UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualification:-

B.Sc.

Biochemical Eng E126: Introduction to Bioprocess Design Principles

COURSE CODE	:	**BENGE126**
UNIT VALUE	:	**0.50**
DATE	:	**05-MAY-05**
TIME	:	**14.30**
TIME ALLOWED	:	**3 Hours**

TURN OVER

Answer ***FOUR QUESTIONS, ONE FROM EACH SECTION PLUS TWO OTHERS.*** **Only the first four answers will be marked.**
ALL questions carry a total of ***25 MARKS*** *each, distributed as shown* [ ]

PART A

1.

The Reynolds number is dimensionless and is used to define the balance between which forces that act during flow of fluid in a pipe? [5]

Define the Reynolds number for pipe flow. [5]

Calculate the flow velocity needed for water being pumped in a circular pipe of 5cm radius to be:

a) Laminar
b) Turbulent

[5]

What is the MOODY chart? Sketch one and indicate the key axes and regions of interest on it. [10]

2.

State the equations and correlations used in order to estimate the pressure drop in a packed bed. Defend the validity of the assumptions on which these equations are based. [10]

In adopting a new chromatographic matrix you record a change in pressure drop. The mean particle size has not changed however. What may be contributing to the change in pressure drop across the column? [5]

Using the equations and correlations you have identified above estimate the size of particle that will result in a pressure drop of 2.5 bar. Do you feel that this is an acceptable set of conditions to operate under?

Flowrate: 150 L/h
Column radius: 30 cm
Bed height: 15cm

List any assumptions that you make in addition to those covered in the first part of the question. [10]

PLEASE TURN OVER

3.

A process development team intends to use centrifugation to recover an intracellular protein from yeast homogenate. Some of the background information is given below.

a) Calculate the mass balance and evaluate the centrifuge performance. [15]

b) If the yield is lower than 95%, determine the amount of buffer needed to achieve 95% yield using a washing stage. [10]

Background information

Homogenate volume: 1000L
Debris concentration: 100g/L
Product concentration: 1 g/L
Soluble contaminants concentration: 65 g/L
Centrifuge carry over: 5%
Centrifuge dewatering level: 50%
Assume for the purposes of calculation that the density of the cells and the liquor are the same at 1kg/L.

4. A membrane system was used to recover an intracellular protein from 1000L of yeast homogenate. Debris concentration is 100g/L. It started with concentration process to 500L in the retentate tank and the yield was 30%. To increase the yield, 1000L of buffer is available for a diafiltration process. Assume for the purposes of calculation that the density of the cells and the liquor are the same at 1kg/L.

a) Calculate the mass balance of the entire process. [15]

b) If the target for yield is 90%, how can the process operation be altered to meet the target without using additional buffer? [10]

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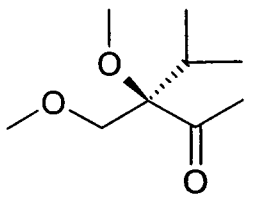
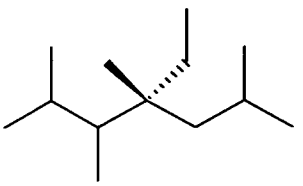
PART B

5.

a) Determine whether the following stereoisomers **A** and **B** are R or S isomers [4]

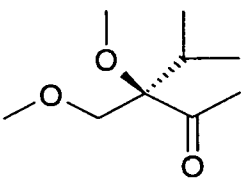


A

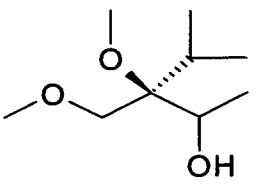


B

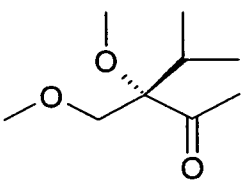
A newly identified enzyme is able to convert **A** and its enantiomer **A2** into products **X** and **Y**. After 50% of a racemic mixture of **A** and **A2** was converted, the product was obtained as 94% **X** and 6% **Y**.



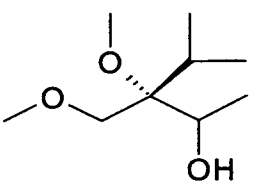
A



X (94%)



A2



Y (6%)

b) Calculate the enantiomeric excess of product X [2]

c) Calculate the E-value (E_R) for the reaction. [4]

You may find the following formula useful in your calculations:

$$E_R = \frac{\ell_n\left[1-c\left(1+ee_p\right)\right]}{\ell_n\left[1-c\left(1-ee_p\right)\right]}$$

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d) Using a graphical method, determine whether this enzyme is suitable to obtain **X** with an enantiomeric excess of 0.95 [10]

e) Briefly describe an enzyme engineering strategy to obtain **Y** with an enantiomeric excess of 0.95. [5]

6.

This question concerns the operation and control of biocatalytic reactors.

a) What are the four key parameters to be controlled in an industrial biocatalytic conversion? [4]

b) Explain why they need to be controlled. [7]

c) What methods are available for the control of these parameters? [4]

d) Explain in detail the process development implications of implementing these methods. [10]

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