

Cork Institute of Technology

Higher Certificate in Science in Applied BioSciences – Award

(NFQ Level 6)

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.

Examiners: Dr. H. Tarrant
Prof. R. Fitzgerald

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_a** 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 acid

In each case name the amino acid you have drawn.

- (h) What is the (a) the H^+ 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 α -helix and the β -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 (ϵ) for p-nitrophenol (PNP) at 405 nm;

A_{405}	[PNP] (μM)
0.000	0
0.180	10
0.421	20
0.592	30
0.810	40

Express ϵ 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. Write brief, informative notes on three of the following;

- (a) Fixed time and continuous monitoring methods of enzyme measurement
- (b) Protein sequencing.
- (c) DNA sequencing.
- (d) Choosing a technique for protein estimation [19 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. Write an essay on this process making use of diagrams to illustrate your answer. [9 marks]

- Q6.** (a) Distinguish between the structures of the following fatty acids; *cis*- Δ^6 -decanoic acid and *trans*- Δ^6 -decanoic acid. [4 marks]
- (b) Distinguish between the structures of mono-, di- and tri-glycerides and draw a diagram of a triglyceride [5 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) 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]