

Answer all questions

Total Marks: 30

Instructions: For all numerical problems, the answer must show the base equations, the condition validation (if needed), unit for each value in the steps, and the final answer derived from the correct steps and calculations. Marks will not be awarded, even the answer is correct, if the above conditions are not fulfilled. Each of the six questions carries equal marks.

1. Cholesterol containing 12 mg/liter was extracted with ethyl acetate from a dilute buffer solution. The ratio of buffer solution to the solvent was 50 and the equilibrium constant for the cholesterol was 200. Calculate the concentration of the cholesterol in ethyl acetate after extraction. What fraction of the cholesterol has been removed?

2. The adsorption isotherm of erythromycin on activated carbon is as follows:

$$q = 36 y^{0.40}$$

Where q is in mg/cm^3 carbon and y is in mg/liter . A 10 cm^3 of fresh carbon was mixed with 5 liter of the fermentation beer containing 50 mg/liter of the antibiotic. Deduce the operating line for the extraction. The graphical solution obtained by using the equilibrium and operating lines offers the values of q 14 mg/cm^3 and y 0.10 mg/L . What percent recovery of the erythromycin can be expected? The symbol q and y carry usual meaning described in the text book.

3. (a) Portrait the different adsorption isotherms graphically and write the corresponding equations separately with the symbols thereof. (b) 80 cm^3 of dextran will adsorb upto 7.8×10^{-6} mol of immunoglobulin G per cubic centimeter of adsorbent. This adsorption follows Langmuir isotherm, with a constant K of $1.9 \times 10^{-5} \text{ mol}/\text{liter}$. What concentration in 1.2 liters of feed solution will exhaust 90 % of the dextran capacity?

4. Yeast cells are collected from the fermentation broth using a laboratory bottle centrifuge consisting of number of cylinders rotated perpendicularly to the axis of rotation. During the operation the distance between the surface of liquid and the axis of rotation is 3 cm, and the distance from the bottom of the cylinder to the axis is 10 cm. The diameter of the yeast cells (assuming spherical) are $8 \mu\text{m}$ and density of $1.10 \text{ g}/\text{cm}^3$. The fluid has closely similar physical property with that of water. The centrifuge is to be operated at 500 r/min . Calculate the time required to complete the separation of the cells from the fermentation broth.

5. (a) State the essential stages involved in downstream processing and identify the unit operation typically used in each of the stages. (b) Mention the characteristics of the feed that prompted you to select centrifugation instead of filtration in the initial stage of insoluble removal from the feeds.

6. (a) What are the routes through which you can alter the standard chemical potential of the solute in the lighter phase to improve the extraction? (b) Depict graphically, how the extractability of the solute increases under these altered conditions. (c) Draw the diagrams of Tubular bowl centrifuge and Basket centrifuge and mention their differences (no need to show equations).

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