Name:

Enrolment No:

UPES

End Semester Examination, May 2025

Course: Biophysics **Semester: IVth**

Program: B.Tech – Biotechnology & B.Tech - Biomedical **Duration: 3 hours**

Course Code: PHYS2030 **Max. Marks: 100**

Instructions: Carefully read and attempt all the questions.

S. No.	Section A Short answer questions/ MCQ/T&F (20Qx1.5M= 30 Marks)	Marks	COs
Q1.	**Recall the postulate of quantum theory.** A. Energy is continuous B. Electrons follow circular orbits only C. Energy is quantized and exchanged in discrete units called quanta D. Atoms do not emit radiation	1.5	CO1
Q2.	**Hydrogen bonding occurs when hydrogen is bonded to:** A. Carbon, sulfur, or silicon B. Oxygen, nitrogen, or fluorine C. Phosphorus, arsenic, or bromine D. Any metal ion	1.5	CO2
Q3.	**Electrostatic interactions are strongest when:** A. The dielectric constant is high B. The charges are far apart C. The dielectric constant is low and charges are close D. In aqueous environments	1.5	CO2
Q4.	**One of the unusual properties of water is:** A. Low surface tension B. Maximum density at 0°C C. High heat capacity and heat of vaporization D. It behaves as a non-polar solvent	1.5	CO1
Q5.	**In an enzyme-catalyzed reaction, the rate increases with substrate concentration until:** A. The enzyme is saturated B. All substrate is converted to product C. Temperature reaches 0°C D. The reaction becomes zero-order	1.5	CO2
Q6.	**The enthalpy change (ΔH) of a reaction reflects:** A. The amount of disorder in the system B. The heat absorbed or released C. Activation energy D. The reaction rate	1.5	CO2
Q7.	**Recall the most abundant lipids in biological membranes.** A. Sphingomyelin B. Phosphatidylcholine C. Cholesterol D. Cardiolipin	1.5	CO1
Q8.	**Identify a secondary active transporter.** A. Na^+/K^+-ATPase B. Aquaporin C. Glucose-Na^+ symporter D. Voltage-gated K^+ channel	1.5	CO1

Q9.	**During an action potential, depolarization is caused by:** A. Cl^- influx B. K^+ efflux C. Na^+ influx D. Ca^{2+} efflux	**1.5**	**CO2**
Q10.	**The patch clamp technique is used to measure:** A. Entire neuron activity B. Single ion channel currents C. Metabolic rate D. Membrane elasticity	**1.5**	**CO2**
Q11.	**Recall the compounds used in Anfinsen's renaturation experiments?** A. SDS and ATP B. Urea and β-mercaptoethanol C. Heat and ethanol D. Acetone and NaCl	**1.5**	**CO1**
Q12.	**Levinthal's paradox suggests:** A. Protein folding is a random and slow process B. Proteins cannot fold spontaneously C. Proteins fold via specific pathways, not by random search D. All proteins fold the same way	**1.5**	**CO1**
Q13.	**The energy landscape theory of protein folding illustrates:** A. Folding requires enzymes B. Proteins fold through a linear pathway C. Proteins fold via multiple paths down an energy funnel D. All folding happens in one step	**1.5**	**CO2**
Q14.	**A folding funnel represents:** A. Increase in entropy B. Progressive decrease in free energy toward native state C. Increase in protein size D. Increase in temperature	**1.5**	**CO1**
Q15.	**Molecular chaperones assist protein folding by:** A. Directly folding proteins B. Preventing aggregation and providing folding environment C. Breaking misfolded structures D. Hydrolyzing misfolded proteins	**1.5**	**CO2**
Q16.	**The delay between absorption and fluorescence emission is typically:** A. Microseconds B. Nanoseconds C. Seconds D. Hours	**1.5**	**CO2**
Q17.	**UV absorbance at 280 nm is primarily due to:** A. Peptide bonds B. Aromatic amino acids C. Aliphatic residues D. Sulfur-containing residues	**1.5**	**CO1**
Q18.	**The melting temperature (Tm) of a protein is defined as:** A. The temperature at which all proteins degrade B. The temperature at which 50% of the protein is unfolded C. The temperature at which proteins are phosphorylated D. The point of maximum absorbance	**1.5**	**CO1**
Q19.	**In ITC, the binding isotherm provides information about:** A. Molecular geometry B. Stoichiometry, enthalpy, and binding constant C. Molecular diffusion D. pH dependence only	**1.5**	**CO1**
Q20.	**…….. is not a limitation of ITC?** A. High sample consumption B. No need for labeling C. Low throughput D. Sensitivity to heat artifacts	**1.5**	**CO2**

Section B (4Qx5M=20 Marks)			
Q1.	Explain the concept of secondary active transport, classify its types, and provide an example for each type.	**5**	**CO3**
Q2.	Discuss the role and significance of hydrogen bonding and van der Waals interactions in biological systems.	**5**	**CO2**
Q3.	Describe the patch clamp technique and summarize its importance in studying the properties of biological membranes.	**5**	**CO2**
Q4.	Describe binding energy and analyze its contribution to enzyme catalysis.	**5**	**CO3**
Section C (2Qx15M=30 Marks)			
Q1.	Design an experiment to evaluate the suitability of two different buffers in maintaining protein stability. (7) Describe the experimental method and its detailed steps. (8)	**15**	**CO4**
Q2.	Explain the principle behind isothermal titration calorimetry (ITC). (5) Describe the working mechanism of ITC with the help of a labeled diagram. (10)	**15**	**CO4**
Section D (2Qx10M=20 Marks)			
Q1.	Identify the conditions necessary for conformational changes in proteins. (3) Explain how diphosphoglycerate (2,3-BPG) influences the binding affinity of oxygen to hemoglobin. (7)	**10**	**CO3**
Q2.	Analyze how protein folding processes comply with the second law of thermodynamics. (4) Illustrate and explain the energy-entropy funnel model with a labeled diagram. (6)	**10**	**CO4**