Name:

Enrolment No:

UPES

End Semester Examination, May 2025

Course: Structural Biology and Biophysical Chemistry **Semester: VIth**

Program: INT-BMSC-MICROBIOLOGY **Duration: 3 hours**

Course Code: HSMB3012O **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.	**At the folding transition midpoint (Tm), what is the Gibbs free energy difference (ΔG) between folded and unfolded states?** A. Positive B. Negative C. Zero D. Undefined	1.5	CO1
Q2.	**Charged amino acids are most commonly found:** A. Inside the hydrophobic core B. On the surface of proteins C. In disulfide bridges D. At the N-terminal only	1.5	CO1
Q3.	**Protein folding is thermodynamically favorable because:** A. Enthalpy decreases and entropy increases B. Enthalpy increases and entropy decreases C. Enthalpy decreases and entropy of the solvent increases D. Both enthalpy and entropy increase	1.5	CO2
Q4.	**Recall the reason for glycine occupying a wider region in a Ramachandran plot compared to other amino acids.** A. Its side chain restricts rotation B. It lacks a side chain beyond a hydrogen atom C. It forms extra hydrogen bonds D. It is always charged	1.5	CO1
Q5.	**Which of the following is not an advantage of CD spectroscopy?** A. Requires small amounts of protein B. Non-destructive and fast C. Suitable for detecting protein folding D. Provides atomic-resolution structure	1.5	CO2
Q6.	**NMR spectroscopy primarily detects nuclei that have:** A. High molecular mass B. A magnetic moment and non-zero spin C. UV absorbance D. Free electrons	1.5	CO2
Q7.	**The phase problem in X-ray crystallography refers to the:** A. Difficulty in obtaining high-resolution crystals B. Loss of amplitude during detection	1.5	CO2

	C. Inability to directly measure phase information from diffraction data D. Decay of crystals under X-rays		
Q8.	**Describe the primary reason for using cryo-cooling (e.g., liquid nitrogen) during X-ray data collection.** A. Increase signal intensity B. Prevent water evaporation C. Reduce radiation damage to the crystal D. Enhance diffraction resolution	**1.5**	**CO2**
Q9.	**In an XFEL experiment, why are extremely short X-ray pulses important?** A. They improve sample cooling B. They outrun radiation damage before it destroys the sample C. They decrease signal intensity D. They increase crystal size	**1.5**	**CO1**
Q10.	**XFEL sources are particularly powerful for studying:** A. Very large crystals only B. Single molecules and nanocrystals C. Only metal complexes D. Only surface topographies	**1.5**	**CO1**
Q11.	**Identify the detector revolutionized Cryo-EM by increasing resolution and sensitivity.** A. Photographic film B. CCD camera C. Direct Electron Detector (DED) D. CMOS sensor	**1.5**	**CO1**
Q12.	**Efficient FRET requires that:** A. Donor emission spectrum overlaps acceptor absorption spectrum B. Donor absorption spectrum overlaps acceptor absorption spectrum C. Acceptor emits at a longer wavelength than the donor absorbs D. Donor and acceptor are separated by > 100 nm	**1.5**	**CO1**
Q13.	**Fluorescence emission typically occurs at a longer wavelength than absorption because of:** A. Excited state instability B. Vibrational relaxation before photon emission C. Higher energy of emitted photons D. Stronger absorption	**1.5**	**CO2**
Q14.	**In a Jablonski diagram, fluorescence occurs when an excited electron returns from:** A. Ground state to excited state B. Excited singlet state to ground singlet state C. Triplet state to ground state D. Excited state to a vibrational state	**1.5**	**CO1**
Q15.	**During an EPR experiment, if no signal is detected, a logical explanation could be:** A. The sample contains no unpaired electrons B. The magnetic field is too high	**1.5**	**CO2**

	C. The sample temperature is too low D. The microwave frequency is too high		
Q16.	**In an MD simulation, you see that water molecules near the protein surface are highly ordered. What does this most likely indicate?** A. Water evaporation B. Formation of clathrate structures C. Formation of a hydration shell D. Instability in the simulation	**1.5**	**CO2**
Q17.	**In MD simulations, periodic boundary conditions are mainly used to:** A. Limit simulation time B. Increase the size of the system C. Mimic an infinite system and avoid edge effects D. Increase the number of atoms artificially	**1.5**	**CO1**
Q18.	**Identify the regions in the RNA secondary structure NOT preferred for RNA-protein interactions.** A. Helices B. Internal loops C. Bulge loops D. Multibranch loops	**1.5**	**CO1**
Q19.	**Recall the correct statement about the G-U wobble base pair in RNA.** A. It destabilizes the secondary structure completely B. It is forbidden in stems and loops C. It is less stable than Watson-Crick pairs but tolerated in RNA D. It forms only in DNA	**1.5**	**CO1**
Q20.	**Identify the TRUE statements about RNA pseudoknots.** A. They are formed by simple hairpin loops B. They involve base pairing between two completely adjacent regions C. They result from base-pairing between a loop and a complementary sequence outside the loop D. They are unstable and never found in functional RNAs	**1.5**	**CO2**
	Section B **(4Qx5M=20 Marks)**		
Q1.	List additional common base-pairing interactions found in RNA and examine the methods and significance of RNA secondary structure prediction.	**5**	**CO3**
Q2.	Differentiate between the processes of minimization and equilibration during molecular dynamics simulations.	**5**	**CO2**
Q3.	Define the Stokes shift and identify the amino acids typically analyzed using fluorescence spectroscopy in a protein.	**5**	**CO2**
Q4.	State Bragg's Law and derive Bragg's equation, supporting your derivation with an appropriate diagram.	**5**	**CO3**

Section C (2Qx15M=30 Marks)			
Q1.	Design an experiment to investigate protein-protein interactions within a cellular environment. Evaluate the chosen technique and analyze its limitations.	**5 + 10**	**CO4**
Q2.	Plan an experimental approach to examine the influence of different buffers on protein stability and explain the underlying principle with the aid of an illustrative diagram.	**7 + 8**	**CO4**
Section D (2Qx10M=20 Marks)			
Q1.	Differentiate between synchrotron radiation and XFEL and describe the concept of bunching as it applies to XFEL.	**5 + 5**	**CO3**
Q2.	Explain the concept of Larmor frequency. Describe the working principle of NMR spectroscopy and evaluate its advantages over X-ray crystallography for structural studies.	**3 + 7**	**CO3**