BIOPHYSICS OF MACROMOLECULES
(BIOT 3232)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one 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: **10 × 1 = 10**

(i) Which of the following is a polar and uncharged amino acid?
(a) Histidine (b) Proline
(c) Glycine (d) Threonine.

(ii) Examples of basic amino acids are
(a) Glutamic acid and Aspartic acid (b) Glycine and Leucine
(c) Histidine and Lysine (d) Methionine and Lysine.

(iii) The structure of a DNA-RNA hybrid is
(a) A form (b) B form
(c) between A and B form (d) Z form.

(iv) Henderson-Hasselbalch Equation is
(a) $pKa = pH + \log_{10} ([HA]/[A^-])$ (b) $pH = pKa + \log_{10} ([HA]/[A^-])$
(c) $pKa = pH + \log_{10} ([A^-]/[HA])$ (d) $pH = pKa + \log_{10} ([A^-]/[HA])$.

(v) Which of the following is NOT true about protein structure?
(a) The hydrophilic/hydrophobic character of amino acid residues is important to the final structure of the protein
(b) Hydrogen bonds are not important to maintain a protein structure
(c) The alpha helix, beta pleated sheet and beta turns are examples of protein secondary structure
(d) Covalent cross-linking is the only strong force that stabilize three dimensional structure of a protein.

(vi) Phopsholipds are amphopathic molecules. It means
(a) Phosphplipds can interact only with negatively charged ions
(b) Phospholipids can interact with both positively and negatively charged ions
(c) Phospholipids can interact only with nonpolar compounds
(d) Phospholipids can interact both with polar and nonpolar compounds.

(vii) The most stabilizing force in a DNA double helix is
(a) Hydrogen bond (b) Stacking interaction
(c) Vander Waals interaction (d) Ionic interaction.

(viii) The term bathochromic shift is associated with
(a) UV-visible spectroscopy (b) IR spectroscopy
(c) Scanning electron microscopy (d) Transmission electron microscopy.

(ix) Wavelength of UV region is
(a) 100-400 nm (b) 40-400 nm
(c) 400-800 nm (d) 8000-1800 nm.

(x) Three dimensional structure of a protein can be determined by
(a) infra red spectroscopy (b) X ray crystallography
(c) UV spectroscopy (d) scanning electron microscopy.

Group - B

2. (a) Explain why Peptide bond is rigid and planar. *[(CO1)(Explain/LOCQ)]*
(b) Discuss the factors effecting α-Helix stability. *[(CO3)(Discuss/HOCQ)]*
(c) The ribose pucker is conformationally important in nucleic acids - Explain. *[(CO1)(Explain/IOCQ)]*

4 + 5 + 3 = 12

3. (a) Draw and explain the titration curve of Aspartic acid. *[(CO1)(Explain/IOCQ)]*
(b) Justify the statement "pKa of any functional group is greatly affected by its chemical environment". *[(CO1)(Justify/IOCQ)]*

6 + 6 = 12

Group - C

4. (a) Name the weak forces stabilizing the three dimensional structure of a protein molecule. *[(CO3)(Remember/LOCQ)]*
(b) Describe the positions where polar amino acid residues can form hydrogen bonds in a protein molecule. *[(CO2)(Understand/IOCQ)]*
(c) Analyze the stabilizing forces in the following cases:
(i) Aspartic acid residues are usually found on the surface of a protein molecule.
(ii) In a DNA molecule, phosphate groups are positioned outward the helical structure. *[(CO3)(Analyze/HOCQ)]*

2 + 5 + (2.5 + 2.5) = 12

5. (a) Define allosteric enzymes. Draw the graphs illustrating the kinetics of an allosteric enzyme and a single-subunit enzyme. *[(CO3)(Remember/LOCQ)]*
(b) Discuss the properties of an allosteric enzyme. *[(CO3)(Remember/LOCQ)]*
(c) State the major difference between the postulates of MWC model and the symmetry model to explain the properties of allosteric enzymes. MWC model emphasizes on chemical kinetics to explain the properties of allosteric enzymes. Do you agree with this statement? Justify your answer. *[(CO3)(Differentiate, Analyze/HOCQ)]*

(1 + 2) + 4 + (2 + 3) = 12

Group - D

6. (a) Derive the equation used for quantitative analysis of a substance using UV-visible spectroscopy. *[(CO4)(Derive/HOCQ)]*

   (b) State the conditions where the above equation cannot be used. *[(CO4)(Remember/LOCQ)]*

   (c) A chemist has a sample of phenyl alanine with an absorbance of 0.81 at λ of 257nm. The molar extinction coefficient is 8850 L m-1 cm-1. The pathway is 3 cm. What is the concentration? *[(CO4)(Solve/HOCQ)]*

6 + 3 + 3 = 12

7. (a) Describe with figure, the major vibrations of bonds in a molecule. *[(CO1)(Describe/LOCQ)]*

   (b) Explain why use interferometer gives high resolution spectra in an IR-spectrophotometer. *[(CO3)(Understand/LOCQ)]*

   (c) IR spectroscopy can be used to follow the progress of a reaction. Do you agree with this statement? Justify your answer. *[(CO1)(Analyze/IOCQ)]*

6 + 3 + 3 = 12

Group - E

8. (a) Design the different processes of ion detection in Mass Spectrometer. *[(CO5)(Design/IOCQ)]*

   (b) Evaluate the advantages of Optical microscope over Electron microscope. *[(CO6)(Evaluate/LOCQ)]*

8 + 4 = 12

9. (a) Explain with a diagram the working principle of Surface Plasmon Resonance. *[(CO6)(Explain/IOCQ)]*

   (b) Enumerate the process of protein crystallization. *[(CO6)(Enumerate/IOCQ)]*

7 + 5 = 12

Cognition Level	*LOCQ*	*IOCQ*	*HOCQ*
Percentage distribution	*30.21*	*44.79*	*25*

Course Outcomes (CO):

After completing the course, the students will be able to:

1. Describe the structure of different macromolecules.
2. Elucidate structure-function relations of enzymes
3. Explain the interactions of macromolecules.
4. Illustrate the thermodynamics and kinetics of macromolecular transition.
5. Describe the spectroscopic techniques for biomolecular structural analysis.
6. Explain the working principle of some non-spectroscopic techniques for structural analysis

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