17/12/19 (M) Lib 3

Exam.Code:1032
Sub. Code: 7866

1129

M. E. (Bio-Technology)

First Semester

ME-BIO-104: Bio-Separation and Bio-Process Technology

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: Attempt five questions in all, including Question No. I which is compulsory and selecting two questions from each Section.

x-x-x

I. Answer the following:-

a. Justify, with reasons why bioseparations are often technically very challenging.

b. Give a brief overview of cell-removal operation.

c. Define ideal stage concept.

d. Define aqueous two phase liquid extraction process.

e. Explain principle of any membrane filtration equipment.

f. What do you mean by the low Ks value?

g. Define specific cake resistance.

h. Differentiate between a chemostat or turbidostat?

i. The reverse of Hydraulic Retention Time [HRT] is the _____.

j. Why are airlift reactors generally considered more energy efficient compared to STRs?

(1x10)

SECTION-A

2. A) Describe typical unit operations required in the recovery and purification of an intracellular protein product from a bacterial source, downstream of the bioreactor. Give your recommendations.

B) Enlist various membrane-driven processes used as a separation technique. What could be various important parameters for choosing any membrane-separation process? (4,6)

3. A) What is a marker or a ladder? Why is this considered standard? How does size of the DNA affect its migration through the agarose gel during electrophoresis?

B) Validate the statement "Separate optimization of fermentation and recovery does not necessarily yield the optimal process". Also discuss how incorporating the process with the in-situ product recovery is useful for any process. (6,4)

P.T.O.

4. A)With the help of protein structure and surface chemistry, explain the following terms a) Stern layer b) salting-in and salting-out.

   B) Aqueous two-phase extraction is used to recover –amylase from solution. A polyethyleneglycol-dextran mixture is added and the solution separates into two phases. The partition coefficient is 4.2. Calculate the maximum possible enzyme recovery when a) the volume ratio of the upper to lower phase is 50 b) the volume ratio of the upper to lower phase is 0.5.

(4,6)

SECTION-B

5. Assume the experimental measurements for a certain organism have shown that cells can convert two-thirds (wt/wt) of the substrate carbon (alkane or glucose) to biomass.(i) Calculate the stoichiometric coefficients for the following biological reactions:

   Hexadecane: $C_{16}H_{34} + aO_2 + bNH_3 \rightarrow cC_{4.4}H_{7.3}N_{0.86}O_{1.2} + dH_2O + eCO_2$

   Glucose: $C_6H_{12}O_6 + aO_2 + bNH_3 \rightarrow cC_{4.4}H_{7.3}N_{0.86}O_{1.2} + dH_2O + eCO_2$

   (ii) Determine the degree of reduction for the substrate and bacteria for both reactions.

   (iii) Calculate the yield coefficients $Y_{X/S}$, $Y_{X/O2}$ and RQ for both reactions. Comment on the differences.

   b)List down the factors that affect specific growth rate. If there is a mathematical description of the same, show that also.

(6,4)

6. Consider an organism which follows the Monod equation where $\mu_{max} = 0.5hr^{-1}$, $K_S = 0.2$ g/l.

   (i) In a continuous perfectly mixed vessel at steady state with no cell death if $S_o = 50$ g/l and $Y_{X/S} = 1$ g/g. What dilution rate will give the maximum total rate of cell production?

   (ii) For the same value of D using tank of same size in series, how many vessels will be required to reduce the substrate concentration to 1 g/l?

   b) Explain how and why 'wash-out' occurs in an ideal CSTR. Show that this problem can be overcome by separating and recycling part of the cells coming out of the reactor back to the reactor vessel.

(6,4)

7. Fermentation of *Candida utilis* exhibit substrate inhibition kinetics given by the following equation

$$\mu = \frac{\mu_{max}.S}{K_S+S+S^2/K_I} \qquad S^2=K_S*I$$

Where S is the substrate concentration and μ is the specific growth rate. For a continuous fermentation using sterile feed, derive an equation for the steady state variation of biomass concentration, substrate concentration and maximum cell productivity with dilution rate when(i) I=0(ii) I is not equal to zero.

b) Explain different types of inhibition by toxic compounds along with the graphical representation.

c) What are the salient postulates of the William's two-compartment model for microbial growth?

d) What is the generation time if 100 bacterial cells growing logarithmically for 5 hours produce 1.7×10^6 cells? (4,2,2,2)

x-x-x