UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2009/2010

November 2009

IMG 315 – Food Biotechnology
[Bioteknologi Makanan]

Duration: 3 hours
[Masa: 3 jam]

Please check that this examination paper consists of TWELVE pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi DUA BELAS muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions: Answer **FIVE (5)** out of eight questions. You may answer the question either in Bahasa Malaysia or in English.

*[**Arahan**: Jawab **LIMA (5)** dari lapan soalan. Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]*

Please read the following instructions:
This examination paper consists of 4 parts (Part A, B, C and D)
1. Answer ONE (1) question in Part A
2. Answer TWO(2) questions in Part B
3. Answer ONE(1) question in Part C and
4. Answer ONE(1) question in Part D.

[Sila baca arahan berikut:
Kertas peperiksaan ini mengandungi 4 bahagian (Bahagian A,B,C dan D)
1. Jawab SATU (1) soalan Bahagian A
2. Jawab DUA (2) soalan Bahagian B
3. Jawab SATU (1) soalan Bahagian C dan
4. Jawab SATU (1) soalan Bahagian D]

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].

…2/-

PART A. Answer the following question.

1. Write short notes on the following parts of the question.

   (a) Safety assessment of genetically modified products.
   (5 marks)

   (b) Disruption of cells in the downstream processing of fermentation products.
   (5 marks)

   (c) Fermentation productivity.
   (5 marks)

   (d) How ammonium sulfate precipitates proteins.
   (5 marks)

PART B. Answer TWO questions only.

2. Answer all parts of this question.

   (a) Explain the importance of aeration for fermentation. How can it be assured that sufficient air supply is obtained by the cells grown, and what is/are the effect/s if the requirement is not fulfilled?

   (10 marks)

   (b) Table 1 (Appended) shows the readings obtained from an experiment to measure the K_La of a fermenter using the Dynamic Gassing Out method. Calculate the K_La value of the fermenter, based on the equation

   $$dCL/dt = K_La(C^* - C_L) - xQO_2,$$

   where

   x = [biomass] , gdm^{-3}

   QO_2 = specific respiration rate (mmol O_2 g^{-1}biomass h^{-1})

   dC_L/dt = changes in dissolved oxygen concentration in a certain time, i.e. oxygen transfer rate, mmoles O_2 $dm^{-3}h^{-1}$

   K_La = volumetric oxygen transfer coefficient,

   C^* = saturated dissolved oxygen concentration, $mmoles/dm^3$

   C_L = concentration of dissolved oxygen in the fermentation broth, $mmoles/dm^3$

   t = time,

   (10 marks)

3. Write an essay giving an outline on the operation of a feasible fermentation plant in Malaysia for a product of your choice, with priority given on the use of a suitable local substrate. Include in your essay, ways on how the production of the product can be maximized, and the cost, minimized.

   (20 marks)

4. Write short notes on the following.

   (a) Fed batch fermentation.

   (b) Air lift fermenter.

   (c) Production of indigenous alcoholic drinks

   (d) Yield coefficient.

   (20 marks)

PART C. Answer ONE question only.

5. Answer all parts of this question.

(a) You are given a protein system (Table 2) with the following characteristics. Describe how you would separate protein Z from the others.

(5 marks)

Table 2

Protein	Solubility in $(NH_4)_2SO_4$, %	Solubility in ethanol, %	Isoelectric point, pI	Denaturation temperature, ^oC
W	10-20	5-10	4.6	80
X	70-80	10-20	6.4	40
Y	60-75	10-20	4.6	40
Z	50-70	5-10	6.4	70

(b) Data for the first step in a protein purification protocol is given in Table 3. Complete the purification table (Table 4) by filling in the labelled parts, a to f. Be sure to include units (where relevant) for each of the columns provided in the purification table.

(8 marks)

Table3: Data

STEP	VOLUME (ml)	PROTEIN (mg/ml)	ACTIVITY (units/ml)
Lysate/starting material	25	20	30
Step 1	10	15	50

Table 4

STEP	SPECIFIC ACTIVITY	YIELD	FOLD PURIFICATION OF STEP
Lysate/starting material	**a**	**c**	**e**
Step 1	**b**	**d**	**f**

(c) Describe how charge and size can be used to separate charged macromolecules.

(7 marks)

6. Answer all parts of this question.

(a) Table 5 gives the results of a protein purification procedure.

(i) Fill in Table 5 at places labelled ‘a’ to ‘m’.

(ii) Discuss the results of this purification. How successful was this purification attempt? Did specific activity and yield change in the expected manner at each step? What modifications would you make in your purification process next time based on the results in this table?

(10 marks)

Table 5

Purification Step	Enzyme Activity, Units/ml	Protein concentration, mg/ml	Volume of fraction, ml	Total activity	Yield %	Specific Activity	Purification Factor
Crude	100,000.00	20.0	40	**a**	100		1
Ammonium Sulfate pellet - resuspended	100,000.00	10.0	10	**b**	**e**	**h**	**k**
Dialysate	70,000.00	3.5	12	**c**	**f**	**i**	**l**
Ion Exchange	7,000.00	0.35	4	**d**	**g**	**j**	**m**

(b) Describe a purification method that takes advantage of protein net charge.

(10 marks)

PART D. Answer ONE question only.

7. Answer all parts of this question.

   (a) What is gene cloning?

   (3 marks)

   (b) Describe the molecular structure of a nucleic acid.

   (5 marks)

   (c) How does the genetic modification technology affect the agricultural sector?

   (12 marks)

8. Answer all parts of this question.

   (a) What is a vector?

   (3 marks)

   (b) Explain the criteria of choosing a vector.

   (5 marks)

   (c) Explain the Polymerase Chain Reaction (PCR) method for determining genetically modified food.

   (12 marks)

BAHAGIAN A. *Jawab soalan berikut.*

1. Tulis catatan-catatan ringkas mengenai perkara-perkara berikut:

(a) Penilaian keselamatan produk terubahsuai genetik.

(5 markah)

(b) Pemecahan sel dalam proses hiliran hasil fermentasi.

(5 markah)

(c) Produktiviti fermentasi.

(5 markah)

(d) Bagaimana amonium sulfat memendakkan protein.

(5 markah)

BAHAGIAN B. *Jawab DUA soalan sahaja.*

2. *Jawab semua bahagian soalan ini.*

   (a) *Terangkan tentang kepentingan pengudaraan untuk sesuatu fermentasi. Bagaimakah dapat dipastikan bekalan udara mencukupi didapati oleh sel-sel yang ditumbuhkan, dan apakah kesan sekiranya keperluan ini tidak dapat dipenuhi.*

   (10 markah)

   (b) *Jadual 1 (dilampirkan) menunjukkan bacaan yang diperolehi daripada satu eksperimen untuk mengukur K_La suatu fermenter menggunakan kaedah Dynamic Gassing Out Kirakan nilai K_La fermenter tersebut, berdasarkan persamaan:*

   $$dCL/dt = K_La(C^* - C_L) - xQO_2,$$

   dimana

   x = *[biojisim]*
   QO_2 = *kadar respirasi spesifik (mmol O_2 g^{-1}biojisim j^{-1})*
   dC_L/dt = *perubahan kepekatan oksigen terlarut dalam suatu jangkamasa, iaitu kadar pemindahan O_2, mmoles O_2 $dm^{-3}j^{-1}$*
   K_La = *pekali pemindahan oksigen volumetrik*
   C^* = *kepekatan oksigen terlarut tertepu, mmoles/dm^3*
   C_L = *[oksigen terlarut] dalam kaldu fermentasi, mmoles /dm^3*
   t = *masa,*

   (10 markah)

3. *Tulis satu karangan memberikan kerangka pengoperasian loji fermentasi yang dapat dilaksanakan di Malaysia, untuk penghasilan suatu produk yang anda pilih, dengan keutamaan diberikan untuk penggunaan substrat tempatan yang sesuai. Masukkan juga dalam karangan anda cara-cara bagaimana penghasilan produk tersebut dapat dimaksimumkan, dan kos diminimumkan.*

   (20 markah)

4. *Tuliskan nota ringkas mengenai perkara-perkara berikut.*

   (a) *Fermentasi suap kelompok.*

   (b) *Fermenter angkut udara.*

   (c) *Penghasilan minuman beralkohol tempatan.*

   (d) *Pekali hasil.*

   (20 markah)

BAHAGIAN C. *Jawab SATU soalan sahaja.*

5. Jawab semua bahagian soalan ini.

(a) Anda diberikan satu sistem protein dengan ciri-ciri berikut (Jadual 2). Terangkan bagaimana anda dapat memisahkan protein Z daripada protein lain.

(5 markah)

Jadual 2

Protein	*Keterlarutan dalam $(NH_4)_2SO_4$, %*	*Keterlarutan dalam etanol, %*	*Titik Isoelektrik, pI*	*Suhu denaturasi, ^oC*
W	*10-20*	*5-10*	*4.6*	*80*
X	*70-80*	*10-20*	*6.4*	*40*
Y	*60-75*	*10-20*	*4.6*	*40*
Z	*50-70*	*5-10*	*6.4*	*70*

(b) Data bagi langkah pertama dalam protokol penulenan protein diberi dalam Jadual 3. Lengkapkan jadual penulenan (Jadual 4) dengan mengisikan bahagian berlabel a hingga f. Pastikan unit diberikan (dimana sesuai) bagi setiap kolum dalam jadual tersebut.

(8 markah)

<u>Jadual 3: Data</u>

LANGKAH	*ISIPADU (ml)*	*PROTEIN (mg/ml)*	*AKTIVITI (Unit/ml)*
Lysate/bahan permulaan	*25*	*20*	*30*
Langkah 1	*10*	*15*	*50*

Jadual 4: Penulenan

LANGKAH	*AKTIVITI SPESIFIK*	*HASIL*	*TAHAP PENULENAN LANGKAH*
Lysate/bahan permulaan	***a***	***c***	***e***
Langkah 1	***b***	***d***	***f***

(c) Terangkan bagaimana cas dan saiz boleh diguna untuk pemisahan makromolekul bercas.

(7 markah)

6. Jawab semua bahagian soalan ini.

(a) Jadual 5 memberi keputusan prosedur penulenan protein.

(i) Isikan nilai berkaitan pada tempat yang dilabelkan 'a' hingga 'm'.

(ii) Bincangkan keputusan penulenan ini. Bagaimanakah tahap kejayaan percubaan penulenan ini? Adakah perubahan aktiviti spesifik dan hasil berubah mengikut jangkaan pada setiap langkah? Apakah modifikasi yang anda akan buat dalam proses penulenan selepas ini berdasarkan keputusan dalam jadual ini.

(10 markah)

Jadual 5

Langkah Penulenan	*Aktiviti Enzim, Unit/ml*	*Kepekatan Protein, mg/ml*	*Isipadu fraksi, ml*	*Aktiviti total*	*Hasil %*	*Aktiviti Spesifik*	*Faktor Penulenan*
Kasar	*100,000.00*	*20.0*	*40*	***a***	*100*		*1*
Pelet Amonium Sulfat – Dilarut semula	*100,000.00*	*10.0*	*10*	***b***	***e***	***h***	***k***
Dialisat	*70,000.00*	*3.5*	*12*	***c***	***f***	***i***	***l***
Penukaran Ion	*7,000.00*	*0.35*	*4*	***d***	***g***	***j***	***m***

(b) Bincangkan kaedah penulenan yang berdasarkan cas net protein.

(10 markah)

BAHAGIAN D. *Jawab SATU soalan sahaja.*

7. Jawab semua bahagian soalan ini.

(a) Apakah pengklonan gen?

(3 markah)

(b) Jelaskan struktur molekul asid nukleik.

(5 markah)

(c) Bagaimanakah teknologi modifikasi gen memberi kesan terhadap sektor pertanian?

(12 markah)

8. Jawab semua bahagian soalan ini.

(a) Apakah vektor?

(3 markah)

(b) Jelaskan kriteria pemilihan sesuatu jenis vektor.

(5 markah)

(c) Jelaskan kaedah Tindakbalas Rantaian Polimerase (PCR) dalam penentuan makanan terubah-suai genetik.

(12 markah)

Appendix/Lampiran 1

Table 1: Experimental data obtained from a Gassing out method of measuring K_La

Time	D.O (% saturation)
0*	88.8
2	87.4
4	85.4
6	83.4
7	81.1
9	79.0
11	76.8
13	74.8
15	72.6
17	70.6
19	68.3
21	66.2
22**	65.7
23	67.1
24	69.3
25	72.2
26.5	76.1
28	79.2
31	83.2
33	84.8
36	86.0
38	86.3

*- aeration was turned off

**- aeration was turned on