UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For the following qualifications :-

B.Sc.

Biochemical Eng E126: Introduction to Bioprocess Design Principles

COURSE CODE	:	**BENGE126**
UNIT VALUE	:	**0.50**
DATE	:	**21-MAY-02**
TIME	:	**10.00**
TIME ALLOWED	:	**3 hours**

02-C0101-3-40

TURN OVER

UNIVERSITY OF LONDON

Biochemical Engineering

E126

Introduction to Bioprocess Design

*Answer **THREE QUESTIONS**, including Question 1.*
ALL questions carry equal marks, distributed as shown [ ]

1. a) Present the two basic equations used to relate the flow rate of a liquid through a bed of particles to the relevant operating variables. In each equation define all terms and the units of measurement. List any assumptions implicit in the use of these equations. [40%]

b) For a packed bed system in use by your company it has been necessary to carry out some design calculations. Comment on the effects that each change will have.
i) Doubling bed length
ii) Halving particle radius
iii) Halving bed diameter
iv) Increasing the pipework length between bed and detector
v) Reducing the bed voidage by 10% [60%]

2. a) What does Bernoulli's equation define, and what do the principal components of the equation refer to? [20%]

b) Define the structure and use of a MOODY chart. [20%]

c) What are the essential differences between laminar and turbulent flows? [20%]

d) Water is to be pumped through a pipe with diameter as below. Estimate the likely range of corresponding Reynolds numbers you would expect for such a pipe in normal operation justifying any assumptions made. d_p = 2cm [40%]

3. Describe in detail, using quantitative and qualitative arguments, how you would choose between a plug flow packed bed, fed-batch stirred tank, batch stirred tank and continuous stirred tank reactor for an enzyme catalysed reactions with the following properties:

a) Michaelis-Menten kinetics [20%]

b) Substrate inhibition [20%]

c) Product inhibition [20%]

d) Very low intrinsic rate of reaction [40%]

In each case the reaction requires pH control and the enzyme is very costly. In addition, high conversions are necessary since the product is for use as a pharmaceutical.

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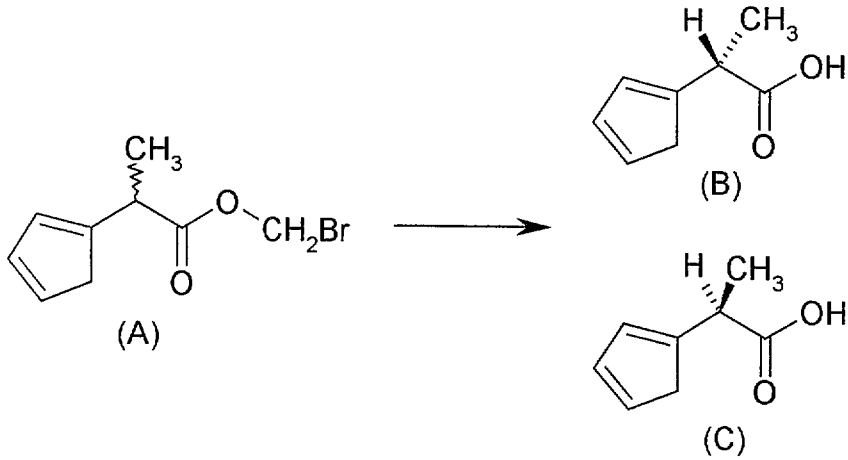
4. a) Explain what is meant by the terms "enantiomer", "enantioselective" and "enantiomeric excess". [20%]

The racemic ester (A) was resolved with an esterase to yield compounds (B) and (C).
After 50% of the total racemic ester was converted, the product was obtained as 95% B and 5% C.



b) Calculate the enantiomeric excess of the S-isomer of the product. [5%]

c) Calculate the E-value (E_R) for the reaction. [5%]

You may find the following formula useful in your calculations:

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

d) Is this enzyme suitable to obtain an enantiomeric excess of 0.95? Consider both yield and quality of the product. [50%]

e) Briefly describe a strategy to obtain an enantiomeric excess of 0.98. [20%]

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5. A 100L mammalian cell culture broth is concentrated to 50L within 2 hours using a membrane separation unit. Just 20% of a secreted antibody protein product is recovered in the permeate during this concentration process.

   You are required to predict how much diafiltration buffer may be needed to increase this product recovery from 20% to 90% and how much time this may take using the same membrane separation unit. Detail all assumptions made. [60%]

   The subsequent trials using your prediction result in just 70% yield with the diafiltration process taking 3 hours longer than predicted.

   Prepare a report which puts forward analyses of why these differences between predicted and experimental results are occurring and how the next trials should be conducted to confirm which analysis most likely explains the differences. [40%]

END OF PAPER