Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2015/2016

COURSE NAME	:	FERMENTATION TECHNOLOGY
COURSE CODE	:	BNN 30304
PROGRAMME CODE	:	BNN
EXAMINATION DATE	:	JUNE / JULY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

Q1 (a) Bioreactors are differentiated by configuration, oxygen requirements and applications.

(i) Define the term *bioreactor*

(2 marks)

(ii) Differentiate between *airlift bioreactor* and *membrane bioreactor*

(4 marks)

(b) The oxygen demand of an industrial fermentation process is normally satisfied by aerating and agitating the fermentation broth

(i) Identify **THREE (3)** structural components involved in aeration and agitation.

(3 marks)

(ii) Draw an aeration system (sparger) in a fermenter and explain its principle during fermentation

(4 marks)

(iii) Illustrate a diagram for unbaffled fermenter and baffled fermenter, and differentiate **ONE (1)** characteristic between them.

(4 marks)

(c) In cultivation of baker's yeasts in a stirred tank and an aerated tank, lethal agents are added to the fermentation medium to kill the organism immediately. Increase in dissolved oxygen concentration upon addition of lethal agents is monitored by the aid of dissolved oxygen (DO) analyzer and a recorder. Using the following data in Table 1, determine the oxygen transfer coefficient (k_La) for the bioreactor. Saturation DO concentration is $C^* = 9$ mg/l

Table 1: Tabulated measurement of dissolved oxygen in fermentation medium.

Time (minute)	C_L or DO (mg/l)
1.0	1.0
2.0	3.0
2.5	4.0
3.0	5.0
4.0	6.5
5.0	7.2

(8 marks)

Q2 (a) Differentiate between *chemical antifoam* and *mechanical antifoam* in fermentation

(3 marks)

(b) The concept of scale up or scale down is the intermediary activities translating a successful bench product to production scale, or alternatively a system for translating a production process back to bench scale.

(i) Explain the necessity of scale up or scale down in a fermentation industry

(3 marks)

(ii) Identify **THREE (3)** variables to be considered when changing fermentation scale

(3 marks)

(c) Consider the scale up of a fermentation from 5 L to 5000 L vessel. The small fermenter has a height-to-diameter ratio of 3. The impeller diameter is 30% of the tank diameter. Agitator speed is 700 rpm and three Rushton impellers are used. Assume that the fermenter is cylindrical.

(i) Determine the dimensions (height of the tank, diameter of the tank, diameter of the impeller) of the large fermenter.

(6 marks)

(ii) Calculate the agitator speed at constant impeller tip speed.

(4 marks)

(iii) Calculate agitator speed at constant Reynolds number.

(4 marks)

(iv) Based on the results obtained in Q2(c)(ii) and Q2(c)(iii), predict your conclusion.

(2 marks)

Q3 (a) Enzymes are biological molecules that catalyse reaction to turn a substrate into a product. Maintaining enzyme stabilisation is vital in an enzymatic reaction and as a result of enzyme conformation stability, the catalytic function of an enzyme is preserved.

(i) Identify **TWO (2)** denaturants and its target on enzyme.

(4 marks)

(ii) Discuss **ONE (1)** enzymatic stabilisation technique by chemical modification(s) and give an example.

(6 marks)

(b) One of the techniques for maintaining enzyme stabilisation is through immobilised-enzyme technology.

(i) Differentiate between *adsorption* and *covalent attachment* techniques in immobilised-enzyme technology.

(4 marks)

(ii) Relate (with example) the application of immobilized-enzyme technology in a particular (biopharmaceutical / food / textile / waste water treatment) industries.

(7 marks)

(iii) Discuss **FOUR (4)** advantages and limitations of immobilized-enzyme technique as compared to conventional enzyme stabilisation technique.

(4 marks)

Q4 Fermentation is a naturally-occurring metabolic process that converts sugar to acids, alcohol or gases. In industries, microbial fermentations are widely-used to provide renewable resources and the process also does not involve the use of toxic reagents. Microorganisms are typically grown on a large scale and allowed to react with carbon source to produce valuable commercial products.

(a) List **THREE (3)** important factors affecting the rate of fermentation.

(3 marks)

(b) Briefly explain on how the factors stated in Q4(a)(i) can lead to higher or lower yield of fermented product.

(3 marks)

(c) To the best of your knowledge, provide **TWO (2)** different organisms that involve in fermentation, together with its product.

(2 marks)

(d) Illustrate the general process flow of getting purified fermented products in pharmaceutical industry.

(5 marks)

(e) Name **ONE (1)** specific fermented product and outline the details for important processes in obtaining the fermented product. The reaction(s), raw materials, microorganism(s), variable(s) and culturing techniques must be included.

(12 marks)

Q5 (a) Discuss the potential biohazards that are imposed by fermentation on the safety of:

(i) Workers
(ii) Products
(iii) Environment

(6 marks)

(b) Identify **THREE (3)** containment steps that could be taken to reduce the potential biohazards that have been mentioned in Q5(a).

(3 marks)

(c) The key objective of an industrial process is to generate maximum profits. This is achieved through minimising the cost of fermentation, yet no compromise on the product quality as well as increasing the selling cost of the product. As an entrepreneur, analyse the economical aspects of fermentation process and plan on how to maximise your profits.

(10 marks)

(d) Low cost and increased productivity of microbial fermentations lead to higher application of bacterial systems in the industries. Nonetheless, significant effort has also been invested in addressing certain key issues associated with microbial fermentation such as formation of unwanted insoluble aggregates of the overexpressed recombinant protein in a pharmaceutical industry. Criticize these situations, provide thorough explanations on the future of fermentation technology.

(6 marks)

-END OF QUESTIONS –

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FORMULA:

1. $V = \pi r^2 H$
2. $Re = \frac{ND^2\rho}{\mu}$
3. $N = \frac{P}{\rho N^3 D^5}$
4. $P = k_1 \mu N^2 D^3$
5. $P = N_P \rho N^3 D^5$
6. $OTR = k_L a\,(C^* - C_L)$
7. $OUR = q_{o2}X$