# 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.*

## Group – A
## (Multiple Choice Type Questions)

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

    (i)     Microfiltration membranes have pore size in the range
            (a) 0.1 t0 10 µm                        (b) 1 to 20 µm
            (c) 10 to 20  µm                        (d) 50 to 80 µm

    (ii)    Membrane material used in U F is of the type
            (a) Symmetric                           (b) Isotropic
            (c) Anisotropic                         (d) Asymmetric

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

    (iv)    The most common ion-exchange resin used in aqueous two-phase extraction is
            (a) Polyvinylidene difluride            (b) Polyethylene glycol
            (c) Polysulfone                         (d) Polytetrafluoroethylene

    (v)     Absolute alcohol from fermentation broth may be obtained by the following methods
            (a) Liquid-liquid extraction            (b) adsorption
            (c) pervaporation                       (d) azeotropic  distillation

    (vi)    Which of the following will help to confirm the molecular wt. of the purified protein?
            (a) Isoelectric focussing               (b) Affinity chromatography
            (c) Native PAGE                         (d) Gel filtration

    (vii)   Which method is commonly used to separate inhibitory fermentation product such as ethanol from fermentation broth ?
            (a) Aqueous two-phase extraction        (b) liquid-liquid extraction
            (c) Adsorption                          (d) Ultrafiltration

    (viii)  Cell lysis by sonication the frequency of sound waves used is
            (a) More than 20,00 Khz                 (b) less than 20,000 Khz
            (c) less than  10 Khz                   (d) any frequency

(ix) Gel permeation chromatography separates protein on the basis of
(a) molecular size (b) charge
(c) PI (d) molecular shape

(x) A mixture of nitrogen and oxygen can be separated by the technique
(a) Liquefaction (b) Supercritical extraction
(c) Adsorption (d) Pressure swing adsorption.

## Group- B

2. (a) Define polarization modulus. [(CO2) (Remember/LOCQ)]

(b) It is desired to use a cross flow filtration system to desalt 1000 liters of a protein solution containing NaCl. The system is capable of operating at a transmembrane flux of 30 lit/m² hr. To remove 99.91 % of the salt, determine the membrane area required if the operation is continued for three hours.
[(CO2) (Analyse/IOCQ)]
**4 + 8 = 12**

3. (a) Define transmembrane pressure drop. [(CO1) (Remember/LOCQ)]

(b) Equipment is available for ultra filtration of a protein at constant volume to remove low molecular weight species. The flow channels for this system are tubes 0.1 cm in diameter and 100 cm long. The protein has a diffusion coefficient of $9 \times 10^{-7}$ cm² /sec. The solution has a viscosity of 1.2 cp and a density of 1.1 g/cm³. The system is capable of operating at a bulk stream velocity of 300 cm/ sec. At this velocity, determine the transmembrane flux if the polarization modulus is found to be 1.35. [(CO2) (Analyse/IOCQ)]
**4 + 8 = 12**

## Group - C

4. Write notes on: **(4 × 3) = 12**
(i) Partition coefficient,
(ii) Aqueous two-phase extraction,
(iii) operating line and equilibrium curve. [(CO3) ( Remember/LOCQ)]

5. (a) Explain the function of columns in chromatography. [(CO4, Understand/LOCQ)]

(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 protein per cycle, and a cycle takes 6 hr , from equilibrium through regeneration. You want a throughput of 10 gm/hr. Available standard column diameters are 20 cm and 25 cm. Calculate bed depths to each of these columns?
[(CO5) (Evaluate / HOCQ)]
**5 + 7 = 12**

# Group - D

6. (a) What do you understand by the term "Kolmogoroff length".

[(CO6) (Understand/LOCQ)]

(b) We wish to precipitate the protein α- macroglobulin in 100 lit of aqueous solution at $20^0C$ in a tank at a concentration of 0.2 gm/lit., mol. wt. of protein 820,000. The precipitated particles have a density of 1.3 gm/cm³. The solution is stirred with a 75 W motor. The operation is continued for 5.24 min. Calculate the particles to reach a size of 1.0 μm, assuming that growth is governed by diffusion only. [(CO6) (Evaluate/HOCQ)]

**2 + 10 = 12**

7. (a) What do you understand by the term "micromixing". [(CO6) (Remember/LOCQ)]

(b) A high speed centrifuge is used to completely clarify a ribosomes suspension. The centrifuge is operated at high R P M for 8.1 hrs with a tube containing the ribosome suspension in which the maximum distance of travel of particles radially outward is one cm and the initial distance from the centre of rotation to the particles nearest the centre of rotation is 4.0 cm. Calculate the R P M of the high speed rotor. [(CO2) (Evaluate/HOCQ)]

**2 + 10 = 12**

# Group - E

8. (a) Define D B T and W B T. [(CO6) (Remember/LOCQ)]

(b) A nonporous wet cake of biological solids that is 0.5 cm thick is to be dried by blowing dry air across the top surface. The initial moisture content is 70 wt % water, and it is desired to dry the cake to a water content of 5 wt %. Calculate the diffusion coefficient of water in the cake if the drying operation is continued for 14.4 hrs.
Data given :-
$X_C$ = 2.333 gm water / gm dry solids, $X_m$ = 0.053 gm water / gm dry solids.

[(CO6) (Analyse/IOCQ)]
**2 + 10 = 12**

9. Explain the operation of the following: - **(3 × 4) = 12**
   i) Spray dryer [(CO1)
   ii) Agitated bed adsorption [(CO4)
   iii) Ion exchange resign. [(CO1)[ (Analysis/IOCQ)]

| Cognition Level | LOCQ | IOCQ | HOCQ |
|---|---|---|---|
| Percentage distribution | 32.29% | 39.58% | 28.12% |

**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

| Department & Section | Submission Link |
|---|---|
| BT | https://classroom.google.com/c/NDA1NzEyOTcxNTAx/a/NDY0NTE4MzQxMDc2/details |