

**CORK INSTITUTE OF TECHNOLOGY**  
**INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ**

**Autumn Examinations 2009**

**Biochemistry Legacy**

**School:** Science

**Programme Title:** Higher Certificate in Applied Biosciences

**Programme Code:** CR\_SBIOS\_2

**External Examiner(s):** Prof. Gary Walsh

**Internal Examiner(s):** Dr. Heloise Tarrant

**Instructions:** Attempt five questions.

Question 1 **section A** is compulsory.

Attempt **two** questions from **section B**, and **two** questions from **section C**.

**Duration:** 3 hours

**Sitting:** Autumn 2009

**Note to Candidates:** Please check the Programme Title and the Module Title to ensure that you have received the correct examination paper.  
If in doubt please contact an Invigilator.

## 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  $\text{MgSO}_4$ . Both NaCl and  $\text{MgSO}_4 \cdot 2\text{H}_2\text{O}$  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;  $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$  (molecular wt = 138) and  $\text{Na}_2\text{HPO}_4 \cdot \text{H}_2\text{O}$  (molecular wt = 268.07). The  $\text{pK}_a$  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  $\text{NAD}^+$  and NADH had an absorbance (in a 1 cm cuvette) of 0.311 at 340 nm, and 1.2 at 260 nm. Both  $\text{NAD}^+$  and NADH absorb at 250 nm but only NADH absorbs at 340 nm. The extinction coefficients ( $\epsilon$ ) are given below:

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

Using the Beer-Lambert Law, calculate the concentrations of  $\text{NAD}^+$  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) 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 an experiment proving 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. [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]