M. Sc. (Biotechnology) Part I Examination, 2017

Molecular Biophysics and Chemistry of Biomolecules

Paper - 1/5

Time : Four hours Full Marks : 100

Group – A

1. a.

i. Why the de-Broglie wave associated with a moving car is not observable?

ii. Are mater waves are electromagnatics?

iii. An electron and proton have same amount of kinetic energy. Which of these two possesses greater wave length?

iv. De-Broglie hypothesis support the Bohr,s model of stationary orbit- comment on this statement.

v. What is the difference between light wave and matter wave?

b. The red light from a helium-neon laser has a wave length of 633 nm. What is the energy of one photon?

c. Calculate the uncertaintity in the positionof a ball of mass 100 gm travelling 40.2 m/s if the velocity is known to 0.0447m/s. (2+1+2+3+2)+3+3

Or,

1. a. Starting from derivation of schorindger equation draw the wave function and probability distribution for a particle in a box at the n=3 energy level.

b. Write down Schorindger wave equation for a simple harmonic oscillator.

c. For wave function $\Psi = Ae^{i(kx-wt)}$ determine momentum operator ad energy operator. (8+2+6)

2. a. Compare and contrast light microscopy (LM) and transmission electron microscopy for the following parameters

i) What is the radiant energy ?

ii) What is used to bend the energy rays?

iii) What is the approximate resolution limit?

Iv) What is the usual magnification range?

b. What are the similarities and differences between a scanning electron microscope (SEM) and a confocal scanning laser microscope (CSLM)?

c. Name the microscope

i. illuminates the specimen with light of two different phases
ii. Uses circular filters in the condenser and objective to give contrast to parts of the cell with different refractive indices
iii. The specimens are placed in a high vacuum for viewing.
iV. can visualize unfixed specimens in water or buffer.

d. You have two genes in two separate plasmid with GFP and RFP respectively. Using fluorescence microscopy how you can show that these two protein s basically reside in cytoplasm and after stress these two proteins colocalize in the nucleus. (4+3+4+5)

Or,

2. a. Mention the basic working principle of fluorescence activated cell sorter (FACS). What are light source used in FACS? What is the significance of forward and backward scattering? Design an experiment to demonstrate the early apoptosis, late apoptosis and necrosis of a population of cells treated with cytotoxic drugs.
b. Multiphoton microscopy is safer than confocal microscopy ---explain. (4+1+3+5)+3

3. a. What is the wavelength ranges of ultra violet and visible lights? 2+2

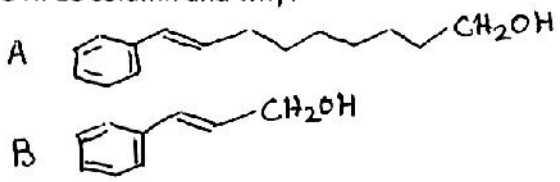
b. At higher concentration of solutes, Lambert-Beer's law deviates from linearity. What are the probable causes? 4

c. A protein contains 2 arginine and 2 lysine residues. Are you sure that it will be degraded by trypsin under physiological conditions? Note that trypsin cleaves a peptide bond that contains arginine or lysine residues. 4

d. Holding the fact that in tropical countries, plants are exposed to moderately high temperature, enzymes prepared from such sources are recommended to preserve at low temperature like 4^0 to -20^0C. Why? 4

4. a. What are the functional components of a C_8 and a C_{18} – reverse phase HPLC column? 4

b. Of the two compounds illustrated below, which one has higher affinity towards C_{18} – reverse phase HPLC column and why? 2+2



c. Mention any two functions of a guard column attached to an HPLC column. 4

d. In a HPLC run, a very small peak appeared. How could you distinguish that the peak represents a component separated in the chromatogram or a noise? 4

5. a. A crude protein solution was prepared in 20 mM Na-phosphate, pH 7.5 containing 0.5 M NaCl. Can it be applied to a DEAE-cellulose column equilibrated with the same buffer for the purpose of purification? Explain. 4

b. Mention two reasons why protein solutions are dialyzed against a suitable buffer. 4

c. What are the advantages of an HPLC system over traditional column chromatography? 4

d. What are the limitations of an analytical HPLC system? 4

6. a. Mention four methods by which purity of a protein could be ascertained. (Only the names are required like NMR spectroscopy). 4

b. Why very large proteins invariably form multimeric structures? 4

c. All amino acids are colorless. Then why hemoglobin is red? 4

d. Is it possible that a protein does not absorb light at 280 nm? In that case, is it possible that the protein could be fluorescent? Explain in 2-3 sentences. 4

Group C
Answer *all* questions

7. (a) Discuss the role of hydrogen bonding in maintaining the structural stability of the biomacromolecules in solution.

(b)Two monomers of a protein form dimer spontaneously at 27 ^{o}C, pH 7.4, 1 atm . Enthalpy change of the above reaction is 2 Kcal / mole. Entropy change of the reaction is – 10 / ^{0}K.mole. Number of moles of water released on dimerisation is ten. Solvent entropy increase per mole released water is 2 cal / ^{o}K.mole. Explain the spontancity of the above dimer formation from thermodynamic points of view, mentioning clearly the role of water molecules in the reaction. What type of interaction you suggest from the above data that might be involved in dimer formation?

(c) Biological systems always are far from equilibrium. What happens if it achieves equilibrium? [4+10+2=16]

OR

7. (a) Describe the Euler's criteria of a proper thermodynamic variable defining the physical state of a thermodynamic system.

(b) For ideal monoatomic gas, pv=nRT. Show that P is the thermodynamic variables that follows Euler's criteria

(c) Deduce the mathematical representation of first law of thermodynamics of conservation of energy.

(d) Prove that Cp - Cv = nR [4+4+4+4=16]

Answer *any four* from the following [4 x4 =16]

(i) Compare the functions of the enzymes Glucokinase and Hexokinase.
Explain how the Hexokinase reaction is an example of coupled reaction.

(ii) Compare Mitochondria with that of the bacterial respiratory chain

(iii) What are the implications of having the pair of enzymes (i) isocitrate lyase and (ii) malate synthase?
How bacteria utilize acetyl CoA under anaerobic condition?

(iv) Describe the role of pyridoxal phosphate in transaminase reaction. Ammonia is toxic. How skeletal muscle dump its toxic ammonia burden to liver?
State the reaction of urea formation in mammals.

(v) DNP and cyanide inhibit the respiratory chain at different places – explain.
Explain why human prefer less efficient glycolysis mode of glucose metabolism in emergency?

(vi) Calculate the maximum possible number of ATP that could be produced from complete beta-oxidation of one mole of palmitic acid.

(vii) What the different possible fates of pyruvate produced from glucose metabolism?

(viii) Explain with suitable examples, the difference between substrate level phosphorylation and membrane associated phosphorylation.

(ix) Explain how *E coli* degrade gluconate by Entner-Doudoroff pathway.

(x) What are the useful spins off products of TCA cycle?