THE OPEN UNIVERSITY OF SRI LANKA

B.Sc DEGREE PROGRAMME 2008/2009

CHU 3139 –LEVEL 5- BIOCHEMISTRY 1

FINAL EXAMINATION

DURATION : THREE HOURS

DATE : Saturday 20th June 2009 Time: 10.00 a.m. – 12.30 p.m.

INSTRUCTIONS TO CANDIDATES:

This paper consists of 6 questions.
The first question is compulsory. You may select 3 questions from the rest of the questions (No.2 to 6) and answer **4 questions in total.**

Q1. a) A food sample (chicken egg) was subjected to the following tests.

i) Sample was treated with Ilca's reagent (acetic anhydride and acetic acid). A green colour was observed.

ii) The Carr – Price test was performed (sample was treated with antimony trichloride in chloroform). A blue colour appeared and then faded away.

iii) Molisch test was carried out. No colour change was observed.

iv) The Biuret test gave a purple colour.

Giving reasons, explain each of the above observations. What type of substances could be present in the sample? (16 marks)

b) A carbohydrate sample (P) was purified and subjected to a series of tests. P gave a reddish purple colour when treated with Morgan-Elson reagent. On subjection to paper chromatography 3 spots were observed. The Rglc values of the 3 spots were 1.5, 1.0 and 0.9. Provide a tentative structure for P. Assume that P is a trisaccharide. Describe clearly how you arrived at this structure.

Sugar	Rglc	Sugar	Rglc
Glucose	1.0	Rhamnose	1.5
Mannose	1.1	Arabinose	1.6
Galactose	0.9	Glucosamine	0.9

(9 marks)

Q2 (i) Membranes are made of lipid bilayers. Draw the structure of a membrane and label all the major components. (6 marks)

(ii) Name the three methods of membrane transport. (3 marks)

(iii) Write a short description of the type of transport which requires energy from hydrolysis of ATP. (10 marks)

(iv) How would you separate a mixture of double stranded DNA molecules of 10 kb and 40 kb size? Describe the method and any conditions that are important. (6 marks)

Q3 (i) Briefly describe the types of electron transfer reactions commonly found in biological transformations. (6 marks)

(ii) The conversion of pyruvate to lactate is common in anaerobic conditions.

(a) What enzyme is responsible for this conversion?

(b) Is a cofactor necessary? If so what is the cofactor?

(c) Using standard reduction potentials of the half reactions given below, calculate the free energy change for the conversion of pyruvate to lactate. Faraday constant F = 96.5 kJ/V mol. (13 marks)

TABLE 15-4. STANDARD REDUCTION POTENTIALS OF SOME BIOCHEMICALLY IMPORTANT HALF-REACTIONS

Half Reaction	$\mathcal{E}^{\circ\prime}$ (V)
$\frac{1}{2}O_2 + 2H^+ + 2e^- \rightleftharpoons H_2O$	0.815
$SO_4^{2-} + 2H^+ + 2e^- \rightleftharpoons SO_3^{2-} + H_2O$	0.48
$NO_3^- + 2H^+ + 2e^- \rightleftharpoons NO_2^- + H_2O$	0.42
Cytochrome a_3 (Fe^{3+}) + e^- $\rightleftharpoons$ cytochrome a_3 (Fe^{2+})	0.385
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	0.295
Cytochrome *a* (Fe^{3+}) + e^- $\rightleftharpoons$ cytochrome *a* (Fe^{2+})	0.29
Cytochrome *c* (Fe^{3+}) + e^- $\rightleftharpoons$ cytochrome *c* (Fe^{2+})	0.235
Cytochrome c_1 (Fe^{3+}) + e^- $\rightleftharpoons$ cytochrome c_1 (Fe^{2+})	0.22
Cytochrome *b* (Fe^{3+}) + e^- $\rightleftharpoons$ cytochrome *b* (Fe^{2+}) (*mitochondrial*)	0.077
Ubiquinone + $2H^+ + 2e^-$ $\rightleftharpoons$ ubiquinol	0.045
Fumarate$^-$ + $2H^+ + 2e^-$ $\rightleftharpoons$ succinate$^-$	0.031
FAD + $2H^+ + 2e^-$ $\rightleftharpoons$ $FADH_2$ (*in flavoproteins*)	−0.
Oxaloacetate$^-$ + $2H^+ + 2e^-$ $\rightleftharpoons$ malate$^-$	−0.166
Pyruvate$^-$ + $2H^+ + 2e^-$ $\rightleftharpoons$ lactate$^-$	−0.185
Acetaldehyde + $2H^+ + 2e^-$ $\rightleftharpoons$ ethanol	−0.197
FAD + $2H^+ + 2e^-$ $\rightleftharpoons$ $FADH_2$ (*free coenzyme*)	−0.219
S + $2H^+ + 2e^-$ $\rightleftharpoons$ H_2S	−0.23
Lipoic acid + $2H^+ + 2e^-$ $\rightleftharpoons$ dihydrolipoic acid	−0.29
$NAD^+ + H^+ + 2e^-$ $\rightleftharpoons$ NADH	−0.315
$NADP^+ + H^+ + 2e^-$ $\rightleftharpoons$ NADPH	−0.320
Cystine + $2H^+ + 2e^-$ $\rightleftharpoons$ 2 cysteine	−0.340
Acetoacetate$^-$ + $2H^+ + 2e^-$ $\rightleftharpoons$ β-hydroxybutyrate$^-$	−0.346
$H^+ + e^-$ $\rightleftharpoons$ $\frac{1}{2}H_2$	−0.421
Acetate$^-$ + $3H^+ + 2e^-$ $\rightleftharpoons$ acetaldehyde + H_2O	−0.581

Source: Mostly from Loach, P.A., *In* Fasman, G.D. (Ed.), *Handbook of Biochemistry and Molecular Biology* (3rd ed.), *Physical and Chemical Data*, Vol. 1, *pp.* 123–130, CRC Press (1976).

(iii) What happens to pyruvate produced by glycolysis during aerobic oxidation? Write an equation for the overall reaction. (6 marks)

Q4 (a) When succinate is converted to fumarate through the citric acid cycle, the reducing equivalents produce 2 moles of ATP on oxidative phosphorylation. However, oxidation of malate to oxaloacetate is found to be associated with production of 3 moles of ATP. Clearly explain this observation.
(12 marks)

(b) What intermediates of the citric acid cycle are important for synthesis of other compounds? Name these intermediates and the end products they biosynthesize.
(6 marks)

(c) Calculate the energy as ATP when 2 moles of acetylCoA are oxidized via the citric acid cycle.
(7 marks)

Q5 (a) What is transamination? (4 marks)

(b) Name the coenzyme required for transamination reactions.
(4 marks)

(c) Explain how ammonium ions are formed during oxidative deamination.
(6 marks)

(d) Briefly explain how these ions are transported from tissues to the liver and how the level of ammonia in the blood is regulated? (6 marks)

(e) In what form do these ammonium ions enter the urea cycle? (do not describe the entire cycle) (5 marks)

Q6 (i) Fructose is a sugar found abundantly in fruits. How do glucose and fructose differ structurally? (6 marks)

(ii) Describe the energy producing pathways of fructose metabolism.
(9 marks)

(iii) What are the differences between cyclic and non-cyclic electron flow in photosynthetic organisms? Compare the products formed by the two pathways.
(10 marks)

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