

# Cork Institute of Technology

## Bachelor of Science (Honours) in Herbal Science – Stage 2

(NFQ Level 8)

Summer 2007

### Biochemistry

(Time: 3 Hours)

Answer Section A (compulsory) and TWO questions from each of Sections B and C. Use separate answer books for each section and mark the questions attempted.

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### Section A

**Q1. Compulsory**, answer all parts. (24 marks)

- (a) With respect to laboratory measurements, define the terms **error**, **accuracy** and **precision**.
- (b) Distinguish between the **primary** and **secondary** structure of a protein. Give two examples of protein secondary structure.
- (c) Define the term **mutarotation**, using diagrams of D-glucose to illustrate your answer.
- (d) List four roles of lipids in the body.
- (e) Define the terms **pH**, **pK<sub>a</sub>** and **pI**.
- (f) When 0.3 ml of a 0.6 mM pyruvate solution is added to a reaction mixture with a final volume of 3.2 ml, calculate the final pyruvate concentration of the reaction mixture.
- (g) Draw the structure of one amino acid in each of the following groups;
  - (i) sulphur-containing amino acid,
  - (ii) neutral, hydrophilic amino acid
  - (iii) aromatic amino acidIn each case name the amino acid you have drawn.
- (h) What is: (a) the H<sup>+</sup> concentration, and, (b) the pH of a 0.007 M solution of HCl?
- (i) If there are 16 mg of NaCl in a 350 ml volume, calculate the number of moles of NaCl present and the molarity (concentration) of the solution. [Atomic weight Na = 23, Cl = 35.5]
- (j) Distinguish between an **aldose** and a **ketose**. To which of these classes of carbohydrate does glucose belong?
- (k) Write a note on tRNA structure.
- (l) How does the polar nature of the peptide bond contributes to the formation of the  $\alpha$ -helix and the  $\beta$ -pleated sheet?

## Section B

(Analytical Biochemistry - 38 marks)

Answer any **two** of the following questions (Q2, Q3 or Q4).

- Q2.** (a) Define the Beer-Lambert Law. [4 marks]
- (b) Distinguish between the absorbance spectrum and the absorbance maximum of a compound and explain how you would determine each of these values in the lab. [5 marks]
- (c) Given the following experimental data, determine the molar extinction coefficient ( $\epsilon$ ) for p-nitrophenol (PNP) at 405 nm;

$A_{405}$	[PNP] ( $\mu\text{M}$ )
0.000	0
0.180	10
0.421	20
0.592	30
0.810	40

Express  $\epsilon$  in units of  $\text{M}^{-1}\text{cm}^{-1}$ , showing clearly how you arrived at such units.

*Note: path length of light through cuvette = 1 cm*

[10 marks]

- Q3.** (a) Given a stock solution of 100 mM sucrose, describe how you would prepare a series of dilutions containing 0, 4, 8, 12, 16 and 20 mM sucrose in a final volume of 1 ml. [5 marks]
- (b) Describe how you would prepare 50 ml of a 0.2 M acetate buffer, pH 4.5 using stock solutions of 0.5 M acetic acid and 0.5 M sodium acetate. ( $\text{pK}_a = 4.75$ ) [6 marks]

- (c) A preparation of the enzyme sucrase was incubated with its substrate, sucrose, at various pH values. After 5 minutes at 30°C the reaction was stopped and the amount of reducing sugar liberated at the different pH values was determined. Using the following data plot a graph of the effect of pH on sucrase activity and determine the pH optimum of the enzyme:

pH	Sucrase Activity ( $\mu\text{mol/ml/min}$ )
2.5	0.58
3.5	0.60
4.5	0.66
5.5	0.34
6.5	0.23
7.5	0.20

[8 marks]

- Q4.** (a) Given the reaction  $A \rightarrow B$ , draw a graph illustrating how the concentrations of A and B vary as the reaction progresses. On this graph indicate how  $\Delta[A]/\Delta t$  and  $d[B]/dt$  may be determined. *Note: Choose arbitrary time points.* [6 marks]

- (b) The following data was obtained from a study of the kinetics of hexokinase;

[Substrate] (mM)	$v_o$ ( $\mu\text{mol/min}$ )
0.00	0
0.05	25
0.10	40
0.15	50
0.20	57
0.25	63
0.30	67
0.35	70
0.40	73

Estimate the value of  $K_M$  and  $V_{\max}$  for hexokinase using a Lineweaver-Burk plot and explain the significance of each of these parameters in defining the enzyme's activity.

[13 marks]

## Section C

(Structural and Metabolic Biochemistry - 38 marks)

Answer any **two** of the following questions (Q5, Q6, Q7 or Q8).

- Q5. (a) Draw the structure of ATP, indicating the position of the high energy phosphoanhydride bonds. [4 marks]
- (b) In all organisms, pyruvate is the end-product of glycolysis. However, the fate of pyruvate will differ under aerobic and anaerobic conditions. Describe three possible fates of pyruvate and indicate the circumstances under which each will occur. [6 marks]
- (c) Oxidative phosphorylation is the final stage in the energy-yielding metabolism of aerobic organisms. Briefly describe this process making use of diagrams to illustrate your answer. [9 marks]

- Q6. (a) Using diagrams, distinguish between the structures of the following fatty acids; *cis*- $\Delta^6$ -decanoic acid and *trans*- $\Delta^6$ -decanoic acid. [3 marks]
- (b) Distinguish between the structures of mono-, di- and tri-glycerides and draw a diagram of a triglyceride [3 marks]
- (c) Write an essay on biological membranes under the following headings;
- (i) lipid composition and regulation of membrane fluidity
  - (ii) fluid-mosaic model
  - (iii) classes of membrane proteins
  - (iv) membrane transport
- Use diagrams wherever possible to illustrate your answer. [10 marks]

- Q7. (a) Describe how DNA is packaged to fit within the nucleus. [4 marks]
- (b) Explain how Meselson and Stahl proved the semi-conservative nature of DNA replication. [5 marks]
- (c) Write a short essay describing the process of replication using diagrams to illustrate your answer. [10 marks]

- Q8.** (a) In a test for blood glucose, a paper strip impregnated with glucose oxidase and other reagents is exposed to a drop of blood. The reaction that takes place is as follows:



The  $\text{H}_2\text{O}_2$  produced causes a color change that is proportional to the amount of glucose present. Since glucose oxidase is specific for the  $\beta$  form of D-glucose, explain why total blood glucose ( $\alpha$  and  $\beta$  forms) can be determined from this test. [5 marks]

- (b) Explain, with the aid of a diagram, how non-reducing sugars arise and name a chemical test to identify them. [5 marks]
- (c) Polymers of glucose have different properties depending on the type of glycosidic linkage that exists between the glucose monomers. Discuss this statement using starch, glycogen and cellulose as examples. [9 marks]