

BITS, PILANI- DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY
SECOND SEMESTER 2009-2010
Comprehensive Examination

Course No.: CHEM 441

23.05.10

Maximum Marks: 80

Course Title: Biochemical Engineering

Maximum Time: 3 hours

1.a) Plot a graph showing the effect of substrate concentration [S], on the rate of an enzyme catalyzed reaction V. Show the position of K_m on the x axis.

b) Inhibition effect of a sulfa drug was studied experimentally, on an enzyme. From its Lineweaver-Burk plot, $1/K_m$ value for the enzyme without the inhibitor was 0.8 and in presence of inhibitor was 0.38. From this data state the nature of the drug's inhibition giving your reason.

c) What are the advantages of immobilizing an enzyme? State any one example of commercial value and its mode of immobilization. (5+5+5)

2a) State one advantage and one disadvantage of using complex media over synthetic media.

b) Human insulin could be produced due to recombinant DNA technology. Briefly explain.

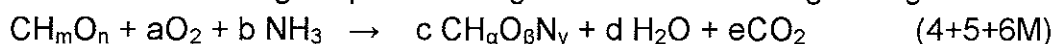
c) Give the flow diagram for a typical continuous plate heat exchange sterilizer. For a sterilization unit, the Del factor for various stages was worked out. It has $v.h/v.t = 0.2$. if its $v.t$ is 40 and specific death of the organism to be killed (at 121°C) is 3.5 min^{-1} , find the holding time required at the said temperature.

(3+5+7)

3. a) Depict the exergonic and endergonic coupled reaction involving ATP.

b) Baker's yeast is used in baking industry as well as to produce alcohol by controlling its metabolic route. Explain.

c) Consider the following simplified biological conversion using an organism.



Give the elemental balances of C, H, O and N through equations

4 a) Solubility of O_2 is only 10 ppm at ambient conditions. What design elements you would introduce in a bioreactor to increase dissolved oxygen (DO) and get the desired oxygen-transfer rate during scale up?

b) A bioreactor having stirred glucose media registers around 65 KJ due to Q_{exch} (heat-transfer rate to exchanger). After inoculation with an organism, the heat registered, increases up to 120KJ. Explain. Do you expect Q_{exch} to vary if the media is changed to methanol? OR

The maximum growth yield coefficient for a bacillus growing in butanol is 0.6g x/g of substrate. The heat of combustion of cells is 22 KJ/g cells and heat of combustion of substrate is 29.3 KJ/g. Determine the metabolic heat generated by the cells per unit mass of butanol consumption. (5+5)

5 a) Draw a schematic diagram of a CSTR and give the equation for its mass balance of its biomass or substrate.

b) An organism Z which follows Monod equation, is growing in a chemostat. The system has $\mu_{\max} = 0.7\text{h}^{-1}$ and K_s of 2.5 g/l. In a perfectly mixed vessel at steady state, if $S_f = 60$ g/l, what dilution rate D will give maximum total rate of cell production?

c) Write a note on any major sensor which is associated with monitoring a reaction in a fermenter. (5+6+4)

6 a) Describe how Penicillin G is extracted from the filtered broth using counter-current extraction technique to finally obtain crystalline penicillin salt.

b) Discuss with a generalized flow chart depicting a bioprocess, the costing involved. (5+5)

BITS, PILANI- DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY
FIRST SEMESTER 2009-2010
TEST – 2 (OPEN BOOK)

Course No.: CHEM 441 187.04.10 Maximum Marks: 20
Course Title: Biochemical Engineering Maximum Time: 50 minutes

1.a) You are asked to formulate a suitable medium for growing a simple organism like *E. Coli*. What ingredients will you put in?

b) Give one advantage of continuous sterilization over batch sterilization.

c) The overall Del factor for a fermenter is 35. If the specific death rate of a bacillus spore at 121°C is 2.8 min^{-1} , what will be the time required for sterilization? **(1.5+1+2.5)**

2a) For a *Chemostat model*, how do you arrive at the following equation:

$$D_{\max} = \mu_{\max} \cdot S_f / K_s + S_f$$

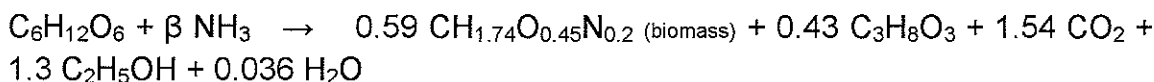
Based on this eqn., when will a 'wash out' occur?

b) In large bioreactors, discuss the role of impellers; take into account their parameters like N , D_i and Q . **(3+2)**

3. a) How will you arrive at an expression for oxygen-transfer rate per unit of reactor volume, QO_2 ? Explain its significance.

b) Which are the various ways heat is generated in a bioprocess? Show any one model, with the help of a diagram, by which this heat can be removed. **(3+2)**

4 Consider the following equation which describes the growth of an organism



a) Determine the biomass yield coefficient $Y_{x/s}$

b) Determine the product yield coefficient $Y_{EtOH/s}$; $Y_{CO_2/s}$

c) Determine β

(5M)

BITS, PILANI- DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY
SECOND SEMESTER 2009-2010
TEST – I (CLOSED BOOK)

Course No.: CHEM 441 **07.03.09** **Maximum Marks: 25**
Course Title: Biochemical Engineering **Maximum Time: 50 minutes**

1. a) How does the job profile of a biochemical engineer differ from that of a bio-medical engineer? (3X2 M)

b) What technique you will use to isolate various organelles inside the cell?

c) What are cell /nuclear membranes made up of? How do they help it in its function?

2. From the following kinetic data, determine: (6+4+4M)

a). K_m & V_{max} for the reaction

[S] (mM)	V_o ($\mu\text{mol L}^{-1} \text{min}^{-1}$)
2.0	139
3.0	179
4.0	213
10.0	313
15.0	370

b) What is the difference between competitive and non-competitive enzyme inhibition? How will their kinetics differ when plotted as Lineweaver Burk Plot?

c) Mention any two advantages of immobilizing an enzyme?

What are the various methods available to immobilize an enzyme? State any one example of commercial value.

3. You wish to produce a small peptide using *E.coli*. You know the amino acid sequence of the protein. The protein converts a colourless substrate into a green product. You have access to a high-copy number plasmid with a penicillin resistant gene and normal reagents for genetic engineering. Briefly discuss the steps you would do to get an engineered *E.coli* and to get it to produce this protein. (5M)

BITS, PILANI – DUBAI
SECOND SEMESTER 2009 – 2010
Fourth Year- Quiz 2

Course Code: CHE C441
Course Title: Biochemical Engineering
Duration : 20 minutes

Date: 24/03/10
Max Marks: 14
Weightage: 7%

Name:	ID No:	Prog:
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- 1) According to Monod's equation, when does the saturation constant (K_s) is equal to the concentration of the rate-limiting substrate $[S]$? (1M)

- 2) Give the expression for cell mass balance for an ideal chemostat which is running in the steady state condition. (2M)

- 3) Sketch any one model of a CSTR in which immobilized enzyme catalyzed reaction takes place. (2M)

- 4) Which technique is used to monitor Residence Time Distribution (RTD) in an reactor. (1M)

- 5) a) Dissolved oxygen (DO) probe in a bioreactor works on which principle?

b) Continuous on-line monitoring is done using (1+1M)

- 6) Name any two cell disruption techniques used in down-stream processing. (2M)

7) From a crude enzyme mixture, pure enzyme X needs to be obtained. This is done using a combination of ion-exchange and affinity chromatographic runs. Which will be used first and which later; give reasons. (2M)

8) A scientist has to choose between two centrifuges to separate the cells from the fermentation broth; A has angular velocity of 5000 s^{-1} and a radius of 1 m while that for centrifuge B is 4500 s^{-1} and 1.5m. Which will do the separation faster? Explain. (2M)

9) The equipment Podbielniak extractor is run on principle. (1M)

BITS, PILANI – DUBAI
SECOND SEMESTER 2009 – 2010
Fourth Year

Course Code: CHE C441
 Course Title: Biochemical Engineering
 Duration : 20 minutes

Date: 24/03/10
 Max Marks: 16
 Weightage: 8%

Name: ID No: Sec / Prog:

- 1) In cellular metabolism, give the two half reactions of ATP formation and its usage. (2 marks)

- 2) Name the common pathway in glucose metabolism. (1M)

- 3) Eukaryotes have better energy efficiency in utilizing glucose than the prokaryotes. Justify. (2M)

- 4a) Michaelis-Menton constant K_m , equals the substrate concentration $[S]$, when the rate of the enzyme reaction is (1M)

- b) Finish the steady state equation of Michaelis-Menton: (1.5M)

$d[S]/dt = ???$

- 5) a) Give a method of introducing *vector-foreign DNA* recombinant into the host cell. (1M)

- b) Immobilized amylase is used in industry. (1M)

- 6) a) How are pure culture stored? (1M)

PTO

b) What do you understand by 'batch culture' and 'fed-batch culture'? (1.5M)

7) a) Most organisms can be killed by moist heat treatment at for mins. (1M)

b) List the items that need to be sterilized for carrying out fermentation. (1,5M)

c) Define or give equation for Del factor of sterilization. (1.5M)