BT 301: Biophysics **MIDSEM 18 Sep 23** Instr: R. Swaminathan

Total marks = 30. Section A carries 10 marks; Section B carries 20 marks

SECTION A (1 x 10 = 10)

1. Name the spectroscopic technique which measures the intensity of transition from ground to higher energy electronic states?
2. Name the spectroscopic technique which measures the differential absorption of a sample to left and right circularly polarized light.
3. Name the spectroscopic technique which measures the relaxation of excited singlet electronic state to lower energy state.
4. Applying the random flight model, calculate the end to end distance in a biopolymer if number of repeating rigid monomer units are 101 and length of each repeat unit is 5 Å.
5. Which among the following is an essential amino acid for humans: a) Ala; b) Cys; c) Asp; d) Arg; e) Ser; f) Val; (*tick all that apply*)
6. Which protein secondary structure is associated with a dipole moment?
7. What is the persistence length for double stranded DNA?
8. How is the magnetic dipole operator **m** related to momentum operator **p** and position operator **r**.
9. Which value among the following, most likely represents the bimolecular quenching constant k_q for Trp by O_2 at room temperature. A) 1.1×10^8 $M^{-1}s^{-1}$; B) 1.1×10^4 $M^{-1}s^{-1}$; C) 1.1×10^6 $M^{-1}s^{-1}$; D) 1.1×10^{10} $M^{-1}s^{-1}$; E) 1.1×10^{12} $M^{-1}s^{-1}$;
10. Which among the following is NOT a component of steady state fluorometer: a) Constant Fraction Discriminator; b) Time to amplitude converter; c) Monochromator; d) Photomultiplier tube; e) Polarizer;

SECTION B (2 x 10 = 20)

11. Arrange the following processes in the decreasing order of the rate at which they occur starting from the fastest event. (e.g. rocket > plane > car > bicycle):

Internal conversion; Solvent relaxation; Electronic absorption; Fluorescence; Phosphorescence

12. Show that $[\theta] = 3298 \Delta\varepsilon$

13. Calculate the distance between D and A if efficiency of FRET is 0.20 and $R_0 = 20$ Å

14. Describe two unique differences between STATIC and DYNAMIC fluorescence quenching.

15. List two major differences in the structure of B-DNA and A-DNA.

16. Draw the structure of a TRIPEPTIDE using a sequence of your choice. All bonds/atoms in the main and side chains must be clearly depicted.

17. Explain what is DNA condensation. Give example.

18. Draw the JABLONSKI DIAGRAM and show the following transitions:

Internal conversion; Electronic absorption; Fluorescence; Phosphorescence; Intersystem crossing;

19. A student has a monomeric protein of 100 residues with a single Trp in sequence. Quenching of the fluorescence arising from sole Trp by iodide yields two values depending on the condition:
    a. In absence of DNA, the k_q for Trp is large
    b. In presence of added DNA the k_q for Trp reduces by 10-fold relative to condition 'a'

What conclusions can the student draw from these results?

20. Plot the Stern-Volmer plot measured from steady state fluorescence that shows:

    a. A fluorophore undergoing dynamic fluorescence quenching only.

    b. The same fluorophore undergoing both static and dynamic quenching.