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
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.
SYMBOLS ARE OF USUAL SIGNIFICANCE

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i) Sedimentation coefficient is defined as
   (a) $S = v/w^2R$ (b) $S = 1/w^2R$ (c) $S = v/Wr$ (d) $S = v^2/w^2R$.

   (ii) At dew point R H will be
   (a) 100 %   (b) 50%   (c) 80%   (d) 0.0 %.

   (iii) Micro-filtration membranes have pore sizes in the range
   (a) 0.1 to 10 μm   (b) 10 to 20 μm   (c) 20 to 30 μm   (d) 30 to 50 μm.

   (iv) Penicillin is more soluble in organic at pH
   (a) 2 to 3   (b) 4 to 5   (c) 6 to 7   (d) 8 to 9.

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

   (vi) 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.

   (vii) Reynolds number for the centrifugation of spherical particles
   (a) $Re = 2avp/\mu$ (b) $Re = avp/\mu$ (c) $Re = 2vp/\mu$ (d) $Re = 2av/\mu$.
   (p = row = density)

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

   (ix) Molecular weight of a protein can be determined by
   (a) size exclusion chromatography   (b) ion exchange chromatography
   (c) affinity chromatography   (d) electrophoresis.

(x) Absolute alcohol from fermentation broth can be obtained by the following method
(a) liquid-liquid extraction   (b) adsorption
(c) pervaporation   (d) azeotropic distillation.

Group- B

2. (a) Why cross flow filtration is called tangential flow filtration?
$$[(CO1)(Remember/IOCQ)]$$
(b) Explain cross flow filtration and dead end filtration with the help of a clean diagram.
$$[(CO2)(Understand/IOCQ)]$$
$$2 + (5 + 5) = 12$$

3. (a) What do you understand by the term MWCO level?   [(CO2)(Remember/LOCQ)]
(b) Explain equivalent time.   [(CO2)(Understand/LOCQ)]
(c) Explain liquid sterile filtration in detail.   [(CO2)(Analyse/IOCQ)]
$$2 + 3 + 7 = 12$$

Group - C

4. (a) What do you understand by the following: **(6 × 2) = 12**
     (i) Partition coefficient
     (ii) Operating line
     (iii) Equilibrium curve
     (iv) Extraction factor
     (v) H E T S
     (vi) Aqueous two-phase extraction system.   [(CO3)(Remember/LOCQ)]

5. (a) What do you understand by on-off chromatography ?   [(CO4)(Understand/IOCQ)]
(b) Explain affinity chromatography and size exclusion chromatography.
$$[(CO4)(Understand/LOCQ)]$$
$$2 + (5 + 5) = 12$$

Group - D

6. (a) Explain salting in effect for protein solubility.   [(CO5)(Understand/IOCQ)]
(b) Discuss tertiary structure of protein.   [(CO5)(Understand/IOCQ)]
$$5 + 7 = 12$$

7. (a) Define primary nucleation, secondary nucleation and supersaturation.
$$[(CO6) (Remember/LOCQ)]$$
(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 a good crystallization result. For maintaining power per volume constant upon scale-up to 300 liters, what should be the diameter and speed of the larger-scale impeller? The solvent has the same density and viscosity as water.
$$[(CO6)(Evaluate/HOCQ)]$$
$$(2 + 2 + 2) + 6 = 12$$

Group - E

8. Explain the following: **(6 × 2) = 12**
   (i)   Free water
   (ii) Bound water
   (iii) Enthalpy
   (iv) Specific heat
   (v)   Entropy
   (vi) Humidity.   [(CO1)(Understand/LOCQ)]

9. Write notes on: **(3 × 4) = 12**
   (i)   Spray dryers
   (ii) Polymer-based resign
   (iii) Ion exchange resign.   [(CO1, CO6)(Understand/LOCQ)]

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	66.66	27.08	6.25

Course outcome (CO):

After completing of this course, the student 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