MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

DEPARTMENT OF BIOTECHNOLOGY

I Sem- M.Tech Industrial Biotechnology

BIO 5152: Advanced Bioseparation Processes

END SEMESTER EXAMINATION -February 26, 2021

Time: 2.00 pm to 5.00 pm **Answer ALL questions** **Marks: 50**

1A	You are purifying a biomolecule for a pharmaceutical drug application. Would you prefer a step that has (i) a high-fold purification and low yield or (ii) a low-fold purification and high yield? Justify your answer.	**2m**
1B	What is the distance between two particles attracted to each other at the "secondary minimum"? Assume, that the Debye radius is 0.5 nm.	**3m**
1C	A pilot-scale disc-stack centrifuge has 25 discs with inner and outer diameters 2 cm and 10 cm, respectively. The half-cone angle is 35°. At a speed of 3000 rpm and feed rate of 3.5 L/min, 70% of the cells are recovered. A bigger centrifuge needs to be used for industrial treatment of 80 L/min. What operating speed is needed to achieve the same sedimentation performance if the larger centrifuge contains 55 discs with outer diameter 15 cm, inner diameter 4.7 cm, and half-cone angle 45°?	**5m**
2A	State the principle of ion exchange chromatography.	**3m**
2B	How does the use of filter aids help in the process of filtration?	**3m**
2C	A rough analysis of cell contents suggests their cytoplasm contains the following by weight: 2% is proteins of average molecular weight 45,000; 3% is soluble lipids of molecular weight 200; 4% is sugars of molecular weight 180; and 5% is salts like NaCl. What is the osmotic pressure inside these cells relative to pure water at 37°C?	**4m**
3A	Explain the difference between free settling and hindered settling.	**2m**
3B	Proteins A and B have the precipitation rate constants $\kappa_A = 5 \times 10^{57} \times e^{-380\ kJ\ /\ RT}$ per sec $\kappa_B = 4.2 \times 10^{64} \times e^{-415\ kJ\ /\ RT}$ per sec If you have a solution with equal activities of each protein, what will be the activity after 30 min at 30°C?	**3m**
3C	Downstream process engineer wants to separate biomolecules using reverse micellar extraction process. Explain the principle and steps involved in reverse micellar	**5m**

	extraction process and also factors affecting protein solubilisation.	
4A	We are carrying out the ultrafiltration of chymotrypsin in a spiral wound module at a rate of 1.3 x 10^{-3} cm/sec. The solution concentration is 0.44 wt%, the protein's diffusion coefficient is 9.5 x 10^{-7} cm^2/sec, and the boundary layer is about 180 X 10^{-4} cm thick. How high is the surface concentration?	**3m**
4B	In a steady state, counter current dialyzer of rectangular cross section, urea is removed by pure water as dialysate. Inlet feed concentration is 1500 mg/L, Feed and dialysate flow rates are 18 L/h and 90 L/h, respectively. The overall mass transfer coefficient is 10^{-6} m/s. Feed and dialysate chambers are identical in shape. Width of each channel is 5 mm and height 5 mm. In the feed side, the urea concentration has to be reduced from 1500 mg/L (inlet) to 300 mg/L (outlet). Find the membrane area required. Neglect mass transfer resistances on both sides.	**7m**
5A	A modified Dextran will adsorb up to 8x10^{-8} mol of immunoglobin G per cm^3 Dextran. The adsorption follows a Langmuir isotherm with K = 2x10^{-8} mol/ltr. How much dextran do you need to adsorb 95% of the protein in 1.2 litre of solution initially containing 4x10^{-6} mol/ltr.	**3m**
5B	An adsorption column with a diameter of 2.0 cm and a bed height of 5.8 cm was used to isolate trypsin. The concentration of trypsin in the feed was 0.19 mg/mL. The external void fraction in the bed was 0.35. The bulk density of the adsorbent is 1.03 g/cm^3. The volumes at breakthrough and exhaustion are 150 and 450 cm^3, respectively. Estimate the loading capacity of the adsorbent for trypsin.	**3m**
5C	Design engineer want to develop antibiotic extraction process using single and multiple stage batch configuration. Explain the operating principle, pros and cons of each process.	**4m**