

BIOPHYSICS OF MACROMOLECULES
(BIOT 3242)

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) Examples of acidic amino acids are
(a) Glutamic acid and Aspartic acid (b) Glycine and Leucine
(c) Histidine and Lysine (d) Methionine and Lysine.
- (ii) Number of amino acid residues in a protein of molecular weight 58300 is
(a) 110 (b) 253
(c) 530 (d) 330.
- (iii) Henderson-Hasselbalch Equation is
(a) $pK_a = pH + \log_{10} \left(\frac{[HA]}{[A^-]} \right)$ (b) $pH = pK_a + \log_{10} \left(\frac{[HA]}{[A^-]} \right)$
(c) $pK_a = pH + \log_{10} \left(\frac{[A^-]}{[HA]} \right)$ (d) $pH = pK_a + \log_{10} \left(\frac{[A^-]}{[HA]} \right)$.
- (iv) Real, inverted and same size image as that of the object is formed in
(a) Telescope (b) Photocopier
(c) Camera (d) Spotlight.
- (v) Number of residues per turn in a Polyproline is
(a) 2.2 (b) 3
(c) 3.6 (d) 4.4.
- (vi) Light emitted from glow worm and fireflies is an example of
(a) Photoluminescence (b) Bioluminescence
(c) Electroluminescence (d) Radioluminescence.
- (vii) Which of the following statement is NOT correct regarding melting of a DNA?
(a) Melting point of a DNA depends on its base composition
(b) Melting curve of a DNA is hyperbolic in nature
(c) Salt concentration of the DNA solution influences the melting point
(d) The melting process can be monitored by measuring absorbance at 320 nm.

- (viii) Renaturation occurs with proteins which
(a) have lower energy in the denatured state
(b) have lower energy in the native state
(c) have very low energy level in both the native and the denatured state
(d) have almost equal energy level in the native and the denatured state .
- (ix) Bohr effect states that
(a) Hemoglobin binds more oxygen in low pH
(b) Hemoglobin binds more oxygen in high pH
(c) The allosteric nature of hemoglobin's oxygen binding property is lost in presence of protons
(d) All the above.
- (x) Dichromate ion absorbs near 500 nm. Based on this information, it can be concluded that
(a) dichromate ion absorbs in the visible region
(b) solution of dichromate salt is colourless
(c) dichromate ion absorbs in the UV region
(d) dichromate ion absorbs outside the visible region.

Group - B

2. (a) Write notes on Reverse Turns. [(CO3)(Illustrate/LOCQ)]
(b) Compare A, B and Z DNA. [(CO1)(Compare/IOCQ)]
5 + 7 = 12
3. (a) Draw and explain the titration curve of Aspartic acid. [(CO1)(Comment/IOCQ)]
(b) pKa of any functional group is greatly affected by its chemical environment- Explain with examples. [(CO3)(Explain/HOCQ)]
7 + 5 = 12

Group - C

4. (a) Where do you expect the following amino acids to be present (on the surface or in the interior) in a protein molecule? State the reason. (i) Phenylalanine, (ii) Threonine, (iii) Glutamic acid. [(CO3)(Justify/IOCQ)]
(b) What is melting of an alpha helix? State a physical parameter that can be used to monitor the melting of alpha helix. Derive the equation describing the relation between melting point of an alpha helix and thermodynamic parameters. [(CO4)(Remember, Derive/LOCQ, IOCQ)]
(2 × 3) + (1 + 1 + 4) = 12
5. (a) Based on the two-state model, derive the equation for kinetic study of denaturation of a protein. Discuss how the kinetic constant can be determined experimentally using the equation. [(CO4)(Derive, Discuss/HOCQ,IOCQ)]

- (b) Explain cooperative nature for melting of an alpha helix.

[[CO4](Analyze/LOCQ)]

(4 + 4) + 4 = 12

Group - D

6. (a) State the frequency region in the electromagnetic wave that gives the IR spectrum. Discuss the basic principle of IR spectroscopy.

[[CO5](Discuss/IOCQ)]

- (b) Define and illustrate the major types of vibrations in a molecule.

[[CO5](Illustrate/LOCQ)]

(2 + 6) + 4 = 12

7. (a) What are the different types of vibrations in a molecule? Draw diagrams of different types of vibrations in a three-atomic non-linear molecule.

[[CO5](Understand/LOCQ)]

- (b) Discuss three applications of IR.

[[CO5](Discuss/IOCQ)]

(3 + 3) + 6 = 12

Group - E

8. (a) What do you mean by Surface Plasmon Resonance? [[CO6](Evaluate/LOCQ)]

- (b) Explain with a schematic diagram, the scanning process and image formation in a Scanning Electron Microscope. [[CO6](Illustrate/HOCQ)]

4 + 8 = 12

9. (a) Briefly explain the production of X-rays. [[CO6](Explain/IOCQ)]

- (b) What is the principle behind Mass Spectrometry? [[CO6](Evaluate/IOCQ)]

8 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	26	56	18

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

