

# Cork Institute of Technology

## Higher Certificate in Science in Applied BioSciences – Award

(NFQ Level 6)

Autumn 2007

### Biochemistry

(Time: 3 Hours)

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

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

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

### Section A

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

- (a) Name and 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
- (b) List four of the main functions of lipids.
- (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 (i) the  $[H^+]$  and (ii) the pH of 0.05 M HCl?
- (f) 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.
- (g) Cellulose and starch are both polymers of glucose. What structural feature is responsible for their different properties?
- (h) Describe the processes of passive diffusion, facilitated diffusion and active transport, with respect to the transport of a molecule across a cell membrane.
- (i) List two different fates of pyruvate and explain why the fate of pyruvate differs under aerobic and anaerobic conditions.

- (j) 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).
- (k) Define **anabolism** and **catabolism**.
- (l) 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.** Describe how you would proceed in making up each of the following solutions:

- (a) 1.7 L of 30% (w/v) glycerol (glycerol is a thick, viscous liquid). [3 marks]
- (b) 10 ml of 100 mM NaCl containing 500  $\mu$ M MgSO<sub>4</sub>. Both NaCl and MgSO<sub>4</sub>·2H<sub>2</sub>O are available. (Atomic wt. Na = 22.99; Cl = 35.46; Mg = 24.3; S = 32.1; H = 1.01; O = 16.00). [6 marks]
- (c) 0.8 L of a 0.05 M phosphate buffer, pH 7.4. The following salts are available; NaH<sub>2</sub>PO<sub>4</sub>·H<sub>2</sub>O (molecular wt = 138) and Na<sub>2</sub>HPO<sub>4</sub>·H<sub>2</sub>O (molecular wt = 268.07). The pK<sub>a</sub> of the buffer is 7.2. [10 marks]

- Q3.** (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) A solution containing NAD<sup>+</sup> and NADH had an absorbance (in a 1 cm cuvette) of 0.311 at 340 nm, and 1.2 at 260 nm. Both NAD<sup>+</sup> and NADH absorb at 250 nm but only NADH absorbs at 340 nm. The extinction coefficients ( $\epsilon$ ) are given below:

Compound	$\epsilon$ (M <sup>-1</sup> cm <sup>-1</sup> )	
	<u>260 nm</u>	<u>340 nm</u>
NAD <sup>+</sup>	18,000	$\approx 0$
NADH	15,000	6220

Using the Beer-Lambert Law, calculate the concentrations of NAD<sup>+</sup> and NADH in the solution. [10 marks]

**Q4.** Write brief, informative notes on each of the following;

- (a) Tests to identify mutagenic chemicals
- (b) Edman degradation
- (c) DNA sequencing
- (d) Random and systematic experimental error

[19 marks]

## Section C

(Structural and Metabolic Biochemistry - 38 marks)

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

**Q5. (a)** List the main roles of proteins in biological systems.

[4 marks]

(b) Describe how scientists proved that the final shape of a protein is governed by its amino acid sequence. [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. [9 marks]

**Q6.** Write an essay on glycolysis under the following headings –

- (i) energy-consuming reactions,
- (ii) energy-yielding reactions and
- (iii) control of the rate of glycolysis.

[19 marks]

**Q7.(a)** Write brief notes on the structure and function of tRNA, rRNA and mRNA. [6 marks]

(b) Write a short essay on **translation**, including the following topics in your answer

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

*Use diagrams wherever possible to illustrate your point.*

[13 marks]

- Q8.** (a) The following data was obtained for an enzyme-catalyzed reaction;

<u>[Substrate] (<math>\mu\text{M}</math>)</u>	<u><math>v_o</math> (<math>\mu\text{mol/ml/20 min}</math>)</u>
2.0	0.150
4.0	0.200
8.5	0.275
12.5	0.315
17.0	0.340
20.0	0.350
80.0	0.360

Use two different graphical methods to determine  $K_M$  and  $V_{\max}$  for the enzyme? [14 marks]

- (b) Which method would you consider more accurate? Explain your reasoning. [5 marks]