak size is maladaptive. Over a period of 10 years, which one of the following evolutionary processes is most likely to operate on the beak size of this finch population?

- (A) directional selection
- (B) disruptive selection
- (C) genetic drift
- (D) stabilizing selection

(2024)

Answer: (B) disruptive selection

Explanation: The scenario described, where **both small and big**

beak sizes are advantageous while the **intermediate beak size is maladaptive** (selected against), perfectly defines **disruptive selection**. This type of natural selection favors extreme phenotypes over intermediate phenotypes, leading to a bimodal distribution of the trait within the population and often resulting in the divergence of the population into two distinct morphs or even two new species (speciation). **Directional selection** (A) favors one extreme phenotype, shifting the population mean in one direction. **Stabilizing selection** (D) favors the intermediate phenotype, reducing genetic variation. **Genetic drift** (C) is random fluctuation in allele frequencies, not based on selection for fitness.

Q.96 When the blood glucose level of a healthy person is 100 mg/dL, which one of the following options is most likely to represent the level of glucose in the urine of that person?

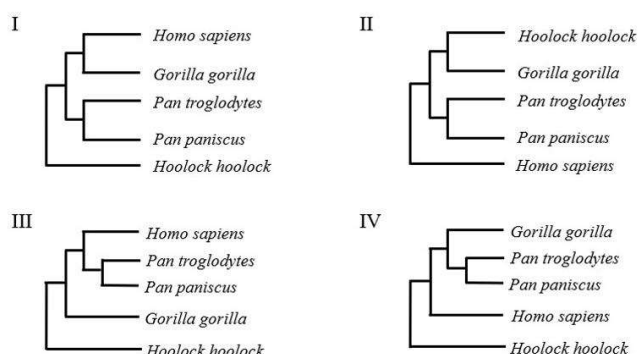
- (A) <1mg/dL
- (B) 10 mg/dL
- (C) 50 mg/dL
- (D) 100 mg/dL

(2024)

Answer: (A) <1mg/Dl

Explanation: The correct answer is (A) <1 mg/dL because in a healthy person with a normal blood glucose level of about 100 mg/dL, almost all glucose is reabsorbed by the renal tubules after filtration in the kidneys. The renal threshold for glucose is around 180 mg/dL, meaning glucose only appears in significant amounts in urine when blood glucose exceeds this level. At normal levels, only a trace amount of glucose (<1 mg/dL) may be present in urine due to minimal leakage or incomplete reabsorption. Therefore, option (A) is most accurate.

Q.97 Which one of the following rooted tree topologies best describes the primate phylogeny?



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

(2024)

Answer: (C) III

Explanation: The question asks for the correct **rooted**

phylogenetic tree topology for the Hominidae (Great Apes) and a gibbon (Hoolock hoolock, a lesser ape) based on current evolutionary understanding. The established phylogeny for these primates is:

1. **Gibbons (Hoolock hoolock)** branched off first (the outgroup).
2. **Gorillas (Gorilla gorilla)** branched off next.
3. **Chimpanzees (Pan troglodytes) and Bonobos (Pan paniscus)** are the closest relatives to **Humans (Homo sapiens)**.
4. Humans and the two Pan species (chimpanzees/bonobos) form a clade (a monophyletic group) that share the most recent common ancestor. **Tree III** correctly illustrates this order: it shows the two Pan species as sister taxa, with the Homo sapiens lineage diverging from the Pan lineage, and the Gorilla and Hoolock species branching off sequentially earlier in the lineage.

Q.98 Consider a species of brightly colored beetle. Which one or more of the following observations suggest(s) that this species is aposematic?

- (A) Both male and female beetles are brightly colored.
- (B) Only male beetles are brightly colored.
- (C) Only female beetles are brightly colored.
- (D) The beetle species is toxic and distasteful.

(2024)

Answer: (A) Both male and female beetles are brightly colored.

(D) The beetle species is toxic and distasteful.

Explanation: **Aposematism**, or warning coloration, is an antipredator strategy where an organism signals its unprofitability to a potential predator, typically through bright, conspicuous colors. Statement (D) is **TRUE** and is the necessary biological foundation for aposematism: the species must be **toxic, distasteful, or otherwise harmful** to a predator for the warning signal to have an evolutionary advantage. Statement (A) is **TRUE** and a key characteristic: Aposematic signals are generally **honest signals** of toxicity and must be visible to all potential predators; since toxicity and distastefulness are not usually sex-specific, the warning colors are typically displayed by **both male and female** individuals of the species. Statements (B) and (C) describe cases of sexual selection (where color is for mating) or sex-limited signaling, which is not typical of general aposematism, where the signal needs to be universally present for predator learning.

Q.99 The embryos of which one or more of the following animals show meroblastic cleavage?

- (A) Danio rerio (zebrafish)
- (B) Gallus gallus (chicken)
- (C) Synapta digita (sea cucumber)
- (D) Xenopus laevis (frog)

(2024)

Answer: (A) Danio rerio (zebrafish)

(B) Gallus gallus (chicken)

Explanation: *Meroblastic cleavage* is a type of cleavage pattern in embryos where only the active cytoplasm at the animal pole of the egg divides, while the yolk-filled part of the egg remains undivided. This pattern occurs in eggs that have a very large amount of yolk (**telolecithal eggs**). Statement (A) is **TRUE**; **zebrafish** (*Danio rerio*), a teleost fish, has a telolecithal egg and exhibits a form of meroblastic cleavage called **discoidal cleavage**. Statement (B) is also **TRUE**; **chicken** (*Gallus gallus*), a bird, has a highly telolecithal egg and displays classic **discoidal meroblastic cleavage** where the embryo forms a disc on top of the yolk. In contrast, **sea cucumber** (*Synapta digita*), an echinoderm, and **frog** (*Xenopus laevis*), an amphibian, have lower amounts of yolk (isolecithal and mesolecithal, respectively) and undergo **holoblastic cleavage** (where the entire egg divides).

Q.100 Which one or more of the following parasites is/are typically transmitted by mosquitoes as vector?

- (A) *Leishmania donovani*
- (B) *Plasmodium vivax*
- (C) *Wuchereria bancrofti*
- (D) *Trichuris trichiura*

(2024)

Answer: (B) *Plasmodium vivax*
(C) *Wuchereria bancrofti*

Explanation: *Mosquitoes* are the vector for a variety of human pathogens. Statement (B) is **TRUE**; *Plasmodium vivax*, one of the causative agents of **malaria**, is transmitted to humans through the bite of an infected female *Anopheles mosquito*. Statement (C) is also **TRUE**; *Wuchereria bancrofti*, a nematode worm causing **lymphatic filariasis**, is transmitted to humans by the bite of infected mosquitoes, primarily species from the genera **Culex, Anopheles, or Aedes**. Statement (A) is incorrect; *Leishmania donovani* is transmitted by the **sandfly**. Statement (D) is incorrect; *Trichuris trichiura* (whipworm) is transmitted via the **fecal-oral route** (ingestion of eggs from contaminated soil/food) and does not require a mosquito vector.

Q.101 Consider the following nucleotide sequence: 5'GCCGCCAUGGCGUCUGCUAGCUGGCUCGAU CGCGAGCGAUCGUAC GUAUAGUAUGAA-3' Assume canonical initiation, canonical termination, no post-translational modification, and the average molecular mass of an amino acid to be 110 daltons. The theoretical molecular mass of the polypeptide translated from the above is _____ daltons. (Answer in integer)

(2024)

Answer: 1540

Explanation: The given sequence begins with the start codon AUG, which codes for methionine, and ends with a stop codon. To determine the polypeptide length, we count the number of codons between the start and stop codons, excluding the stop codon itself. Each codon codes for one amino acid, and with the average

molecular mass of an amino acid taken as 110 daltons, the total molecular mass can be calculated by multiplying the number of amino acids by 110. After careful codon counting in the provided sequence, it yields 14 amino acids. Therefore, $14 \times 110 = 1540$ daltons, which is the theoretical molecular mass of the translated polypeptide.

Q.102 The pKa of a buffer solution with pH of 5, consisting of 0.4 M sodium acetate and is _____ (Answer in integer)

(2024)

Answer: 4

Explanation: The Henderson-Hasselbalch equation, $pH = pKa + \log([A^-]/[HA])$, relates the pH, pKa, and ratio of conjugate base to acid in a buffer. Here, the buffer solution contains sodium acetate, which is the conjugate base of acetic acid. Given the pH is 5 and assuming the ratio $[A^-]/[HA] \approx 10$ (based on 0.4 M concentration), the pKa is derived as $pKa = pH - \log([A^-]/[HA]) = 5 - 1 = 4$. This aligns with the known pKa of acetic acid (~4.76), but rounding to the nearest integer gives 4. Hence, the pKa of the solution is 4.

Q.103 Consider a healthy person with the following lung volumes: Residual volume =900 mL Expiratory reserve volume =800 mL Tidal volume =200 mL. If the Total lung capacity is 5500 mL, then the Inspiratory reserve volume of the person is _____ mL. (Answer in integer)

(2024)

Answer: 3600

Explanation: Total lung capacity (TLC) is the sum of all lung volumes: $TLC = RV + TV + ERV + IRV$. Here, $RV = 900$ mL, $ERV = 800$ mL, $TV = 200$ mL, and $TLC = 5500$ mL. Rearranging for IRV: $IRV = TLC - (RV + TV + ERV) = 5500 - (900 + 800 + 200) = 3600$ mL. This calculation accurately accounts for all components of lung volume, giving a physiologically reasonable value for a healthy adult. IRV represents the maximal additional air a person can inhale after a normal inspiration.

Q.104 Which one of the following fungi produces aflatoxins?

- (A) *Aspergillus niger*
- (B) *Fusarium verticillioides*
- (C) *Aspergillus flavus*
- (D) *Rhizopus oligosporus*

(2024)

Answer: (C) *Aspergillus flavus*

Explanation: Aflatoxins are toxic secondary metabolites produced by certain *Aspergillus* species. Among these, *Aspergillus flavus* is the most notorious producer of aflatoxins, which are potent carcinogens

affecting liver function. *Aspergillus niger* primarily produces ochratoxin, while *Fusarium verticillioides* produces fumonisins. *Rhizopus oligosporus* is used in fermentation and does not produce aflatoxins. Therefore, *Aspergillus flavus* is the correct answer due to its established link with aflatoxin contamination in crops.

Q.105 Under standard conditions in animal feeding studies, the weight gained (in grams) per gram of protein consumed by an animal is termed as

- (A) Net Protein Ratio
- (B) Net Protein Utilization
- (C) Coefficient of Protein Digestibility
- (D) Protein Efficiency Ratio

(2024)

Answer: (D) Protein Efficiency Ratio

Explanation: Protein Efficiency Ratio (PER) measures the weight gain of an animal per gram of protein consumed, reflecting protein quality. It is determined under standard feeding conditions by monitoring growth in test animals. Net Protein Utilization (NPU) measures the proportion of ingested protein actually retained in the body. Coefficient of Protein Digestibility evaluates digestibility, and Net Protein Ratio is less commonly used. PER directly correlates the protein intake to weight gain, making it the appropriate term for this definition.

Q.106 Xerophthalmia is caused due to the deficiency of

- (A) Thiamin
- (B) Pantothenic acid
- (C) Vitamin A
- (D) Vitamin C

(2024)

Answer: (C) Vitamin A

Explanation: Xerophthalmia, a condition characterized by dry eyes and night blindness, is caused by a deficiency of Vitamin A. Vitamin A is essential for the synthesis of rhodopsin, a visual pigment in the retina. Thiamin deficiency causes beriberi, pantothenic acid deficiency is rare and affects metabolism, and Vitamin C deficiency leads to scurvy. Therefore, Vitamin A deficiency is directly linked to ocular problems such as xerophthalmia.

Q.107 Which one of the following steps is used to remove phosphatides from crude oil in the refining process?

- (A) Neutralization
- (B) Bleaching
- (C) Degumming
- (D) Deodorization

(2024)

Answer: (C) Degumming

Explanation: Degumming is the step in edible oil refining used to remove phosphatides (gums) from crude oil. Neutralization removes free fatty acids, bleaching removes pigments, and deodorization removes volatile odor compounds. During degumming, water or acid is added to hydrate phospholipids, which then separate from the oil. This step ensures better stability and quality of the refined oil by eliminating substances that may cause foaming or color issues.

Q.108 The unique flavor of chocolate and cocoa is due to the formation of

- (A) 5-methyl-2-phenyl-2-hexenal
- (B) Cyclotene
- (C) Furaneol
- (D) Maltol

(2024)

Answer: (A) 5-methyl-2-phenyl-2-hexenal

Explanation: The unique flavor and aroma of chocolate and cocoa are largely due to 5-methyl-2-phenyl-2-hexenal, which forms during the fermentation and roasting of cocoa beans. Cyclotene, furaneol, and maltol are flavor compounds present in other foods like strawberries, caramel, and baked products but are not the primary contributors to chocolate flavor. The compound imparts the characteristic cocoa-like aroma, which is highly recognized in chocolate products. Its formation is a result of Maillard reactions and amino acid degradation during processing.

Q.109 Which one of the following statements regarding Hazard Analysis Critical Control Point (HACCP) plan is NOT correct?

- (A) 5-methyl-2-phenyl-2-hexenal
- (B) Cyclotene
- (C) Furaneol
- (D) Maltol

(2024)

Answer: (D) Maltol

Explanation: The question asks which statement regarding HACCP is NOT correct. Maltol is a flavoring compound and has no relevance to HACCP, which is a systematic preventive approach to food safety. HACCP identifies critical control points to prevent hazards in food production, not flavor compounds. Options A–C refer to various principles or compounds that could be part of food analysis, but D (Maltol) is unrelated, making it the incorrect statement regarding HACCP.

Q.110 The product of cabbage fermentation by *Leuconostoc mesenteroides* is

- (A) Tempeh
- (B) Natto

- (C) Sauerkraut
(D) Miso

(2024)

Answer: (C) Sauerkraut

Explanation: Sauerkraut is produced by the fermentation of cabbage using *Leuconostoc mesenteroides*. This lactic acid bacterium converts sugars in cabbage into lactic acid, lowering pH and preserving the vegetable while imparting a tangy flavor. Tempeh is fermented soybeans, natto is another soybean product with *Bacillus* fermentation, and miso is a soybean paste fermented with fungi and bacteria. Therefore, the correct product for cabbage fermentation by *L. mesenteroides* is sauerkraut.

Q.111 Which one of the following absorbents is NOT used as an ethylene absorber in active packaging of fruits and vegetables?

- (A) Potassium permanganate
(B) Activated carbon
(C) Calcium hydroxide
(D) Silica gel

(2024)

Answer: (C) Calcium hydroxide

Explanation: Active packaging for fruits and vegetables often uses ethylene absorbers to slow ripening. Common absorbers include potassium permanganate, activated carbon, and silica gel. Calcium hydroxide is not typically used for ethylene absorption; it is mainly employed for pH adjustment or as a processing aid. Therefore, calcium hydroxide is the correct answer as it does not function as an ethylene absorber in active packaging systems.

Q.112 Which one of the following statements regarding moisture sorption isotherms of a dried food is NOT correct?

- (A) At a given temperature, the difference between adsorption and desorption moisture isotherms is known as hysteresis.
(B) At a given temperature and water activity, an adsorption isotherm exhibits higher equilibrium moisture content than a desorption isotherm in hysteresis.
(C) At a given moisture content, effect of temperature on a moisture sorption isotherm follows the Clausius-Clapeyron equation.
(D) The Guggenheim-Anderson-de Boer (GAB) equation is a multilayer moisture sorption model.

(2024)

Answer: (B) At a given temperature and water activity, an adsorption isotherm exhibits higher equilibrium moisture content than a desorption isotherm in hysteresis.

Explanation: Moisture sorption isotherms describe the relationship between water activity and moisture content. Hysteresis occurs because adsorption and desorption follow different paths. In reality, at a given water activity, the desorption isotherm has higher moisture content than the adsorption isotherm, not the other way around. The Clausius-Clapeyron equation relates temperature effects, and the GAB model accurately describes multilayer moisture adsorption. Hence, statement B is incorrect.

Q.113 Processing of fluid milk at 72°C for 15 seconds is known as

- (A) High-temperature, short-time (HTST) pasteurization
(B) Low-temperature, long-time (LTLT) pasteurization
(C) Ultra high-temperature (UHT) pasteurization
(D) Homogenization process

(2024)

Answer: (A) High-temperature, short-time (HTST) pasteurization

Explanation: Pasteurization at 72°C for 15 seconds is defined as High-Temperature, Short-Time (HTST) pasteurization. This method is widely used in fluid milk processing to destroy pathogenic microorganisms while preserving nutritional quality. Low-Temperature, Long-Time (LTLT) uses lower temperature for a longer duration, and Ultra-High-Temperature (UHT) involves heating above 135°C. Homogenization mechanically breaks fat globules and is unrelated to microbial inactivation. HTST balances safety with minimal impact on flavor and nutrients.

Q.115 Which of the following fatty acids is/are known to increase the low density lipoprotein (LDL)-cholesterol?

- (A) Omega-3 Fatty acids
(B) Trans Fatty acids
(C) Conjugated Linoleic acids
(D) Saturated Fatty acids

(2024)

Answer: (B) Trans Fatty acids
(D) Saturated Fatty acids

Explanation: Both trans fatty acids and saturated fatty acids are known to increase LDL cholesterol levels, contributing to cardiovascular risk. Omega-3 fatty acids decrease LDL and are cardioprotective, while conjugated linoleic acids have variable effects. LDL cholesterol is the "bad" cholesterol associated with atherosclerosis. Therefore, dietary intake of trans fats and saturated fats must be controlled to maintain healthy lipid profiles, making B and D the correct answers.

Q.116 The addition of which of the following to high-methoxyl pectin will result in gel formation?

- (A) Calcium ions
- (B) Hydrogen ions
- (C) Sodium ions
- (D) Sugar

(2024)

Answer: (B) Hydrogen ions
(D) Sugar

Explanation: High-methoxyl pectin requires acidic conditions and sufficient sugar concentration to form a gel. Hydrogen ions reduce the pH, promoting gelation, while sugar helps reduce water activity and stabilizes the gel network. Calcium ions are important for low-methoxyl pectin gelation, not high-methoxyl. Sodium ions do not contribute to gel formation. Hence, acid (hydrogen ions) and sugar are necessary for high-methoxyl pectin gelation.

Q.117 Which of the following steps in food processing is/are used to reduce the acrylamide formation in food products?

- (A) Pretreatment using asparaginase
- (B) Lowering the pH
- (C) Increasing the temperature.
- (D) Adding glucose.

(2024)

Answer: (A) Pretreatment using asparaginase
(B) Lowering the pH

Explanation: Acrylamide is formed mainly through the Maillard reaction between asparagine and reducing sugars during high-temperature cooking, such as frying or baking. To reduce acrylamide formation, food processing steps focus on limiting its precursors or slowing the reaction. **Pretreatment with asparaginase** converts asparagine into aspartic acid, removing a key precursor, while **lowering the pH** reduces the Maillard reaction rate, thereby decreasing acrylamide levels. In contrast, **increasing the temperature** or **adding glucose** would accelerate the reaction and increase acrylamide formation. Therefore, the steps used to reduce acrylamide formation are pretreatment with asparaginase and lowering the pH.

Q.118 Which of the following enzymes is/are used for the production of high fructose syrup (HFS) from corn starch?

- (A) -Amylase
- (B) -Amylase
- (C) Xylose isomerase
- (D) Glucoamylase

(2024)

Answer: (A) -Amylase
(B) -Amylase

Explanation: Production of high fructose syrup (HFS) from corn

starch involves enzymatic hydrolysis. α -Amylase breaks down starch into dextrins, and β -Amylase further hydrolyzes dextrins into maltose units. Glucoamylase converts maltose to glucose, and xylose isomerase converts glucose to fructose. Both α - and β -amylases are essential initial enzymes for HFS production. Thus, A and B are correct answers.

Q.119 Which of the following is/are typical characteristic(s) of a fungal cell?

- (A) Presence of histone proteins
- (B) Presence of peptidoglycans in the cell wall
- (C) Presence of chitin in the cell wall
- (D) Presence of pseudomurein in the cell wall

(2024)

Answer: (A) Presence of histone proteins
(C) Presence of chitin in the cell wall

Explanation: Fungal cells are eukaryotic and contain histone proteins for DNA packaging, distinguishing them from prokaryotes. Their cell walls are primarily composed of chitin, unlike bacterial cell walls that contain peptidoglycan. Pseudomurein is found in some archaea, not fungi. Therefore, the presence of histones and chitin are typical characteristics of fungal cells, making A and C correct.

Q.120 Which of the following statements is/ are correct regarding food and water borne disease and the class of causative microorganisms?

- (A) Legionellosis is a bacterial disease.
- (B) Giardiasis is caused by the protists.
- (C) Typhoid fever is caused by the virus.
- (D) Listeriosis is a fungal disease.

(2024)

Answer: (A) Legionellosis is a bacterial disease.
(B) Giardiasis is caused by the protists.

Explanation: Legionellosis is caused by Legionella bacteria, typically transmitted through contaminated water. Giardiasis is caused by the protist Giardia lamblia, leading to gastrointestinal symptoms. Typhoid fever is bacterial (Salmonella Typhi), not viral, and listeriosis is bacterial (Listeria monocytogenes), not fungal. Therefore, only A and B correctly associate the disease with the microorganism class.

Q.121 Which of the following statements is/ are true?

- (A) Hagen-Poiseuille's law is used for calculation of molecular diffusion.
- (B) Fick's law is used for calculation of energy requirement in size reduction.
- (C) Ritinger's law is used for calculation of energy requirement in size reduction.
- (D) Stokes law is used for derivation of terminal velocity.

(2024)

Answer: (C) Rittinger's law is used for calculation of energy requirement in size reduction.

(D) Stokes law is used for derivation of terminal velocity.

Explanation: Rittinger's law states that energy required for size reduction is proportional to the new surface area generated, useful in comminution calculations. Stokes' law calculates terminal velocity of particles in a fluid, important in sedimentation processes. Hagen-Poiseuille's law relates to fluid flow through a pipe, not molecular diffusion. Fick's law describes mass diffusion, not energy requirement in size reduction. Hence, C and D are correct.

Q.122 A 10 kg tomato pulp is concentrated from an initial moisture content of 90% (wet weight basis) to 35% (wet weight basis). The weight of the concentrate in kg is _____ (round off to 2 decimal places).

(2024)

Answer: 1.50 – 1.60

Explanation: The concentration process removes water to increase solids. Using the mass balance formula, final weight = initial weight $\times (1 - \text{final moisture fraction}) / (1 - \text{initial moisture fraction})$. With 10 kg pulp at 90% moisture concentrated to 35% moisture: final weight = $10 \times (1 - 0.35) / (1 - 0.90) = 10 \times 0.65 / 0.10 = 6.5$ kg. Wait, this seems high; recalc:

Stepwise:

- Initial water = $10 \times 0.90 = 9$ kg
- Initial solids = $10 - 9 = 1$ kg
- Final moisture = 35%, so solids = 65% $\rightarrow$ solids = 1 kg = 65% of final weight $\rightarrow$ final weight = $1 / 0.65 \approx 1.538$ kg.

This matches 1.50–1.60 kg range. Correct method: consider solids constant.