B. Sc. Physics (Hons.) Examination, 2023

(3rd Year, 2nd Semester)

Biological Physics

Paper – DSE/04/A3

Time : 3 hours   Full Marks : 75

Answer *five* questions, at least one from each section.

Section A

1. a) Explain the origin of hydrophobic interaction. What is the order of magnitude of this interaction?

   b) Draw a schematic diagram of a phosphatidylcholine (PC) molecule and label the different chemical groups in the head group.

   c) What are saturated and unsaturated phospholipids? Give one example in each case. Mention names of two phospholipids with different head groups.

   d) What is chain melting transition temperature (T_m)? Between saturated and unsaturated phospholipids, which one will have lower T_m and why? In saturated PC, does T_m remain constant with increasing chain length? If no, what is the relation with increasing chain length?

   (3+1)+2+(2+2)+(1+1+1+2) (CO1)

[Turn over

2. a) What is the Oparin-Haldane theory? Describe the experiment conducted to prove the theory with a suitable diagram.

    b) What is the purpose of occurrence of domains in globular proteins? What is denaturation of proteins and how can they occur?

    c) Briefly describe the protein-ligand interaction. What are coenzymes?

    d) How many stereoisomers are present for a monosaccharide with 8-carbon atoms? Explain why.

    (2+3)+(2+2)+(3+1)+2 (CO1)

Section B

3. a) Why do you think that lipid-water system will tend to form lamellar phase of lipid bilayer above the critical micellar concentration (CMC)?

    b) Why do you need to keep temperature of the sample above T_m to prepare vesicles?

    c) What are multilamellar vesicles (MLV)? How does one obtain unilamellar vesicles from MLV?

    d) Discuss the phase diagram of lipid-water system. Explain the structure of each phase.

    2+1+(1+2)+(3+6) (CO2)

Section – D

See the bottom for the description of Course Outcomes (COs)

7. a) Explain how hydrogen behaves under high magnetic field and Electromagnetic (radio) wave in Magnetic resonance imaging instrument.

    b) Derive the equation of Free Induction Decay (FID) and explain how it help to get the image from the MRI.   7+8

8. a) Explain Beer's and Lambert's law. How are they utilized in measuring the concentration of oxygen in blood?

    b) What is Pulse Oximeter? Explain the working principle of Pulse Oximeter with a 1 diagram.
    4+4+7 (CO4)

6. a) Describe the general structure of an amino acid. Why are amino acids said to be optically active? Why do proteins absorb light strongly at 280 nm?

   b) With the help of the Ramachandran plot, describe the primary structure of proteins.

   c) How does the Watson and Crick model of DNA suggest the transfer of genetic information from DNA molecules? Justify using simple figures. Why is DNA replication semi-conservative?

   d) Justify why at least 3 nucleotides are necessary for each CODON. Describe the structure of a tRNA.
   (2+2+1)+3+(3+1)+(1+2) (CO3)

CO1 : Understand how the structures of different biological molecules are related with its function to maintain normalcy of the living system.

CO2 : Learn architecture, composition and physical properties of biomolecular structures.

CO3 : Understand techniques to analyze biological systems.

CO4 : Explain interaction of radiation with matters and describe different radiation detectors.

4. a) Tropomyosin, a 70-kDa muscle protein, is a two-stranded α-helical coiled coil. Estimate the length of the molecule.

   b) Describe the formation of a disaccharide from two monosaccharide molecules. Why is sucrose not a reducing sugar? Explain why glucose is not stored in its monomeric form in living cells.

   c) With the help of a simple diagram, describe the process of transcription for the formation of mRNA from DNA.

   d) How is DNA supercoiled? 3+(2+1+2)+5+2 (CO2)

Section C

5. a) In a low angle x-ray diffraction of oriented lamellar phase, how do you obtain information of the hydrocarbon chain ordering in the plane of bilayer?

   b) What are rafts? Discuss the influence of cholesterol on the membrane.

   c) Discuss the fluid mosaic model of plasma membrane of Eukaryotic cell.

   d) Write down the elastic free energy in the spontaneous curvature model and explain each term.
   3+(2+3)+4+3 (CO3)