

Cork Institute of Technology

Higher Certificate in Science in Applied Biology – Award
(National Certificate in Science in Applied Biology – Award)
(NFQ – Level 6)

Autumn 2005

Biochemistry

(Time: 3 Hours)

Answer Section A (compulsory) and TWO questions from each of Sections B and C.

Examiners: Dr. H. Tarrant
Dr. T. Beresford

Use separate answer books for each section and mark the questions attempted.

Section A

Q1. **Compulsory**, answer **12** parts only. [24 marks]

- (a) Draw the structure of one amino acid in each of the following groups;
- (i) neutral non-polar amino acid,
 - (ii) basic amino acid
 - (iii) sulphur-containing amino acid
- In each case name the molecule you have drawn.
- (b) Define the terms **precision** and **accuracy** with respect to a set of replicate measurements made in the laboratory.
- (c) Distinguish between an aldose and a ketose. To which of these classes of carbohydrate does glucose belong?
- (d) Define **energy of activation** (E_a) and use a diagram to show how an enzyme affects the E_a of a reaction pathway.
- (e) What is the pH of (i) 0.05 M HCl, and (ii) 0.1 M HCl?
- (f) Describe the processes of passive diffusion, facilitated diffusion and active transport, with respect to the transport of a molecule across a cell membrane.
- (g) When 3.5 ml of a 0.7 mM sucrose stock solution is added to a reaction mixture with a final volume of 6 ml, calculate the concentration of the final sucrose solution.
- (h) Cellulose and starch are both polymers of glucose. What structural feature is responsible for their different properties?

- (i) What is the central dogma of molecular biology?
- (j) Explain how stereoisomers (enantiomers) arise in carbohydrate chemistry.
- (k) List two different fates of pyruvate and explain why the fate of pyruvate differs under aerobic and anaerobic conditions.
- (l) If there are 14 mg of KOH in a 500 ml volume, calculate (a) the number of moles of KOH present and (b) the molarity (concentration) of the solution. (Atomic weight K = 39, O = 16, H = 1).
- (m) Define **anabolism** and **catabolism**.
- (n) Using diagrams, summarise how DNA is packaged to fit within the cell.

Section B

(Analytical Biochemistry - 38 marks)

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

- Q2. (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. (pKa = 4.75) [5 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

[9 marks]

Q3. (a) List the different detection systems used to determine substrate or product levels during an enzyme-catalysed reaction. Write short notes on three of these methods. [9 marks]

(b) The following data was obtained for an enzyme-catalysed reaction:

[Substrate] (M)	v_o ($\mu\text{mol/ml/20 min}$)
0.20×10^{-5}	0.150
0.40×10^{-5}	0.200
0.85×10^{-5}	0.275
1.25×10^{-5}	0.315
1.70×10^{-5}	0.340
2.00×10^{-5}	0.350
8.00×10^{-5}	0.360

Use a Lineweaver-Burk plot to determine the V_{max} and K_M of the enzyme. [10 marks]

Q4. Write notes on three of the following;

- (i) Tests to identify mutagenic chemicals
- (ii) Edman degradation
- (iii) SDS-PAGE
- (iv) DNA sequencing

[19 marks]

Section C

(Structural and Metabolic Biochemistry - 38 marks)

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

Q5. (a) Define the terms **transcription** and **translation**. [3 marks]

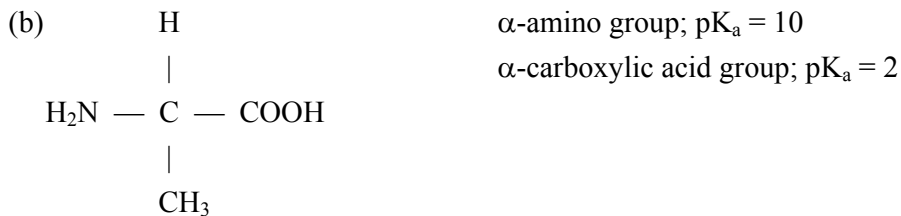
(b) Write an essay on **translation**, using the following headings as a guide:

- (i) structure of ribosomes and tRNA
- (ii) initiation
- (iii) chain elongation and formation of the peptide bond, and
- (iv) termination and post-translational modification.

Use diagrams wherever possible to illustrate your answer.

[16 marks]

Q6. (a) List the main roles of proteins in biological systems. [3 marks]



Given the above information, use the Henderson-Hasselbalch equation to verify the zwitterionic nature of alanine at pH 7. [6 marks]

(c) Define the four levels of protein structure and write notes explaining how each contributes to the final 3-D structure of the protein. [10 marks]

Q7. (a) List the main biological roles of lipids. [3 marks]

(b) Draw the full structures of the following fatty acids, *cis*- Δ^6 -decanoic acid and *trans*- Δ^6 -decanoic acid. [6 marks]

(c) Write brief notes on each of the different classes of lipids, using diagrams to illustrate your points. [10 marks]

Q8. Write an essay on glycolysis, including in your answer a discussion of the control of this metabolic process. [19 marks]