

2015

BIOCHEMISTRY

Paper – BCT – 202

(Biophysical Chemistry)

Full Marks – 25

8 MAY 2015

*The figures in the margin indicate full marks**Candidates are required to give their answers in their own words as far as practicable*Answer **any five** questions taking at least **one** from each **Group****Group – A**

1. The general expression of the FID signal can be expressed by :

$$S(t) = S_0 \exp(i\Omega t) \cdot \exp\left(-\frac{t}{T_2}\right)$$

Sketch the FID profile (S(t)-t). Write down the Fourier transformed pattern for the function. How many peak(s) will be visible and what determines the half width of the peak(s) ?

5

2. Why Bloch's equation may not be applicable if spin is not 1/2 ? There are three frequency terms, namely Larmor frequency, Rabi frequency and frequency of the RF field. Explain the origin of such frequencies.

5

3. Briefly differentiate between scalar and dipolar coupling. Name some of the 2D FTNMR techniques where the two classes of coupling are used.

5

4. (a) Show how the two spin states $|\alpha\rangle$ and $|\beta\rangle$ flip when operated by I^+ and I^- operators. Hints : Evaluate $I^+|\alpha\rangle$, $I^+|\beta\rangle$ and $I^-|\alpha\rangle$, $I^-|\beta\rangle$.

(b) Show that $I^+|\alpha\rangle = |\beta\rangle$.

5

5. If we equate $\hbar\gamma B_0$ as ν_0 and $\sigma\hbar\gamma B_0$ as ν

$$H = -\frac{\nu_0 - \nu}{2} \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

Explain the terms ν and ν_0 in the Hamiltonian expressed above. What the eigenvalues of the Hamiltonian will signify ?

5

Group – B

6. (a) Describe the basic working principle of MALDI.

(b) Human serum albumin possess a single tryptophan residue. Explain how binding of bilirubin with HSA can be investigated using fluorescence spectroscopy ?

2+3

7. (a) Why IR spectroscopy sometimes can provide you more information over absorption spectroscopy ?

(b) What do you mean by excited state lifetime of a fluor ? What is the average range of lifetime for an amino acid ?

2+3

[Turn Over]

8. (a) Describe the process of coulombic explosion in case of electrospray ionisation.
- (b) Define solvent perturbation. Why is it important to study the absorption spectrum of a biological sample ? 3+2
9. (a) A myoglobin sample is prepared to study its Circular Dichroic spectrum. The temperature of the sample is changed from 20°C to 80°C. What type of changes do you expect to get if wavelength versus ellipticity is plotted for this transition ?
- (b) Calculate the distance between two domains of an oligomeric protein, if the energy transfer is 60% efficient and the domains are labelled with Fluorescein and Tetmethyl-rhodamine respectively. Förster distance is provided to be 55Å. 3+2
10. (a) Compare the quantum yield of Tyr, Trp and Phe.
- (b) Distinguish between static and dynamic quenching.
- (c) How can you define the anisotropy of a protein molecule ? 1+3+1

Group – C

Each one is of 5 marks. Division is (1.5+1.5+2)

11. (a) Macromolecular crystals contain
- No solvent molecules
 - Mostly solvent molecules
 - Empty space apart from the macromolecules.
 - Substantial amount of solvent though the exact amount varies for crystal to crystal.
- (b) How many techniques are usually employed to obtain macromolecular crystals?
- 2
 - 4
 - 3
 - 5
- (c) State if the following statements are true or false :
- Protein crystals may contain center of inversion.
 - 5-fold non-crystallographic symmetry can be present in protein crystals.
12. (a) If you are successful in obtaining crystals of a protein with a homolog whose solution structure have previously been determined
- Phasing must be possible by molecular replacement.
 - Phasing is never possible by molecular replacement.
 - Phasing is possible only by molecular replacement coupled with SAD data.
 - Molecular replacement phasing may be possible depending on the extent of homology and solution structure quality.
- (b) Can P4₂2, P4₁22 and P4₃22 spacegroups be distinguished from the diffraction pattern ?
- Yes, all three can be distinctly identified from the diffraction.
 - Only P4₂2 can be differentiated but not P4₁22 and P4₃22
 - Only P4₃22 can be distinguished from P4₂2 and P4₁22.

(iv) These space groups cannot be distinguished from the diffraction.

(c) State if the following statements are true or false :

(i) Sampling larger reciprocal space increases resolution.

(ii) $I_{hkl} = I_{-h-k-l}$ is called Friedel's law.

13. (a) Which has more contribution towards electron density

(i) Amplitude of the reflections

(ii) Intensity of the reflections

(iii) Phase of the reflections

(iv) Amplitudes and the phases contribute equally.

(b) Multiple anomalous dispersion refers to

(i) A technique to determine phases that requires data collection at different wavelengths of X-ray.

(ii) A method to calculate electron density map from phases and amplitudes.

(iii) A mathematical treatment of the collected data to eliminate experimental errors.

(iv) Use of different but similar chemicals to obtain macromolecular crystals.

(c) State if the following statements are true or false :

(i) Ewald's sphere is a ball required to collect diffraction data.

(ii) Dimension of the Ewald's sphere changes upon changing the wavelength of the incident X-ray.

[Turn Over]