M.TECH/BT/3RD SEM/BIOT 6101/2018

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)   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) Proteins are separated in the SDS-PAGE according to their
          (a) charge   (b) hydrophobicity
          (c) size   (d) polarity.

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

    (iv) Gel-permeation chromatoghaphy separates proteins on the basis of
          (a) molecular size   (b) charge
          (c) PI   (d) ionic concentration.

    (v)   The most common ion-exchange resin used in aqueous two-phase extraction is
          (a) polyvinyl difluride   (b) polyethylene glycol
          (c) polysulfone   (d) polytetrafluoroethylene.

    (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) Basic principle of centrifugation depends on
          (a) concentration gradient   (b) velocity gradient
          (c) centrifugal force   (d) pressure gradient.

    (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) Which of the following will help to confirm the molecular weight of the purified protein?
          (a) Isoelectric focusing   (b) Affinity chrogatography
          (c) Native PAGE   (d) Gel filtration.

    (x)   Liquid-liquid extraction depends on
          (a) volatility   (b) solubility
          (c) immiscibility   (d) distribution coefficient.

Group - B

2. (a) Explain concentration polarization and 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 0.1 cm diameter and 100 cm long. The protein has diffusion coefficient of 9×10^{-7} cm^2/sec. The solution has a 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/ m^2 hr.
                                                          4 + 8 = 12

3. (a) It is desired 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) Explain transmembrane pressure drop with a suitable equation.
                                                          9 + 3 = 12

Group - C

4. (a) A pilot scale reciprocating-plate extraction 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 plate) 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 150,000 liters every 12 hrs.

(b) What do you understand by the term operating line and equilibrium curve?

9 + 3 = 12

5. (a) What is nucleation?

(b) "Initial mixing is the mixing required to achieve homogeneity" — justify.

(c) Data were obtained on the precipitation of a protein by the addition of ammonium sulfate. The initial concentration of the protein was 15 gm/liter. At ammonium sulfate 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/liter, respectively. From this information, estimate the ammonium sulfate concentration to give 95% recovery of the protein as precipitate.

2 + 4 + 6 = 12

Group - D

6. (a) What do you understand by crystal growth?

(b) Explain crystallization kinetics from batch experiments.

(c) Define relative humidity (R H). "R H is 100%" — what does it mean?

4 + 4 + 4 = 12

7. (a) Explain protein solubility in terms of size and charges.

(b) Explain different types of mechanical cell disruption process.

(c) Discuss different methods of protein precipitation.

4 + 4 + 4 = 12

Group - E

8. (a) Define bound water and unbound water.

(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.

(c) Define D B T and W B T.

3 + 6 + 3 = 12

9. (a) Write notes on: Spray dryer and Freeze dryer

(b) Wet biological solids contained in a tray are dried by blowing air with 2% R H and at 60 ^{0}C and pressure 760 mm Hg across the tray. For the constant drying rate period, estimate the maximum molar flux of water.
Given data:
Latent heat of vaporization of water = 540 K cal/Kg, $T_s = T_{100\%} = 23^0$C
Heat transfer coefficient (h) = 100 K cal/m^2 hr ^{o}C.

(4 + 4) + 4 = 12