UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualifications:-

B.Eng. *B.Sc.* *M.Eng.*

Biochemical Eng E100: Introduction to Biochemical Engineering

COURSE CODE	:	**BENGE100**
UNIT VALUE	:	**0.50**
DATE	:	**12-MAY-05**
TIME	:	**14.30**
TIME ALLOWED	:	**2 Hours**

TURN OVER

Answer ***THREE QUESTIONS.*** **Only the first three answers given will be marked.**
ALL questions carry a total of ***25 MARKS*** *each, distributed as shown* [ ]

1.

Describe the main technical and social issues that must be considered by companies when assessing new therapeutic approaches to the treatment of HIV-AIDS. Illustrate your answer by reference to a particular therapy. [25]

2.

(i) Define the term *sterile* and explain the significance of aseptic operation in industrial fermentation processes. [5]

(ii) Outline the various methods available for the destruction of microorganisms and the mechanism by which each promotes cell death. Comment also on their potential application in large scale industrial fermentations. [9]

(iii) For sterilisation temperatures of 110 °C and 121 °C calculate the holding time necessary to sterilise 95 m^3 of liquid fermentation medium. Clearly state any assumptions made. Which sterilisation temperature would be most appropriate and why?

Data:			
	Spore count of medium	=	$1x10^{11}$ spores L^{-1}
	Activation energy of spores	=	283.6 KJ $mole^{-1}$
	Preexponential factor of spores	=	$9.5x10^{37}$ min^{-1}
	Ideal gas constant	=	$8.3x10^{-3}$ KJ $mole^{-1}$ K^{-1}

[11]

3.

The aerobic growth of a bacteria can be described by the following stoichiometric equation:

$$aC_6H_{12}O_6 + bO_2 + cNH_3 \rightarrow dC_6H_{10}O_3N_1 + eCO_2 + fH_2O$$

Under the conditions used the biomass contains 5.7% (w/w) ash and the yield coefficient of biomass on substrate is $Y_{x/s}$ = 0.45 kg (dry cell mass) . Kg^{-1} glucose.

You are requested to order culture medium components to obtain a biomass concentration of 30 kg (dry cell mass) m^{-3} in a 5 m^3 liquid volume bioreactor. Calculate the required masses (in kg) of:

(a) glucose [10]
(b) ammonia [15]

Atomic masses: H = 1; C = 12; N = 14; O = 16
Molecular masses: glucose = 180; O_2 = 32; ammonia = 17; biomass = 144; CO_2 = 44; water = 18

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4.

Two different strains of a microorganism have been tested for growth and product formation in batch culture. The following data have been obtained:

Strain A			Strain B		
Time (h)	Biomass (g/l)	Product (mg/l)	Time (h)	Biomass (g/l)	Product (mg/l)
0	1.05	0.00	0	1.05	0.00
10	1.86	0.00	10	1.70	0.00
20	3.32	1.00	20	2.90	1.00
30	5.90	1.50	30	4.75	1.50
40	10.50	2.00	40	7.90	2.00
50	18.70	3.00	50	13.00	3.00
60	33.20	3.50	60	21.50	3.50
70	59.00	10.00	70	35.60	5.00
80	60.00	18.00	80	59.00	11.00
90	61.00	24.00	90	60.00	20.00
100	61.00	30.00	100	61.00	25.00
110	62.00	40.00	110	61.00	30.00
120	62.00	40.00	120	62.00	35.00
130	61.00	40.00	130	62.00	40.00
140	60.00	37.00	140	61.00	40.00

i) What type of metabolite is the product likely to be? Give reasons [8]

ii) Plotting of the data in an appropriate graph indicated that there was no significant lag phase for either strain and that the exponential growth phase finished at 70 hs (strain A) and 80 hs (strain B). Estimate the maximum specific growth rate and doubling time for each strain [9]

iii) Based solely on the data provided, which strain would you recommend to use in a production scale fermentation? Give reasons. [8]

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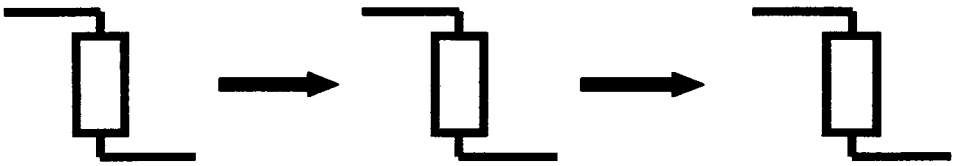
5.

A purification strategy has been developed for the isolation of an antibody; details are given below.

i) Calculate; purity (%), product yield coefficient (%), capacity (g l^{-1}) throughput (g h^{-1}) and productivity (g h^{-1} ml^{-1}) for each chromatographic stage (answers should be given to 2 significant figures). [12]

ii) Perform a mass balance around the hydrophobic interaction chromatography step with respect to protein and antibody, and comment on the result and likely reasons for your observations. [5]

iii) Briefly comment on the logic of this sequence of chromatographic steps and based on the data note the role each step of the purification strategy is performing. [8]



Ion Exchange Chromatography (IEX) | Hydrophobic Interaction Chromatography (HIC) | Gel Filtration (GF)

	IEX	HIC	GF
Column Volume (L)	10	5	100
Load (L)	100	20	7.5
Operation Time (hours)	8	6	8
Antibody Conc. (g/L)	3	13.8	30
Protein Conc. (g/L)	10	26	33.3
Waste Material (L)	120	30	250
Antibody Conc. (g/L)	0.2	0.1	0.068
Protein Conc. (g/L)	4	9	0.16
Product Material	20	7.5	5
Antibody Conc. (g/L)	13.8	30	41.6
Protein Conc. (g/L)	26	33.3	42

Notes: 1) The protein assay will detect all protein 2) the antibody assay detects intact antibody only

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