CHEMISTRY OF BIOMOLECULES (BIOT 2101)

Time Allotted : 3 hrs

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and <u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A (Multiple Choice Type Questions)

- 1. Choose the correct alternative for the following:
 - (i) Concentration of hydrochloric acid solution having pH 1.0 is
 (a) 1(N)
 (b) 0.1 (N)
 (c) 0.01 (N)
 (d) 0.001 (N)
 - (ii) The X-ray crystallography studies of Rosalind Franklin and Maurice Wilkinsshowed that(a) DNA contains only four kinds of nucleotides
 - (b) DNA has helix major regularity of 0. 34 nm
 - (c) the amount of adenine found in DNA is equal to the amount of thymine
 - (d) the same base pairing rules apply to all species.
 - (iii) Charge on a protein molecule is guided by
 - (a) number of amino acids present in the protein
 - (b) number of polar amino acids present in the protein
 - (c) number of basic and acidic amino acids present in the protein
 - (d) number of sulphur containing amino acids present in the protein.

(iv) Consider a short linear ds-DNA molecule with 10.5 bp/turn, contains 15 complete turns. The ends of the DNA molecules are sealed together to make arelaxed circle. The linking number of that relaxed circle DNA is

(a) 15.0,
(b) 105,
(c) 25.5
(d) 10.5.

(v) The I in spectroscopic experiment is 0.75 and $I_0 = 0.9$ for solute solution. What is the % transmittances?

Full Marks: 70

 $10 \times 1 = 10$

(a) 8.333% (b) 0.9% (c) 0.83% (d) 83.33%.

- (vi) The DNA of two bacterial species differs in base composition, with species 'A' having 30% G+C and species B having 60% G+C. If the two types of DNA are centrifuged to equilibrium in cesium chloride, they will be separated on the basis of their density and form two bands in the gradient. The band with species 'A' DNA will occur at a position that is
 - (a) lower in the centrifuge tube than the band with species B DNA.(b) higher in the centrifuge tube than the band with species B DNA.(c) at the same position in the centrifuge tube as species B DNA.(d) can't tell from the information given.

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- (vii) Which of the following is correct about NMR spectroscopy?
 - (a) NMR spectroscopy observes spinning patterns of atomic nuclei in a electric field.
 - (b) It stands for Nuclear Magnetic Resolution.
 - (c) NMR spectroscopy observes spinning patterns of atomic nuclei in a rotating magnetic field.
 - (d)NMR spectroscopy observes spinning patterns of atomic nuclei in a oscillating magnetic field.

(viii) If pK₁ of an amino acid is 2.34 and pK₂ is 9.6, then the isoelectric point pI will be
(a) 7.14
(b) 5.97
(c) 3.67
(d) 11.94.

- (ix) Which of the following statement is correct?
 - (a) Starch is a polysaccharide and cellulose is a protein
 - (b) Starch contains alpha 1-4 glycosidic linkage and cellulose contains beta 1-4 glycosidic linkage
 - (c) The monomeric units of starch is glucose and that of cellulose is ribose
 - (d) Both starch and cellulose give blue colour with iodine.

(x) Which of the following is not a method of protein estimation?

(a) Lowry(c) Bradford

(b) BCA

(d) Infrared absorbance at 280 nm.

Group - B

2. (a) Draw the structure of the following.

(i)palmitic acid (ii) D-glucose (iii) D-glyceraldehyde. [(CO1)(Remember/LOCQ)]

(b) Your are given two unlabelled vials containing two colourless crystalline solids. One vial contains glucose and the other contains sucrose. Design an experiment to identify the bottle containing glucose. [(CO1)(Design/HOCQ)]

6 + 6 = 12

3. (a) Name the systems that act as physiological buffers. Explain the buffering action of carbonic acid/bicarbonate system at physiological pH.

[(CO1)(Remember, Understand/LOCQ)]

- (b) Differentiate between conformation and configuration. [(CO1)(Differentiate/HOCQ)]
- (c) Why glyceraldehyde is called an optically active compound? What is the structural basis of optical activity of glyceraldehyde? What is the relation between D-glyceraldehyde and L-glyceraldehyde so far optical properties are concerned?

[(CO1)(Understand/IOCQ)](3 + 3) + 2 + (2 + 1 + 1) = 12

Group - C

- 4. (a) All amino acids are optically active. State whether the statement is true or false. Justify your answer. [(CO2)(Justify/HOCQ)]
 - (b) In a protein molecule, a Leu residue is replaced by a Val residue due to mutation. Function of the protein was not much affected by this change. Explain the observation. [(CO2)(Comment/HOCQ)]

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(c) Define domain and motif of a protein molecule with example. [(CO2)(Define/LOCQ)]

4 + 4 + 4 = 12

- 5. (a) What happens when
 - (i) Formaldehyde is added to a solution of tryptophan
 - (ii) Nitrous acid is added to alanine?
- [(CO2)(Undersatnd/IOCQ)]
- (b) Some amino acids like hydroxyproline do not have their molecular codes in the RNA and hence cannot be incorporated during synthesis of proteins. Yet these amino acids are present in protein. Comment on this observation. [(CO2)(JComment/HOCQ)]
 (4 × 2) + 4 = 12

Group - D

6. (a) Reassociation of two complementary ssDNA molecules follows second order kinetics. Based on that, derive the relation between initial concentration of ssDNA with the fraction of ssDNA will remain in the reassociation process after time t.

[(CO3)(Remember/LOCQ)]

(b) In an experiment, the A₂₆₀ value of the following aqueous solutions of three different DNA (all samples DNA length is same in base pairs) was measured separately at different temperature from 10°C to 100°C.

(i) poly dAdT, (ii) poly dGdC, and (iii) poly dAdTdGdC.

You draw the expected nature of A_{260} vs. Temperature denaturation curve of the above experiment and explain the result. [(CO3)(Remember/explain/IOCQ)]

(c) The Tm value of a DNA is 75.0°C. Calculate % of A, T, G and C in the DNA sample.

[(CO3)(Analyse/HOCQ)]

(d) There is circular DNA of size 3000 bp with 150 negative supercoil. Calculate the number of twist, writhe and linking number of the DNA. If we add 75 positive supercoil to that DNA then calculate the vale of σ . Explain all the logic.

[(CO3)(Analyse/HOCQ)] 3 + 3 + 2 + (2 + 2) = 12

7. (a) Draw Photo-51 which was the observation by R. Franklin through X-ray diffraction study of DNA and explain what you understand about the structure of DNA from it.

[(CO3) (Understand/LOCQ)]

(b) Describe the features of secondary of DNA by proposed by Watson and Crick with a labelled diagram. [(CO3) (Understand/LOCQ)]
(c) There is circular double stranded DNA molecule. Write the names of three different topological forms it, in which it can exist. Draw the labelled general structures of those three topological forms you mentioned following DNA molecules. [(CO3) (Understand/IOCQ)]
(d) Calculate weight in grams of a double-helical DNA molecule stretching from the Earth to the Venus (~107 × 10⁶ km). The DNA double helix weighs about 1 ×10 ⁻¹⁵ g per 2,000 nucleotides pairs, write your all logic. [(CO6) (Analyse/HOCQ)]
(1+2) + (1+3) + 3 + 2 = 12

Group - E

8. (a) Explain application of fluorescence spectroscopy in structure determination of protein. Explain fluorophore with an appropriate example existing as biomolecules.

[(CO5) (Explain/IOCQ)]

- (b) Explain how we can differentiate the secondary structures of protein (α -helix, and β -sheet) by CD spectroscopy with a diagram. [(CO5) (Explain/IOCQ)]
- (c) Draw and explain the graphical pattern of the following:
 - (i) Changes of absorbance value with the concentration of absorbing species.
 - (ii) Changes of transmittance value with the concentration of absorbing species.

[(CO5) (Explain/IOCQ)]

(2+2)+4+(2+2)=12

- 9. (a) Derive the expression of Bragg's equation for X-ray diffraction experiment for biomolecules. [(CO5) (Understand/IOCQ)]
 - (b) Describe principle and steps for structure determination of proteins by X-ray diffraction crystallography. [(CO5) (Understand/LOCQ)]
 - (c) Describe the principle of estimation of DNA by Diphenylamine reagent with VISspectroscopy. [(CO4) (Estimate/HOCQ)]

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	31.25	35.42	33.33

Course Outcome (CO):

After completion of this course, the students will be able to:

- 1. Calculate the pH of a buffer system, identify different stereoisomer's of carbohydrate and lipids and understood the chemistry of carbohydrate and lipids.
- 2. Explain the different structural components and physiochemical properties of amino acids, proteins.
- 3. Analyses and explain the different structural components and physiochemical properties of DNA and RNA.

4. Select and apply suitable spectroscopic techniques for estimation biomolecules.5. Select and apply suitable techniques for and structure determination of of biomolecules.

6. Able to solve mathematical problems related to estimation and structural features of biomolecules.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

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