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	:	**07-MAY-04**
TIME	:	**10.00**
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. Prove that this is so using the following definitions and units:

Density, kg/m^3
Viscosity, Ns/m^2
Length, m
Time, s
Mass, kg [10]

Sketch how the velocity profile in a circular pipe for an incompressible fluid changes as a function of Reynolds number. What is it that makes the velocity assume a profile? [5]

The Reynolds number is also correlated against surface roughness. Sketch out a diagram that demonstrates the relationship between Reynolds number, surface roughness and friction factor. How would you use this graph? [10]

2.

A number of assumptions are made when deriving equations to describe the flow of the liquid through a packed bed. List these assumptions and detail how each of these will also affect the values that are generated from the correlations and equation used. [10]

Using these equations and correlation estimate the pressure drop that will result from the following conditions:

Flowrate: 20 L/h
Column radius: 5 cm
Particle radius: 30 micron
Bed height: 15 cm

List any assumptions that you make in addition to those covered in the first part of the question. [15]

PLEASE TURN OVER

3.

1000 L of fermentation broth needs to be processed to recover monoclonal antibody product. The concentration of monoclonal antibody is 1 g/L and cell concentration is 200 g/L. Assume for the purpose of calculation, that the density of the cells and the liquor are the same at 1 kg/L.

There is a disk – stack centrifuge available. The solids carry over in the centrifuge is 5% and the dewatering level of the sediment is 50% at a typical set of operating conditions. Also there are 1000 L of buffer available to use.

As a biochemical engineer, you are asked to propose two process options and calculate their mass balance. Based on you results submit a brief report to your manager, giving your recommendation on the process options and reviewing the impact on the subsequent affinity chromatography purification stage. [25]

4.

A microfiltration system is used to recover 1000 L of fermentation broth monoclonal antibody product. The concentration of monoclonal antibody is 1 g/L and cell concentration is 200 g/L. The microfiltration has a rejection coefficient for monoclonal antibody of 0.5, rejection coefficient for whole cells of 1.0 and a rejection coefficient for liquor and salts of 0 at a typical set of operating conditions.

Two sets of experiments were run.

i) Run concentration step with CF = 4, then run a diafiltration step by adding 1000 L buffer
ii) Run concentration step with CF = 2, then run a diafiltration step by adding 1500 L buffer

Assess the respective process performances based on their mass balance and review the impact on the subsequent affinity chromatography purification stage. [25]

PLEASE TURN OVER

Part B

5.

This question concerns the application of biocatalysis to industrial chemistry.

a) Under what conditions is it favourable to use biocatalysis in industrial chemistry? [5]

b) Describe the key reaction chemistries used by biocatalysis, giving examples. Why are these types of conversion favoured for biocatalysis rather than chemocatalysis? [10]

c) What are the key bottlenecks in the implementation of biocatalytic processes? [5]

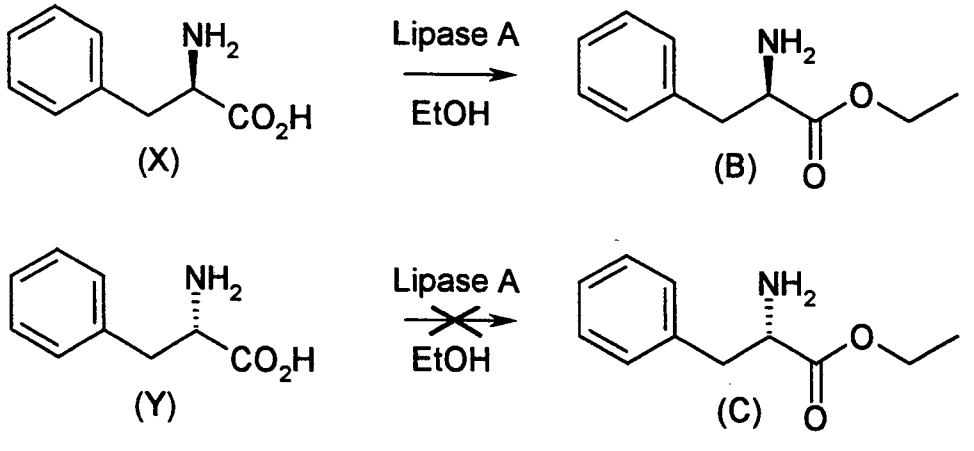
d) Draw a typical process flowsheet for an isolated enzyme-based biocatalytic process and indicate typical performance metrics to be achieved at each point. [5]

6.

a) Explain what is meant by the terms "enantiomer", "diastereomer" and "enantiospecific". [3]

Lipase A catalyses the esterification of the R-isomer (X) of phenylalanine in the presence of ethanol (EtOH). However, Lipase A converts the S-isomer (Y) only very slowly.

At the end of the reaction with a racemic mixture of phenylalanine in which **all** of substrate X was converted to product B, the product ester was obtained as 99.5% B and 0.5% C.



b) Calculate the enantiomeric excess of the R-isomer (B) of the product [2]

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c) Calculate the E-value (E_R) for the reaction. [8]

You may also find the following formula useful in your calculations:

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

d) Describe **briefly**, with a reaction diagram, a strategy that could be used to convert both substrates X and Y to product B. [7]

END OF PAPER