

DOWNSTREAM PROCESSING
(BIOT 6133)

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) Medical oxygen is best prepared by a packed bed of adsorbent of the type
(a) activated carbon (b) sintered alumina
(c) molecular sieve (d) ZSM-5.
 - (ii) Membrane materials used in ultra-filtration is of the type
(a) Symmetric (b) isotropic (c) anisotropic (d) asymmetric.
 - (iii) 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.
 - (iv) Basic principle of centrifugation depends on
(a) concentration gradient (b) velocity gradient
(c) centrifugal force (d) pressure gradient
 - (v) Liquid-liquid extraction depends on
(a) volatility (b) solubility
(c) immiscibility (d) distribution coefficient.
 - (vi) Which of the following will help to confirm the molecular wt. of the purified protein?
(a) isoelectric focusing (b) affinity chromatography
(c) native PAGE (d) gel filtration.
 - (vii) Dialysis is a membrane separation operation used for the removal of low molecular weight solutes such as ions of MW range
(a) $10 < MW < 100$ (b) $MW > 10$ (c) $MW < 10$ (d) $MW > 100$.
 - (viii) A mixture of nitrogen and oxygen can be separated by the technique
(a) liquefaction (b) supercritical extraction
(c) adsorption (d) pressure swing adsorption.

- (ix) In gas chromatography, the basis for separation of the components of the volatile material is the difference in
 (a) partition coefficients (b) conductivity
 (c) molecular weight (d) molarity.
- (x) What do you mean by the term sorption?
 (a) Attachment (b) Detachment
 (c) Diffusion (d) Thermal expansion

Group – B

2. (a) What do you understand by sedimentation coefficient and partition coefficient?
 (b) Estimate how long it would take to completely clarify a suspension of ribosome in a high speed centrifuge operating at 10,000 R P M with a tube containing the ribosome suspension in which the maximum distance of travel of particles radially outward is 1 cm and the initial distance from the centre of rotation to the particles nearest the centre of rotation is 4 cm.
 Given data $S = 70 \times 10^{-13}$ sec

(3 + 2) + 7 = 12

3. (a) It is desire to filter a cell broth at a rate of 2000 liters/hr on a rotary vaccum filter at a vaccum pressure of 70 KPa. The cycle time for the drum will be 60 sec, and the cake formation time (filtering time) will be 15 sec. The broth has a viscosity of 2 C P and a cake solids (dry basis) per volume of filtrate of 10 gm/lit. Specific cake resistance 9×10^{10} cm/gm.
 Determine the area of the filter if you neglect filter medium resistance.
 (b) What is HEPA filter?
 (c) What do you understand by 50,000 Da MWCO membrane?

7 + 2 + 3 = 12

Group – C

4. (a) It is desired to achieve complete recovery of bacterial cells from a fermentation broth with a pilot plant scale tubular centrifuge. The cells are spherical with a radius of 0.5 μ m and have a density of 1.10 gm/cm³. The speed of the centrifuge is 5000 RPM, the bowl diameter is 10 cm, the bowl length is 100 cm, and the outlet opening of the bowl has a diameter of 4 cm. Estimate the maximum flow rate of the fermentation broth that can be attained.
 (b) Define sedimentation velocity and equilibrium sedimentation

8 + 2 + 2 = 12

5. (a) Define nucleation.
 (b) Data were obtained on the precipitation of a protein by the addition of ammonium sulphate. The initial concentration of the protein was 15 g/lit. At ammonium sulphate concentration of 0.5 and 1.0 M, the concentration of the protein remaining in the mother liquor at equilibrium were 13.5 and 5.0 gm/lit, respectively. From this information, estimate the ammonium sulphate concentration to give 95 % recovery of the protein as precipitate.

3 + 9 = 12

Group – D

6. (a) Gustafson et al. obtained the following data on equilibrium adsorption of glycine and of phenylalanine on Amberlite XAD. Fit the data to Freundlich isotherm and determine the adsorption parameters for the two amino acids.

Glycine	Soln. conc. (mol/L)	0.0126	0.0251	0.10	0.1995
	Amt. adsorbed (mol/g solid)	7.94×10^{-6}	1.41×10^{-5}	5.62×10^{-5}	1.12×10^{-4}
Phenylalanine	Soln. conc. (mol/L)	0.0112	0.0224	0.0302	0.0355
	Amt. adsorbed (mol/g solid)	6.0×10^{-5}	1.2×10^{-4}	1.58×10^{-4}	1.78×10^{-4}

- (b) What are the assumptions of Langmuir adsorption isotherm?
9 + 3 = 12
7. (a) Ray and Box reported the following data on equilibrium adsorption of propane on activated carbon at different temperatures. Fit the data using Langmuir isotherm, calculated its parameters and correlation coefficients.

T = 310.9K	P (kPa)	15.6	31.74	59.6	99.97	293	479.2	679.1
	q (mmol/g)	2.819	3.48	3.97	4.342	4.94	5.294	5.304
T = 338.7K	P (kPa)	27.2	53.2	99.97	244.8	424	617.1	803.2
	q (mmol/g)	2.469	3.078	3.635	4.188	4.475	4.71	5.289

- (b) What are the different criteria for selection of adsorbent?
9 + 3 = 12

Group – E

8. Explain downstream processing operations for recovery of the following with the help of a flow sheet.
 (a) Citric acid (b) Intracellular proteins
(6 + 6 = 12)
9. (a) Discuss the principle and application of reverse osmosis.
 (b) Draw a comparison of ultra-filtration and microfiltration.

6 + (3 + 3) = 12