

**BIOSEPARATION TECHNOLOGY
(BIOT 2211)**

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) SDS-PAGE is applied for
(a) Separation of proteins
(b) Synthesis of proteins
(c) Separation of carbohydrates
(d) Separation of amino acids.
- (ii) Filtration rate depends on
(a) pressure difference
(b) area of filter
(c) viscosity of medium
(d) all of these.
- (iii) Concentration polarization occurs in which of the following processes
(a) reverse osmosis
(b) ultra-filtration
(c) micro-filtration
(d) all of the above.
- (iv) At terminal velocity
(a) $F_D = F_G + F_B$
(b) $F_G = F_D + F_B$
(c) $F_B = F_D + F_G$
(d) None of the above.
- (v) Cell disruption in homogenizer is based on
(a) applied voltage
(b) operating pressure
(c) salt concentration
(d) osmotic pressure
- (vi) In filtration out of the two resistances
(a) r_m is variable, r_c is constant
(b) r_c is variable, r_m is constant
(c) r_c decreases over time
(d) r_m increases over time
- (vii) In gel filtration chromatographic separation, bio-molecules are separated based on what property of bio-molecules?
(a) Size
(b) Charge
(c) Hydrophobic interaction
(d) Metal ion affinity.

- (viii) The most important application of dialysis is
(a) artificial kidneys
(b) desalination of brackish water
(c) recovery of salts and sugars from natural products
(d) removal of alcohol from beer.
- (ix) The only membrane separation in which the permeate undergoes a phase change is
(a) electrodialysis (b) pervaporation
(c) ultrafiltration (d) reverse osmosis
- (x) Which of the following isotherm is applicable to physical adsorption?
(a) Langmuir (b) BET
(c) Kisluik (d) None of these.

Group - B

2. (a) Define concentration polarization and polarization modulus. How is polarization modulus mathematically related to filtration flux? *[[CO1](Remember/LOCQ)]*
(b) Derive Ruth's equation for constant pressure filtration. *[[CO2](Understand/IOCQ)]*
(4 + 2) + 6 = 12
3. (a) A continuous disc stack centrifuge is operated at 5000 rpm for separation of baker's yeast. At a feed rate of 60 L/min, 50% of the cells are recovered. For operation at constant centrifuge speed, solids recovery is inversely proportional to the flow rate.
(i) What flow rate is required to achieve 90% cell recovery if the centrifuge speed is maintained at 5000 rpm?
(ii) What operating speed is required to achieve 90% recovery at a feed rate of 60 L/min? *[[CO2](Calculate/IOCQ)]*
(b) How are cells disrupted by non-mechanical methods? *[[CO1](Remember/LOCQ)]*
6 + 6 = 12

Group - C

4. (a) Define (i) Transmembrane pressure drop (ii) Sedimentation coefficient. *[[CO3](Remember/LOCQ)]*
(b) It is desired to use a cross flow filtration system to desalt 1000 lit of a protein solution containing NaCl. The system is capable of operating at a transmembrane flux of 30 lit/(m²hr). Determine the time needed and the volume of water required in a cross flow filtration unit with a membrane area of 100 m², to remove 99.95 % of the salt. *[[CO4](Calculate/IOCQ)]*
(3 + 3) + 6 = 12
5. (a) A solution containing 0.9 wt% protein is to undergo ultrafiltration using a pressure difference of 5 psi. The membrane permeability is $A_w = 1.37 \times 10^{-2}$ kg/s.m².atm. Assuming no effects of polarization, predict the mass flux. (1 psi = 0.068 atm). *[[CO4](Understand/LOCQ)]*

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

[[CO2](Understand/LOCQ)]

6 + 6 = 12

Group - D

6. (a) Define dialysis. How it is used for protein purification? [[CO4](Understand/LOCQ)]
 (b) What do you understand by the term 'chromatography'? Explain the principle of any two types of chromatography techniques. [[CO4](Understand/LOCQ)]

6 + (2 + 4) = 12

7. (a) What variables are likely to affect the 'selectivity factor' for a pair of analytes?

[[CO3](Analysis/IOCQ)]

- (b) A chromatogram of a mixture of A and B resulted in the following data:

	Non retained	A	B
Retention time (min)	3.1	13.3	14.1
Peak width (min)	--	1.07	1.16

(i) Calculate the resolution.

(ii) Calculate the selectivity.

(iii) Calculate the length of the column necessary to achieve resolution of 1.5, if the original height of the column is 23.5 cm.

[[CO3,CO4](Evaluate/HOCQ)]

4 + (4 + 4) = 12

Group - E

8. (a) Define (i) humidity (ii) bound water (iii) unbound water.

[[CO4](Remember/LOCQ)]

- (b) Explain difference between Dry Bulb Temperature and Wet Bulb Temperature. Which one is higher?

[[CO3](Explain/IOCQ)]

(2 × 3) + (5 + 1) = 12

9. (a) During precipitation of protein, mathematically prove that $M = M_0(1 + k_A N_0 t)$, where

N_0 is the initial number of solute in solution with molecular weight M_0 , M is the molecular weight of the solute aggregate at time t , k_A = rate constant.

[[CO6](Analysis/IOCQ)]

- (b) Define 'relative humidity' and 'percentage humidity'.

[[CO6](Remember/LOCQ)]

8 + (2 + 2) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	33.33	50	16.67

Course Outcome (CO):

After completion of this course, the students will be able to:

1. Acquire basic understanding of different bioseparation processes and design principle for commonly used process equipments.
2. Obtain knowledge about the basic principles and application of sedimentation, centrifugation and filtration.
3. Explain the principles of extraction and membrane based separation of bioproducts and can apply the knowledge for calculations of extraction process.
4. Understand the principle of adsorption, chromatography and relation of adsorption with chromatography.
5. Apply different chromatographic techniques for separation of different Bioproducts.
6. Comprehend the knowledge of precipitation, drying, crystallization and will be able to solve numerical problems related to these processes.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*