BIOSEPARATION TECHNOLOGY
(BIOT 4102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Micro-filtration membranes have pore sizes in the range
(a) 0.1 to 10 µm (b) 1 to 20 µm
(c) 10 to 20 µm (d) 50 to 80 µm.

(ii) Consequence of concentration polarization is
(a) solvent diffuses back from the membrane surface to the solution
(b) solute diffuses back from the membrane surface to the solution
(c) rate of diffusion increases
(d) None of the above.

(iii) Non-mechanical methods of cell disruption include
(a) French press (b) bead mill
(c) ball mill (d) osmotic shock.

(iv) In gel filtration chromatography, separation takes place based on
(a) Size (b) charge
(c) hydrophobic interaction (d) metal ion affinity.

(v) Inhibitory fermentation product is best separated by
(a) liquid-liquid extraction (b) aqueous two phase extraction
(c) adsorption (d) ultra-filtration (UF).

(vi) Which one of the following should be used for the first step of purification of a protein from a complex mixture ?
(a) precipitation (b) ion exchange chromatography
(c) affinity chromatography (d) hydrophobic interaction chromatography.

(vii) In cell lysis by sonication, the frequency of sound waves used is
(a) greater than 20 Khz (b) less than 20 Khz
(c) less than 10 Khz (d) any frequency.

(viii) A protein can precipitate when its PI is
(a) equal to pH (b) greater than pH
(c) less that pH (d) no relation.

(ix) Gel permeation chromatography separates protein on the basis of
(a) molecular size (b) charge
(c) pI (d) molecular shape.

(x) The only membrane separation in which the permeate undergoes a phase change is
(a) Electrodialysis (b) Pervaporation
(c) Ultrafiltration (d) Reverse osmosis.

Group – B

2. (a) What is HEPA filter ? How are HEPA filters routinely tested?

(b) Explain transmembrane pressure drop with the help of suitable equation.

(c) Explain sedimentation time, sedimentation coefficient and sigma analysis with proper equation.

3 + 3 + (2 + 2 + 2) = 12

3. (a) Define partition coefficient, operating line, equilibrium curve with proper mathematical equations (wherever applicable).

(b) A counter current extractor with four equilibrium stages is available for separating a desired bio-product from a contaminating impurity, which is 11 % of the weight of the bio-product in a feed stream. For the extraction solvent being used, which is immiscible with the feed stream, the bio-product has a partition coefficient K of 10, while the impurity has K = 1. For an S/F ratio of 0.2, what will be the ratio of impurity to bio-product in the extract phase at the outlet of the extractor ?

(2 + 2 + 2) + 6 =12

Group – C

4. (a) Why micro-mixing is important in fermentation ?

(b) We wish to precipitate the protein macroglobulin contained in 100 litres of aqueous solution at 20 ^{0} C in a tank at a conc. of 0.2 gm/litre. Macroglobulin is a globular protein with a mol. wt. of 820,000 and a diffusion coefficient of 2.41×10^{-7} cm^2 /sec at 20 ^{0}C. The precipitate particles have a density of 1.3 gm/cm^3 . The solution is stirred with a 75 W motor. Calculate the conc. of nuclei at the end of "initial mixing" period.

2 + 10 = 12

5. Write short notes on: **(3 × 4) = 12**
   (i) Affinity chromatography
   (ii) Size exclusion chromatography
   (iii) Gas chromatography.

Group – D

6. Experiments at 25° C were performed to determine the permeabilities of a cellulose-acetate membrane. The laboratory test section shown in figure has membrane area A= $2.0\times10^{-3}m^2$.The inlet feed solution concentration of NaCl is C_1 =10kg NaCl/m^3 solution (density= 1004kg solution/m^3). The water recovery is assumed low so that the concentration C_1 in the entering feed solution flowing past the membrane and the concentration of the exit feed solution are essentially equal. The product solution contains C_2 = 0.39kg NaCl/m^3 solution (density= 997kg solution/m^3) and its measured flowrate is $1.92\times10^{-8}m^3$ solution/s. A pressure differential of 54.42 atm is used. Calculate the permeability constants of the membrane and the solute rejection R(π = 7.48 atm). **12**

7. (a) A solution containing 0.9 wt% protein is to undergo ultrafiltration using a pressure difference of 5psi. The membrane permeability is $K_p=1.37\times10^{-2}$ kg/s.m^2.atm. Assuming no effects of polarization, predict the mass flux. (1psi= 0.068 atm).

   (b) Write a note on any one membrane separation process mentioning its advantages, disadvantages and applications in the field of biotechnology. **6 + 6 = 12**

Group – E

8. (a) Discuss some basic concepts of scale-up and design calculations of a crystallizer.

   (b) A nonporous wet cake of biological solids that is 0.5 cm thick is to be dried by blowing dry air across the top surface. The initial moisture content is 70 wt % water, and it is desired to dry the cake to a water content of 5 wt %. The diffusion coefficient of water in the cake has been estimated to be 7×10^{-6} cm^2 sec^{-1}. Estimate how long the drying will take. (assume $Dt / d^2 > 0.1$) D is the diffusion coefficient of water in the solid matrix. **5 + 7 = 12**

9. (a) What do you understand by the terms bound water, unbound water and relative humidity?

   (b) 1 litre lab scale crystallization apparatus having 3.5 cm impeller diameter at a speed of 900 rpm led to good crystallization result. Calculate the Reynolds number for the lab scale crystallizer. **(2 + 2 + 2) + 6 = 12**

Department & Section	Submission Link
BT	https://classroom.google.com/c/MjQyMDQxNDg5MTQx/a/Mjc1NTMyNzE0ODU2/details