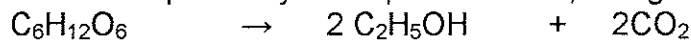


**BITS PILANI, DUBAI CAMPUS
DUBAI INTERNATIONAL ACADEMIC CITY
SECOND SEMESTER 2010-2011
Comprehensive Examination**

Course No.: BIOT 441/CHEM 241 25.05.11 Max. Marks: 40
Course Title: Biochemical Engineering Maximum Time: 3 hours

1. a) What is the difference between non competitive and uncompetitive inhibition effect in enzyme kinetics? Explain using a Lineweaver-Burk plot,
b) For an enzyme, $1/K_m$ value without the inhibitor was found to be $1.2M$ and in presence of a drug inhibitor it was $0.64M$. From this data state the nature of the drug's inhibition giving your reason.
c) Glucose isomerase is used for high-fructose corn syrup production. Discuss briefly some important biochemical characteristics which would have improved when it is immobilized. (4+3+3M)

- 2 a) Give any four criteria based on which you would select a media for a production fermenter.
b) In a sterilization unit, the total number of organisms in a medium was reduced from 10^{11} to 10^{-3} , compute the Del factor.
c) Calculate theoretical product yield coefficient $Y_{p/s}$, for ethanol fermentation by an organism as depicted by the equation below, using one mole of glucose:



- d) Calculate the degree of reduction for the following substrates:.



- 3a) With the help of a sketch, discuss the features required for good O_2 transfer in a reactor with internal mechanical agitation.

- b) Why is heat exchanger required in a fermentor to ensure a set temperature during a bioprocess?
c) Explain Monod equation.

An organism X following Monod eqn. is grown in a CSTR. The system has $\mu_{max} = 0.8h^{-1}$ and K_s of $1.2g/l$. At steady state, if $S_f = 45g/l$, what dilution rate, D will give maximum total rate of cell production? (3+2+5M)

- 4a) Draw a flow-diagram showing Penicillin G is extraction from the cell broth till its final crystalline state. Mention the extraction technique is used in this process.
b) Why are pilot plant studies necessary in bioprocess industries?
c) A bioprocess industry, Biocon, has gone into production of human insulin using recombinant technology. Under what three categories will their costing be done on a regular basis? Discuss. (4+3+3M)

BITS, PILANI- DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY
FIRST SEMESTER 2010-2011
TEST -2 (OPEN BOOK)

Course No.: BIOT C441/CHEM 421
Course Title: Biochemical Engineering

8.05.11

Maximum Marks: 20
Maximum Time: 50 minutes

1.a) For an ideal Chemostat, how does one write an equation expressing material balance on cell concentration and from that derive $\mu_g = D$ (2M)

b) An organism is cultivated in a *Chemostat* under aerobic conditions with glucose as its limiting substrate. When the system is operated at $D = 0.2 \text{ h}^{-1}$, determine the glucose concentration by using Monod equation; $\mu_{\max} = 0.25 \text{ h}^{-1}$ and $K_s = 80 \text{ mg/l}$. (2M)

c) What is residence time distribution, RTD? How is it determined using a tracer technique? (2M)

d) What design features you would ensure is present in a production reactor; discuss in terms of its dimensions, material of construction, aeration and agitator specifications (3M)

e) Discuss the principle by which a pH probe works. (1M)

2. A large production scale fermenter was operated to grow around 1000kg of a microorganism. An intracellular protein X is of commercial value and needs to be extracted in a pure form.

a) Give a general flow-diagram for the product recovery from the harvested broth.

b) Which filtration unit will you choose to use to recover the cells? Explain with an aid of a sketch. Explain the equation by which the rate of filtration can be found.

c) The crude protein mixture obtained after cell disruption is subjected to ion exchange chromatography. Given that protein X is acidic, discuss which ion exchange you would choose and the conditions to operate it.

d) Mention which technique you would use for a final purification? (2+3+2+1M)

3. How does two-phase aqueous extraction work? (2M)

BITS, PILANI- DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY
FIRST SEMESTER 2010-2011
TEST – I (CLOSED BOOK)

Course No.: BIOT/CHEM 441

20.03.11

Maximum Marks: 25

Course Title: Biochemical Engineering

Maximum Time: 50 minutes

Note: Answer all the questions.

1. Following data on Baker's yeast growing in a medium at 23 °C and various oxygen partial pressures that were obtained.

P _{O₂}	0.0	0.5	1.0	1.5	2.5	3.5	5.0
Q _{O₂} (No Sulfanamide)	0	23.5	33.0	37.5	42.0	43.0	43.0
Q _{O₂} (20 mg sulfonamide /ml of medium added to medium)	0	17.4	25.6	30.8	36.4	39.6	40.0

Where,

P_{O₂} : Oxygen Partial Pressure , mmhg (consider as [S])

Q_{O₂} : Oxygen uptake rate, μL of O₂ per hour per mg of cells. (Consider as V)

- a) By use of Line-Weaver Burk plot, calculate the Q_{O₂} max (V_{max}) and the Michaelis-Menten constant K_m.
- b) Determine whether sulfanilamide is a *competitive or noncompetitive* inhibitor to the enzyme responsible to O₂ uptake rate. (3+4)
- c) Give two benefits for immobilization of enzyme. State an example of an immobilized enzyme related to health/drug. (3)

2a) i) Discuss briefly the use of mixed culture in waste water treatment

ii) How will you store a pure culture which you have isolated?

iii) List any *three* aspect of the culture used to inoculate a production scale fermenter.

iv) A drug company is interested in producing Human growth hormone (rHGH) using recombinant technology. What are the main requirements in the 5 major steps involved?

(3+2+2+3)

3. a) List two advantages each in batch and continuous sterilization units.

b) A continuous sterilization unit is designed such that the fraction of destruction at each stage is:

$$V_h / V_t = 0.3; V_m / V_t = 0.65; V_c / V_t = 0.05$$

If V_t = 35, and specific death rate of the organism is 4 min⁻¹, at 121°C, find the holding time. (2+3)

BITS, PILANI – DUBAI
SECOND SEMESTER 2010 – 2011
Fourth Year Quiz 2

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

Date: 11/04/2011
Max Marks: 14
Weightage: 7%

Name: ID No: Sec / Prog:

1) The heat of combustion of the substrate is equal to the sum of and
..... (2 marks)

2) What does Monod's equation express? Depict using a graph. (1+1 mark)

3) Give a schematic diagram of any CSTR designed for
a) a fermenter b) an enzyme-immobilized reaction.. (2 marks)

4) Give the principle on which the dissolved oxygen (DO) probe works. (2 marks)

6) What is the main challenge during scale up operations? (1+1M)

If one needs to have constant oxygen transport rate (OTR) in two bioprocess batches, which parameter(s) he needs to keep constant?

7) When does '*wash out*' occur in a CSTR?

(2M)

8) Why is oxygen transfer in a fermenter a challenge? How is OTR expressed?

(2M)

BITS PILANI, DUBAI CAMPUS

SECOND SEMESTER 2010- 2011

Course Code: BIOT C441/CHE C421

.YEAR Forth year Elective

Date: . 7/03/2011

Course Title: Biochemical engineering

Max Marks:16..

Duration: 20 minutes

Weightage: 8%

Name: ID No: Sec / Prog:
.....

Instructions:

- 1) a-Amylase is an enzyme: State any source of this enzyme and in which industry is it used? (2M)

- 2) The main difference between a Biochemical process and a chemical process is that in the former, one uses..... (1M)

- 3) State any *four* functions which proteins in the cells are called upon to do. (2M)

- 4) What technique would you use to isolate mitochondria, a cell organelle, from cell after it is lysed? (1M)

- 5) Which of the following is valid definition of the specific activity of enzyme E? (1M)
 - a) How well the enzyme binds to the substrate
 - b) The specificity of the enzyme for the substrate divided by the specificity of the enzyme for the inhibitor
 - c) The number of moles of P produced per second per mg E.
 - d) The amount of substrate consumed per unit time.

- 6) Give the reaction equation between E and S which forms the basis of Michaelis-Menton derivation of K_m . How is K_m obtained from a plot of V vs. S? (1.5 x1.5)

PTO

7) What is the net effect on the K_m of an enzyme catalyst if it is competitively inhibited by a chemical? (1 M)

8) How does temperature affect the activity of an enzyme? Draw an *Activity vs. Temp. plot.* (2M)

9) List three methods of immobilization of enzymes. Which functional groups in an enzyme (any 3) may be involved in binding? (1.5x2)

10) In the diagram below, which depicts a unit where enzyme is recycled without being immobilized, identify; a) type of reactor and b) material used for ultrafiltration. (2M)

