

**PHYSICOCHEMICAL TECHNIQUES IN BIOTECHNOLOGY  
(BIOT 5102)**

**Time Allotted : 2½ hrs**

**Full Marks : 60**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 4 (four) from Group B to E, taking one from each group.*

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

**Group – A**

1. Answer any twelve:

**12 × 1 = 12**

*Choose the correct alternative for the following*

- (i) Which of the following is NOT a weak force?  
(a) Sovation (b) Hydrogen bond  
(c) Di-sulphide bond (d) Van der Waal force
- (ii) Which statement is NOT correct for a thermodynamically stable protein?  
(a) The denatured state has lower energy than the native state  
(b) The native state has lower energy than the denatured state  
(c) Those proteins undergo renaturation  
(d) Usually those proteins have shorter chain length and higher S-S linkages.
- (iii) Which thermodynamic parameter changes in the unfavourable direction during protein folding?  
(a) Enthalpy (H) (b) Gibb's free energy (G)  
(c) Entropy (S) (d) None of the above.
- (iv) Circular dichroism is an optical phenomenon that is best described by which one of the following statements?  
(a) It occurs when molecules in solution are exposed to circularly polarized light  
(b) It occurs when molecules in solution are exposed to only left circularly polarized light  
(c) It occurs when molecules in solution are exposed to only right circularly polarized light  
(d) It occurs when molecules in solution are exposed to only monochromatic light.
- (v) Which of the following method is able to detect *complex* protein interactions (more than 2 proteins) at molecular scale resolution?  
(a) X-ray and NMR (b) Surface plasmon resonance  
(c) FRET analysis (d) All of the above
- (vi) Which of the following component combinations is NOT a part of a dual beam UV spectrophotometer?  
(a) Sample, reference cuvette (b) Beam selector  
(c) Prism and grating (d) Michelson interferometer.

- (vii) Which statement is correct for a spectro-fluorometer?  
 (a) It has an excitation filter and an emission filter  
 (b) It has only an emission filter  
 (c) It has only an excitation filter  
 (d) The detector detects the excitation ray.
- (viii) Colloidal solutions are unsuitable for  
 (a) UV-visible spectroscopy  
 (b) Fluorescent spectroscopy  
 (c) Both UV-visible and fluorescent spectroscopy  
 (d) None of the above.
- (ix) In electron microscopy, staining is done with  
 (a) Water soluble dyes (b) Fluorescent compounds  
 (c) Heavy metals (d) Resins
- (x) Phototoxicity is one of the limitations of  
 (a) Scanning Electron Microscopy (b) Scanning Tunnelling Microscopy  
 (c) Fluorescence microscopy (d) Atomic force microscopy

*Fill in the blanks with the correct word*

- (xi) Thio-ester bond is formed between Glutamine and \_\_\_\_\_ residues in a protein.
- (xii) \_\_\_\_\_ lamp is used as the light source in fluorescence microscopy.
- (xiii) Electron microscope gives a magnification of \_\_\_\_\_.
- (xiv) Normal modes of vibrations of a non-linear molecule is \_\_\_\_\_.
- (xv) Bathochromic shift is the shift of peak towards \_\_\_\_\_ wavelength.

### **Group - B**

2. (a) Hydrophobic amino acid residues are usually found in the core, and not on the surface of a protein molecule. Explain the observation with thermodynamic parameters. [[CO1](Explain/IOCQ)]
- (b) Melting of a helix is a cooperative process. Comment on the statement. [[CO1](Comment/HOCQ)]
- (c) For melting of a DNA double helix, derive the relation between  $T_m$  and relevant thermodynamic parameters. [[CO1](Understand/IOCQ)]  
**4 + 4 + 4 = 12**
3. (a) What are the thermodynamic parameters associated with protein folding? Discuss how they change, favourably or unfavourably during protein folding. [[CO1](Understand/IOCQ)]
- (b) Explain the role of aldol condensation in making covalent crosslinks in collagen. [[CO2](Understand/IOCQ)]
- (c) The enzyme-substrate complex is stabilized by van der Waals interaction and this is the most suitable interaction for the enzyme substrate complex. Justify the statement. [[CO1](Justify/IOCQ)]  
**4 + 4 + 4 = 12**

## Group - C

4. (a) What are chromophores? Give two examples. [[CO2](Remember/LOCQ)]  
(b) The peak of a UV-Visible spectrum can shift with the change in chromophore or the solvent. Discuss such shifts with a suitable diagram. [[CO2](Understand/IOCQ)]  
(c) State and derive Lambert-Beer law for quantitative estimation of a chemical through UV-Visible spectroscopy. [[CO2](Understand/IOCQ)]  
**3 + 4 + 5 = 12**
5. (a) What is stretching? What do you mean by symmetric and antisymmetric stretching? Illustrate with a suitable figure. [[CO2](Remember/LOCQ)]  
(b) What is the role of interferometer in FTIR? [[CO2](Understand/IOCQ)]  
(c) How IR spectroscopy can be used to determine the functional group and elucidation of molecular structure? [[CO2](Understand/IOCQ)]  
**(2 + 2 + 2) + 3 + 3 = 12**

## Group - D

6. (a) What is Stoke's shift? Discuss the origin of Stoke's shift with Frank Condon principle. [[CO3](Discuss/IOCQ)]  
(b) State the conditions which are unsuitable for fluorometric analysis of an analyte. [[CO3](Remember/LOCQ)]  
**(2 + 6) + 4 = 12**
7. (a) Draw Jablonski's diagram and explain the energy transfer in fluorescence. [[CO3](Understand/IOCQ)]  
(b) What is 0-0 transition? Why it is not obtained in reality? [[CO4](Remember/LOCQ)]  
**6 + (2 + 4) = 12**

## Group - E

8. (a) State functions of the following components of a scanning electron microscope: (i) condenser lenses, (ii) apertures, (iii) specimen chamber. [[CO4](Understand/IOCQ)]  
(b) What are Auger electrons? Discuss their importance. [[CO4](Remember/LOCQ)]  
(c) Differentiate optical microscope and SEM with respect to (i) fixation, (ii) embedding medium, (iii) sectioning of sample. [[CO2](Understand/IOCQ)]  
**(2 + 2 + 2) + (1 + 2) + 3 = 12**
9. (a) What are the major components of TEM? Describe those components in brief. [[CO4](Describe/IOCQ)]  
(b) The condenser lenses are part of the illuminating system whereas the objective lenses and projector lenses are parts of the image producing system in TEM. Comment on the statement. [[CO4](Comment/HOCQ)]  
(c) Write three applications of TEM. [[CO4](Remember/LOCQ)]  
**(2 + 3) + 4 + 3 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	26.04	65.63	8.33