
UNIVERSITI SAINS MALAYSIA

First Semester Examination
2014/2015 Academic Session

December 2014 / January 2015

EKC 271 – Biotechnology for Engineers
[Bioteknologi untuk Jurutera]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of SEVEN pages of printed material and ONE page of Appendix before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi TUJUH muka surat yang bercetak dan SATU muka surat Lampiran sebelum anda memulakan peperiksaan ini.]

Instruction: Answer **ALL** (5) questions.

Arahan: Jawab **SEMUA** (5) soalan.]

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

Answer ALL questions.

1. [a] Define the following terms:

- [i] Chromosome
- [ii] Gene
- [iii] Codon
- [iv] Chloroplast
- [v] Mutant duplication

[5 marks]

[b] A few hikers of USM to Mount Tahan could go directly down a steep slope but find difficulties to climb up the hill. Under such condition, three (3) by-pass steps in the biological pathways are involved.

[i] Explain the three (3) by-pass steps in the biological pathways including the enzymes and cofactors involved.

[10 marks]

[ii] If one of the hikers has muscular aches due to strenuous exercise, CORI cycle will be involved to solve his/her problems. Explain the concept of CORI cycle.

[10 marks]

2. [a] List down nine (9) methods to avoid contamination in a fermentation process.

[9 marks]

[b] A POME-based production medium contains an initial spores density of 8.5×10^{10} spores/m³. The medium is sterilized thermally at 120°C, and the spore density was noted with the progress of time. The data are shown in Table Q.2.[b].

Table Q.2.[b].

Time(min)	0	5	10	15	20	30
Spore density (spora/m ³)	8.5×10^{10}	4.23×10^9	6.2×10^7	1.8×10^6	4.5×10^4	32.5

[i] Find the thermal death kinetic rate constant in s⁻¹.

[8 marks]

[ii] Calculate the inactivation factor at 40 min.

[8 marks]

Jawab SEMUA soalan.

1. [a] Berikan definisi terma-terma berikut:

- [i] kromosom
- [ii] gene
- [iii] kodon
- [iv] kloroplas
- [v] duplikasi mutan

[5 markah]

[b] Beberapa orang pendaki USM ke Gunung Tahan boleh menuruni cerun yang curam secara terus tetapi mengalami kesukaran untuk mendakinya semula. Dalam keadaan tersebut, tiga (3) langkah pirau di dalam laluan biologi terlibat.

[i] Terangkan tiga (3) laluan pirau didalam laluan biologi termasuk enzim dan kofaktor yang terlibat.

[10 markah]

[ii] Sekiranya seorang daripada pendaki itu mengalami kesakitan akibat latihan yang intensif, kitar CORI akan terlibat untuk mengatasi masalah beliau. Terangkan konsep kitar CORI ini.

[10 markah]

2. [a] Senaraikan sembilan (9) kaedah untuk mengelakkan pencemaran di dalam proses fermentasi.

[9 markah]

[b] Medium berasaskan POME mengandungi ketumpatan spora awalan 8.5×10^{10} spora/m³. Media ini disterilkan pada 120°C, dan ketumpatan sporanya diambil sepanjang masa. Datanya ditunjukkan di dalam Jadual S.2.[b].

Jadual S.2.[b].

Masa(min)	0	5	10	15	20	30
Ketumpatan spora (spora/m ³)	8.5×10^{10}	4.23×10^9	6.2×10^7	1.8×10^6	4.5×10^4	32.5

[i] Carikan pemalar kadar kinetik haba kematian dalam s⁻¹.

[8 markah]

[ii] Kirakan faktor ketidakaktifan pada 40 min.

[8 markah]

3. [a] Describe the characteristics of the following group of microorganisms:
- [i] chemoautotroph [2 marks]
 - [ii] chemoheterotroph [2 marks]
 - [iii] photoautotroph [2 marks]
 - [iv] photoheterotroph [2 marks]
- [b] Explain the advantages and disadvantages of chemostat cultures compared to batch cultures for industrial bioprocesses. [8 marks]
- [c] The batch fermentation of *Pseudomonas C* on methanol gave the results shown in Table Q.3.[c].

Table Q.3.[c].

Time, t (h)	Cell concentrations, X (g/l)	Substrate, S (g/l)
0	0.2	9.23
2	0.211	9.21
4	0.305	9.07
8	0.98	8.03
10	1.77	6.8
12	3.2	4.6
14	5.6	0.92
16	6.15	0.077
18	6.2	0

Plot the necessary graph and determine:

- [i] how long does the lag phase last. [1 mark]
 - [ii] maximum growth rate (μ_{max}) [4 marks]
 - [iii] yield on substrate ($Y_{x/s}$) [2 marks]
 - [iv] mass doubling time (t_d) [2 marks]
- ...5/-

3. [a] Nyatakan ciri-ciri bagi kumpulan mikroorganisma berikut:
- [i] kemoautotrof [2 markah]
 - [ii] kemoheterotrof [2 markah]
 - [iii] fotoautotrof [2 markah]
 - [iv] fotoheterotrof [2 markah]
- [b] Terangkan kelebihan dan kelemahan kultur kemoostat berbanding kultur kelompok untuk perindustrian bioproses. [8 markah]
- [c] Fermentasi kelompok *Pseudomonas C* pada metanol memberikan hasil yang ditunjukkan dalam Jadual S.3.[c].

Jadual S.3.[c].

Masa, t (j)	Kepekatan sel, X (g/l)	Kepekatan substrat, S (g/l)
0	0.2	9.23
2	0.211	9.21
4	0.305	9.07
8	0.98	8.03
10	1.77	6.8
12	3.2	4.6
14	5.6	0.92
16	6.15	0.077
18	6.2	0

Plotkan graf yang diperlukan dan kira:

- [i] berapa lama fasa lamban bertahan. [1 markah]
- [ii] kadar pertumbuhan maksima (μ_{mak}) [4 markah]
- [iii] hasil substrat ($Y_{x/s}$) [2 markah]
- [iv] masa berganda jisim (t_d) [2 markah]

4. [a] What is the chemical basis of enzyme specificity? [3 marks]

[b] What type of enzyme inhibition does the Figure Q.4.[b]. indicate? What are the chemical similarities or differences between the substrate and the inhibitor? [4 marks]

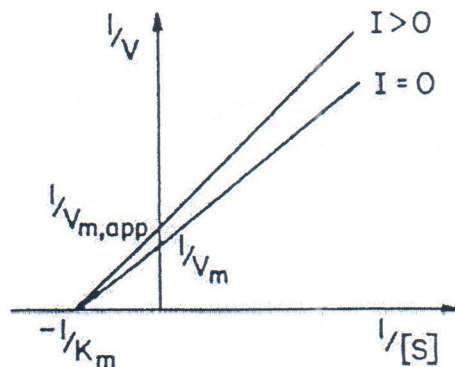


Figure Q.4.[b].

[c] Describe the adsorption and matrix entrapment methods for enzyme immobilization. [6 marks]

5. Lactase catalyses the hydrolysis of lactose to produce glucose and galactose from milk and whey. Experiments are carried out to determine the kinetic parameters for the enzyme. Initial rate data are given in Table Q.5.

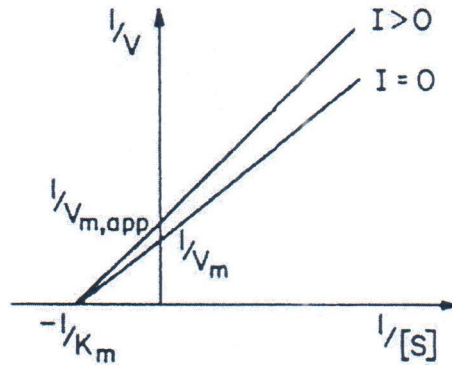
Table Q.5

Lactose concentration $\times 10^{-2}$ (mol L ⁻¹)	Initial reaction rate $\times 10^3$ (mol L ⁻¹ min ⁻¹)
2.50	1.94
2.27	1.91
1.84	1.85
1.35	1.80
1.25	1.78
0.73	1.46
0.46	1.17
0.204	0.779

[a] Calculate the V_{max} and K_M . [8 marks]

[b] Describe what will happen to the K_M and V_{max} values when an uncompetitive inhibitor is added to the reaction mixture. [4 marks]

4. [a] *Apakah asas kimia bagi keberincian enzim?* [3 markah]
- [b] *Apakah jenis perencatan enzim yang ditunjukkan oleh Rajah S.4.[b]? Apakah persamaan dan perbezaan antara substrat dan perencat?* [4 markah]



Rajah S.4.[b]

- [c] *Gambarkan kaedah jerapan dan pemerangkapan matrik bagi pelumpuh-gerak enzim.* [6 markah]
5. *Laktase memungkinkan proses hidrolisis laktosa untuk menghasilkan glukosa dan galaktosa daripada susu dan 'whey'. Ujikaji telah dijalankan untuk menentukan parameter kinetik bagi enzim tersebut. Data kadar mula diberikan di dalam Jadual S.5.*

Jadual S.5

Kepekatan laktosa $\times 10^{-2}$ (mol L ⁻¹)	Kadar tindakbalas mula $\times 10^3$ (mol L ⁻¹ min ⁻¹)
2.50	1.94
2.27	1.91
1.84	1.85
1.35	1.80
1.25	1.78
0.73	1.46
0.46	1.17
0.204	0.779

- [a] *Kirakan V_{\max} dan K_M .* [8 markah]
- [b] *Terangkan apakah yang akan terjadi kepada nilai K_M dan V_{\max} apabila perencat tak-bersaing ditambahkan kepada campuran tindak balas.* [4 markah]

Appendix

List of Equations:

$$S = \frac{DK_s}{\mu_{\max} - D}$$

$$t_b = \frac{1}{\mu_{\max}} \ln \frac{x_f}{x_0}$$

$$t_b = \frac{1}{\mu_{\max}} \ln \left[1 + \frac{\mu_{\max}}{x_{0qp}} (p_f - p_0) \right]$$

$$q_p = Y_{PX} \mu + m_p$$

$$D = \frac{F}{V}$$

$$Q_X = D \left(s_i - \frac{K_s D}{\mu_{\max} - D} \right) Y_{XS}$$

$$t_d = \frac{\ln 2}{\mu}$$

$$\mu = \frac{\mu_{\max} s}{K_s + s}$$

slope of regression line

$$m = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2}$$

$$b = \bar{y} - m\bar{x}$$

Easier Form of Least Squares
Equations

$$m = \frac{\sum x_i y_i - [(\sum x_i \sum y_i)/n]}{\sum x_i^2 - [(\sum x_i)^2/n]}$$

- n is the number of data points