I N D E X

BIOCHEMISTRY: NUMBER OF QUESTION ASKED IN NET EXAM - (JUNE 2014 to DEC 2024)

SECTION		J14		D14		J15		D15		J16		D16		J17		D17		J18		D18		J19		D19		N20 I		N20 II	
		P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C
1	Structure of atoms, molecules & Chemical bonds	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
2	Stabilizing interactions	1	-	1	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-
3	Solution, pH and Colligative properties	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	1	-	1	-	1	-	-	1	-	-	-	-
4	Buffer	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Thermodynamics and Bioenergetics	-	3	-	1	-	-	-	-	-	1	1	-	-	1	-	-	-	-	-	1	-	-	1	-	-	-	-	1
6	Enzyme Basics and kinetics	-	1	-	2	1	1	1	-	-	1	-	-	-	1	-	2	-	1	-	-	2	1	-	1	-	1	-	1
7	Enzyme Inhibition	-	-	2	-	-	-	-	-	1	-	-	1	-	-	1	-	-	-	-	1	-	-	-	-	-	-	1	1
8	Carbohydrates	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-
9	Amino acids and peptides	1	-	-	-	-	-	-	1	1	-	1	-	-	-	2	-	1	-	-	-	-	-	1	-	1	-	-	-
10	Ramachandran plot	-	-	-	-	-	1	-	1	-	-	1	1	-	1	1	-	-	-	1	-	-	-	-	-	-	-	1	-
11	Secondary structure of proteins	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	1
12	Protein Folding	2	-	-	-	-	1	-	-	-	1	-	1	2	-	-	-	-	-	-	-	-	1	-	1	-	-	1	1
13	Nucleotides and Nucleic Acids	-	-	1	1	1	-	-	-	-	1	1	-	-	1	-	2	-	3	1	-	2	-	-	2	-	1	-	-
14	Metabolism of carbohydrates	-	-	-	-	1	2	-	1	1	1	-	-	1	1	1	-	-	-	-	1	1	-	-	-	-	-	1	-
15	Lipid and Amino acid Metabolism	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	1	-	-
16	Nucleotides and Vitamin metabolism.	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-
17	Oxidative phosphorylation	-	-	1	-	-	-	1	1	-	1	-	-	1	1	-	1	-	1	-	-	-	-	-	-	-	-	1	-

SECTION		F22 I		F22 II		S22 I		S22 II		J23 I		J23 II		D23 I		D23 II		J24 I		J24 II		D24 I		D24 II	
		P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C	P-B	P-C
1	Structure of atoms, molecules & Chemical bonds	-	-	-	-	1	-	-	-	1	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
2	Stabilizing interactions	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	1	-
3	Solution, pH and Colligative properties	-	-	-	-	-	-	-	-	1	-	1	-	1	-	-	-	-	-	1	-	-	-	-	1
4	Buffer	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	Thermodynamics and Bioenergetics	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-	-	1	-	1
6	Enzyme Basics and kinetics	2	1	-	1	-	1	-	1	-	1	-	2	-	1	1	-	-	1	-	-	-	2	-	-
7	Enzyme Inhibition	1	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
8	Carbohydrates	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
9	Amino acids and peptides	1	-	2	-	1	-	-	-	-	-	1	1	-	1	-	1	-	-	-	1	1	-	1	1
10	Ramachandran plot	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
11	Secondary structure of proteins	1	-	-	-	-	2	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
12	Protein Folding	-	-	1	-	-	-	1	-	-	-	-	1	-	-	-	-	-	2	-	2	-	2	1	-
13	Nucleotides and Nucleic Acids	-	-	2	-	1	2	1	-	-	1	1	-	1	1	1	1	2	-	1	1	-	1	-	1
14	Metabolism of carbohydrates	-	-	1	1	1	1	-	-	2	1	-	2	2	1	-	-	1	1	-	-	-	-	-	-
15	Lipid and Amino acid Metabolism	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1	1	-	1	1
16	Nucleotides and Vitamin metabolism.	-	-	-	2	-	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-
17	Oxidative phosphorylation	1	-	-	1	1	-	1	1	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-

1 CHAPTER

BIOCHEMISTRY

PART - B

Section 1: Structure of Atoms, Molecules & Chemical Bonds

(SEPT 2022-I)

1. In crystalline NaCl, how many chloride ions surround each sodium ion?
   (1) Four (2) Six
   (3) Eight (4) Ten

(JUNE 2023-I)

2. The solubility of $NaCl$ is greater in water than ethanol. What physical property of the solvent governs this difference?
   (1) Surface tension (2) Viscosity
   (3) Dielectric constant (4) Boiling point

(DEC 2023-II)

3. The amount of energy required to break a single covalent bond is:
   (1) 200-500 kJ/mol (2) 80-150 kJ/mol
   (3) 600-900 kJ/mol (4) 20-70 kJ/mol

(JUNE 2024-I)

4. Which one of the following statements regarding the structure of water molecule is correct?
   (1) The oxygen atom in water is in sp^3 hybridization, with an H-O-H angle of 109.5°.
   (2) The oxygen atom in water is in sp^2 hybridization, with an H-O-H angle of 120°.
   (3) The oxygen atom in water is in sp^3 hybridization, with an H-O-H angle of 104.5°.
   (4) The oxygen atom in water is in sp^2 hybridization, with an H-O-H angle of 90°.

Section 2: Stabilizing Interactions

(JUNE 2014)

1. The maximum number of hydrogen bonds that can form between H_2N - NH_2 (hydrazine) and water is
   (1) 2 (2) 1
   (3) 3 (4) 4

(DEC 2014)

2. In proteins, hydrogen bonds form as follows: Donor (D)-H---Acceptor (A). Hydrogen bond is more favourable if the angle between D-H and A is
   (1) $<90^0$ (2) 180^0
   (3) $>180^0$ (4) 120^0

(JUNE 2016)

3. Predominant interactions between phospholipids that stabilize a biological membrane include
   (1) hydrogen bonds and covalent interactions.
   (2) van der Waal and ionic interactions.
   (3) hydrophobic interactions and hydrogen bonding.
   (4) covalent and hydrophobic interactions.

(DEC 2019)

4. The interaction energy between two opposite charges separated by 3Å in vacuum is -500 $kJmol^{-1}$.
   The interaction energy between these two charges in water will be closest to
   (1) -1500 $kJmol^{-1}$ (2) -166 $kJmol^{-1}$
   (3) -55 $kJmol^{-1}$ (4) -6 $kJmol^{-1}$

(JUNE 2023-II)

5. In a hydrogen bond of the type D-H...A, where D-H is a weakly acidic donor group and A is a lone-pair-bearing acceptor atom, the D...A distance is
   (1) one-and-a-half times the sum of the van Der Waals radii.
   (2) equal to the sum of the van Der Waals radii.
   (3) less than the sum of the van Der Waals radii.
   (4) twice the sum of the van Der Waals radii.

(DEC 2024-I)

6. Which type of interaction primarily contributes to the stability of a nucleosome?
   (1) Hydrogen bonds between DNA base pairs and serine/threonine residues of histones.
   (2) Van der Waals interactions between DNA base pairs and hydrophobic residues of histones.
   (3) Hydrogen bonds between the DNA phosphate backbone and the main chain atoms of histones.
   (4) Electrostatic interactions involving the DNA phosphate backbone and lysine residues of histones.

(DEC 2024-II)

7. Which one of the following properties is NOT responsible for the self-sealing nature of ruptured biological membranes?
   (1) The amphipathic character of the lipids
   (2) A hydrophobic interaction between lipid molecules

(3) Hydrogen bonding between the head groups of the lipids and water
(4) Covalent interactions among lipid molecules

Section 3: Solution, pH and Colligative properties

(DEC 2015)

1. The ionic strength of a 0.2 M Na_2HPO_4, solution will be
(1) 0.2 M (2) 0.4 M
(3) 0.6 M (4) 0.8 M

(DEC 2015)

2. The genome of a bacterium is composed of a single DNA molecule which is 10^9 bp long. How many moles of genomic DNA is present in the bacterium? [Consider Avogadro No = 6 X 10^{23}]
(1) 1/6 X 10^{-23} (2) 1/6 X 10^{-14}
(3) 6 X 10^{14} (4) 6 X 10^{23}

(JUNE 2016)

3. The solubility of gases in water depends on their interaction with water molecules. Four gases i.e. carbon dioxide, oxygen, sulphur dioxide and ammonia are dissolved in water. In terms of their solubility which of the following statements is correct?
(1) Ammonia >Oxygen>Sulphur dioxide> Carbon dioxide
(2) Oxygen>Carbon dioxide>Sulphur dioxide > Ammonia
(3) Sulphur dioxide>Oxygen> Ammonia> Carbon dioxide
(4) Ammonia>Sulphur dioxide> Carbon dioxide> Oxygen

(JUNE 2018)

4. The (OH^-) of 0.1 N HCl solution is
(1) 10^{-14} M (2) 10^{-13} M
(3) 10^{-12} M (4) 10^{-7} M

(DEC 2018)

5. Which one of the following statements is true?
(1) The specific rotation of enantiomers will be identical.
(2) The rate constant of a first order reaction has only time but no concentration units.
(3) The value of pH + pOH depends on temperature.
(4) The bond disassociation energy (kJ/mol) of –C–C - will be greater than -C=C-.

(JUNE 2019)

6. Equal volumes of pH 4.0 and pH 10.0 solutions are mixed. What will be the approximate pH of the final solution?
(1) 7.0 (2) 5.0
(3) 6.0 (4) 4.0

(JUNE 2023-I)

7. What is the pH of a 10^{-7} M solution of HCl?
(1) 6.00 (2) 6.79
(3) 7.00 (4) 7.50

(DEC 2023-I)

8. The pH of endocytic vesicles is 5.2, and the pH of gastric juice is 2.0. The endocytic vesicle has a [H^+] that is
(1) 15.85 times lower than that of gastric juice.
(2) 0.1585 times lower than that of gastric juice.
(3) 158.5 times lower than that of gastric juice.
(4) 1585 times lower than that of gastric juice.

(JUNE 2023-II)

9. One gram of a polysaccharide composed of 1000 glucose units has the same effect on osmolarity as that of
(1) 1 mg glucose (2) 100 mg glucose
(3) 500 mg glucose (4) 1000 mg glucose

(JUNE 2024-II)

10. The pH of water in Lonar lake was found to be 10.5, 10.3, 10.1, 10.4, 10.7, and 10.4 for measurements taken once daily over six days. What would be the average pH of the lake water during this period?
(1) 10.56 (2) 10.26
(3) 10.36 (4) 10.46

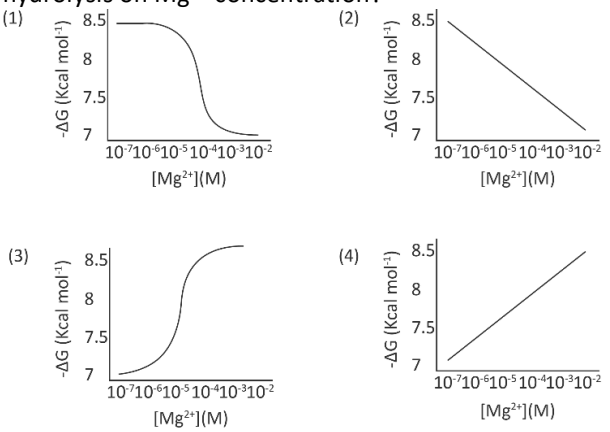
Section 4: Thermodynamics and Bioenergetics

(DEC 2016)

1. Equilibrium constant (K'eq) of reaction is a ratio of product to substrate concentration. The reaction between (K'eq) and free energy change in a reaction (ΔG') is follows ΔG' = -RT ln K'eq
Reaction A and reaction B have K'eq values of 10 and 100, respectively.
Which of the following statement is correct with respect to ΔG'**?**
(1) ΔG' of A= ΔG' of B (2) ΔG' of A > ΔG' of B
(3) ΔG' of B > ΔG' of A (4) ΔG' of A ≈ ΔG' of B

(DEC 2019)

2. Which one of the following graphs best describes the dependence of free energy change (ΔG) of ATP hydrolysis on Mg^{2+} concentration?



(JUNE 2023-I)

3. The standard free energy ($kJ\ mol^{-1}$) of hydrolysis of glucose-1-phosphate is:
(1) -40.3 (2) -35.8
(3) -7.7 (4) -20.9

Section 5: Enzyme Basics and kinetics

(JUNE 2015)

1. A 1% (w/v) solution of a sugar polymer is digested by an enzyme (20µg, MW=200,000). The rate of monomer sugar (MW=400) liberated was determined to have a maximal initial velocity of 10 mg formed/min. The turnover number (min^{-1}) will be
(1) 5 X 10^4 (2) 2.5 X 10^{-2}
(3) 4.0 X 10^{-6} (4) 2.5 X 10^5

(DEC 2015)

2. Enzymes accelerate a reaction by which one of the following strategies?
(1) Decreasing energy required to form the transition state.

(2) Increasing kinetic energy of the substrate.
(3) Increasing the free energy difference between substrate and the product.
(4) Increasing the turn over number of enzymes.

(JUNE 2019)

3. Which one of the following statements is **NOT** correct?
(1) Allosteric enzymes do not obey Michaelis-Menten kinetics.
(2) The free-energy change provides information about the spontaneity but not rate of a reaction.
(3) Competitive and non-competitive inhibitions are kinetically indistinguishable.
(4) A K_{cat}/K_m (M^{-1} S^{-1}) of ~2x 10^8 for an enzyme indicates that the value is close to diffusion-controlled rate of encounter.

(JUNE 2019)

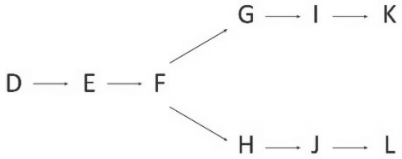
4. Choose the INCORRECT statement from the following statements made for an enzyme- catalyzed reaction
(1) The kinetic properties of allosteric enzyme do not diverge from Michaelis-Menten behaviour.
(2) In feedback inhibition, the product of a pathway inhibits an enzyme of the pathway
(3) An antibody that binds tightly to the analog of the transition state intermediate of the reaction S → P, would promote formation of P when the analog is added to the reaction.
(4) n enzyme with K_{cat} = 1.4 x 10^4 s^{-1} and K_m = 9 x 10^{-5} M has activity close to the diffusion controlled limit.

(FEB 2022-I)

5. The enzyme alkaline phosphatase was tested for its catalytic activity using the substrate para-nitrophenylphosphate. The K_M obtained was 10 mM and Vmax was 100umol/min. Which one of the following options represents the initial velocity of the reaction at a substrate concentration of 10 mM?
(1) 50 µmol/min (2) 100 µmol/min
(3) 500 µmol/min (4) 20 µmol/min

(FEB 2022-I)

6. A schematic of a metabolic pathway is shown below.



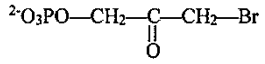
Under which of the following conditions would stoichiometric amounts of end products K and L be obtained if a concerted feedback inhibition mechanism were in operation?
(1) K inhibits F→G and L inhibits F→H; D→E is inhibited at equal amounts of K and L
(2) D→E is inhibited at equal amounts of K and L; K inhibits F→H and L inhibits F→G
(3) D→E is inhibited at equal amount of G and H; K inhibits F→H and L inhibits F→G
(4) K inhibits F→H and L inhibits F→G.

(DEC 2023-II)

7. An enzyme "X" converts a L-amino acid to a racemic mixture of D- and L- forms. Which one of the following coenzymes is utilized by enzyme X for this conversion?
(1) Pyridoxal phosphate
(2) Thiamine pyrophosphate
(3) Tetrahydrofolate
(4) Flavin adenine dinucleotide

Section 6: Enzyme Inhibition

(DEC 2014)

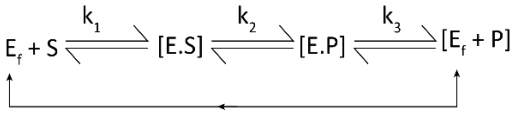
1. Choose the correct statement from the following:
(1) Iodoacetamide inactivates an enzyme by reaction with a critical serine residue at neutral pH.
(2) Proline racemase causes isomerisation of L-proline to D-proline. Ribose will be an appropriate transition state analog.
(3) Tosyl-1-phenylalanine chloromethyl ketone binds at the active site of chymotrypsin and modifies an essential arginine residue.
(4)  binds to triose phosphate isomerase at the active site and covalently modifies a glutamic acid residue required for enzyme activity.

(DEC 2014)

2. Reaction products inhibit catalysis in enzymes by
(1) covalently binding to the enzyme.
(2) altering the enzyme structure
(3) occupying the active site.
(4) form a complex with the substrate.

(JUNE 2016)

3. Penicillin acts as a suicide substrate. Which one of the following steps of catalysis does a suicide inhibitor affect?



(1) K_1 (2) K_2
(3) K_3 (4) K_4

(DEC 2017)

4. Indicate the **INCORRECT** statement from the following:
(1) Allosteric enzymes function through reversible noncovalent binding of allosteric modulators or effectors.
(2) Monoclonal antibodies that catalyze hydrolysis of esters or carbonates can be produced.
(3) Enzymes are not inhibited irreversibly by heavy metals such as Hg^{2+}, Ag^{+}.
(4) Acid phosphatases hydrolyze biological phosphate esters at ~ pH 5.0.

(NOV 2020-II)

5. A plot with which one of the following axes is drawn to exhibit enzyme inhibition kinetics applying Dixon's plot?
(1) $V_i vs [I]$ (2) $\frac{1}{V_i} vs \frac{1}{[I]}$
(3) $\frac{1}{V_i} vs [I]$ (4) $V_i vs \frac{1}{V_i}$

(FEB 2022-I)

6. Following statements are made about uncompetitive inhibition of an enzyme:
A. Uncompetitive inhibitor binds to both free enzyme as well as an enzyme- substrate complex.

B. Addition of uncompetitive inhibitor lowers the V_{max} of the reaction.
C. Apparent K_M of the enzyme is lowered.
D. Apparent K_M of the enzyme remains unchanged.

Which one of the following option represents the correct combination of the statements?

(1) B and C (2) A and C
(3) A and B (4) A and D

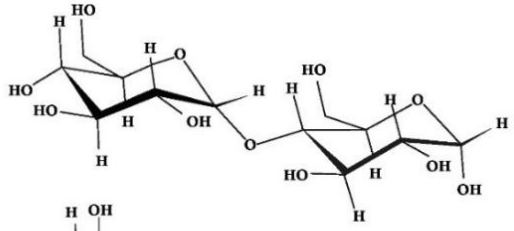
Section 7: Carbohydrates

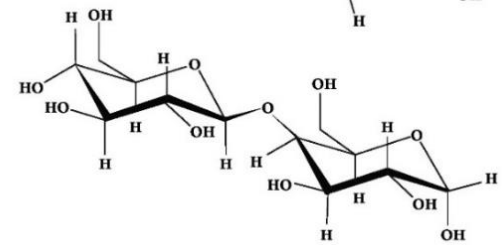
(NOV 2020-I)

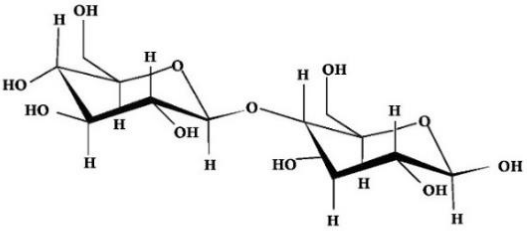
1. A stoichiometric mixture of α *and* β anomers of D-glucose in water exhibits
   (1) net optical rotation proportional to the sum of the optical activities of each anomer
   (2) no optical activity as the sign of optical rotation are opposite and they cancel each other
   (3) no optical activity as the α *and* β anomers in the linear forms that are optically inactive
   (4) no optical activity as they form a racemic mixture

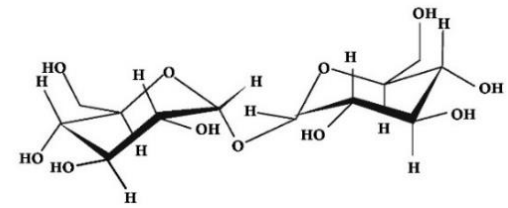
(JUNE 2023-I)

2. Which one of the following sugars will not reduce Tollen's reagent?

1.


2.


3.


4.


(JUNE 2024-II)

3. Which one of the following statements regarding the stereoisomers of D- glucose is INCORRECT?
   (1) D-mannose is a C-2 epimer of glucose.
   (2) D-allose is a C-3 epimer of glucose.
   (3) D-galactose is a C-4 epimer of glucose.
   (4) D-talose is a C-5 epimer of glucose.

Section 8: Amino acids and peptides

(JUNE 2014)

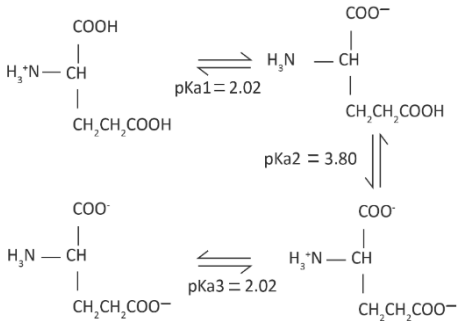
1. The peptide unit (C^{α} - C'O - NH - C^{α}) is planer due to
   (1) restriction around C^{α} - C' bond
   (2) restriction around C' - N bond
   (3) restriction around N - C^{α} bond
   (4) hydrogen bonding between carbonyl oxygen and imino hydrogen of the peptide backbone

(JUNE 2016)

2. The -COOH group of cellular amino acids can form which of the following bonds inside the cell?
   (1) Ether and ester bonds.
   (2) Ester and amide bonds.
   (3) Amide and ether bonds.
   (4) Amide and carboxylic anhydride bonds.

(DEC 2016)

3. Choose the most appropriate pH at which the net charge is 0 for the molecule from the data shown below.



(1) 2.02 (2) 2.91
(3) 5.98 (4) 6.87

(DEC 2017)

4. Choose the correct statement from the following:
   (1) Disulfide bonds in a 20-residue peptide can be formed only if the cysteines are adjacent to each other.
   (2) The amino acid isoleucine has only one chiral centre.
   (3) Both bases and sugar contribute to chirality of nucleic acids.
   (4) The pI of aspartic acid is less than that of glutamic acid.

(DEC 2017)

5. Which one of the following peptides can coexist in both cis- and trans conformation?
   (1) Ala-Ala-$CONH_2$ (2) Pro-Gly-$CONH_2$
   (3) Asn-Gly-$CONH_2$ (4) Val-Pro-$CONH_2$

(JUNE 2018)

6. Which one of the following pair of amino acids are glucogenic and ketogenic in nature?
   (1) Alanine and Lysine
   (2) Lysine and Leucine
   (3) Isoleucine and Phenylalanine
   (4) Aspartate and Lysine

(DEC 2019)

7. Which one of the following statements is true regarding amino acids?
   (1) Proline has high propensity to form α-helix in globular proteins
   (2) Both isoleucine and threonine can have diastereomers

(3) Side chain pKa of aspartic acid is more than the side chain pKa of glutamic acid
(4) The ψ dihedral angle of proline is more restricted than the ϕ dihedral angle

(NOV 2020-I)

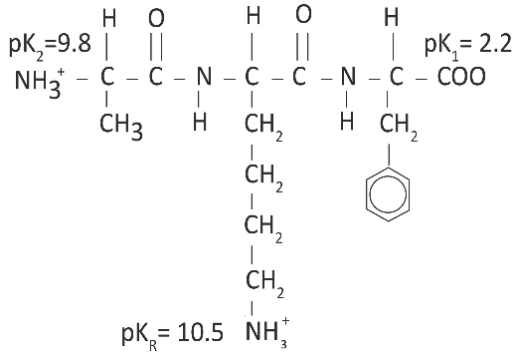
8. Which one of the following options represent a series of the amino acids with the decreasing pk_a values of their side chain?
(1) Arg Lys Cys His (2) Lys Arg Cys His
(3) Lys Arg His Cys (4) Arg Cys Lys His

(FEB 2022-I)

9. Following are the pka's of the ionizable groups in lysine
$pKa_1 = 2.16$ (α - carboxylic group)
$pKa_2 = 9.06$ (α - amino group)
$pKa_3 = 10.54$ (α - amino group)
Which one of the following options represents the pI of lysine?
(1) 7.25 (2) 5.61
(3) 6.35 (4) 9.8

(FEB 2022-II)

10. The pKa of the ionizable groups in the tripeptide shown below are indicated in the structure.



The isoelectric point (pI) of this peptide is
(1) 10.15 (2) 6
(3) 6.35 (4) 7.5

(FEB 2022-II)

11. What is the net charge of the peptide Tyr-Val-Arg at pH 5.0? The pK_as of alpha amino and carboxyl groups are 9.6 and 2.3, respectively. The pK_as of Tyr and Arg side chains are 10.46 and 12.48, respectively.
(1) 1.0 (2) 5
(3) 2.5 (4) 11

(SEPT 2022-I)

12. Which one of the following small molecule neurotransmitters is NOT synthesized from tyrosine?
(1) Epinephrine (2) Dopamine
(3) Serotonin (4) Norepinephrine

(JUNE 2023-II)

13. Several proteins are modified by phosphorylation at specific amino acid residues to alter their activities. Which one of the following amino acids is NOT typically a site of phosphorylation in proteins?
(1) Lysine (2) Serine
(3) Threonine (4) Tyrosine

(DEC 2024-I)

14. A novel organism synthesizes proteins using ribosomes from the C-terminal end to the N-terminal end, which is opposite to the usual direction (N-terminus to C-terminus). In this case, which main chain atom will act as the nucleophile for the reaction to form peptide bonds?
(1) Nitrogen of the amine group
(2) Carbon of the carboxyl group
(3) Oxygen of the carboxyl group
(4) Alpha-carbon (Cα)

(DEC 2024-II)

15. The pKa of an amino acid side chain was measured in aqueous solution. Which one of the following is the correct arrangement of the amino acids in the decreasing order of their side chain pKa?
(1) Serine > Lysine > Histidine > Aspartate
(2) Lysine > Histidine > Aspartate > Serine
(3) Aspartate > Histidine > Lysine > Serine
(4) Serine > Histidine > Lysine > Aspartate

Section 9: Ramachandran plot

(DEC 2016)

1. Choose the correct statement about peptides in Ramchandran plot.
(1) Peptides that are unstructured will have all the backbone dihedral angles in the disallowed regions.
(2) It is not possible to conclude whether two peptide adopts entirely helix or entirely beta sheet confirmation.
(3) The occurrence of beta turn conformation formation in a peptide can be deduced.
(4) The sequence of a peptide can be deduced.

(DEC 2017)

2. The ϕ and Ψ values of a β-strand composed of all D-amino acids will mainly occupy which quadrant in the Ramachandran plot?
(1) upper left (2) upper right
(3) lower left (4) lower right

(DEC 2018)

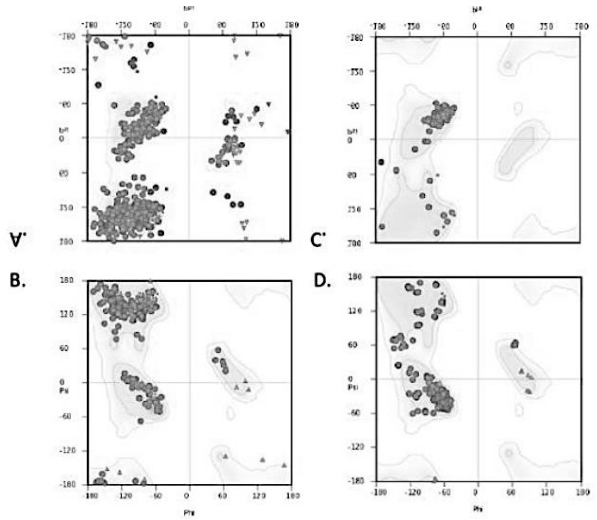
3. Which one of the following statements on protein conformation is NOT true?
(1) Dihedral angles of side-chains in amino acids are depicted in the Ramachandran plot.
(2) Infrared spectroscopy can be used to deduce hydrogen bonding in peptides.
(3) Three dimensional structures of protein composed of 100 amino acids can be obtained by nuclear magnetic resonance spectroscopy
(4) Globular proteins have α-helical and β- sheet components

(NOV 2020-II)

4. If the pyrollidine ring of proline is reduced to a linear to a linear form, the new amino acid will have
(1) constrained ϕ than proline
(2) constrained ψ than proline
(3) relaxed ϕ than proline
(4) unaffected ϕ and ψ

(JUNE 2024-I)

5. Given below are Ramachandran plots for four different proteins.

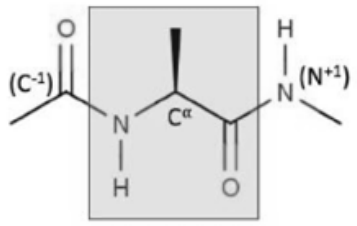


Choose the correct pair of proteins, both of which are predominantly alpha helical in nature.

(1) A and B (2) A and C
(3) B and D (4) C and D

(JUNE 2024-I)

6. In the representation of the di-peptide shown below, the superscript '-1' denotes the atom of the previous amino acid while '+1' denotes the atom of the next amino acid. The atomic coordinates of how many AND which of the following atoms are required to uniquely define the torsion angles, ϕ and Ψ of the Ramachandran plot?



(1) 4 atoms; C^{-1}, N, C^{α}, C for ϕ; N, C^{α}, C, N^{+1} for Ψ
(2) 2 atoms; N and C^{α} for ϕ; C^{α} and C for Ψ
(3) 4 atoms; H, N, C^{α}, C for ϕ; N, C^{α}, C, O for Ψ
(4) 3 atoms; C^{-1}, N, C^{α} for ϕ; C^{α}, C, N^{+1} for Ψ

Section 10: Secondary structure of proteins

(JUNE 2015)

1. In an alpha helical polypeptide, the backbone hydrogen bonds are between
   (1) NH of n and CO of n + 4 amino acids
   (2) CO of n and NH of n + 3 amino acids
   (3) CO of n and NH of n + 4 amino acids
   (4) NH of n and CO of n + 3 amino acids

(JUNE 2019)

2. Which one of the statements on protein conformation, detailed below is INCORRECT?
   (1) L- amino acids can occur in Type I' β- turns where ϕ, ψ are positive
   (2) A peptide rich in proline is unlikely to adopt α- helical structure
   (3) Proline residues have high propensity to occur in β-turns
   (4) The dihedral angles ϕ, ψ of amino acids in unfolded proteins are exclusively positive

(FEB 2022-I)

3. How many hydrogen bonds involving the backbone CO and NH can be observed in an a-helix consisting of 15 amino acid residues?
   (1) 10 (2) 11
   (3) 12 (4) 13

(DEC 2023-II)

4. If the length of a single continuous α -helical polypeptide is 108 A˚, which one of the following statements is true?
   (1) The α-helix contains 72 amino acids without Proline(s) and Glycine(s)
   (2) The α-helix contains 76 amino acids without Alanine(s) and Valine(s)
   (3) The α-helix contains 80 amino acids without Lysine(s) and Aspartic Acid(s)
   (4) The α-helix contains 74 amino acids without Arginine(s) and Histidine(s).

Section 11: Protein Folding

(JUNE 2014)

1. Which one of the following is unfavorable for protein folding?
   (1) Hydrophobic interaction
   (2) van der Waals interaction
   (3) Conformational entropy
   (4) Hydrogen bonding

(JUNE 2014)

2. Which one of the following is the most appropriate statement regarding folded proteins?
   (1) Charged amino acid side chains are always buried.
   (2) Charged amino acid side chains are seldom buried.
   (3) Non-polar amino acid side chains are seldom buried.
   (4) Tyrosine residues are always buried.

(JUNE 2017)

3. Protein stability is represented as

$$\text{Folded} \underset{}{\overset{K_{eq}}{\rightleftharpoons}} \text{Unfolded}$$

Prior to development of sensitive calorimeters, thermodynamic parameters of processes were determined by following equation

$$In\ K_{eq} = \frac{-\Delta H^0}{R}\left(\frac{1}{T}\right) + \frac{\Delta S^0}{R}$$

ΔH^0 and ΔS^0 are standard changes m enthalpy and entropy, respectively.

Which one of the following statements is correct for estimating ΔG, ΔH and ΔS?

   (1) Determining the ratio of folded and unfolded protein at 37°C
   (2) Plotting K_{eq} as a function of ΔH
   (3) Plotting K_{eq} against ΔS
   (4) Plotting K_{eq} against temperature

(JUNE 2017)

4. Glycerol is added to protein solutions to stabilize the preparations by
   (1) increasing the viscosity of solution
   (2) stabilizing the pH
   (3) preferential hydration of proteins
   (4) interacting and neutralising the surface charges on the proteins

(NOV 2020-II)

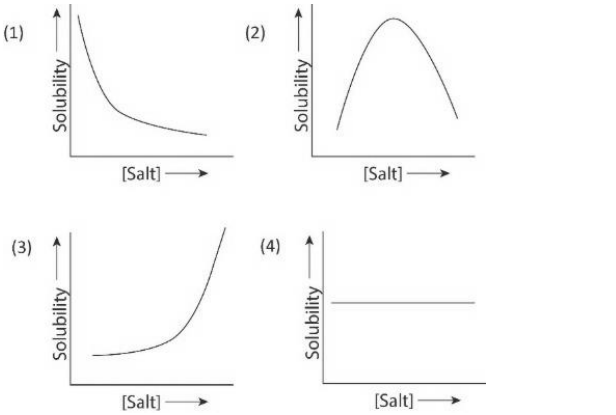
5. The following table lists names of scientists and advances made by them

Column A		Column B	
A	Linus Pauling	(i)	Myoglobin structure
B	Emil Fischer	(ii)	Model of α-helix
C	John Kendrew	(iii)	Lock and Key model
D	Christian Anfinsen	(iv)	Sequence-structure relationship

Which one of the following options correctly matches contents of column A and column B?
(1) A - (iii); B - (iv); C - (ii); D - (i)
(2) A - (ii); B - (iii); C - (i); D - (iv)
(3) A - (ii); B - (i); C - (iii); D - (iv)
(4) A - (i); B - (iii); C - (ii); D - (iv)

(FEB 2022-II)

6. Protein X is an all helical protein with 100 amino acids including 2 cysteines and a pI of 7.0. Which one of the following graphs best describes the solubility of this protein under different ammonium sulphate (salt) concentrations?



(SEPT 2022-II)

7. Which one of the following is NOT CORRECT in the context of protein structure and folding?
(1) β-sheets are more common in the interiors of proteins than surfaces,
(2) β-sheets are less likely to form than α-helices in the earliest stages of protein folding,
(3) Proline residues can occupy the N-terminal turn of an α-helix,
(4) α-helices are less likely to form than β-sheets in the earliest stages of protein folding,

(DEC 2024-II)

8. Which one of the following bonds support the three intertwined polypeptide strands in the triple helical structure of collagen?
(1) Disulfide bonds (2) Hydrogen bonds
(3) Co-ordinate bonds (4) Ionic bonds

Section 12: Nucleotides and Nucleic Acids

(DEC 2014)

1. Chirality of DNA is due to
(1) the bases.
(2) base stacking.
(3) hydrogen bonds between bases.
(4) deoxyribose

(JUNE 2015)

2. Following are three single stranded DNA sequences that form secondary structures.
(a) ATTGAGCGATCAAT
(b) ATTGAGCGATATCAAT
(c) AGGGAGCGATCCCT
Based on their stability, which one is correct?
(1) (a) = (b) = (c) (2) (c) > (a) > (b)
(3) (b) > (c) = (a) (4) (b) > (c) > (a)

(DEC 2016)

3. Consider a short double-stranded linear DNA molecule of 10 complete turns with 10.5 bp/ turn. The ends of the DNA molecule are sealed together to make a relaxed circle. This relaxed circle will have a linking number of
(1) 105 (2) 20.5
(3) 10.0 (4) 10.5

(DEC 2018)

4. Which one of the following statements on nucleic acids is NOT true?
(1) The conformation of ribose in DNA is α- 2'-deoxy-D-ribofuranose.
(2) Hydrolysis of RNA takes place under alkaline conditions unlike DNA, as the 2'-hydroxyl in RNA acts as a nucleophile in an intramolecular displacement
(3) DNA can occur in different three- dimensional forms.
(4) In DNA, deamination of cytosine to uracil can occur in a non-enzymatic manner.

(JUNE 2019)

5. On sequence analysis of a double stranded DNA, the results showed the content of cytosine, C was 20%. What is the amount of A and T put together?
(1) 20% (2) 30%
(3) 50% (4) 60%

(JUNE 2019)

6. Sugar puckering in double stranded nucleic acids is exclusively
(1) C-2' endo in double stranded DNA
(2) C-3' endo in double stranded DNA
(3) C-2' endo in double stranded RNA
(4) C-3' endo in hybrid duplex with one strand as DNA and other as RNA

(FEB 2022-II)

7. Heating of some nucleic acids shows an increase in the absorbance at 260 nm (A260) typified by the plot shown above. The sharp transition midpoint is defined as melting temperature (Tm). Which one of the following nucleic acid samples is NOT expected to generate such a typical profile upon heating of its solution?
(1) Double stranded DNA
(2) Double stranded RNA
(3) DNA:RNA hybrid DNA:RNA
(4) Single stranded DNA having imperfect secondary structures

(FEB 2022-II)

8. Consider the following double stranded DNA
A. 5'- AGTAGTATCAACTATCATGA-3'
3'- TCATCATAGTTGATAGTACT-5'
B. 5'- GACGTGCCAGGTGCGAGGTC-3'
3'- CTGCACGGTCCACGCTCCAG-5'

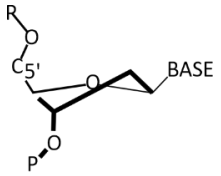
C. 5'- TACGATGCACATGCTTGGAC-3'
3'- ATGCTACGTGTACGAACCTG-5'
D. 5'- GAACGCTACGTTGCGATCCG-3'
3'- CTTGCGATGCAACGCTAGGC-5'

Arrange the DNA fragments (A to D) in the order of decreasing melting temperature.

(1) B>D>C>A (2) C>A>B>D
(3) D>C>A=B (4) A=B>C>D

(SEPT 2022-I)

9. Identify the ribose conformation in the nucleotide shown below.



(1) C2'-endo (2) C2'-exo
(3) C3'-endo (4) C5'-exo

(SEPT 2022-II)

10. The B-form double stranded DNA was invaded by a complementary RNA sequence to form an R-loop structure. During this process,
(1) Sugar puckering on the DNA strand that pairs with RNA will remain unchanged.
(2) Sugar puckering on the DNA strand that pairs with RNA will change.
(3) Sugar puckering on the DNA strand that pairs with RNA will remain unchanged but the number of base pairs per turn in the RNA-DNA hybrid will increase.
(4) Sugar puckering on the DNA strand that pairs with RNA will change but the number of base pairs per turn in the RNA-DNA hybrid with remain unchanged.

(JUNE 2023-II)

11. Which one of the following statements is TRUE?
(1) A, B, and Z DNA helices are left-handed.
(2) A, and B DNA helices are right-handed, Z DNA helix is left-handed.
(3) A, and Z DNA helices are left-handed, B DNA helix is right-handed.
(4) A, and B DNA helices are left-handed, Z DNA helix is right-handed.

(DEC 2023-I)

12. One strand of a palindromic dsDNA is composed of 5 -CCGCGGCGG -3'. Which one of the following forms of nucleic acid structures will be adopted in water if sense and antisense strands are mixed in equal proportion followed by annealing?
(1) A-form of double-stranded nucleic acid
(2) B-form of double-stranded nucleic acid
(3) Z-form of double-stranded nucleic acid
(4) Both will remain as single strands

(DEC 2023-II)

13. The base composition of the genome of a newly identified virus is given below:
Adenine: 25%; Cytosine: 35%;
Guanine: 30%; Thymidine: 10%
Based on this information, the genome of this virus is:
(1) double-stranded DNA. (2) single-stranded DNA.
(3) double-stranded RNA. (4) single-stranded RNA.

(JUNE 2024-I)

14. A DNA molecule is completely transcribed into messenger RNA by an RNA polymerase. The base composition of the DNA template strand is G = 24.1%; C = 18.5%; A = 24.6%; T = 32.8%. The base composition of the newly synthesized RNA molecule is:
(1) G = 24.1%, C = 18.5%, A = 24.6%, U = 32.8%
(2) G = 24.6%, C = 24.1%, A = 18.5%, U = 32.8%
(3) G = 18.5%, C = 24.1%, A = 32.8%, U = 24.6%
(4) G = 32.8%, C = 24.6%, A = 18.5%, U = 24.1%

(JUNE 2024-I)

15. Which one of the following options represents a classical Hoogsteen base pairing?
(1) anti A base-paired with anti T
(2) anti G base-paired with anti C
(3) syn A base-paired with anti T
(4) anti G base-paired with anti U

(JUNE 2024-II)

16. Which one of the following properties of grooves is a hallmark of the Z-form of DNA?
(1) Narrow and deep major groove
(2) Wide and deep major groove
(3) Narrow and shallow major groove
(4) Flat major groove

Section 13: Metabolism of carbohydrates

(JUNE 2015)

1. Which one of the following enzymes is NOT a part of pyruvate dehydrogenase enzyme complex in linkage step of glycolysis and TCA cycle?
(1) Pyruvate dehydrogenase.
(2) Dihydrolipoyl transferase.
(3) Dihydrolipoyl dehydrogenase.
(4) Dihydrolipoyl oxidase.

(DEC 2016)

2. Excess oxygen consumed after a vigorous exercise is
(1) to pump out lactic acid from muscle
(2) to increase the concentration of lactic acid in muscle
(3) to reduce dissolved carbon dioxide in blood
(4) to make ATP for gluconeogenesis

(JUNE 2017)

3. The energy-rich fuel molecules produced in the TCA cycle are
(1) 2 GTP, 2 NADH and 1 F ADH_2
(2) 1 GTP, 2 NADH and 2 $FADH_2$
(3) 1 GTP, 3NADH and 1 $FADH_2$
(4) 2 GTP and 3 NADH

(DEC 2017)

4. What is the effect of sudden increase in the levels of ATP and citrate on an erythrocyte undergoing glycolysis?
(1) It inhibits glycolysis.
(2) It stimulates glycolysis.
(3) The rate of glycolysis remains unaltered.
(4) The rate of glycolysis increases gradually.

(JUNE 2019)

5. The first step in glycogen breakdown releases glucose units as
(1) glucose 6- phosphate
(2) glucose 1- phosphate

(3) glucose
(4) glucose and glucose 6- phosphate

(NOV 2020-II)

6. Which one of the following enzymes present in erythrocytes helps bypass the first step of ATP formation in glycolysis?
(1) Bisphosphoglycerate mutase
(2) Phosphoglycerate kinase
(3) Glyceraldehyde 3-phosphate dehydrogenase
(4) Phosphofructose mutase

(FEB 2022-II)

7. Phosphofructokinase catalyses one of the regulatory steps in glycolysis. Which one of the following metabolic changes leads to the activation of phosphofructokinase?
(1) Increased ATP concentration
(2) Decreased AMP concentration
(3) High citrate levels
(4) Increased fructose 2, 6, bisphosphate concentration

(SEPT 2022-I)

8. Which one of the following correctly describes the effect of a mutation in phosphofructokinase (PFK), that leads only to the loss of allosteric regulation by ATP?
(1) Decrease in the activity of PFK
(2) Increase in the activity of PFK
(3) Decrease in the amount of ATP generated by PFK
(4) Increase in amount of ATP generated by PFK

(JUNE 2023-I)

9. In mature erythrocytes, the end-product of glycolysis that contains the carbons of glucose is:
(1) ethanol (2) pyruvate
(3) acetaldehyde (4) lactate

(JUNE 2023-I)

10. During glycolysis in plants, alanine and related amino acids are directly produced from which one of the following precursors?
(1) 3-Phosphoglycerate
(2) Phosphoenolpyruvate
(3) Pyruvate
(4) Acetyl-CoA

(DEC 2023-I)

11. Which one of the following enzymes does NOT catalyze the oxidation of substrate by reducing the electron acceptor, NAD^+?
(1) Lactate dehydrogenase
(2) Pyruvate dehydrogenase
(3) Succinate dehydrogenase
(4) Isocitrate dehydrogenase

(DEC 2023-I)

12. In the production of alcohol by fermentation, in the absence of oxygen, yeasts convert glucose to pyruvate and pyruvate to ethanol. Fermentation promotes glycolysis by
(1) Converting acetaldehyde to alcohol to prevent feed-back inhibition
(2) Generating NADH for mitochondrial ATP generation
(3) Preventing toxicity of acetaldehyde
(4) Generating NAD^+ for glycolysis

(JUNE 2024-I)

13. Which one of the following pairs correctly matches the enzyme with its allosteric activator?
(1) Phosphofructokinase : Citrate
(2) Pyruvate dehydrogenase : NADH
(3) Pyruvate carboxylase: ADP
(4) Pyruvate kinase: Fructose-1,6-bisphosphate

Section 14: Lipid and Amino acid Metabolism

(JUNE 2016)

1. Which of the following is NOT true for cholesterol metabolism?
(1) HMG-CoA reductase is the key regulator of cholesterol biosynthesis.
(2) Biosynthesis takes place in the cytoplasm.
(3) Reduction reactions use NADH as cofactor.
(4) Cholesterol is transported by LDL in plasma.

(DEC 2018)

2. Choose the correct answer from the following statements on biosynthesis.
(1) In the biosynthesis of palmitate, all the carbon atoms are derived from activated malonate.
(2) The amino acids Met, Thr, Lys, Ile, Val and Leu are biosynthesized from oxaloacetate and pyruvate in most bacteria.
(3) Alanine is a major precursor for the biosynthesis of porphyrin.
(4) Tryptophan is converted to L-DOPA in the biosynthesis of epinephrine.

(DEC 2023-I)

3. Which one of the following pairs of metabolic intermediates does NOT provide a backbone carbon skeleton for the synthesis of amino acids?
(1) Succinate and citrate
(2) 3-phosphoglycerate and phosphoenolpyruvate
(3) Ribose 5-phosphate and erythrose 4-phosphate
(4) α-ketoglutarate and oxaloacetate

(JUNE 2024-II)

4. Which one of the following compounds can serve as a direct acceptor of an additional amino group derived from amino acid catabolism?
(1) Fumarate (2) Glutamine
(3) α-Ketoglutarate (4) Asparagine

(DEC 2024-I)

5. The citric acid cycle (TCA) operates only in the presence of molecular oxygen (O_2). This is because:
(1) O_2 activates enzymatic dehydrogenation reactions in the cycle.
(2) O_2 accepts electrons from the electron transport chain, allowing reoxidation of NADH to NAD^+.
(3) O_2 removes toxic by-products of the TCA cycle.
(4) O_2 activates ATP synthase.

(DEC 2024-II)

6. Skeletal muscle cells need to convert pyruvate to lactate while sustaining anaerobic respiration to
(1) facilitate TCA cycle.
(2) maintain the acidic extracellular environment.
(3) recycle NADH.
(4) generate more ATPs from the NADH.

Section 15: Nucleotides and Vitamin metabolism.

(DEC 2015)

1. A cell line deficient in salvage pathway for nucleotide biosynthesis was fed with medium containing ^{15}N labelled amino acids. Purines were then extracted. Treatment with which one of the following amino acids is NOT likely to produce ^{15}N labelled purines?
   (1) Aspartic acid (2) Glycine
   (3) Glutamine (4) Aspartamine

(DEC 2019)

2. Match the following vitamins with the corresponding pathological conditions arising from their deficiencies.

Vitamin	Disease
(i) A	(a) Pernicious anemia
(ii) B12	(b) Subdermal hemorrhaging
(iii) D	(c) Night blindness
(iv) K	(d) Rickets

   Codes:
   (1) i – c; ii – a; iii – d; iv–b
   (2) i – c; ii – b; iii – d; iv–a
   (3) i – c; ii – a; iii – b; iv–d
   (4) i – d; ii – a; iii – b; iv – d

(SEPT 2022-II)

3. Catabolic end product of purines is
   (1) Xyloric acid (2) Allantoin
   (3) Urea (4) Uric acid

(DEC 2024-I)

4. Which one of the following statements is true regarding β-oxidation of fatty acids?
   (1) It occurs in the intermembrane space (IMS) region of mitochondria.
   (2) All the reactions are the same for the saturated and unsaturated fatty acids.
   (3) Fatty acids are oxidized at C-3 position to remove a two-carbon unit.
   (4) Lipoprotein lipase catalyzes the first step.

Section 16: Oxidative phosphorylation

(DEC 2014)

1. Proton motive force during oxidative phosphorylation is generated in mitochondria by
   (1) exchanging protons for sodium ions
   (2) pumping protons out into intermembrane space
   (3) pumping hydroxyl ions into the mitochondria
   (4) hydrolysis of ATP

(DEC 2015)

2. Coupling of the reaction centers of oxidative phosphorylation is achieved by which one of the following?
   (1) Making a complex of all four reaction centers.
   (2) Locating all four complexes in the inner membrane.
   (3) Ubiquinone and cytochrome C.
   (4) Pumping of protons.

(JUNE 2017)

3. Rotenone is an inhibitor of the electron transport chain. The addition of rotenone to cells results in which of the following?
   (1) Generation of mitochondrial reactive oxygen species and block in ATP generation.
   (2) Block in ATP generation but no generation of reactive oxygen species.
   (3) Generation of reactive oxygen species but no block in ATP generation.
   (4) Permeabilization of the inner membrane to compounds which are usually not able to traverse the membrane.

(NOV 2020-II)

4. Electron transfer from donors such as NADH and $FADH_2$ to O_2 occurs in
   (1) membranes of ER, chloroplast and mitochondria
   (2) chloroplast only
   (3) mitochondria only
   (4) organellar membranes which possess ATP synthase

(FEB 2022-I)

5. Iron-sulphur clusters (Fe-S] are the key prosthetic groups that carry electrons in all of the below EXCEPT:
   (1) NADH - CoQ reductase
   (2) Succinate - CoQ reductase
   (3) Cytochrome c oxidase
   (4) COQH2 -Cytochrome C reductase

(SEPT 2022-I)

6. At which one of the following electron transport chain complexes does Antimycin A typically inhibit the respiratory chain?
   (1) Complex I (2) Complex II
   (3) Complex III (4) Complex IV

(SEPT 2022-II)

7. Which of the following represents the most oxidized form of carbon?
   (1) HCOOH (2) HCHO
   (3) CH_3OH (4) CO_2

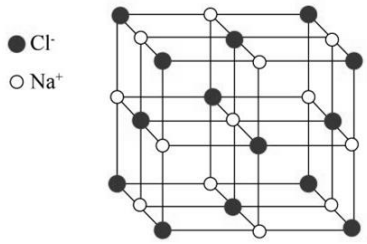
(JUNE 2024-II)

8. In which one the following, the proton motive force generated in mitochondrial electron transport is NOT used?
   (1) Transport of ATP into the cytosol from mitochondrial matrix.
   (2) Transport of ADP from the cytosol into the mitochondrial matrix.
   (3) Transport of phosphate ions from the cytosol into the mitochondrial matrix.
   (4) Transport of NADH from the cytosol into the mitochondrial matrix.

EXPLANATIONS

Section 1: Structure of Atoms, Molecules and Chemical Bonds.

1. **Correct Answer is (2):** We must know the crystal structure of sodium chloride crystal to determine the number of chloride ions present in them. NaCl has a cubic unit cell. It is best thought of as a face-centered cubic (FCC) array of anions with an interpenetrating FCC cation lattice (or vice-versa). Each ion of chloride is surrounded by six ions of sodium and each ion of sodium is surrounded to six ions of chloride.



FCC Structure of NaCl

2. **Correct Answer is (3):** Dielectric constant is a measure of a solvent's ability to reduce the electrostatic forces between charged particles. A higher dielectric constant means the solvent can better stabilize and separate ions in solution, which is crucial for dissolving ionic compounds like NaCl. Water has a much higher dielectric constant (~78.5) compared to ethanol (~24.3), which is why NaCl is more soluble in water than in ethanol.

3. **Correct Answer (1 or 2):** The amount of energy required to break a single covalent bond varies depending on the bond type, but generally falls within the range of 200-500 kJ/mol for most common covalent bonds.

1. 200-500 kJ/mol (Answer 1): This is the typical range for many covalent bonds, particularly those involving atoms like carbon, hydrogen, oxygen, and nitrogen. For example, the C-H bond has a bond dissociation energy around 413 kJ/mol, and the C-C bond is around 348 kJ/mol. This range is most commonly associated with the bond dissociation energies of single covalent bonds.
2. 80-150 kJ/mol (Answer 2): This range would apply to weaker single covalent bonds, particularly those involving larger atoms or bonds in certain organometallic compounds. However, it is less common for single covalent bonds between atoms commonly found in organic molecules.

4. **Correct answer (3):** In a water molecule, the oxygen atom is sp^3 hybridized, forming a bent molecular geometry due to the two lone pairs of electrons on oxygen. These lone pairs create electron repulsion, reducing the H-O-H bond angle from the ideal tetrahedral angle of 109.5° to approximately 104.5°. This gives water its characteristic bent shape.

Section 2: Stabilizing Interactions

1. **Correct Answer is (4):** Hydrazine (H_2N-NH_2) has two nitrogen atoms, each with a lone pair of electrons, making them potential hydrogen bond acceptors. Additionally, the N-H groups can act as hydrogen bond donors. In total, hydrazine can form four hydrogen bonds with water: two as donors (through the N-H bonds) and two as acceptors (through the lone pairs on nitrogen).

2. **Correct Answer is (2):** In proteins, hydrogen bonds are most favorable and strongest when the D-H---A angle is close to 180°. This linear alignment allows for optimal overlap of the orbitals involved in hydrogen bonding, maximizing bond strength and stability.

3. **Correct Answer is (3):** Biological membranes are primarily stabilized by hydrophobic interactions and hydrogen bonds. The hydrophobic tails of phospholipids avoid water and interact with each other, driving the formation of the lipid bilayer. Meanwhile, hydrogen bonds can form between the polar head groups of phospholipids and water molecules or other polar groups, further stabilizing the membrane structure.

4. **Correct Answer is (4):** The energy of interaction is inversely proportional to di-electric constant.
$E = \frac{k\, q_1 q_2}{r^2 D}$
Strength of electrostatic interactions in water is 80 times less as compared to air or vacuum.
Energy in water - 500 /80 = 25/4 - 6.25kJmol^{-1}

5. **Correct Answer is (3):** In a hydrogen bond, the distance between the donor (D) and acceptor (A) atoms is typically shorter than the sum of their van der Waals radii. This is because the attractive force in a hydrogen bond pulls the donor and acceptor atoms closer together than they would be in a purely van der Waals interaction, resulting in a distance that is less than the sum of the van der Waals radii.

6. **Correct Answer is (4)**:
Nucleosome stability is primarily driven by the electrostatic interactions between the negatively charged DNA phosphate backbone and the positively charged lysine residues on histones. These interactions help bind the DNA to the histone proteins, facilitating the compact structure of the nucleosome and contributing to chromatin stability.

7. Correct Answer is (4): Biological membranes self-seal due to non-covalent forces: amphipathic lipid nature, hydrophobic interactions that drive lipid tails inward, and hydrogen bonding between lipid heads and water. Covalent bonds do not occur between lipids, so they don't contribute to self-sealing.

Section 3: Solution, pH and Colligative Properties

1. Correct Answer is (3): Formula for ionic strength,
$I = ½ \Sigma C_i \times (Z_i)^2$
Where, C_i = concentration of any ion
Z_i^2 = charge of any ion
$0.2\ M\ Na_2HPO_4 \longrightarrow 2\ Na^+ + HPO_4^{-2}$

Charge	+1	-2
Concentration	0.4M	0.2M

$$I = \frac{1}{2}\sum C_{Na} \times (Z_{Na})^2 + C_{HPO_4^{-2}} \times (Z_{HPO_4^{-2}})^2$$
$$I = \frac{1}{2}\sum 0.4 \times (1)^2 + 0.2 \times (-2)^2$$
$$I = \frac{1}{2}\sum 0.4 \times 1 + 0.2 \times 4$$
$$I = \frac{1}{2}\sum 0.4 + 0.8$$
$I = ½ \times 1.2 = 0.6$ M

2. Correct Answer is (1): If there are 6×10^{23} chromosomes = 1 mole of chromosomes
Since, bacteria have only one chromosome,
1 chromosome = $\frac{1}{6 \times 10^{23}}\ mole$
$= \frac{1}{6} \times 10^{-23}\ mole$

3. Correct Answer is (4): The solubility of gases in water is influenced by their ability to form interactions, particularly hydrogen bonds, with water molecules.
- **Ammonia (NH_3)** is highly soluble in water because it can form strong hydrogen bonds due to its lone pair of electrons and its ability to accept and donate hydrogen bonds.
- **Sulphur dioxide (SO_2)** is also quite soluble as it can interact with water molecules through dipole interactions and can partially ionize in water.
- **Carbon dioxide (CO_2)** is non-polar being linear and moderately soluble because it can react with water to form carbonic acid, though this is a weaker interaction compared to SO_2.
- **Oxygen (O_2)** is the least soluble because it is a nonpolar molecule and does not interact strongly with water molecules.

4. Correct Answer is (2): HCl is strong acid so will dissociate 100 % to yield H^+.
$[H^+] = 10^{-1}$ molar
$[H^+] \times [OH^-] = 10^{-14}$
$0.1 \times [OH^-] = 10^{-14}$
$[OH^-] = \frac{10^{-14}}{10^{-1}} = 10^{-13}$ M

5. Correct Answer is (2) and (3):
- Statement 1 is **false**. Enantiomers have opposite specific rotations, meaning if one enantiomer rotates light by +52°, the other will rotate it by -52°. Therefore, their specific rotations are equal in magnitude but opposite in direction, not identical.
- Statement 2 is **true**. The rate constant k for a first-order reaction has units of sec^{-1}, which means it has units of time only and no concentration units.
- Statement 3 is **true**. The relationship pH + pOH = 14 is true only at 25°C. As temperature increases, the dissociation of water increases, changing the concentrations of H^+ and OH^- ions, and therefore altering the values of pH and pOH.
Statement 4 is **false**. A double bond (–C=C–) is stronger and has higher bond dissociation energy compared to a single bond (–C–C–). Therefore, the bond dissociation energy of a double bond is greater than that of a single bond.

6. Correct Answer is (1): When equal volumes of solutions with pH 4.0 (acidic) and pH 10.0 (basic) are mixed, the resulting solution will have a pH that is approximately neutral. This is because the number of H^+ ions in the pH 4.0 solution is balanced by the number of OH^- ions in the pH 10.0 solution.
pH = 4 means $[H^+]=10^{-4}$ M.
pH = 10 means $[H^+]=10^{-10}$ M or $[OH^-]=10^{-4}$M.
Since both solutions are mixed in equal volumes, the acidic and basic effects cancel each other out, leading to a final pH close to neutral, which is approximately 7.0.

7. Correct Answer is (2):
The equation for pH is as follows:
$pH=-\log[H^+]$
$pH=-\log(10^{-7}) = 7$
We get pH equal to 7. But this is not practically possible because an acidic solution cannot have pH 7, it must be lesser than that. This is case of very dilute solution of acid so we have to take into account H^+ provided by water. It may be noted that in very dilute acidic solution when H^+ concentrations from acid and water are comparable, the concentration of H^+ from water cannot be neglected.
Therefore, Total $[H^+]$ = $[H^+]$ obtained from HCl + $[H^+]$ obtained from H_2O
Since HCl is a strong acid and is completely ionized = $[H^+]_{HCl}=1.0\times10^{-7}$
The concentration of H^+ from ionization from water = $[H^+]_{H2O}=1.0\times10^{-7}$
Total $[H^+] = [H^+]_{HCl} + [H^+]_{H2O}$
$= 1.0\times10^{-7} + 1.0\times10^{-7}$
$= 2.0\times10^{-7}$
$pH= -\log[\text{Total } H^+]$
$= -\log(2 \times 10^{-7}) = 6.79$
So, pH of 10^{-7} M HCl will be less than 7 (6.79).

8. Correct Answer is (4):
$pH = -\log [H^+]$
$[H^+] = \text{antilog} - pH$
The pH of gastric juice is 2,
$[H^+] = \text{antilog} - 2$
$[H^+] = 0.01 = 1 \times 10^{-2}$
The pH of endocytic vesicles is 5.2

$[H^+]$ = antilog - 5.2
$[H^+]$ = **0.63 X 10^{-5}**
Ratio of $[H^+]$ in stomach gastric juice to endocytotic vesicle
= $\frac{1 \times 10^{-2}}{0.63 \times 10^{-5}}$
= 1585/1
The $[H^+]$ concentration in endocytic vesicles is approximately 1585 times lower than that in gastric juice.

9. **Correct Answer (1):** Osmolarity depends on the number of particles in solution, not their mass. A polysaccharide composed of 1000 glucose units behaves as a single molecule in solution. Therefore, 1 gram of this polysaccharide contributes to osmolarity the same as 1 molecule of glucose. Since 1 molecule of glucose weighs approximately 1 mg, the polysaccharide's effect on osmolarity is equivalent to that of 1 mg of glucose.

10. **Correct Answer (3): Step 1: Calculate the H+ ion concentration for each pH value**
The H^+ ion concentration is calculated using the formula:
pH= – log **$[H^+]$**
$[H^+]$ = Antilog - [pH]
Step 2: Calculate the H^+ concentration for each pH
$[H^+]$ = Antilog - [10.5] = 3.16×10^{-11}
$[H^+]$ = Antilog - [10.3] = 5.01×10^{-11}
$[H^+]$ = Antilog - [10.1] = 7.94×10^{-11}
$[H^+]$ = Antilog - [10.4] = 3.98×10^{-11}
$[H^+]$ = Antilog - [10.7] = 2.00×10^{-11}
$[H^+]$ = Antilog - [10.4] = 3.98×10^{-11}
Step 3: Add all the $[H^+]$ concentrations
Total $[H^+]=26.07 \times 10^{-11}$
Step 4: Calculate the average $[H^+]$ concentration
Average of $[H^+]=26.07 \times 10^{-11}/6 = 4.345 \times 10^{-11}$
Step 5: Calculate the average pH
Average pH= – log **$[H^+]$**
Average pH= – log $(4.345 \times 10^{-11}) = 10.36$.

Section 4: Thermodynamics and Bioenergetics

1. **Correct Answer is (2):**
Let's calculate ΔG° for both K'eq values in K.cal/mole
Reaction A: ΔG° = -1.36 log 10 = -1.36 k.cal/mole
Reaction B: ΔG° = -1.36 log 100 = -1.36 x 2 = - 2.72 k.cal/mole
ΔG' of A = -1.32 (less negative) is more than ΔG' of B = -2.72 k.cal/mole

2. **Correct Answer is (1):**

	ATP	→	ADP + P_i
Charge	-4		-3

Structure of ATP is comparatively unstable because of more repulsive charges. Electrostatic repulsive forces are acting on it because of negatively charged phosphate ions. It readily hydrolyses and releases energy around ΔG° = –7.3 kcal/mol. Mg^{2+} ions stabilize the structure of ATP because of positive charges. If structure of ATP gets stabilized, its hydrolysis will not be as spontaneous or as frequent as earlier. So, ΔG° will become lesser negative. The process is cooperative, i.e., interaction is at more than one place. As concentration of ATP is increased, initially the change is very less, but after certain time the value of ΔG° will rapidly become lesser negative.

3. **Correct Answer is (4):** Glucose-1-phosphate is not energy rich molecule and thus do not have standard free energy change lesser negative than -30 KJ/mol. The hydrolysis of glucose-1-phosphate involves breaking the bond between the phosphate group and the glucose molecule. The standard free energy change (ΔG°) for this hydrolysis reaction is -20.9 KJ/mol.

Section 5: Enzyme Basics and Kinetics

1. **Correct Answer is (4):** Enzyme concentration = 20 µg
Molecular weight of enzyme = 200,000 D = 2×10^5
Concentration of enzyme in molar
2×10^5 g = 1M
1 g = $\frac{1}{2 \times 10^4}$ M
20×10^{-6} g = $\frac{20 \times 10^{-6}}{2 \times 10^5}$ M = 1×10^{-10} M
V_{max} must be in M/min.
V_{max} for sugar liberation = 10 mg/min
Molecular weight of sugar = 400
If 400 g = 1 Molar or 1 g = 1/ 400 Molar
10 mg (0.01g) = $\frac{1}{400} \times 0.01 = 0.25 \times 10^{-4}$ M
$k_{cat} = v_{max}/E_t$
$k_{cat} = \frac{0.25 \times 10^{-4} M/min}{1 \times 10^{-10} M} = \frac{2.5 \times 10^{-5}}{1 \times 10^{-10}}$
$k_{cat} = 2.5 \times 10^5$/min

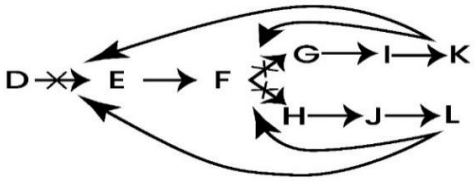
2. **Correct Answer is (1):** Enzymes accelerate a reaction by decreasing energy required to form the transition state i.e., activation energy. Enzymes cannot increase kinetic energy of substrate. Kinetic energy increases on increasing the temperature. Enzymes do not disturb reaction equilibrium or free energy. Increasing the turn over number of enzymes means speed of enzymatic reaction is increased. It has no relation to accelerating the reaction. The turnover number of an enzyme, or the k_{cat}, is the maximal number of molecules of substrate converted to product per active site per unit time. It is constant.

3. **Correct Answer is (3):** Allosteric enzymes obey Hill's kinetics, they do not obey Michaelis-Menten kinetics. Competitive and non-competitive inhibitions are kinetically distinguishable. The free-energy change provides information about the direction of reaction not rate. In competitive inhibitors there is an increase in K_m, and V_{max} remains same. In non-competitive inhibitors there is a decrease in V_{max}, and K_m remains same. A K_{cat}/K_m (M^{-1} S^{-1}) of ~2×10^8 for an enzyme indicates that the value is close to diffusion-controlled rate of encounter.

4. **Correct Answer is (1):** Allosteric enzymes diverge from Michaelis-Menten behavior and obey Hill's kinetics. Rest of all statement are true.

5. **Correct Answer is (1):**
Given: Vmax = 100umol/min
K_M = 10 mM;
Substrate concentration[S] = 10 mM.
Since, Substrate concentration[S] = K_M = 10mM;
$V_0 = ½ V_{max}$
V_o = ½ x 100µmol/min= 50 µmol/min.

6. **Correct Answer is (1):** In concerted feedback inhibition more than one end product or all end product are present in excess to repress the first enzyme. This is seen when Allosteric enzyme is present. Allosteric enzymes inhibits at first step of the metabolic pathway.



In above metabolic pathway, K will inhibit F->G; L will inhibit F->H and K&L will together inhibit D->E.

7. **Correct Answer (1):** An enzyme that converts an L-amino acid to a racemic mixture (containing both L- and D-forms) is involved in the process of racemization. Pyridoxal phosphate, identifies the coenzyme that commonly participates in amino acid transformations, including racemization. Pyridoxal phosphate (derived from vitamin B6) is a versatile coenzyme that acts in various enzymatic reactions involving amino acids, such as transamination, decarboxylation, and, relevantly, racemization.

Section 6: Enzyme Inhibition

1. **Correct Answer is (3):** Iodoacetamide inactivates an enzyme by reaction with a critical cysteine residue at neutral pH. Prolyl-carboxylase will be an appropriate transition state analog. Tosyl-1-phenylalanine chloromethyl ketone binds at the active site of chymotrypsin and modifies an essential histidine residue.

2. **Correct Answer is (3):** If concentration of product is higher, the reaction products bind to the enzyme's active site, preventing the substrate from binding. This inhibits the catalysis as the enzyme is occupied and unable to process additional substrate molecules.

3. **Correct Answer is (3):** In suicide irreversible inhibition, the inhibitor binds to the enzyme and is processed just like a substrate. However, during this process, the inhibitor forms a covalent bond with the enzyme, leading to irreversible inactivation of the enzyme. This blocks further catalysis and affects the K3 step, where the normal turnover would occur.

4. **Correct Answer is (3):** In allosteric enzymes, effectors or modulators can bind on regulatory subunits through non-covalent interactions. Experimentally, monoclonal antibodies that catalyze hydrolysis of esters or carbonates have been produced. Acid phosphatases hydrolyze biological phosphate esters at ~ pH 5.0, because it is working in acidic pH. Enzymes could be inhibited irreversibly by heavy metals such as Hg^{2+}, Ag^{+}.

5. **Correct Answer is (3):** In a Dixon plot for estimating the inhibition constant (K_i) between an inhibitor and an enzyme, the reciprocal of the reaction rate (1/v) is usually plotted against increasing initial concentrations of the inhibitor employed (i_0) for a fixed concentration of the substrate.

6. **Correct Answer is (1):** Uncompetitive inhibitor binds only to the complex formed between the enzyme and the substrate i.e. the E-S complex and NOT to the free enzyme. It decreases both V_{max} of the reaction and K_M of the enzyme. It decreases K_M of the enzyme thus increases affinity of the enzyme for the substrate so that it can readily form ES complex on which uncompetitive inhibitor can bind.

Section 7: Carbohydrates

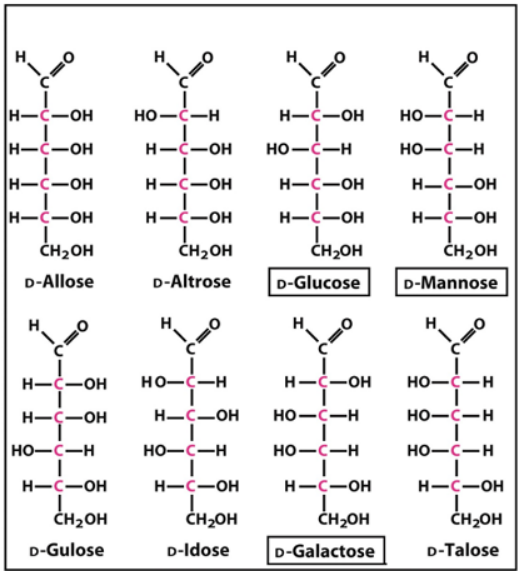
1. **Correct Answer is (1):** Anomers are a type of epimer specifically at the hemiacetal (or hemiketal) carbon in a cyclic sugar. D-glucose exists in two anomeric forms: α-D-glucose and β-D-glucose. In a typical solution of D-glucose in water, these two forms exist in equilibrium, where about 33% is in the α-form and 66% is in the β-form. The mixture exhibits an overall optical rotation of +52°, which is the result of the sum of the optical activities of the two anomers.
- If the proportion of α-D-glucose increases, the overall optical rotation will increase.
- If the proportion of β-D-glucose increases, the optical rotation will decrease slightly.

The signs of the optical rotation of both anomers are not opposite (both are positive), meaning they don't cancel each other out. Moreover, anomers are observed in their cyclic forms, not in linear forms, and they are optically active. A racemic mixture (which is optically inactive) is not formed here, as racemic mixtures occur with D- and L-glucose, not with α-D-glucose and β-D-glucose.

2. **Correct Answer is (4):** Tollen's reagent, also known as silver mirror test, is a chemical test used to detect reducing sugars. It is based on the reduction of silver ions (Ag^{+}) to metallic silver (Ag) in the presence of a reducing agent Option 1 has α-1, → 4-glycosidic bond, option 2 and 3 has β-1, → 4-glycosidic bond, thus each has free reducing end and capable of reacting with Tollen's reagent. Option 4 is Trehalose is actually a non-reducing sugar and is capable of reducing Tollen's reagent. Trehalose is a disaccharide composed of two glucose units linked by an α-1, →α 1-glycosidic bond, so it donot

have free reducing end (hemi-acetal or hemi-ketal carbon).

3. **Correct Answer (4):**



D-glucose has four chiral centers, at carbons 2, 3, 4, and 5. Epimers differ in configuration at only one chiral center. D-mannose is indeed the C-2 epimer of glucose, D-allose is the C-3 epimer, and D-galactose is the C-4 epimer. However, D-talose is not the C-5 epimer of glucose. D-talose actually differs from glucose at both C-2 and C-4 positions, making it a diastereomer but not an epimer of glucose. The C-5 epimer of glucose would be L-idose, not D-talose.

Section 8: Amino Acids and Peptides

1. **Correct Answer is (2):** Rotation is possible between N and C_α (called as ϕ), and between C_α and C' (called as ψ) because they are pure single bonds. Rotation is not possible between C' and N because it have partial double bond character.

2. **Correct Answer is (2):** The carboxyl group of amino acid can react with an alcohol (such as of sugar) to form an ester bond. Amino acids form ester bond with 3' end of ribose sugar of t-RNA. The carboxyl group of one amino acid can react with the amino group ($-NH_2$) of another amino acid to form an amide bond, also known as a peptide bond.

3. **Correct Answer is (2):** For acidic amino acids, pI would be average of acidic groups. pI = $\frac{pKa_1 + pKa_2}{2}$
$= \frac{2.02+3.8}{2} = \frac{5.82}{2} = 2.91$

4. **Correct Answer is (4):** Disulfide bonds are formed when cysteines are opposite to each other not when they are adjacent to each other. Isoleucine and threonine have 2 chiral centres. Only sugars contribute to chirality of nucleic acids, bases lack chiral carbon. The pI of aspartic acid is (2.05 + 3.65)/2 = 5.7/2 = 2.85. The pI of glutamic acid is (2.05 + 4.25)/2 = 6.3/2 = 3.15. Aspartic acid is stronger acid as compared to glutamic acid.

5. **Correct Answer is (4):** bond formed by proline at its N-terminal with amino acid X will be cis (– X – Pro – Y –) and on its C-terminus with amino acid Y it will form trans bond.

6. **Correct Answer is (3):** Out of 20 standard amino acids 4 amino acids are both glucogenic and ketogenic i.e provide glucose and ketone bodies. They are isoleucine, tyrosine, tryptophan and phenylalanine. Leucine and lysine are purely ketogenic and rest of them are purely glucogenic amino acids.

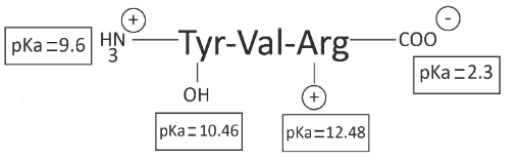
7. **Correct Answer is (2):** Proline is breaker of α-helix. Both isoleucine and threonine have 2 chiral carbons (C_α and C_β) and thus can exist as diastereomers. pKa of side chain of Asp = 3.65. pKa of side chain of Glu = 4.25. Restriction is more ϕ dihedral angle of proline not at ψ angle.

8. **Correct Answer is (1):** pKa of side chain of Arg = 12.5.
pKa of side chain of Lys = 10.5.
pKa of side chain of Tyr = 10.
pKa of side chain of α-amino group = 9-10.
pKa of side chain of Cys = 8.3.
pKa of side chain of His = 6.
pKa of side chain of Asp = 3.9.
pKa of side chain of Glu = 4.25.
pKa of side chain of α-carboxylic group = 1.7-2.5.
On comparing pKa values of different R group of amino acids the decreasing pk_a values of their side chain is Arg > Lys> Cys > His

9. **Correct Answer is (4):** For basic amino acids, pI would be average of basic (amino) groups i.e.
pI= $\frac{pKa_1 + pKa_2}{2}$
$= \frac{9.06+10.54}{2} = \frac{19.6}{2} = 9.8$

10. **Correct Answer is (1):** There are 2 basic groups in peptide chain, so it is a basic peptide. For basic peptide having 2 basic and 1 acidic pKa values, the pI would be average of two basic groups.
pI = $\frac{pKa_1 + pKa_2}{2}$
pI = $\frac{10.5+9.8}{2} = \frac{20.3}{2} = 10.15$

11. **Correct Answer is (1):** Based on the pKa of ionizable group and the surrounding pH, we can predict whether a compound will be protonated or deprotonated. If the pH is lower than the pKa, then the ionizable group will be protonated. If the pH is higher than the pKa, then the ionizable group will be deprotonated. At pH=5 following state will be observed

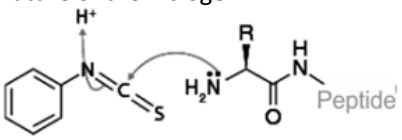


Thus, there are two protonated and one deprotonated group. Hence, net charge will be **1.0**

12. **Correct Answer is (3):** Epinephrine, Dopamine, L-DOPA and Norepinephrine are Tyrosine derived neurotransmitter. Serotonin is tryptophan derived neurotransmitter.

13. **Correct Answer (1):** Lysine residue is not typically a site of phosphorylation in proteins. The most common amino acids to be phosphorylated are serine, threonine, and tyrosine. Other amino acids which can be phosphorylated are histidine and aspartic acid.

14. **Correct Answer is (1):**
In protein synthesis, peptide bonds are typically formed between the carboxyl group of one amino acid and the amine group of another. In the novel organism, if the protein synthesis occurs in the reverse direction (C-terminus to N-terminus), the nitrogen of the amine group will still act as the nucleophile, attacking the carbonyl carbon of the carboxyl group of the preceding amino acid, forming a peptide bond. The reversal of synthesis direction does not change the nucleophilic nature of the nitrogen.



15. **Correct Answer is (1):**
pKa reflects side chain acidity; Serine (~13) has the highest, followed by Lysine (~10.5), Histidine (~6), and Aspartate (~3.7) due to their ionizable groups.

Section 9: Ramachandran plot

1. **Correct Answer is (3):** Unstructured peptides can still have many dihedral angles in the allowed regions, so option 1 is false. It is not possible to definitively conclude if a peptide adopts an entirely helical or beta-sheet conformation based solely on ϕ and ψ values, making option 2 false. The Ramachandran plot provides insight into secondary structures, including beta turns, which can be identified by specific dihedral angle patterns, so option 3 is correct. The sequence of a peptide cannot be determined from the Ramachandran plot, as it only gives information about the structure, not the specific sequence, so option 4 is false. For sequence determination, techniques like Edman degradation or Tandem MS are used.

2. **Correct Answer is (4): I**n the Ramachandran plot, **L-amino acids** forming a β-strand have ϕ and ψ values that generally fall in the **upper left** quadrant. **D-amino acids** are the mirror image of L-amino acids, so their dihedral angles will appear as the mirror opposite. Thus, for a β-strand composed of **D-amino acids**, the ϕ and ψ values will fall in the **lower right** quadrant of the Ramachandran plot.

3. **Correct Answer is (1):** The Ramachandran plot represents the dihedral angles of the main chain (ϕ and ψ) in amino acids, not the side chains. Therefore, statement (1) is NOT true. Infrared spectroscopy can indeed be used to deduce hydrogen bonding in peptides (statement 2 is true). The three-dimensional structure of small proteins (around 100 amino acids) can be determined by nuclear magnetic resonance (NMR) spectroscopy (statement 3 is true). Globular proteins typically contain α-helical and β-sheet components.

4. **Correct Answer is (3):** In proline, the pyrrolidine ring constrains the ϕ (phi) angle due to steric hindrance between the nitrogen and the α-carbon (N – C_α bond). When the pyrrolidine ring is reduced to a linear form, this steric hindrance is removed, allowing more flexibility in the ϕ angle, resulting in a more relaxed ϕ value compared to proline. The ψ angle (C_α – COOH bond) remains more flexible, as it is less affected by the ring structure.

5. **Correct Answer (4):** The Ramachandran plots shown in the image are used to visualize the phi (ϕ) and psi (ψ) dihedral angles of amino acid residues in protein structures. These plots help identify secondary structure elements such as alpha-helices and beta-sheets.
   - **Alpha-helices** predominantly show clusters in the region where phi is approximately -57° and psi is approximately - 47°.
   - ***Analyzing the plots:***
   - **Plot A**: Shows clusters around the regions typical for both alpha-helices and beta-sheets.
   - **Plot B**: Displays clusters that are more scattered, not predominantly in the alpha-helical region.
   - **Plot C**: Has a prominent cluster in the region typical for alpha-helices.
   - **Plot D**: Shows a significant cluster in the alpha-helical region.

   Given this, the correct pair of proteins that are predominantly alpha-helical in nature is:

6. **Correct Answer is (1):** Atoms required to uniquely define the torsion angles
   - **Phi (ϕ)** is the torsion angle around the N-Cα bond, and to define this angle, you need the coordinates of four atoms: C^{-1} (the carbonyl carbon of the previous amino acid), N (the nitrogen of the current amino acid), C^α (the alpha carbon of the current amino acid), and C (the carbonyl carbon of the current amino acid).
   - **Psi (ψ)** is the torsion angle around the C^α-C bond, and to define this angle, you need the coordinates of the atoms: N (the nitrogen of the current amino acid), C^α (the alpha carbon of the current amino acid), C (the carbonyl carbon of the current amino acid), and N^{+1} (the nitrogen of the next amino acid)

Section 10: Secondary structure of proteins

1. **Correct Answer is (3):** In an α-helix, the structure is stabilized by hydrogen bonds that form between the backbone carbonyl oxygen (CO) of amino acid 'n' and the amide hydrogen (NH) of the amino acid located four residues ahead (n + 4) in the sequence.

2. **Correct Answer is (4):** The dihedral angles ϕ, ψ of amino acids in unfolded proteins can be either positive or negative, not necessarily exclusively positive, thus statement 4 is incorrect. Rest of all statements are correct.

3. **Correct Answer is (2):** The number of hydrogen bonds in an α-helix is generally the number of amino acids minus 4. For a helix with 15 amino acids, the number of hydrogen bonds is: 15 - 4 = 11.

4. **Correct Answer is (1):** The distance between two amino acids in α-helical polypeptide chain is 1.5 A°. Thus, total number of amino acids in 108 A˚ will be 108 A˚ / 1.5 A˚ = 72. α-helical polypeptide chain do not contain proline as it is helix breaker, further glycine is least expected as it destabilized α-helix.

Section: 11: Protein Folding

1. **Correct Answer is (3):** During folding protein goes form disordered to ordered state. In other words, the entropy decreases which is not thermodynamically favorable.

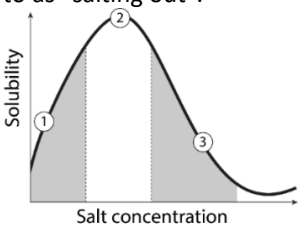
2. **Correct Answer is (2):** Charged amino acid side chains are seldom buried in folded proteins because they prefer to interact with the aqueous environment on the surface via ionic bonds and hydrogen bonds. Non-polar side chains tend to be buried inside the protein core to avoid water, stabilizing the structure through hydrophobic interactions.

3. **Correct Answer is (4):** The given equation is van't hoff equation. It is a straight line equation: y = mx + c
If ΔH° and ΔS° are independent of temperature, as they often are to a reasonable approximation, a plot of ln K_{eq} versus 1/T, known as a van't Hoff plot**,** yields a straight line of slope -Δ H°/R and intercept ΔS°/R. This relationship permits the values of ΔH° and ΔS° to be determined from measurements of K_{eq} at two (or more) different temperatures. ln K_{eq} is plotted on Y axis and 1/T on X axis.

4. **Correct Answer is (3):** Glycerol has a high affinity for water, which means it attracts water molecules, leaving fewer water molecules available to interact directly with the protein. This is called preferential hydration. In simpler terms: glycerol stabilizes proteins by encouraging more water to stay around the protein, which keeps the protein in its natural, stable structure.

5. **Correct Answer is (2):** Linus Pauling gave model of α-helix. Emil Fischer proposed Lock and Key model of enzyme – substrate interaction. John Kendrew described myoglobin structure. Christian Anfinsen performed experiments on protein denaturation and renaturation, i.e., protein always attains same conformation in favorable conditions, how many times it is folded or unfolded.

6. **Correct Answer is (2):** The solubility of proteins usually increases slightly in the presence of salt, referred to as "salting in" as shown by (1). However, at high concentrations of salt (3), the solubility of the proteins drop sharply and proteins can precipitate out, referred to as "salting out".



7. **Correct Answer is (4):** In α-helix structure of proteins, the polypeptide chains are stabilized by intramolecular hydrogen bonding whereas β- sheet structure of proteins is stabilized by inter-molecular hydrogen bonding. In the earliest stages of protein folding, forming intra-molecular hydrogen bonding is much more efficient and favourable than forming intermolecular hydrogen bonds, thus α-helix are likely to occur than β-sheets.

8. **Correct Answer is (**2):
Hydrogen bonds between polypeptide strands stabilize collagen's triple helix.

Section 12: Nucleotides and Nucleic Acids

1. **Correct Answer is (4):** Ribose sugar has three chiral carbon atoms. Deoxyribose sugar has two chiral carbon atoms. Base do not have chiral carbon. Thus, chirality is due to sugar.

2. **Correct Answer is (2):** The stability of DNA secondary structures (like hairpins or stem-loops) is influenced by factors such as GC content and length of complementary sequence between 5'-end and 3'-end.
Sequence (c) - AGGGAGCGATCCCT: This sequence has a higher GC content and symmetrical regions that are more likely to form a stable hairpin due to stronger GC base pairs, making it the most stable of the three.
Sequence (a) - ATTGAGCGATCAAT: This sequence has a moderate amount of GC content and forms a reasonable secondary structure, but it is less stable than sequence (c) due to fewer GC pairs and more AT pairs.
Sequence (b) - ATTGAGCGATATCAAT: This sequence has an internal mismatch (ATAT sequence in the middle) that creates a destabilizing loop, making it the least stable of the three.

3. **Correct Answer is (3):** Linking number = twist + writhe

Lk = Tw + Wr
Lk = 10 + 0 = 10

4. **Correct Answer is (1):** The conformation of ribose in DNA is β- 2'-deoxy-D-ribofuranose not α- 2'-deoxy-D-ribofuranose.

5. **Correct Answer is (4):** In double-stranded DNA, the base pairing follows Chargaff's rule, which states that:
- Cytosine (C) pairs with Guanine (G) and Adenine (A) pairs with Thymine (T).
- This means the amount of C is equal to the amount of G, and the amount of A is equal to the amount of T.

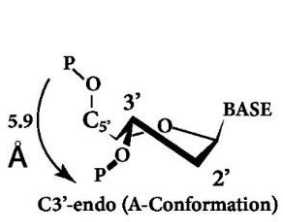
Given that C = 20%, it means that G = 20% as well, since they pair together. Therefore, the total percentage of C and G together is:
C + G = 20% + 20% = 40%
The total DNA content must add up to 100%. So, the remaining percentage must be **A** and **T** together, which is:
A + T = 100 – (C+G) = 100 – 40 = 60%

6. **Correct Answer is (4):** C-2' endo sugar puckering is typical in B-form DNA, which is the most common form of double-stranded DNA. C-3' endo sugar puckering is typical in A-form DNA and is observed in double-stranded RNA (dsRNA) as well as in RNA-DNA hybrid duplexes. In such hybrids, the RNA strand adopts the C-3' endo conformation due to the presence of the 2'-OH group, which prefers the A-form conformation.

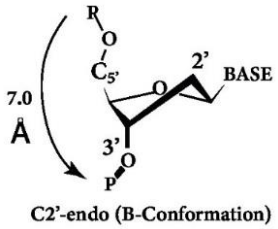
7. **Correct Answer is (*):** The graph is exam question was not given, thus we were not able to predict correct answer but if graph would have been like given in question which is showing sharp transition in absorbance on heating suggest that it is double stranded nucleic acid which can be DS DNA, DS RNA or RNA-DNA hybrid but cannot be single stranded. In case of single stranded nucleic acid the change is absorbance on heating would have been negligible.

8. **Correct Answer is (1):** G-C base pairs have 3 hydrogen bonds, while A-T base pairs have two. Therefore, double-stranded DNA with a higher number of G-C base pairs will be more strongly bonded together, more stable, and will have a higher melting temperature. Therefore, A sequence has 6 GC Bp. B has 14, C has 10 and D has 12 GC Bp. Thus, B has highest melting point and A has lowest melting point.

9. **Correct Answer is (1):** The sugar puckers in DNA/RNA structures are predominately in either C2'-endo (B-DNA) or C3'-endo (A-DNA, DS-RNA), corresponding to the B- or A-form conformation in a duplex. In these two sugar conformations, the distance between neighbouring phosphorus (P) atoms and the orientation of P relative to the sugar/bases are also dramatically different.



C3'-endo (A-Conformation)



C2'-endo (B-Conformation)

10. **Correct Answer is (2):** According to question, a complementary RNA sequence joins with a B-form of DNA producing a DNA-RNA hybrid (R-loop). Due to this, some changes are seen in the sugar puckering of the DNA, as it will exhibit confirmation similar to A-form DNA. A-form DNA shows C3'-Endo confirmation while B-form DNA shows C2'-Endo conformation. A-form type DNA confirmation is seen in dsRNA, RNA-DNA hybrid and ds DNA in extreme dehydrated condition.

11. **Correct Answer 2:** DNA can exist in several different forms, referred to as A, B, and Z forms. The B-form of DNA is the most common form under physiological conditions and is a right-handed helix. The A-form of DNA is also a right-handed helix and is seen in dehydrated samples of DNA. Z-DNA is a left-handed DNA where the double helix winds to the left in a zig-zag pattern and often seen where there is alternate pyrmidine –purine sequence (like CpG Islands) and are methylated.

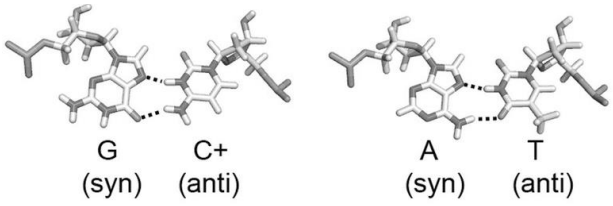
12. **Correct Answer is (2):** When the sense and antisense strands of such a DNA sequence are mixed in equal proportion and annealed (heated and then slowly cooled), they will naturally pair up to form double-stranded DNA. The structure adopted by this double-stranded DNA in water is typically the B-form. The B-form of DNA is the most common form found in biological systems and under physiological conditions (aqueous, near-neutral pH, moderate ionic strength).
The other forms mentioned, A-form and Z-form, are less common and typically require specific conditions or sequences to form. The A-form is also right-handed but more compact, often found in dehydrated samples of DNA, or in RNA-DNA hybrid helices, while the Z-form is a left-handed helix and forms under high salt conditions or with certain sequences (typically alternating purine-pyrimidine stretches, particularly with CG repeats).

13. **Correct Answer (2):** The base composition of the newly identified virus's genome is given as:
Adenine: 25%; Cytosine: 35%;
Guanine: 30%; Thymidine: 10%
Given these percentages, the sum of the purines (Adenine and Guanine) does not equal the sum of the pyrimidines (Cytosine and Thymidine). In a double-stranded DNA (dsDNA) or double-stranded RNA (dsRNA), due to base pairing rules (A-T or A-U, and G-C), the percentage of purines would equal the percentage of pyrimidines. This imbalance suggests the genome cannot be double-stranded.

The correct answer, (2) single-stranded DNA, is supported by the presence of Thymidine (indicating DNA rather than RNA) and the unequal base pairing that rules out a double-stranded structure.

14. **Correct Answer (3):** In the process of transcription, RNA is synthesized complementary to the DNA template strand. In RNA, uracil (U) replaces thymine (T).
Given the DNA template strand composition:
- DNA template: G = 24.1%, C = 18.5%, A = 24.6%, T = 32.8%
- RNA transcript will be complementary: C = 24.1%, G = 18.5%, U = 32.8%, A = 24.6%

15. **Correct Answer (3):** The Hoogsteen base pairing is an alternative base-pairing geometry to the canonical Watson-Crick base pairs. In Hoogsteen base pairing, one of the nucleobases typically adopts a syn conformation rather than the standard anti conformation, leading to different hydrogen bonding patterns. This pairing occurs when guanine or adenine rotates around its glycosidic bond to adopt the syn conformation, which allows it to form a hydrogen bond with cytosine or thymine in the anti-conformation. This is different from the usual Watson-Crick pairing where both bases are in the anti-conformation.



Hoogsteen base pairing

16. **Correct Answer (4):** Z-DNA has a very different groove arrangement: The minor groove in Z-DNA is very deep and narrow. The major groove in Z-DNA is essentially non-existent or "flat". This is because the phosphate groups zigzag back and forth, creating a nearly flat surface where the major groove would typically be in B-DNA.

Section 13: Metabolism of Carbohydrates

1. **Correct Answer is (4):** Pyruvate dehydrogenase complex (PDC) is a complex of 3 enzymes and 5 coenzymes that converts pyruvate into acetyl-CoA by a process called pyruvate decarboxylation. The 3 enzymes are: Pyruvate dehydrogenase (E1), Dihydrolipoyl transacetylase (E2) and Dihydrolipoyl dehydrogenase (E3). The 5 coenzymes are: TPP (thiamine pyrophosphate), lipoate, coenzyme A, FAD and NAD^+.

2. **Correct Answer is (4):** After vigorous exercise, the body consumes extra oxygen in a process known as oxygen debt or excess post-exercise oxygen consumption. One of the primary reasons for this is to produce ATP, which is required for various recovery processes, including gluconeogenesis.

3. **Correct Answer is (3):** During one complete turn of the TCA (tricarboxylic acid) cycle, the following energy-rich fuel molecules are produced:
- **1 GTP (or ATP):** This is produced during the conversion of succinyl-CoA to succinate.
- **3 NADH:** These are produced during the oxidative decarboxylation reactions catalyzed by isocitrate dehydrogenase, α-ketoglutarate dehydrogenase, and malate dehydrogenase.
- **1 $FADH_2$:** This is produced during the conversion of succinate to fumarate by succinate dehydrogenase.

4. **Correct Answer is (1):** If the levels of ATP and citrate both increase, they will inhibit the enzyme PFK-1, and the rate of glycolysis slows down.

5. **Correct Answer is (2):** It is the 1st step of glycogen breakdown. G-1-P to G-6-P → glucose

6. **Correct Answer is (1):** The Luebering–Rapoport pathway is a metabolic pathway in mature erythrocytes involving the formation of 2,3-bisphosphoglycerate (2,3-BPG), which regulates oxygen release from hemoglobin and delivery to tissues. Through the this pathway bisphosphoglycerate mutase catalyzes the transfer of a phosphoryl group from C1 to C2 of 1,3-BPG, giving 2,3-BPG. 2,3-bisphosphoglycerate forms 3-PG by the action of bisphosphoglycerate phosphatase. The concentration of 2,3-BPG varies proportionately with the pH, since it is inhibitory to catalytic action of bisphospho glyceromutase.

7. **Correct Answer is (4):** Phosphofructokinase-2 converts fructose-6-phosphate to fructose-2,6-bisphosphate. The product, fructose-2,6-bisphosphate activates phosphofructokinase-1, the rate limiting step in glycolysis.

8. **Correct Answer is (2):** Phosphofructokinase (PFK) has allosteric site where ATP can bind and it inhibits the activity of PFK. It there is mutation in ATP binding site such that ATP cannot bind to it, then ATP will not able to inhibit PFK. Thus, there will be increase in activity of PFK.

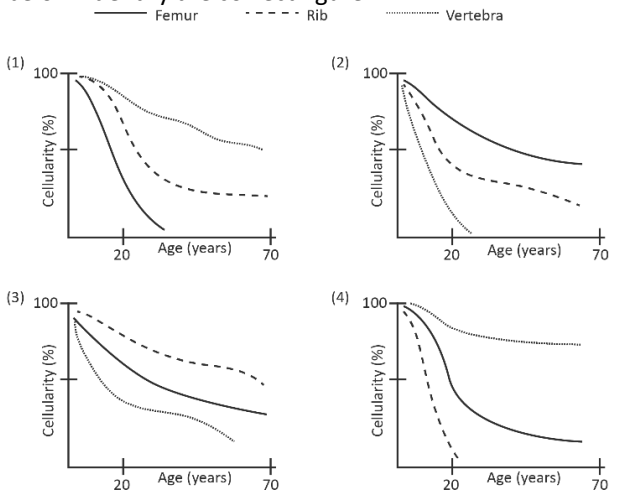
9. **Correct Answer is (4):** Mature red blood cells (RBCs) do not possess mitochondria, and as a result, they undergo anaerobic metabolism, leading to the production of lactate. In the absence of mitochondria, RBCs rely solely on glycolysis for energy production. Glycolysis is an anaerobic process that converts glucose into pyruvate. However, since mature RBCs lack the necessary machinery for aerobic metabolism (such as the citric acid cycle and oxidative phosphorylation in the mitochondria), the pyruvate generated from glycolysis is converted into lactate. This conversion of pyruvate to lactate is catalyzed by the enzyme lactate dehydrogenase (LDH) and serves to regenerate NAD^+, which is required for the continuation of glycolysis. The production of lactate allows RBCs to maintain a sufficient

PART-C

Section 1: Blood

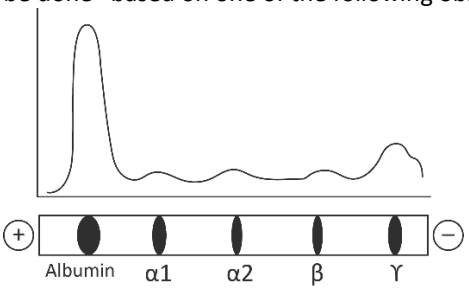
(DEC 2017)

1. Relative rates of red blood cells production in bone marrow of different bones of different ages are shown below: Identify the correct figure.



(JUNE 2019)

2. The blood plasma proteins (albumin and globulins) from a healthy person were separated by electrophoresis as shown below. The diagnosis of acute inflammation can be done based on one of the following observations.



(1) Increase in both αl and α2; decrease in Albumin
(2) Increase in albumin; decrease in αl, α2 and β.
(3) Increase in albumin and decrease in ϒ globulin
(4) Only decrease in albumin.

(FEB 2022-II)

3. The amount of hemoglobin in blood is one of the important health markers. Following statements are made regarding hemoglobin degradation when older red blood cells (RBCs) are destroyed by tissue macrophages.
   A. The globin protein of the hemoglobin is split off and heme is converted first to bilirubin by the action of heme oxygenase.
   B. The globin protein of the hemoglobin is split off and heme is converted first to biliverdin by the action of heme oxygenase.
   C. Carbon monoxide (CO) is formed in the process.
   D. Nitric oxide (NO) is formed in the process.

   Which one of the following represents correct combination of statements?

(1) A and C (2) B and C
(3) A and D (4) B and D

(SEPT 2022-I)

4. A number of statements have been made regarding heme, a component of hemoglobin, as given below:
   (A) It is synthesized in mature erythrocytes
   (B) It is synthesized by the condensation of succinyl-CoA and glycine
   (C) It is synthesized by the condensation of acetyl-CoA and glycine
   (D) Its synthesis is catalyzed by δ amino levulinate synthase

   Which one of the following combinations has both INCORRECT statements?

(1) A and D (2) A and C
(3) B and C (4) B and D

(SEPT 2022-II)

5. Plasma proteins have vital roles in the body ranging from maintaining osmolarity to transport of hormones. Certain statements are given below for the functions of selected plasma proteins:
   (A) Von Willebrand factor is normally synthesized in the liver.
   (B) Ceruloplasmin is a copper carrier protein.
   (C) Genetic deficiency of α_1- antiproteinase causes emphysema.
   (D) Most plasma proteins including albumin are covalently glycosylated.
   (E) α_{1-} acid glycoprotein (AGP) level increases during body's response to inflammation.

   Which one of the following represents all correct combination of statements?

(1) A, B and C (2) B, C and D
(3) B, C and E (4) A, D and E

(SEPT 2022-II)

6. Iron deficiency is a common problem in humans worldwide. The homeostasis of iron in the body is maintained using various proteins (column- X) and their function (column- Y):

Column-X		Column-Y	
A	Ferritin	i.	Hypoxia is known to reduce its synthesis
B	Ferroportin	ii.	Plasma iron binding protein
C	Transferrin	iii.	Intramucosal cell iron binding protein
D	Hepcidin	iv.	Iron leaves mucosal cells through it

Choose the correct option from below that most appropriately matches in column X with that of column Y.

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

(DEC 2024-I)

7. The following statements are made about hematopoiesis in humans.
   A. Bone marrow stem cells are not the source of osteoclast and mast cells.
   B. Normally, three-fourths of the cells in the marrow cavities mature to white blood cells and one-fourth to red blood cells.
   C. In adults, blood cells are not actively produced in the marrow cavities of all the bones.
   D. Hematopoietic stem cells are derived from committed cells.

   Which one of the following options represents all correct statements?
   (1) A and B (2) B and C
   (3) C and D (4) A and D

Section 2: Hemostasis and Blood Groups

[DEC 2014]

1. Given below are few statements with reference to blood clot formation which results from triggered chain of reactions:
   A. Conversion of fibrinogen to fibrin.
   B. Activation of factor XIII, which stabilizes fibrin mesh work.
   C. Activation of factor XII, which promotes plasmin activation.
   D. Enhancement of platelet aggregation.

   Which one of the following of statements is correct with reference to roles of thrombin in hemostasis?
   (1) B, C and D (2) A, B and D
   (3) A, C and D (4) A, B and C

[DEC 2016]

2. If in a blood transfusion, type A donor blood is given to recipient having type B blood, the red blood cells (RBC) of donor blood would agglutinate but the recipients RBCs would be least affected. These observations can be explained in the following statements.
   A. Agglutinins in recipient's plasma caused agglutination by binding with type A agglutinogens.
   B. The agglutinins of donor blood was diluted in recipient's plasma resulting in low agglutination.
   C. Low titre of anti-A agglutinins is the cause of low agglutinations of recipients RBC's.
   D. High agglutination of donor RBC's is the outcome high titre of anti-B agglutinins

   Which of the above statement(s) is/are INCORRECT?
   (1) Only A (2) A and B
   (3) Only B (4) C and D

(DEC 2019)

3. Individuals in a population are divided into various blood groups (in column 'X') based on the set of enzymes they have in column 'Y'):

COLUMN X	COLUMN Y
A	(i) Fucose transferase
B	(ii) GalNAc transferase
AB	(iii) Gal transferase
O	

   Which one of the following combinations is NOT correct for the blood group type and the set of enzymes a person has?
   (1) A - (i) and (ii)
   (2) B - (i) and (iii)
   (3) AB - (i) (ii) and (ii)
   (4) O - (i), (ii) and (iii)

(NOV 2020-I)

4. Fibrinogen, Factor 1, is a soluble glycoprotein present abundantly in plasma. Following biochemical characteristics are given below about this glycoprotein:
   A. It is a dimer of the three polypeptide chains $(A_\alpha B_\beta \gamma)_2$
   B. It is a dimer of two polypeptide chains $(A_\alpha B_\beta)_2$
   C. The chains are covalently linked by 29 inter- and intra-chain disulfide bonds
   D. The chains are covalently linked by 19 inter- and intra-chain disulfide bonds

   Which one of the following represents a combination of correct statements?
   (1) A and C (2) B and C
   (3) A and D (4) B and D

(JUNE 2023-II)

5. Blood hemostasis is the interplay of several intrinsic and extrinsic factors. Deficiency of some of the blood clotting factors and their clinical manifestations are listed below.

Factors	Manifestations
A. V	i. Hageman trait
B. VII	ii. Hypoconvertemia
C. IX	iii. Hemophilia B
D. XII	iv. Parahemophilia

   Which one of the following options represents all correct matches?
   (1) A-(i) B-(ii) C-(iii) D-(iv) (2) A-(iv) B-(ii) C-(iii) D-(i)
   (3) A-(ii) B-(iii) C-(iv) D-(i) (4) A-(iii) B-(i) C-(ii) D-(iv)

(DEC 2023-I)

6. The structure and process of formation of different antigens in blood ABO system are given in the following statements:
   A. Galactose is added to the terminal of H-antigen by a transferase expressed in individuals with type A blood.
   B. The B antigen is formed by a transferase expressed in individuals with type B blood which adds a terminal N-acetyl galactosamine to H-antigen.
   C. The H-antigen is formed by fucose transferase that adds a terminal fucose to its precursor.
   D. The H-antigen is the precursor of both the A- and B-antigens and it is the blood group antigen in persons of type O blood.

   Which one of the following options represents the correct combination of statements?
   (1) A and B (2) B and C
   (3) C and D (4) A and D

(JUNE 2024-I)

7. Given below are the blood clotting factors in column X and their names in column Y.

Column X	Column Y
a. XII	i. Fitsgerald factor
b. HMWK	ii. Laki-Lorand Factor
c. Pre-Ka	iii. Stuart-Prower Factor
d. X	iv. Fletcher Factor

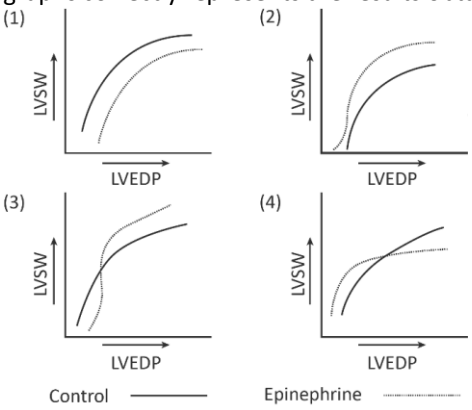
Which of the following combination is a correct match of the factor with its name.

(1) a-iv, b-iii, c-i, d-ii (2) a-ii, b-iii, c-i, d-iv
(3) a-ii, b-i, c-iv, d-iii (4) a-i, b-ii, c-iv, d-iii

Section 3: Cardiovascular System

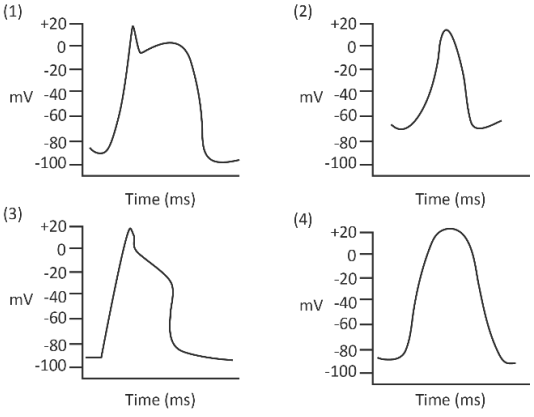
(JUNE 2015)

1. The changes in left ventricular stroke work (LVSW) according to the different left ventricular end-diastolic pressures (LVEDP, which indicates the initial myocardial fiber length) in a dog, under control conditions, were recorded, which follows Starling's law of the heart. This LVSW-LVEDP relationship was investigated in the same dog after constant infusion of norepinephrine, and these two data sets were plotted. Which one of the following graphs correctly represents the results obtained?



[JUNE 2016]

2. Action potentials were recorded intracellularly from different parts of mammalian heart and these are shown below. Which one-of these has been recorded from sinoatrial node?



(DEC 2017)

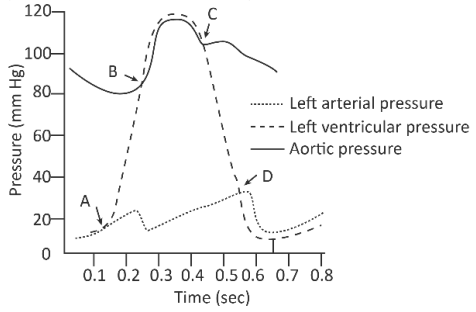
3. The pacemaker cells of sinoatrial node (SA node) are inhibited by the stimulation of vagus nerve. The probable mechanisms of this inhibition are stated as follows:
   A. The acetylcholine-regulated K^+ channels are activated
   B. The outward K^+ causes hyperpolarization of pacemaker cells
   C. The inward "funny current" of pacemaker potential is increased
   D. The increased intracellular cAMP, induced by activation of M2 muscarinic receptors, slows the opening of Ca^{++} channels

   Choose the answer with correct statements.

(1) A and C (2) B and C
(3) A and B (4) C and D

(DEC 2018)

4. The changes in left atrial, left ventricular and aortic pressure in a cardiac cycle are shown below in the figure



Given below are the events of cardiac cycle (column A) associated with marked points (A, B, C, D) in the figure (column B).

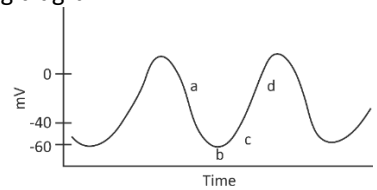
Column A		Column B	
a.	Aortic valve opens	(i)	D
b.	Mitral valve closes	(ii)	B
c.	Mitral valve opens	(iii)	A
d.	Aortic valve closes	(iv)	C

Choose the option that matches the events with marked points in the figure.

(1) a- (ii), b - (iii), c - (i), d - (iv)
(2) a- (i), b- (iv), c - (ii), d - (iii)
(3) a - (iv), b - (i), c- (iii), d-(ii)
(4) a - (iii), b - (ii), c - (iv), d - (i)

(NOV 2020-I)

5. The action potential recorded from pace maker tissue (SA/AV node) of mammalian heart is shown in the following diagram:



On the basis of mechanism of generation of action potential in pace maker tissue (SA/AV node), the following statement were proposed from the above figure

A. 'funny' channels are activated at 'b'
B. Outward flow of K^+ occurs at 'a'
C. T-Ca^{++} channels are closed at 'c'
D. Fast Na^+ channels are opened at 'd'
E. The upward phase at 'd' is largely due to inward movement of Na^+

Which one of the following combinations represent correct statements?

(1) A and B (2) B and C
(3) C and D (4) D and E

(DEC 2023-I)

6. The characteristic features and causes of different heart sounds during a cardiac cycle of humans are given in the following statements.
   A. The second heart sound is loud and sharp when the diastolic pressure is decreased in the aorta or pulmonary artery.
   B. Sudden closure of atrioventricular (AV) valves at the start of ventricular systole caused vibration that produces first heart sound.
   C. The second heart sound is caused by the vibration associated with the closure of aortic and pulmonary valves after the end of ventricular systole.
   D. The first heart sound is soft when heart rate is low as the ventricles are well filled with blood and the leaflets of AV valves float together before systole.

   Which one of the following options represents the combination of all correct statements?
   (1) A, B and C (2) B and C only
   (3) B, C and D (4) A and D only

(DEC 2023-II)

7. Endothelial cells which form the innermost layer of blood vessels secrete many vasoactive substances. The formation and functions of some of these vasoactive substances are proposed in the following statements:
   A. Prostacyclin produced by the endothelial cells promotes vasoconstriction.
   B. Inhibitors of the cyclooxygenase increase the production of prostacyclin.
   C. When endothelial cells are stimulated by acetylcholine or serotonin, nitric oxide (NO) is released that causes relaxation of vascular smooth muscle.
   D. NO is short-lived and inactivated by haemoglobin.

   Which one of the following options represents the combination of correct statements?
   (1) A and B (2) A and C
   (3) C and D (4) B and D

(DEC 2024-I)

8. When blood is forced into the aorta from the left ventricle during systole, a pressure wave is set up in the aorta, which is called a pulse. Some features of the pulse are proposed in the following statements:
   A. The rate of travel of the pulse wave is lower than the velocity of blood flow in arteries.
   B. The pulse wave moves slower with advancing age as the arteries become more rigid.
   C. The pulse wave is strong when the stroke volume is large as in exercise.
   D. The strength of the pulse depends on the magnitude of pulse pressure and not on the mean arterial pressure.

   Which one of the following options represents the combination of correct statements?
   (1) A, B, C, and D (2) B, C, and D only
   (3) C and D only (4) A only

Section 4: Regulation of Heart

(DEC 2014)

1. The heart rate shows variation during respiratory rhythm in most human subjects. Which one of the following statements describing the changes of heart rate during respiratory phases is true?
   (1) The heart rate is accelerated during expiration, but no change occurs during inspiration.
   (2) The heart rate is accelerated during inspiration and decelerated during expiration
   (3) The heart rate is accelerated during expiration and decelerated during inspiration.
   (4) The heart rate is accelerated during inspiration and no change occurs during expiration.

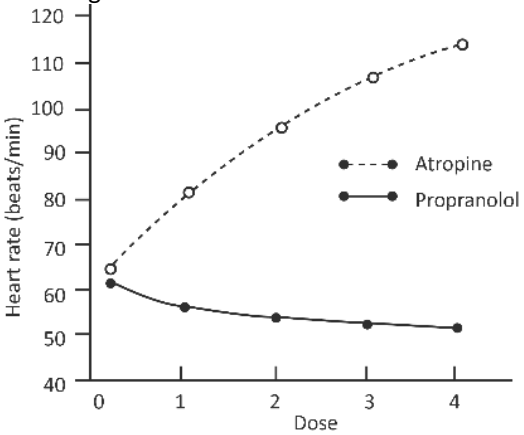
(DEC 2016)

2. The arterial pressure usually raises and falls 4 to 6 mm Hg in a wave like manner causing "respiratory waves". The probable mechanism of these waves has been proposed in the following statements:
   A. The more negative intrathoracic pressure during inspiration reduces the quantity of blood returning to the left side of the heart causing decreased cardiac output.
   B. The changes of intrathoracic pressure during respiration can excite vascular and atrial stretch receptors which affect heart and blood vessels.
   C. The activity of medullary respiratory centers can influence the vasomotor center.
   D. The "respiratory waves" are outcome of the oscillation of the central nervous system ischemic pressure control mechanism.

   Which of the above statement(s) is/are NOT appropriate?
   (1) Only A (2) A and B
   (3) B and C (4) Only D

(JUNE 2017)

3. In an experiment on healthy young men, the muscarinic receptor antagonist, atropine was administered to one group (Group A) while the P-adrenergic receptor antagonist, propranolol was administered to another group (Group B) in four increasing doses of equal concentration for both the drugs. The effects of these two drugs on the heart rate are shown below:



On the basis of these observations, an investigator proposed the following statements:

A. Atropine and propranolol block sympathetic and parasympathetic effects on the heart, respectively
B. As the change of heart rate is more in Group A than in Group B, the sympathetic tone usually predominates in healthy resting individuals.
C. Atropine and propranolol block parasympathetic and sympathetic effects on the heart, respectively D. As substantial changes occur in the heart rate with atropine, the parasympathetic tone is predominant in healthy resting individuals.

Select the option with **INCORRECT** statement(s)

(1) Only A (2) A and B
(3) Only C (4) A and D

(DEC 2019)

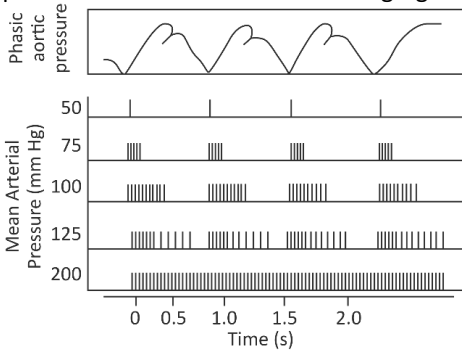
4. Thyroid hormone (T_3) increases the heart rate and the force of contraction of cardiac muscles. The mechanisms of these effects of T_3 have been explained by a researcher in the following statements:
   A. T_3 inhibits the expression of gene for α-myosin heavy chain and enhances the expression of gene for β-myosin heavy chain
   B. The expression of gene for Na^+-Ca^{++} antiporter is enhanced by T_3
   C. The sarcoplasmic reticulum Ca^{++} ATPase is increased by T_3
   D. T_3 increases ryanodine Ca^{++} channels in the sarcoplasmic reticulum
   E. The number of β-adrenergic receptors in heart muscles is inhibited by T_3

   Which one of the following combinations contains both correct explanations?

   (1) A and B (2) B and C
   (3) C and D (4) D and E

   (NOV 2020-II)

5. The discharge patterns in a single afferent nerve fibre from carotid sinus at various levels of mean arterial pressure (MAP) are plotted against changes in aortic pressure with time in the following figure:



   The following statements were proposed from the above figure:
   A. Baroreceptors are more sensitive to phasic change of aortic pressure at normal MAP
   B. The baroreceptor firing rate is reduced at lower MAP than in normal MAP
   C. The phasic change in baroreceptor fibre is less prominent at lower MAP
   D. A burst of action potentials appear in a single baroreceptor fibre during diastole at normal MAP
   E. The discharge of baroreceptors even extends to systole at higher MAP

   Choose the option with both CORRECT statements:

   (1) A and B (2) B and C
   (3) C and D (4) D and E

   (FEB 2022-II)

6. The following statements were proposed by a researcher on the characteristic features of stretch receptors in atria and the effect of these receptors' activity on blood pressure regulation:
   A. The activity of type A receptors are increased by burst of impulses during atrial systole
   B. The activity of type B receptors are increased by burst of impulses at the time of peak atrial filling during late diastole of atria
   C. The discharge of type B atrial receptors is increased when venous return is increased
   D. The activity of type B atrial receptors is increased by positive pressure breathing
   E. The increased activity of most of the atrial receptors initiates reflex circulatory adjustment by increasing blood pressure
   F. The heart rate is decreased reflexly by the increased activity of atrial receptors

   Choose all CORRECT statements from the following options:

   (1) A, B and C (2) B, C and D
   (3) C, D and E (4) D, E and F

   (JUNE 2023-I)

7. The following statements are made with reference to the neural connections of cardiac tissues and the functions of these nerves on heart in adult humans:
   A. The right vagus nerve is distributed mainly to the AV node.
   B. The parasympathetic pre-ganglionic fibers distributed to the heart originate from the superior salivatory nucleus.
   C. The sympathetic post-ganglionic fibers originating from the paravertebral ganglia of the left side primarily innervate SA node.
   D. The sympathetic fibers distributed to heart come mainly from stellate ganglia.
   E. The sympathetic activity alters heart rate slower than that of vagal activity.

   Which one of the following options represents the combination of all correct statements?

   (1) A and B (2) B and C
   (3) C and D (4) D and E

   (JUNE 2023-II)

8. The effects of stimulation of cholinergic vagal fibers on the pacemaker potential of the cells of sinoatrial (SA) node of heart and on the nodal impulse generation are suggested below:
   A. The nodal cell membrane becomes depolarized.
   B. The slope of the pacemaker potential is increased.
   C. The K^+ conductance of nodal cell membrane is decreased.

D. The depolarizing effect of 'h' current (I^h) on the membrane potential is slowed down due to the opening of G protein gated K^+ channels.
E. The opening of Ca^{++} channels are slowed down due to the decreased cAMP level in the nodal cells.

Which one of the following options represents the combination of all correct statements?
(1) A and B (2) B and C
(3) C and D (4) D and E

(JUNE 2024-I)

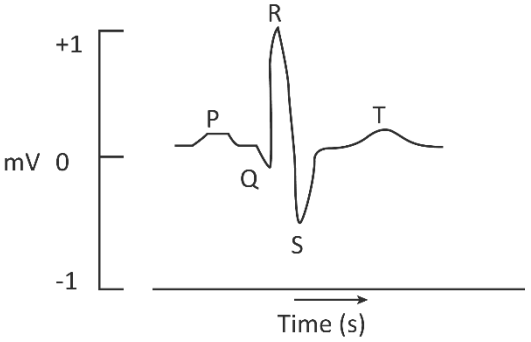
9. The stimulation of sympathetic cardiac nerves increases the rate of action potential generation from the sinoatrial (SA) node of heart. The following statements suggest the mechanism of this action:
A. The depolarizing effect of 'h' current (In) is decreased by sympathetic stimulation.
B. Norepinephrine secreted by the sympathetic endings binds to ß1 adrenoceptors resulting in the increase of intracellular cAMP.
C. The increased intracellular cAMP facilitates the opening of long-lasting (L) Ca^{++} channels.
D. The Ca^{++} current (Ica) due to the opening of voltage-gated L Ca^{++} channels is decreased.

Which one of the following options represents the correct combination of the statements?
(1) A and B (2) B and C
(3) C and D (4) A and C

Section 5: ECG

(JUNE 2018)

1. The different waves of normal electrocardiogram (ECG) of a human subject are shown below:



The relationship of the events of cardiac cycle to these ECG waves are proposed in the following statements:
A. The P wave occurs due to the depolarization of atria
B. The atrial repolarization is responsible for the T wave
C. The QRS complex occurs during ventricular depolarization
D. Q - T interval indicates plateau portion of auricular action potential

Select the combination with **INCORRECT** statements from the following options:
(1) A and B (2) B and C
(3) C and D (4) B and D

(JUNE 2019)

2. Given below are the different intervals/ durations of electrocardiogram of a humansubject (column A) and the events in heart during the process (column B).

COLUMN A		COLUMN B	
a	PR interval	(i)	Ventricular action potential
b	QRS duration	(ii)	Atrio ventricular conduction
c	QT interval	(iii)	Ventricular depolarization
d	ST interval	(iv)	Plateau portion of the ventricular action potential

Which one of the following options is a correct match of entries in columns A and B?
(1) A – (i); B – (iv); C – (ii); D – (iii)
(2) A – (ii); B – (iii); C – (i); D – (iv)
(3) A – (iv); B – (ii); C – (iii); D – (i)
(4) A – (iii); B – (i); C – (iv); D – (ii)

(DEC 2019)

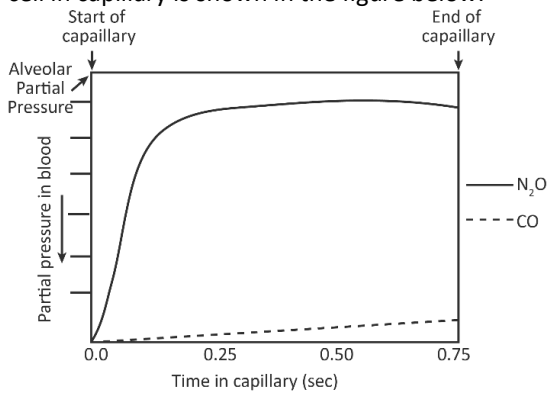
3. The ECG recorded by different leads is analysed on the basis of variation of electrical potential at various loci on the surface of the body, and the time scale relation of different waves. After analysing the ECG, following particulars of heart are proposed to be obtained
A. Stoke volume and cardiac output
B. Volume and pressure changes during cardiac cycle
C. Anatomical orientation of heart
D. Various disturbances in the rhythm and conduction of cardiac excitation
E. The extent, location and progress of ischemic damage to myocardium

Which one of the following combinations represents both INCORRECT particulars of heart?
(1) A and B (2) B and C
(3) C and D (4) D and E

Section 6: Respiratory System

(DEC 2016)

1. The uptake of nitrous oxide (N_2O) and carbon monoxide (CO) in the blood of lung alveolar capillary relative to their partial pressure and the transit time of red blood cell in capillary is shown in the figure below:



The reason for difference in the pattern of alveolar gas exchange of N_2O and CO have been proposed in the following statements:
A. N_2O does not chemically combine with proteins in blood but equilibrate rapidly between alveolar gas and blood.
B. CO has high solubility in the blood
C. CO has high solubility in the alveolar capillary membrane.
D. The dispersion of N_2O between alveolar gas and blood is considered as diffusion limited.

Which of the above statement(s) is/are INCORRECT?
(1) Only A (2) A and B
(3) Only C (4) C and D

(JUNE 2018)

2. The Cl content of red blood cells (RBCs) in the venous blood was found to be higher than that in arterial blood in a human subject. Following proposals were made to explain these observations:
   A. The high pCO_2 in venous plasma leads to increased diffusion of CO_2 into RBC and the formation of $H_2CO_{(3)}$
   B. HCO_3^- content in the RBC of venous blood becomes much greater than that in plasma.
   C. The excess HCO_3^- leaves the RBC of venous blood along with Na^+ to plasma by a Na^+ - HCO_3^-symporter,
   D. The increased Na^+ in the venous plasma is transported to the RBC along with Cl^-

   Select the combination with **INCORRECT** statements from the following options.
   (1) A and B (2) B and C
   (3) A and D (4) C and D

(FEB 2022-I)

3. The pressure in the 'space' between lungs and chest wall is known as intrapleural pressure. The following statements are related to the intrapleural pressure at different phases of respiration:
   A. At the end of quiet expiration the tendency of the lung to recoil from chest wall is balanced by the recoil of chest wall in opposite direction, and intrapleural pressure is subatmospheric.
   B. At the start of inspiration the intrapleural pressure is subatmospheric.
   C. The intrapleural pressure becomes more negative during inspiration.
   D. The intrapleural pressure attains value above atmospheric pressure during expiration.
   E. The intrapleural pressure becomes positive (relative to atmospheric pressure) during strong inspiratory efforts.

   Which one of the following combinations is correct?
   (1) A, B and C (2) B, C and D
   (3) C, D and E (4) A, C and D

(DEC 2023-II)

4. Lung surfactant is composed of phospholipids and proteins and plays an important role in lowering the surface tension of alveoli when they are small in size. The following statements suggest the structure and functions of proteins in lung surfactant:
   A. Surfactant protein B (SP-B) and surfactant protein C (SP-C) are the key protein members of monomolecular film of surfactant.
   B. Surfactant protein A (SP-A) is a large glycoprotein and has a collagen like domain within its structure.
   C. SP-A does not play any role in the feedback uptake of surfactant by the type II alveolar epithelial cells.
   D. The formation of phospholipid film lining the alveoli is inhibited by the proteins in surfactant.

   Which one of the following options represents the combination of correct statements?
   (1) A and B (2) B and C
   (3) C and D (4) A and D

Section 7: Hemoglobin

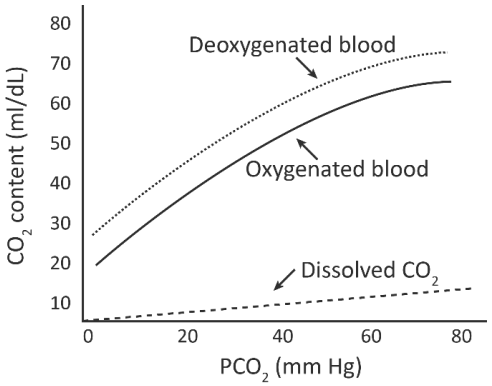
(DEC 2018)

1. The oxygen-haemoglobin dissociation curve illustrates the relationship· between pO_2 in blood and the number of O_2 molecules bound to haemoglobin. The 'S' shape of the curve has been explained in the following proposed statements:
   A. The quaternary structure of haemoglobin determines its affinity to O_2.
   B. In deoxyhaemoglobin, the globin units are tightly bound in a T-configuration.
   C. The interactions between globin subunits are altered when O_2 binds with deoxyhaemoglobin.
   D. The affinity to O_2 in T-conflguration of haemoglobin is increased.
   E. In the relaxed configuration of haemoglobin, the affinity to O_2 is reduced.

   Choose one of the following combinations with both INCORRECT statements.
   (1) A and B (2) B and C
   (3) C and D (4) D and E

(JUNE 2019)

2. The CO_2 dissociation curves of oxygenated and deoxygenated blood are given along with dissolved CO_2 below



   Following are the statements deduced from the curves above and or based on the knowledge about CO_2 transport, which may or may not be correct:
   A. The deoxygenated haemoglobin has greater affinity for CO_2, than oxygenated haemoglobin.
   B. The deoxygenated haemoglobin does not bind with free H^+ ions released during theformation of HCO_3^- from CO_2.
   C. The haemoglobin saturation with O_2 has no effect on CO_2, dissociation curve.
   D. O_2 and CO_2 bind to haemoglobin at different sites.

   Which one of the following options represents a combination of all correct statements?
   (1) A and B (2) B and C
   (3) C and D (4) A and D

(FEB 2022-I)

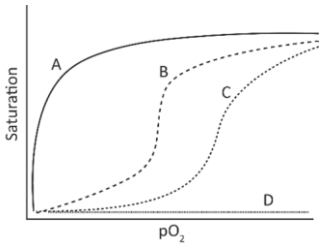
3. Hemoglobin (Hb) transports CO_2 in venous blood as carbamates. The following statements refer to the formation of these carbamates:

A. CO_2 interacts with amino terminal nitrogens of Hb polypeptide chains
B. CO_2 interacts with carboxyl terminal carbons of Hb polypeptide chains
C. Carbamates helps formation of salt bridges between α and β chains of Hb
D. Carbamates helps formation of disulfide bridges between α and β chains of Hb

Which one of the following option is a combination of correct statements:
(1) A and C (2) B and D
(3) B and C (4) A and D

(FEB 2022-I)

4. The curve B in the figure below shows the oxygen dissociation profile at physiological concentration of CO_2 and at pH 7.



An increasing in pH would lead to oxygen dissociation profile indicated by:
(1) Curve B (no change in the dissociation profile)
(2) curve A
(3) Curve C
(4) curve D

(JUNE 2023-II)

5. Following statements are made about the chemical properties and distributions of the respiratory pigments found in animals:
A. Hemoglobins are the most common and widespread respiratory pigments in vertebrates and invertebrates and are always present in blood cells.
B. The heme structure in hemoglobins is an iron (ferrous) porphyrin which varies widely among species, and also varies among the different molecular forms of hemoglobin within any single species. The globin, however is exactly identical.
C. Hemocyanin contains copper and turns bright blue when oxygenated and it is always dissolved in the plasma.
D. Chlorocruorins are similar to hemocyanin, but have a lower affinity for oxygen binding than hemocyanin present in blood cells of some marine annelid worms.
E. Hemerythrins are non-heme, iron-containing respiratory pigment that have a limited and scattered distribution.

Which one of the following options represents the combination of all INCORRECT statements?
(1) A, B and C (2) A, B and D
(3) B, D and E (4) C, D and E

(JUNE 2024-II)

6. Certain statements are made below about hemoglobin.
A. HbA1c has glucose attached to the terminal valine in each β chain.
B. NADH-methemoglobin reductase system in RBC converts methemoglobin to hemoglobin.
C. O_2 binds to the Fe^{2+} in the heme moiety of hemoglobin to form oxyhemoglobin.
D. The affinity of hemoglobin for O_2 is much higher than that of its affinity for carbon monoxide.

Which one of the following options represents combination of all correct statements?
(1) A and B (2) C and D
(3) A and C (4) B and D

Section 8: Regulation of Respiratory System

[JUNE 2014]

1. Respiration can be inhibited voluntarily for some time. The point at which respiration cannot be voluntarily inhibited is known as breaking point. Following explanations are offered for the breaking point:
A. J-receptors stimulate respiratory centers
B. Hering-Breuer reflex operates
C. The rise of arterial pCO_2 stimulates the respiratory centre
D. The fall of arterial pO_2 stimulates the respiratory centre

Which of the above combination is correct?
(1) A and B (2) B and C
(3) C and D (4) A and D

(JUNE 2015)

2. During physical exercise, the oxygen supply to the active muscles is increased which has been explained by the following statements:
A. PO_2 declines and PCO_2 rises in the active muscles
B. The temperature is increased and pH is decreased in active muscles
C. 2, 3-biphosphoglycerate is decreased in RBC and PO_2 rises
D. Metabolites accumulating in the active muscles increase the affinity of hemoglobin to oxygen

Which one of the following is NOT correct?
(1) A only (2) A and B
(3) B and C (4) C and D

(JUNE 2015)

3. In high altitude, hypoxia induces increased number of circulating red blood cells, which can be explained by the following changes:
A. The transcription factors, HIPs are produced.
B. Erythropoietin secretion is increased
C. Myoglobin content is decreased
D. Cytochrome oxidase is decreased

Which one of following is NOT true?
(1) Only A (2) A and B
(3) B and C (4) C and D

(JUNE 2017)

4. The P_{50} value of haemoglobin for oxygen is increased during exercise. The mechanism of this change is described in the following proposed statements.
A. Increased CO_2 production by muscles elevated pCO_2 of blood which affects P_{50} value

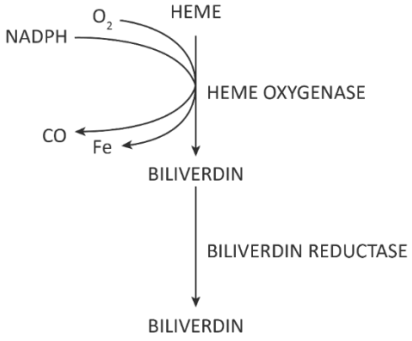
EXPLANATIONS

Section 1: Blood

1. **Correct Answer is (1):** In humans, bone marrow of almost all bones continuously produces RBC up to the age of first five years. But, after that, the pool of hematopoietic stem cells (HSC) decreases rapidly at most of bone marrow sites. Around the age of 20, bone marrow of tibia and femur stop producing erythrocytes. However, after the age of 20 years, RBCs are produced in the bone marrow of membranous bones such as vertebrae, sternum and ribs. The cellularity of HSC in bone marrow declines with age.

2. **Correct Answer is (1):** Globulins are a group of proteins in your blood synthesized in your liver by your immune system. Globulins play an important role in liver function, blood clotting, and fighting infection. Globulins comprise a much smaller fraction of the total serum protein. Five globulin categories are represented: alpha-1, alpha-2, beta-1, beta-2, and gamma. During acute inflammation, increase in alpha-1, alpha-2, beta-1, beta-2, and gamma is observed while there is decrease in Albumin. Albumin plays a major role in maintenance of appropriate osmotic pressure, binding and transport of various substances like hormones, drugs etc. in blood, and neutralization of free radicals.

3. **Correct Answer is (2):** The globin protein of the hemoglobin is split off and heme is converted first into biliverdin, a green pigment which is rapidly reduced to bilirubin, an orange-yellow pigment. Carbon monoxide (CO) is formed in the process and not Nitric oxide (NO).



4. **Correct Answer is (2):** Heme synthesis starts in mitochondria with the condensation of succinyl-CoA with the amino acid glycine, activated by pyridoxal phosphate. ALA synthase is the rate-limiting enzyme of heme synthesis. Heme synthesis is coordinated with globin synthesis during erythropoiesis in erythroblast and does not occur in the mature erythrocyte. Erythropoiesis is the development of mature red blood cells from erythropoietic stem cells. The first cell that is morphologically recognizable in the red cell pathway is the pro-erythroblast.

5. **Correct Answer is (3):** Von Willebrand factor is synthesized by endothelial cells and megakaryocytes not in liver and originates from its precursor pro-von Willebrand factor.
Ceruloplasmin as a metal chelating protein transports and delivers copper to tissues
Alpha-1 antitrypsin (anti-protease) deficiency is a genetic condition that can cause lung and liver damage. Lung symptoms are usually similar to emphysema, including chronic cough, shortness of breath and wheezing.
Albumins and various other blood plasma proteins differ from other blood proteins in that they are not glycosylated.
The serum concentration of AGP rises several fold during an acute phase response, the systemic answer to a local inflammatory stimulus.

6. **Correct Answer is (2):** The correct match is as given in option 2.
Ferritin is an intra-mucosal cell iron binding protein. If a ferritin test reveals that lower blood ferritin level than normal, it indicates the body's iron stores are low and the patient has iron deficiency.
Ferroportin transports ferrous iron out of the cell, generally aided by ceruloplasmin and/or hephaestin (mostly in enterocytes), which oxidize iron to its ferric state so it can bind ferritin in the extracellular medium.
Transferrin is a blood-plasma glycoprotein, which plays a central role in iron metabolism and is responsible for ferric-ion delivery. Transferrin functions as the most critical ferric pool in the body. It transports iron through the blood to various tissues such as the liver, spleen, and bone marrow.
Hepcidin, a small polypeptide produced by hepatocytes, plays a central role in regulating iron uptake by promoting internalization and degradation of ferroportin. Hypoxia suppresses hepcidin, thereby enhancing intestinal iron uptake and release from internal stores.

7. **Correct Answer is (2):**
1. Statement A is incorrect because bone marrow stem cells can give rise to osteoclasts and mast cells, so they are indeed a source for these cells.
2. Statement B is correct because, in the bone marrow, the majority of cells mature into white blood cells (leukocytes), while a smaller portion develops into red blood cells (erythrocytes). The ratio may vary slightly depending on the individual's needs, but typically three-fourths of marrow cells mature into white blood cells, and one-fourth into red blood cells.

3. Statement C is also correct because, in adults, hematopoiesis (the production of blood cells) primarily occurs in the bone marrow of certain bones, such as the sternum, pelvis, and vertebrae, not all bones.
4. Statement D is incorrect because hematopoietic stem cells are multipotent cells capable of differentiating into various blood cell types; they are not derived from committed cells, which are already restricted to developing into specific types of cells.

Section 2: Hemostasis and Blood Groups

1. Correct Answer is (2): Statement C is Incorrect, Plasmin is responsible for clot dissolution. Plasmin is a serine protease that hydrolyzes the peptide bonds located on the carboxyl side of lysines and arginines in fibrin. Cleaving bonds in fibrin leads to the dissolution of the clot. It is not required in the blood clotting process.

2. Correct Answer is (4): According to the question Donor has Blood group type A (i.e Antigen-A & Antibody-B) and the recipient has blood group type B (i.e Antigen-B & Antibody-A). Blood group type A (Donor) could agglutinate Blood group type B (recipient) due to presence of Antibody-B in type A blood and vice versa. But under given situation recipients RBCs are least affected. This is because during transfusion low titre of Anti-B Agglutinins are transfused in recipient from donor as compared to type A agglutinogens. And the agglutinins of donor blood was diluted in recipient's plasma resulting in low agglutination.

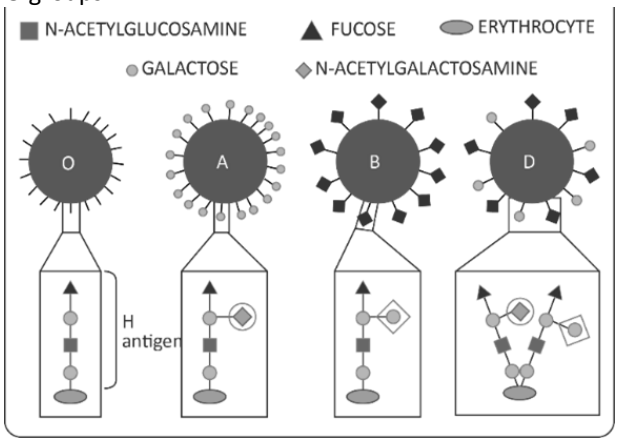
3. Correct Answer 3: Statement A is incorrect. In individuals with type A blood, the enzyme (transferase) adds N-acetyl galactosamine (not galactose) to the terminal of the H-antigen to form the A antigen not galactose.
Statement B is incorrect. In individuals with type A blood, the enzyme (transferase) adds Galactose (not N-acetyl galactosamine) to the terminal of the H-antigen to form the A antigen not galactose

4. Correct Answer is (1): Fibrinogen (Factor I) is a soluble glycoprotein produced by the liver and present abundantly in plasma. It is composed of two trimers (AαBβγ)2, with each trimer composed of three different polypeptide chains namely Aα Bβ and γ. Two AαBβγ trimers joined together by 29 inter- and intra-chain disulfide bonds. The (AαBβγ)2 is transferred to the Golgi where it is glycosylated, hydroxylated, sulfated, and phosphorylated to form the mature fibrinogen glycoprotein that is secreted into the blood.

5. Correct Answer is (2): List of blood clotting factors with their corresponding names:

I Fibrinogen
II Prothrombin
III Tissue Factor or Tissue Thromboplastin
IV Calcium ions (Not technically a protein, but it plays a crucial role in clotting cascade)
V Proaccelerin, Labile Factor, parahemophilia factor
VII Proconvertin/Hypoconvertemia, Stable Factor
VIII Antihemophilic Factor A
IX Antihemophilic Factor B or Christmas Factor
X Stuart-Prower Factor
XI Plasma Thromboplastin Antecedent
XII Hageman Factor
XIII Fibrin-Stabilizing Factor

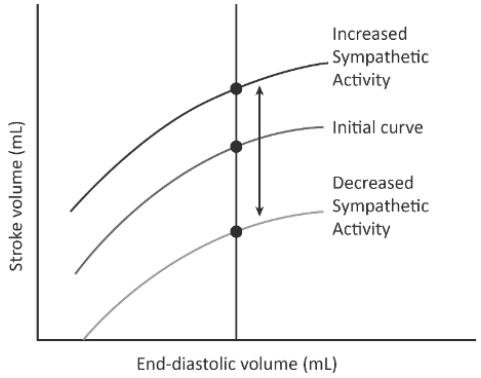
6. Correct Answer is (4): Fucosyl transferase is present in all blood group types (A,B,AB,O). It produces the H antigen on RBCs. H antigen is an essential precursor to the ABO blood group antigens. It is a carbohydrate sequence with carbohydrates linked mainly to protein (with a minor fraction attached to ceramide moiety). Fucosyl transferase is encoded by genes on H locus of chromosome 19.
The A allele encodes a GalNAc transferase that bonds α-N-acetylgalactosamine to the D-galactose end of H antigen, producing the A antigen. The B allele encodes a Gal transferase that joins α-D-galactose bonded to the D-galactose end of H antigen, creating the B antigen.
In case of O allele, the exon 6 contains a deletion that results in a loss of enzymatic activity. The deletion causes a frameshift, and results in translation of an almost entirely different protein that lacks enzymatic activity. This results in H antigen remaining unchanged in case of O groups.



7. Correct Answer is (3): The correct answer is 3. a-ii, b-i, c-iv, d-iii.
Factor XII is also known as the Hageman factor or Laki-Lorand factor. It's named after Oscar Ratnoff, John Hageman, and the researchers Laki and Lorand who independently discovered it.
HMWK is also called the Fitzgerald factor, named after the first patient in whom its deficiency was identified.
Prekallikrein is also known as the Fletcher factor, named after the family in which its deficiency was first described.
Factor X is commonly referred to as the Stuart-Prower factor, named after the first two patients in whom its deficiency was identified.

Section 3: Cardiovascular System37

1. **Correct Answer is (2):** The autonomic nervous system also affects cardiac function curve. As sympathetic activity (nor-epinephrine) increases, the curve shifts upward. In other words, stroke volume at any given end-diastolic volume increases with increase in sympathetic stimulation. Starling's law explains that the heart is enabling to regulate its size under different conditions of venous return

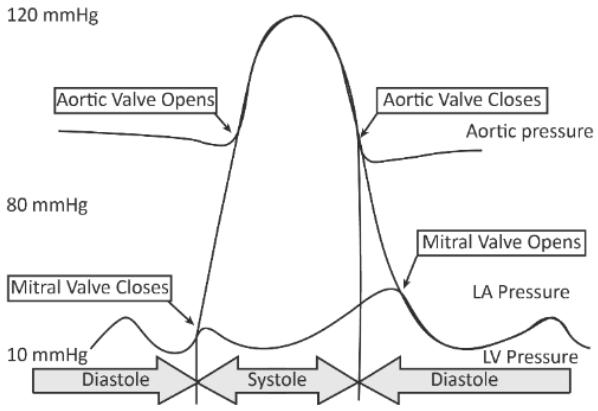


This is important because the tension increases as the heart wall expands and it needs to generate the same pressure that is why contracts more forcefully. If the ventricles are too large, heart failure is more likely to occur because the heart fails to generate enough pressure to maintain cardiac output.

2. **Correct Answer is (2):** Membrane potential (mV) in SA node is never maintained in the "resting potential" stage but starts to depolarize slowly until it reaches threshold. Such a graph is depicted by (2) option.

3. **Correct Answer is (3):** Correct statement are A and B. The vagus nerve is a parasympathetic nerve that innervates the heart. When the vagus nerve is stimulated, it releases acetylcholine, which binds to muscarinic receptors on the pacemaker cells of the SA node. This binding activates G proteins, which in turn activate K^+ channels. The opening of these K^+ channels causes hyperpolarization of the pacemaker cells, which slows down the pacemaker potential.
The inward "funny current" of pacemaker potential is not affected by the vagus nerve. The increased intracellular cAMP, induced by activation of M2 muscarinic receptors, does not slow the opening of Ca^{++} channels.

4. **Correct Answer is (1):** The mitral valve and tricuspid valves are known as the atrioventricular (A-V) valves and connect the atrium to the ventricles. The semilunar valves are located between the aorta and the left ventricle, and between the pulmonary artery and the right ventricle .At the beginning of the cardiac cycle, both the atria and ventricles are relaxed (diastole). Blood is flowing into the right atrium from the superior and inferior venae cavae and the coronary sinus. Blood flows into the left atrium from the four pulmonary veins. The two atrioventricular valves, the tricuspid and mitral valves, are both open, so blood flows unimpeded from the atria and into the ventricles. Approximately 70–80 percent of ventricular filling occurs by this method. The two semilunar valves, the pulmonary and aortic valves, are closed, preventing backflow of blood into the right and left ventricles from the pulmonary trunk on the right and the aorta on the left.



5. **Correct Answer is (1):** Statement A is correct. "Funny" channels (HCN channels) are activated at point 'b' in the diagram. Activation of these channels allows the inward movement of Na+ and contributes to the depolarization phase of the pacemaker potential. Statement B is correct. Outward flow of K^+ occurs at point 'a' in the diagram, which contributes to the repolarization phase of the action potential. T-Ca^{++} channels open for a short time and then close when the membrane potential reaches about -50 mV. Fast Ca^+ channels (Long-lasting, or L-type Ca^{++} channels) are opened at ‘d’ that further depolarizes.

6. **Correct Answer is (3):** Statement A is incorrect. The second heart sound, associated with the closure of the aortic and pulmonary valves, is not directly characterized by changes in diastolic pressure in the aorta or pulmonary artery in the manner described. The loudness of the second heart sound can be influenced by several factors, including the speed at which these valves close and the pressure gradient at the time of valve closure, but it is not specifically described as being louder and sharper with decreased diastolic pressure.

7. **Correct Answer is (3):** Statement A is **incorrect** - Prostacyclin is a product of endothelial cells that typically promotes vasodilation, not vasoconstriction.
Statement B is **incorrect** - Inhibitors of cyclooxygenase, such as NSAIDs, decrease the production of prostacyclin.
Statement C is **correct** - Nitric oxide (NO) released by endothelial cells indeed causes relaxation of vascular smooth muscle.
Statement D is **correct** - NO is indeed short-lived and rapidly inactivated by hemoglobin and other components in blood.

8. **Correct Answer is (3):**

1. Statement A is incorrect because the pulse wave travels faster than the velocity of blood flow in arteries, typically

5-10 m/s compared to 0.3-0.5 m/s for blood flow in the aorta.
2. Statement B is incorrect because the pulse wave speeds up with age as arteries stiffen, increasing velocity due to reduced elasticity, rather than slowing down.
3. Statement C is correct because a larger stroke volume during exercise amplifies the pressure wave, resulting in a stronger pulse.
4. Statement D is correct because pulse strength relies on pulse pressure, the systolic-diastolic difference, not on mean arterial pressure, which is an average.

Section 4: Regulation of Heart

1. Correct Answer is (2): Rhythmic variations in heart rate, occurring at the frequency of respiration, are detectable in most individuals and tend to be more pronounced in children. The heart rate typically accelerates during inspiration and decelerates during expiration.

2. Correct Answer is (4): "Mayer waves" are the outcome of the oscillation of the central nervous system ischemic pressure control mechanism.

3. Correct Answer is (2): Parasympathetic tone usually predominates in healthy, resting individuals. When a resting individual is given atropine, a muscarinic receptor antagonist that blocks parasympathetic effects, the heart rate generally increases substantially. If a resting individual is given propranolol, a β-adrenergic receptor antagonist that blocks sympathetic effects, the heart rate usually decreases only slightly. When both divisions of the autonomic nervous system are blocked, the heart rate of young adults averages about 100 beats/min. The rate that prevails after complete autonomic blockade is called the intrinsic heart rate.

4. Correct Answer is (3): Direct effects of T3 on cardiac function are mediated by binding of T3 to its nuclear receptor sites. T3 markedly increases expression of the sarcoplasmic reticulum Ca^{++}ATPase gene and ryanodine Ca^{++} channel gene. T3 signaling increases the level of the mRNA coding for the sarcoplasmic reticulum calcium ATPase protein, thus there are more calcium ATPase pump units in the sarcoplasmic reticulum. It leads to an increase in the speed of diastolic relaxation, as there is more efficient pumping of the calcium ATPase of the sarcoplasmic reticulum. The increased number of ryanodine channels due to T3- signaling increases release of calcium from the sarcoplasmic reticulum during systole and accounts for the increased systolic contractile activity of the heart.

5. Correct Answer is (1): The carotid sinus baroreceptors are more sensitive than those in the aortic arch. Changes in carotid sinus pressure evoke greater changes in systemic arterial pressure and peripheral resistance than do equivalent changes in aortic arch pressure.

The receptors in the carotid sinus walls respond more to pulsatile pressure than to constant pressure. The figure shows that at normal levels of mean arterial blood pressure (≈100 mmHg), a barrage of impulses from a single fiber of the sinus nerve is initiated in early systole by the pressure rise; only a few spikes occur during late systole and early diastole. At lower arterial pressure, these phasic changes are even more evident, but the overall discharge frequency is reduced. The blood pressure threshold for evoking sinus nerve impulses is approximately 50 mm Hg; maximal sustained firing is reached at approximately 200 mm Hg. Because the baroreceptors adapt, their response at any mean arterial pressure level is greater to a high pulse pressure than to a low pulse pressure.

6. Correct Answer is (1): The activity of type A receptors are increased by burst of impulses during atrial systole while The activity of type B receptors are increased by burst of impulses at the time of peak atrial filling during late diastole of atria. The discharge of type B atrial receptors is increased when venous return is increased. Statement D is false because the activity of type B atrial receptors is increased by negative pressure breathing. Statement E and F are also false.

7. Correct Answer is (4): Statement A is incorrect. The right vagus nerve primarily innervates the SA (sinoatrial) node, not the AV (atrioventricular) node.
Statement B is incorrect. The parasympathetic preganglionic fibers that innervate the heart originate from the nucleus ambiguous, not the superior salivatory nucleus.
Statement C is incorrect. The sympathetic post-ganglionic fibers primarily innervate the SA (sinoatrial) node, but they originate from the paravertebral ganglia on both sides, not just the left side.
Statement D is correct. The sympathetic fibers that innervate the heart primarily originate from the stellate ganglia, which are located at the base of the neck.
Statement E is correct. Sympathetic activity generally increases heart rate, but it takes longer for the sympathetic effects to become evident compared to the rapid effect of vagal (parasympathetic) activity in slowing down heart rate.

8. Correct Answer is (4): Stimulation of the cholinergic vagal fibers in the heart leads to activation of the parasympathetic nervous system. This has a slowing effect on the heart, including the pacemaker cells of the sinoatrial (SA) node.
Statement D: The 'h' current (I^h), or funny current, is a mixed Na^+/K^+ current that contributes to the spontaneous depolarization of pacemaker cells in the heart. When the parasympathetic nervous system is activated, acetylcholine can bind to muscarinic receptors on the SA node, which are coupled to G proteins. This can lead to the opening of G protein-gated K^+ channels, which increases the outflow of K^+ and hyperpolarizes the

cell, thereby slowing down the depolarizing effect of the 'h' current.

Statement E: Acetylcholine binding to muscarinic receptors on the SA node can also inhibit the activity of adenylate cyclase, leading to decreased levels of cAMP within the cell. This can reduce the activation of protein kinase A, which in turn leads to reduced phosphorylation and activation of L-type Ca^{2+} channels. The slowing down of Ca^{2+} channel opening slows the rate of phase 0 depolarization in these cells, thus slowing the heart rate.

The other statements (A, B, C) are incorrect because activation of the parasympathetic system typically results in hyperpolarization of the membrane (not depolarization), a decrease in the slope of the pacemaker potential (not an increase), and an increase in K^+ conductance (not a decrease).

9. Correct Answer is (2):

Statement A is incorrect because sympathetic stimulation actually increases the 'h' current (also known as the funny current or I_f), which contributes to the faster pacemaker potential in the SA node.

Statement B is correct because sympathetic stimulation releases norepinephrine, which binds to beta-1 (ß1) adrenergic receptors on the sinoatrial (SA) node cells. This binding increases intracellular cyclic AMP (cAMP) levels.

Statement C is also correct. The rise in cAMP leads to the activation of protein kinase A (PKA), which phosphorylates and opens L-type Ca^{++} channels. This increases the calcium current (Ica), contributing to faster depolarization and an increased rate of action potential generation in the SA node.

Statement D is incorrect because sympathetic stimulation increases, not decreases, the Ca^{++} current by facilitating the opening of L-type Ca^{++} channels.

Section 5: ECG

1. Correct Answer is (4): T wave is the result of ventricular repolarization. Complete QT interval represents ventricular action potential, while ST interval is the plateau portion of ventricular action potential.

2. Correct Answer is (2):

COLUMN A		COLUMN B	
a	PR interval	(ii)	Atrioventricular conduction
b	QRS duration	(iii)	Ventricular depolarization
c	QT interval	(i)	Ventricular action potential
d	ST interval	(iv)	Plateau portion of the ventricular action potential

3. Correct Answer is (1): The ECG recorded by different leads is analysed on the basis of variation of electrical potential at various loci on the surface of the body, and the time scale relation of different waves. After analysing the ECG, anatomical orientation of the heart, various disturbances in the rhythm and conduction of cardiac excitation and the extent, location and progress of ischemic damage to myocardium can be analysed.

Section 6: Respiratory System 35

1. Correct Answer is (4): Different gasses have different solubility factors. Gasses that are insoluble in blood (i.e. nitrous oxide (N_2O), ether and anesthetic gasses) do not chemically combine with proteins in blood and equilibrate rapidly between alveolar gas and blood. The equilibration occurs in less time than the 0.75 second that the red blood cell spends in the capillary bed (capillary transit time). The diffusion of insoluble gasses between alveolar gas and blood is considered perfusion limited because the partial pressure of gas in the blood leaving the capillary has reached equilibrium with alveolar gas and is limited only by the amount of blood perfusing the alveolus. In contrast, a diffusion limited gas, such as CO has low solubility in the alveolar-capillary membrane but high solubility in blood because of its high affinity for hemoglobin (Hb). These features prevent the equilibration of CO between alveolar gas and blood during the red blood cell transit time.

2. Correct Answer is (4): Statement A and B is correct. Statement C and D is false because excess HCO_3^- leaves the RBC of venous blood by Cl^- - HCO_3^-antiporter.

3. Correct Answer is (1): Intrapleural pressure is always NEGATIVE. The intrapleural pressure DOESN'T attains value above atmospheric pressure during expiration.

4. Correct Answer 1: Statement A is **Correct** - SP-B and SP-C are hydrophobic proteins that are key components of the surfactant monolayer and are critical for reducing surface tension in the alveoli.

Statement B is **Correct** - SP-A is a large collectin family glycoprotein with a collagen-like domain and is involved in the innate immune response in the lung.

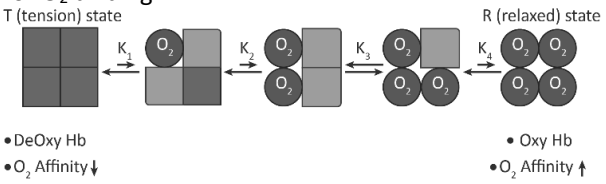
Statement C is **Incorrect** - SP-A does play a role in surfactant homeostasis, including the regulation of surfactant uptake and secretion by alveolar type II cells.

Statement D is **Incorrect** - The proteins in surfactant do not inhibit but rather are critical for the formation and proper function of the phospholipid film lining the alveoli.

Section 7: Hemoglobin

1. Correct Answer is (4): Two different responses at different levels of O_2 suggest Two different states of Hb. One for Low pO_2 and One for High pO_2.

- Tense state (T-state) - Conformation not favorable for O_2 binding.
- Relaxed state (R- state) - Conformation now favorable for O_2 binding.



2. **Correct Answer is (4):** Carbon dioxide does not bind to iron as oxygen does; instead, carbon dioxide binds amino acid moieties on the globin portions of hemoglobin to form carbamino-hemoglobin, which forms when hemoglobin and carbon dioxide bind. Although O_2 and CO_2 bind to Hb at different sites, deoxygenated Hb has greater affinity for CO_2 than oxygenated Hb does. Thus, deoxygenated blood (venous blood) freely takes up and transports more CO_2 than oxygenated arterial blood does. The deoxygenated Hb more readily forms carbamino compounds and also more readily binds free H^+ ions released during the formation of HCO_3. The effect of changes in oxyhemoglobin saturation on the relationship of CO_2 content to Pco_2 is referred to as the Haldane effect and is reversed in the lung when O_2 is transported from the alveoli to red blood cells

3. **Correct Answer is (1):** Majority of CO_2 is transported in form of HCO_3^- in blood but small portion may be transported in form of carbamates bound with amino terminus of hemoglobin polypeptides. Carbamates helps formation of ionic interactions or salt bridges between α and β chains of Hb not covalent bonds (disulphide bonds).

4. **Correct Answer is (1):** Curve B in the figure shows the oxygen dissociation curve at physiological concentration of CO_2 and at pH 7. An increase in pH will shift the curve to the right, which means that hemoglobin will release more oxygen at a given pO_2. This is because an increase in pH decreases the affinity of hemoglobin for oxygen.

5. **Correct Answer is (2):** We have to choose incorrect statements. The incorrect statements are:
   Statement A: Hemoglobins are common and widespread respiratory pigments found in both vertebrates and some invertebrates, but they are not always present in blood cells. For instance, invertebrates such as molluscs and arthropods use hemocyanin (a copper-containing protein) instead of hemoglobin for oxygen transport.
   Statement B: In hemoglobins, it is not the globin that is identical across different species or molecular forms within a single species, but rather the heme group (an iron-containing compound). The globin portion of the molecule, a protein, varies among species and can even vary within a single species, leading to different forms of hemoglobin.
   Statement D: Chlorocruorin are not similar to hemocyanin. They are actually green proteins found in the blood of certain marine worms. They are structurally and functionally more similar to hemoglobins, not hemocyanin. Also, they are found dissolved in plasma, not in blood cells.
   The correct statements are:
   Statement C: Hemocyanin does indeed contain copper and turns bright blue when oxygenated. It is typically found dissolved in the plasma of many invertebrates, particularly molluscs and arthropods.
   Statement E: Hemerythrins are non-heme, iron-containing respiratory pigments found in some marine invertebrates. Their distribution is indeed limited and scattered.

6. **Correct Answer is (3):**
   Statement A is correct: HbA1c is a form of hemoglobin that has glucose attached to the terminal valine in each β chain. This attachment occurs through a nonenzymatic process called glycation, and HbA1c levels are often used as a measure of average blood glucose control over the past 2-3 months.
   Statement B is incorrect: NADH-methemoglobin reductase system in RBCs converts methemoglobin back to hemoglobin. Methemoglobin is formed when the iron in hemoglobin is oxidized from the Fe^{2+} to Fe^{3+} state, which reduces its ability to carry oxygen. The NADH-methemoglobin reductase system helps to prevent the accumulation of methemoglobin by reducing it back to hemoglobin.
   Statement C is correct: Oxygen (O_2) binds to the iron (Fe^{2+}) in the heme moiety of hemoglobin to form oxyhemoglobin. This binding is reversible and is the basis for the oxygen-carrying function of hemoglobin in red blood cells.
   Statement D is incorrect: The affinity of hemoglobin for carbon monoxide (CO) is actually much higher than its affinity for oxygen. This is why carbon monoxide poisoning can be so dangerous, as CO can bind to hemoglobin more effectively than O2, leading to reduced oxygen delivery to tissues.

Section 8: Regulation of Respiratory System 35

1. **Correct Answer is (3):** The point at which respiration cannot be voluntarily inhibited is known as breaking point because the rise of arterial pCO_2 and the fall of arterial pO_2 stimulates the respiratory center where respiratory signal fires and begins the next cycle of respiration.
   In the lungs, either in the capillary walls or the interstitium, are a group of sensory receptors called J receptors. They are normally dormant but are stimulated by an increase in lung interstitial pressure caused by the collection of fluid in the interstitium.

2. **Correct Answer is (4):** During exercise Increased CO2 production by muscles elevated pCO2 of blood which increases P50 value. The decreased pH of blood due to more CO_2 and lactic acid, also reduces the affinity of haemoglobin for oxygen. The level of BPG in RBC increases and makes it easier for the hemoglobin to deliver more O_2 to the tissues. Increased body temperature due to vigorous exercise also shifts the oxy-haemoglobin dissociation curve of the right which will favour oxygen unloading at tissue level. Similar physiological changes are observed for acclimatization at high altitudes.

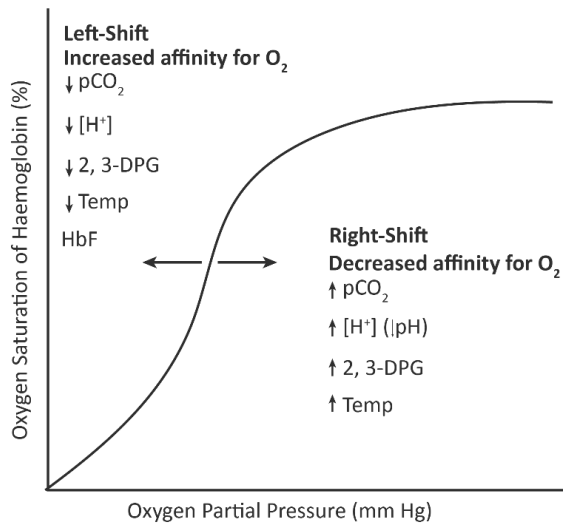
3. Correct Answer is (4): During hypoxia conditions, The transcription factors, Hypoxia Inducing Proteins (HIPs) are produced which modulates expression of various genes. As a result of this there is increase in skeletal muscle capillary, number of mitochondria, and muscle myoglobin occurs, all of which increase oxygen transfer. Erythropoietin hormone is secreted by the kidney which increases erythrocyte and hemoglobin concentration in blood and the oxygen-carrying capacity of blood. The amount of cytochrome oxidase on the inner mitochondrial membrane is also increased so that more efficient oxidative phosphorylation can be carried out.

4. Correct Answer is (2): Statement B & C are Incorrect, The affinity of hemoglobin for oxygen increases as 2,3-bisphosphoglycerate (2,3 - BPG) level is Decreased. Increased body temperature shifts the oxyhaemoglobin dissociation curve of the Right.

5. Correct Answer is (4): At high altitude, atmospheric pressure and alveolar PO_2 decreases. The pH of cerebrospinal fluid is further decreased due to more pCO2. Decreased alveolar PO_2 stimulates peripheral chemoreceptors in aortic bodies and carotid bodies to instruct medullary inspirator centers to increase respiratory rate. The initial increase of ventilation is relatively small but the ventilation steadily increases over next few days. Hyperventilation leads to increased PO_2 decreased PCO_2 in blood, which leads to increase in pH of blood(respiratory alkalosis).

2,3 BPG increases in RBC and shifts the oxygen–hemoglobin dissociation curve to the right, facilitating oxygen unloading in the tissues.

Oxygen-Haemoglobin Dissociation Curve



6. Correct Answer is (2): Specifically, the carotid bodies can detect changes in the quality in the composition of arterial blood flow, such as pH, CO_2, temperature, and partial pressure of arterial oxygen. If these are removed the breaking point becomes longer in subject. Closed glottis refers to the state known as a 'glottal stop,' when the passage is closed, allowing no air (either breath or voiced flow) to pass through. The breaking point will be longer when the subject is told during breath holding that her/his performance is very good because voluntary response takes over involuntary response for some time.

7. Correct Answer is (1):

Statement A is correct. When the inspired air has a low partial pressure of oxygen (Po_2), ventilation is significantly increased to compensate for the reduced oxygen availability. Statement B is correct. The ventilation rate is around 6 L/min when the Po_2 of the inspired air is around 150 mm Hg.

Statement B is correct. When the Po_2 of the inspired air is above 60 mm Hg, the ventilation rate increases slightly to maintain appropriate oxygen levels.

Statement C is incorrect. Increased ventilation in response to low Po_2 leads to a decrease in alveolar partial pressure of carbon dioxide (Pco_2) due to enhanced removal of carbon dioxide.

Statement D is incorrect. The decrease in Po_2 leads to decline in oxy-HB and deoxy-Hb is increased. The deoxy Hb is more like base while oxy-Hb is like acid, thus there is decrease in H^+ concentration.

8. Correct Answer is (4):

Statement A is correct. During exercise, the temperature of the active muscles increases, which leads to a rightward shift in the oxygen-hemoglobin dissociation curve. This shift indicates an increase in P50, meaning that hemoglobin's affinity for oxygen decreases, allowing more oxygen to be released to the tissues.

Statement B is incorrect. During exercise, metabolites like lactic acid accumulate, leading to a lower pH (acidosis) in the muscles, not a higher pH. A lower pH would actually increase P50 by promoting oxygen release from hemoglobin, but the reasoning given in the statement (higher pH) is incorrect.

Statement C is incorrect. During exercise, CO2 levels in the muscles actually increase due to higher metabolic activity, not decrease. The increase in CO2 contributes to the Bohr effect, where increased CO2 lowers the pH, leading to a rightward shift of the oxygen-hemoglobin dissociation curve (increased P50).

Statement D also correct. 2,3-Diphosphoglycerate (2,3-DPG) is a metabolite that binds to hemoglobin and reduces its affinity for oxygen. During exercise, especially in non-trained individuals, 2,3-DPG levels can increase, further causing a rightward shift in the oxygen-hemoglobin dissociation curve, and thereby increasing the P50 value.

9. Correct Answer is (1):

1. **Statement A** is correct because alveolar ventilation, the volume of air reaching the alveoli per minute, is less than the respiratory minute volume (RMV), which includes both alveolar ventilation and the air filling the anatomic dead space (conducting airways).
2. **Statement B** is correct because the anatomic dead space, the volume of air in conducting airways not