

**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) Which one of the following should be used for the first step of purification of a protein from a complex mixture ?
(a) Ultra-filtration (b) gel-filtration
(c) hydrophobic interaction (d) centrifugation
- (ii) Molecular wt. of a protein can be determined by
(a) size exclusion chromatography (b) ion exchange chromatography
(c) affinity chromatography (d) electrophoresis
- (iii) Proteins are separated in the SDS-PAGE according to their
(a) charge (b) hydrophobicity
(c) size (d) polarity
- (iv) The isotherm used in the separation of protein by a solid adsorbent is the type
(a) Langmuir adsorption isotherm (b) Freundlich adsorption isotherm
(c) Tempkin adsorption isotherm (d) Monolayer adsorption isotherm
- (v) Basic principle of centrifugation depends on
(a) concentration gradient (b) velocity gradient
(c) centrifugal force (d) pressure gradient
- (vi) Absolute alcohol from fermentation broth may be obtained by the following methods
(a) liquid-liquid extraction (b) adsorption
(c) pervaporation (d) azeotropic distillation
- (vii) Membrane used in pervaporation are of the type
(a) macro-porous (b) micro-porous
(c) composite membranes (d) asymmetric

- (viii) Penicillin is more soluble in organic phase at pH
(a) 2 to 3 (b) 4 to 5 (c) 6 to 7 (d) 8 to 9.
- (ix) Density gradient can be prepared with
(a) calcium chloride (b) caesium chloride
(c) sucrose (d) both (b) & (c)
- (x) Liquid-liquid extraction depends on
(a) volatility (b) solubility
(c) immiscibility (d) distribution coefficient

Group – B

2. (a) Explain the phenomenon of concentration polarization. What is polarization modulus?
(b) U.F. system (ultra-filtration) was used to remove low molecular weight species from protein solution. The flow channels for this system are tubes with 0.1 cm diameter and 100 cm long. The protein has diffusion coefficient of $9 \times 10^{-7} \text{ cm}^2/\text{sec}$. The solution has viscosity of 1.2 cp and a density of 1.1 gm/cm^3 . The system is capable of operating at a bulk stream velocity of 300 cm/sec. At this velocity, determine the polarization modulus for a transmembrane flux of 45 liters/ ($\text{m}^2 \text{ hr}$).
(3 + 1) + 8 = 12
3. (a) It is desired to filter a cell broth at a rate of 2000 liters/hr on a rotary vacuum filter at a vacuum 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 viscosity of 2 cp and cake solids (dry basis) per volume of filtrate of 10 gm/lit. Specific cake resistance $9 \times 10^{10} \text{ cm/gm}$. Determine the area of the filter if you neglect filter medium resistance.
(b) Explain transmembrane pressure drop with a suitable equation.
9 + 3 = 12

Group – C

4. Write notes on: **(2 × 6) = 12**
(i) Gas Chromatography
(ii) HPLC.
5. (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 $0.5 \mu\text{m}$ and have a density of 1.10 gm/cm^3 . The speed of the centrifuge is 5000 RPM, the bowl dia is 10 cm, the bowl length is 100 cm, and the outlet opening of the bowl has a dia of 4 cm. Estimate the maximum flow rate of the fermentation broth that can be attained.
(b) Define Equivalent time and Sigma Analysis.
8 + 4 = 12

Group – D

6. (a) Briefly describe different types of Chromatographic Columns and Detectors that are used in protein purification.
- (b) A column 20 cm long with an internal diameter of 5 cm, gives sufficient purification to merit scale-up. The column produces 3.2 gm of purified proteins per cycle, and a cycle takes 6 hrs., from equilibrium through regeneration. If you want a throughput of 10 gm/hr. calculate flow rate and bed depths would apply to each standard column as given below. Available standard column diameters are 20 cm and 25 cm.

(3 + 3) + 6 = 12

7. (a) How do size and charges of proteins affect their own solubility in suitable solvents?
- (b) Explain different types of mechanical cell disruption methods.
- (c) Discuss different methods of protein precipitation.

4 + 4 + 4 = 12

Group – E

8. Write short notes on:
(i) Spray Dryer
(ii) Freeze dryer

(2 × 6) = 12

9. (a) Define
(i) bound water
(ii) unbound water
(iii) D B T
(iv) W B T
- (b) It is desired to scale-up a batch crystallization of an antibiotic based on experiments with a one-liter crystallizer. The use of a 3 cm diameter impeller at a speed of 800 rpm led to good crystallization results. For maintaining power per volume constant upon scale-up to 300 liters, what should be the diameter and speed of the large-scale impeller? The solvent has the same density and viscosity as of water.

(4 × 1.5) + 6 = 12

Department & Section	Submission Link
BT	https://classroom.google.com/c/MjQyMDQxMTk3OTYy/a/Mjc1NTMyNzE0ODIz/details