

**DOWNSTREAM PROCESSING
(BIOT 6101)**

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) Ultra-filtration is used for separation with molecular size range from
(a) 0.1 – 10 μ m (b) 10 – 100 μ m
(c) 100 – 200 μ m (d) 200 – 500 μ m.
- (ii) Molecular weight of a protein can be determined by
(a) size exclusion chromatography
(b) ion-exchange chromatography
(c) affinity chromatography
(d) gas liquid chromatography
- (iii) For extraction operation, the selectivity should be
(a) > 1 (b) < 1 (c) 1 (d) zero.
- (iv) In gel filtration, bio-molecules are separated on the basis of
(a) size (b) charge
(c) hydrophobic interaction (d) metal ion affinity.
- (v) Chromatography is based on
(a) different rate of movement of the solute in the column
(b) separation of one solute from other constituents by being captured on the adsorbent
(c) different rate of movement of the solvent in the column
(d) any of the above.
- (vi) Which one of the following is an ion-exchange column?
(a) C M sepharose (b) phenyl agarose
(c) sephadex G-100 (d) protein sepharose

- (vii) Heat sensitive materials like pharmaceuticals may be dried in a
(a) Tray drier (b) Spray drier
(c) Freeze drier (d) none of these.
- (viii) In crystallisation, solubility diagrams are useful in determining
(a) equilibrium condition (b) saturation condition
(c) Supersaturation condition (d) both (b) and (c).
- (ix) Flocculation method will be improved by the use of
(a) centrifugation (b) filtration
(c) lyophilization (d) drying.
- (x) Which of the following will help to confirm the molecular weight of the purified protein?
(a) Isoelectric focusing (b) Affinity chromatography
(c) Native-PAGE (d) Gel filtration.

Group - B

2. (a) Define sedimentation coefficient.
(b) Explain equivalent time with the help of dimensionless acceleration (G).
(c) If bacterial cell debris has $Gt = 54 \times 10^6$ Sec , centrifuge bowl diameter is 10 cm and it is moving with 11600 rpm, calculate the time required for full sedimentation.
2 + 3 + 7 = 12
3. (a) Derive the terminal velocity of centrifugation by applying Stockes equation.
(b) A continuous disc-stack centrifuge is operated at 5000 rpm for separation of baker's yeast, at a feed rate of 60 lt/min, 50% of the cells are recovered. At constant centrifuge speed, solids recovery is inversely proportional to 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 lt/min?
6 + (3 + 3) = 12

Group - C

4. (a) Derive the Ruth equation for constant pressure filtration.

- (b) The following data were obtained in a constant pressure filtration unit for filtration of a yeast suspension.

t (min)	4	20	48	76	120
V (lt filtrate)	115	365	680	850	1130

- (i) Determine the pressure drop across the filter.
 (ii) Determine the filter medium resistance (r_m).
 (iii) Determine the size of filter for the same pressure drop to process 4000 lt of cell suspension in 20 min.

5 + 7 = 12

5. The operation of a pilot scale reciprocating –plate extractor column has been optimized for the extraction of an antibiotic from whole fermentation broth using amyl acetate as solvent. The antibiotic has a partition coefficient (K) of 7.5. The optimal operating conditions are as follows: solvent flow rate of 105 ml/min, flow rate of fermentation broth of 70 ml/min, and ratio of antibiotic in raffinate to antibiotic in feed of 0.07. The column was 2.54 cm in diameter, and the height of the extractor (height of the reciprocating plates) was 1.83 m. The agitator speed was 280 strokes/min. What column size and agitator speed are required to give a ratio of antibiotic in the raffinate to antibiotic in the feed of 0.03 and to handle fermentation broth at a rate of 150000 liters every 12 hours.

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Group - D

6. (a) Define Adsorption isotherm.
 (b) The following laboratory data were collected in a batch adsorption study. Plot the data according to Freundlich Isotherm and determine the values for the constants n and K_F . A volume of 500 ml is placed in each flask, and the waste has an initial COD of 100 mg/lt.

Flask No.	Mass of C (mg)	Volume in Flask (ml)	Final COD (mg C/ lt)
1	965	500	3.5
2	740	500	5.2
3	548	500	8.0
4	398	500	12.5
5	265	500	20.5
6	168	500	33
7	0	500	100

2 + 10 = 12

7. Write notes on any two:
 (i) Freeze Dryers
 (ii) Spray Dryers
 (iii) Membrane based purification.

6 + 6 = 12

Group - E

8. Describe the industrial production of any one of the following with the help of a flow sheet.
 (i) Baker's yeast
 (ii) Ethanol
 (iii) Citric acid and
 (iv) Penicillin
9. (a) Draw a comparison of reverse osmosis to ultrafiltration and microfiltration.
 (b) Define pervaporation. Draw flow chart of any one type of pervaporation process.

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6 + 6 = 12