UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2005/2006

April/May 2006

EKC 171E – Bioscience for Engineers
[Biosains untuk Jurutera]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains TEN printed pages before you begin the examination.

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

Instruction: Answer **FOUR** (4) questions. Answer any **TWO** (2) questions from Section A. Answer any **TWO** (2) questions from Section B.

*[**Arahan:** Jawab **EMPAT** (4) soalan. Jawab mana-mana **DUA** (2) soalan dari Bahagian A. Jawab mana-mana **DUA** (2) soalan dari Bahagian B.]*

[Pelajar dibenarkan menjawab semua soalan dalam Bahasa Inggeris ATAU Bahasa Malaysia ATAU kombinasi kedua-duanya.]

...2/-

Section A : Answer any TWO questions.
Bahagian A : Jawab mana-mana DUA soalan.

1. [a] The central dogma of genetics is a procedure by which the genetic material is used in living processes. List 6 main points of the central dogma and sketch the schematic diagram of the central dogma.

[8 marks]

[b] What feature of the DNA structure provides the basis for reproduction of the original nucleotide sequence in a replica? Sketch a schematic diagram to illustrate your answers.

[6 marks]

[c] Determine the subunit composition of a protein from the following information

Molecular mass by gel filtration	:	200 kD
Molecular mass by SDS – PAGE	:	100kD
Molecular mass by SDS – PAGE with 2-mercaptoethanol	:	40 kD and 60 kD

Give reasons for your answers.

[4 marks]

[d] Treatment of a polypeptide with 2-mercaptoethanol yields the following two polypeptides:

1. Ala – Val – Cys – Arg – Thr – Gly – Cys – Lys – Asn – Phe – Leu

2. Tyr – Lys – Cys – Phe – Arg – His – Thr – Lys – Cys – Ser

Treatment of the intact polypeptide with trypsin yields fragments with the following amino acid compositions:-

3. (Ala, Arg, Cys, Cys, Ser, Val)

4. (Arg, Cys, Cys, Gly, Lys, Thr, Phe)

5. (Asn, Leu, Phe)

6. (His, Lys, Thr)

7. (Lys, Tyr)

Indicate the positions of the disulfide bonds in the intact polypeptide. Explain.

[7 marks]

...3/-

1. [a] *Genetik pusat dogma adalah satu prosedur di mana bahan genetik digunakan dalam proses-proses kehidupan. Senaraikan 6 perkara utama dalam pusat dogma dan lukiskan gambarajah skema untuk pusat dogma.*

[8 markah]

[b] *Apakah ciri struktur DNA yang memberi asas kepada keluaran semula jujukan nukleotida asal dalam bentuk replika. Lakarkan gambarajah skema untuk menggambarkan jawapan anda.*

[6 markah]

[c] *Tentukan komposisi subunit untuk protin dengan menggunakan maklumat berikut:-*

Jisim molekul daripada penapisan gel : 200 kD
Jisim molekul daripada SDS – PAGE : 100kD
Jisim molekul daripada SDS – PAGE dengan 2-merkaptoetanol : 40 kD dan 60 kD

Berikan sebab-sebab untuk jawapan anda.

[4 markah]

[d] *Rawatan bagi suatu polipeptida dengan 2-merkaptoetanol menghasilkan dua polipeptida berikut:*

1. *Ala – Val – Cys – Arg – Thr – Gly – Cys – Lys – Asn – Phe – Leu*

2. *Tyr – Lys – Cys – Phe – Arg – His – Thr – Lys – Cys – Ser*

Rawatan bagi polipeptida yang asal dengan tripsin menghasilkan pecahan-pecahan dengan komposisi asid amino berikut:-

3. *(Ala, Arg, Cys, Cys, Ser, Val)*

4. *(Arg, Cys, Cys, Gly, Lys, Thr, Phe)*

5. *(Asn, Leu, Phe)*

6. *(His, Lys, Thr)*

7. *(Lys, Tyr)*

Tunjukkan kedudukan ikatan-ikatan disulfida dalam polipeptida yang asal. Terangkan.

[7 markah]

...4/-

2. [a] Explain in what direction will the following proteins move in an electric field: toward anode, cathode or neither (stationary).

[i] egg albumin (pI = 4.6) at pH 5.0

[ii] β-lactoglobulin (pI = 5.2) at pH 5.0 and pH 7.0

[6 marks]

[b] What types of RNA occur in a typical cell and what are their functions?

[6 marks]

[c] Discuss in detail the ethanol manufacturing process based on fermentation.

[9 marks]

[d] Define the primary, secondary, tertiary and the quarternary structure of a protein.

[4 marks]

2. *[a] Terangkan ke arah manakah protin-protin berikut akan bergerak di dalam medan elektrik: ke arah anod, katod atau pegun.*

[i] albumin telur (pI = 4.6) pada pH 5.0

[ii] β-laktoglobulin (pI = 5.2) pada pH 5.0 dan pH 7.0

[6 markah]

[b] Apakah jenis-jenis RNA yang terdapat dalam suatu sel yang lazim dan apakah fungsi-fungsinya?

[6 markah]

[c] Bincangkan dengan terperinci proses penghasilan etanol berasaskan proses penapaian.

[9 markah]

[d] Berikan definisi untuk protin yang berstruktur primer, sekunder, tertier dan kuartener.

[4 markah]

...5/-

3. [a] Draw and label the structures of a prokaryotic and eukaryotic cells. Differentiate between the two cells.

[8 marks]

[b] Below is some information on five different proteins.

Protein	Molecular Weight	pI
Cytochrome C	13,000	10.6
Ribonuclease	14,000	7.8
Myoglobin	17,000	7.0
Pepsin	35,500	<1.0
Serum Albumin	66,500	4.8

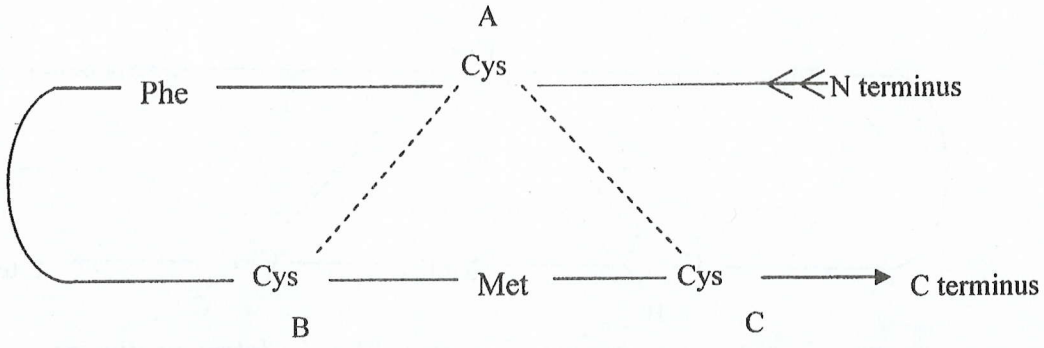
Which range of pH would you choose for loading a mixture of the five proteins in a column of a cation exchanger such as phosphocellulose to allow only pepsin and serum albumin to pass through the column? Explain in terms of its molecular weight and pI's.

[5 marks]

[c] List the major differences between the chemical composition of RNA and DNA.

[2 marks]

[d] A protein has been sequenced after destruction of –S–S– bonds. It is known to contain 3 Cys residues, located as shown below. However, only one of these is a free –SH, two are involved in an –S–S– bond.



The only Met and the only Phe in this protein are in the positions indicated. Cleavage of the intact protein (with –S–S– bridge intact) by either cyanogens bromide or chymotrypsin does not break the protein into 2 peptides. Where is the –S–S– bridge? Explain.

[5 marks]

[e] Write brief note on the transcription and translation process of a protein synthesis.

[5 marks]

...6/-

3. [a] *Lukis dan labelkan struktur-struktur sel prokariot dan sel eukariot. Bezakan antara kedua-dua sel tersebut.*

[8 markah]

[b] *Diberikan beberapa maklumat mengenai lima jenis protin yang berlainan.*

Protin	*Berat Molekul*	*pI*
Sitokrom C	*13,000*	*10.6*
Ribonuklease	*14,000*	*7.8*
Mioglobin	*17,000*	*7.0*
Pepsin	*35,500*	*<1.0*
Serum Albumin	*66,500*	*4.8*

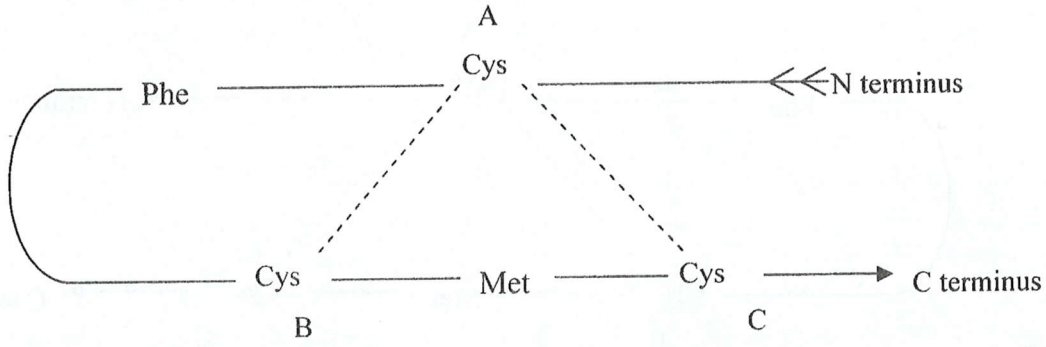
Apakah julat pH yang akan anda pilih untuk memasukkan campuran kelima-lima protin tersebut ke dalam turus penukaran kation seperti fosfoselulosa supaya hanya pepsin dan serum albumin sahaja yang akan melalui turus tersebut? Terangkan dari segi aspek berat molekul dan pI nya.

[5 markah]

[c] *Senaraikan perbezaan-perbezaan utama antara komposisi kimia untuk RNA dan DNA.*

[2 markah]

[d] *Satu protin telah dijujurkan selepas ikatan –S–S– dimusnahkan. Protin ini mempunyai residu 3 Cys dan kedudukannya ditunjukkan di bawah. Walau bagaimanapun, hanya salah satu residu –SH sahaja yang bebas, dua residu lagi terlibat di dalam ikatan –S–S–.*



Terdapat hanya satu Met dan satu Phe di dalam protin ini. Kedudukan mereka ditunjukkan dalam gambarajah di atas. Belahan ke atas protin asal (di mana ikatan –S–S– adalah tidak terusik) samada dengan sianogen bromida atau kimotripsin tidak memutuskan protein kepada 2 peptida. Di manakah titian –S–S– tersebut? Terangkan.

[5 markah]

[e] *Tuliskan nota ringkas mengenai proses transkripsi dan peralihan dalam suatu sintesis protin.*

[5 markah]

...7/-

Section B : Answer any TWO questions.
Bahagian B : Jawab mana-mana DUA soalan.

4. [a] Choose two effectors of the phosphofructokinase reaction.

[5 marks]

[i] Briefly describe how each affects the reaction.

[5 marks]

[ii] Briefly explain how its effect contributes to the regulation of glycolysis

[5 marks]

[b] When one molecule of glucose is completely oxidized to six molecules of CO_2, calculate the percentage of ATP produced by:

[i] Oxidative phosphorylation

[5 marks]

[ii] Substrate-level phosphorylation

[5 marks]

4. [a] Pilih dua jenis pengubah untuk tindakbalas fosfofruktokinase.

[5 markah]

[i] Jelas secara ringkas bagaimana setiap pengubah mempengaruhi tindakbalas tersebut.

[5 markah]

[ii] Jelaskan secara ringkas bagaimana setiap pengubah tersebut memberi kesan kepada peraturan glikolisis.

[5 markah]

[b] Apabila satu molekul glukosa dioksidakan secara lengkap kepada enam molekul CO_2, kirakan peratusan ATP yang dihasilkan daripada:

[i] Fosforilasi oksidatif

[5 markah]

[ii] Fosforilasi peringkat substrat

[5 markah]

...8/-

5. Carbonic anhydrase catalyzes the following reverse reaction:

$$HCO_3^- + H^+ \rightarrow CO_2 + H_2O$$

Initial reaction velocities (v_o) were measured at the following concentrations of HCO_3^-.

Table Q.5

$[HCO^-_3]$, mM	v_o, mM/min
6	0.39
24	0.99
96	1.62

The molecular weight of carbonic anhydrase enzyme (M_r) is 29,100 Da and the enzyme concentration was 0.0025 μg/ml.

[a] Based on the data given in Table Q.5, draw a Lineweaver-Burk plot. Show your calculations.

[5marks]

[b] Calculate:

[i] K_M

[5 marks]

[ii] V_{max}

[5 marks]

[iii] Enzyme turnover number (k_{cat})

[5 marks]

[c] Add a line to the graph corresponding to reactions in which the AZA inhibitor was added at [AZA] = K_I.

[5 marks]

5. *Karbonik anhidrase memangkinkan tindakbalas berbalik berikut:*

$$HCO_3^- + H^+ \rightarrow CO_2 + H_2O$$

Halaju tindakbalas awal (v_o) diukur untuk kepekatan HCO_3^- berikut:

Jadual S.5

$[HCO^-_3]$, mM	*v_o, mM/min*
6	*0.39*
24	*0.99*
96	*1.62*

Berat molekul enzim karbonik (M_r) anhidrase ialah 29,100 Da dan kepekatan enzim ialah 0.0025 μg/ml.

...9/-

[a] Berdasarkan data yang diberikan dalam Jadual S.5, lukiskan plot Lineweaver-Burk. Tunjukkan cara pengiraan anda.

[5 markah]

[b] Kirakan:

[i] K_M

[5 markah]

[ii] V_{max}

[5 markah]

[iii] Nombor pusingan balik enzim (k_{cat})

[5 markah]

[c] Tambahkan satu garisan pada graf yang sepadan dengan tindakbalas di mana perencat AZA ditambahkan pada [AZA] = K_I.

[5 markah]

6. [a] Draw Fischer Projections for the following carbohydrates:

[i] L-mannose

[3 marks]

[ii] L-fucose (6-deoxy-L-galactose)

[3 marks]

[iii] D-xylitol

[3 marks]

[b] Calculate the number of ATP molecules generated by the following net reactions of the citric acid cycle. Assume that all NADH and QH_2 are oxidized to yield ATP, pyruvate is converted to acetyl-CoA, and the malate-aspartate shuttle is operating.

[i] 1 Pyruvate → 3 CO_2

[4 marks]

[ii] Citrate → Oxaloacetate + 2 CO_2

[4 marks]

[c] Explain the principal mechanism used to:

[i] activate glycogen catabolism

[4 marks]

[ii] deactivate glycogen synthesis

[4 marks]

...10/-

6. *[a] Lukiskan Unjuran Fischer bagi karbohidrat-karbohidrat berikut:*

[i] L-mannosa

[3 markah]

[ii] L-fukosa (6-deoksi-L-galaktosa)

[3 markah]

[iii] D-xilitol

[3 markah]

[b] Kirakan bilangan molekul ATP yang dihasilkan daripada tindakbalas bersih kitaran asid sitrik. Anggapkan semua NADH dan QH_2 dioksidakan untuk mengahsilkan ATP, piruvat ditukarkan kepada asetil-CoA, dan olak-alik malat-aspartat beroperasi.

[i] 1 Piruvat → 3 CO_2

[4 markah]

[ii] Sitrat → Oxaloasetat + 2 CO_2

[4 markah]

[c] Jelaskan mekanisma asas yang digunakan untuk:

[i] mengaktifkan katabolisme glikogen

[4 markah]

[ii] menyahaktifkan sintesis glikogen

[4 markah]

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