Cork Institute of Technology

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

(SHERB_8_Y2)

Summer 2008

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
Dr. D. Corrigan
Dr. D. Clare

Section A

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

(a) With respect to laboratory measurements, define the terms **error**, **accuracy** and **precision**.

(b) Name and draw five different functional groups that can be found on biomolecules.

(c) You are given a test tube containing a solution of D-glucose. What three forms of that glucose will be present in the test tube at any one time? Why does this occur?

(d) The melting points of a series of 18-carbon fatty acids are as follows: stearic acid = 69°C, oleic acid = 13°C, linoleic acid = -5°C and linolenic acid = -11°C. What structural feature of these 18-carbon fatty acids could cause these differences in melting point?

(e) Define the terms **pH**, **pK_a** and **pI**.

(f) Define the Beer Lambert Law. The A_{340} of a solution of NADH was found to be 0.35. What was the concentration of this solution? (ε_{NADH} = 6220 $M^{-1}cm^{-1}$).

(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) Draw the structure of a triglyceride and a phosphoglyceride.

(i) Integral membrane proteins are involved in transport of molecules across the cell membrane. Define the terms **passive** and **active** transport, and distinguish between **symport** and **antiport** mechanisms.

(j) Distinguish between an **aldose** and a **ketose**. To which of these classes of carbohydrate does glucose belong?

(k) Calculate the number of millilitres of 2M H_2SO_4 required to prepare 850 ml of a 0.05 M H_2SO_4 solution.

(l) Distinguish between a **coenzyme** and a **prosthetic group**. Name two coenzymes commonly involved in redox reactions.

Section B

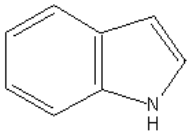
(Analytical Biochemistry - 38 marks)

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

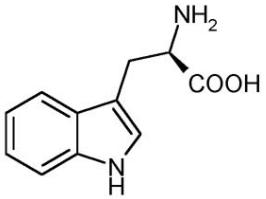
Q2. (a) Explain why a weak acid or base can effectively buffer pH, while a strong acid or base cannot. Use titration curves to illustrate your answer. [5 marks]

(b) At pH 7, tryptophan crosses a lipid bilayer approximately 1,000 times more slowly than indole, a closely related molecule. From the structures of these molecules suggest an explanation of this observation. *(The pKa values of the acid and base groups are 2.4 and 9.4, respectively).*

Indole



Tryptophan



[5 marks]

(c) Describe in detail the preparation of 0.7 L of a 0.03 M phosphate buffer, pH 7.5, from $NaH_2PO_4 \cdot H_2O$ (fw, 138) and $Na_2HPO_4 \cdot H_2O$ (fw, 268.07) salts. ($pK_a = 7.2$) [9 marks]

Q3. (a) Write a brief note on **fixed time** and **continuous monitoring** enzyme assays, listing the factors you would take into consideration when deciding which of the two methods to employ. [5 marks]

When using a fixed time assay, what conditions of substrate and product concentration are necessary to ensure the rate measured is the initial velocity? [5 marks]

(b) The results of an LDH assay are as follows:

[Pyruvate] (mM)	υ_o (μmol/min)
1.5	0.21
2.0	0.24
3.0	0.28
4.0	0.33
8.0	0.40
16.0	0.45

Use a Lineweaver-Burk plot to determine the values of V_{max} and K_m for this LDH preparation. [9 marks]

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

(a) *In vitro* assays for mutagenic chemicals.

(b) Define protein denaturation and write notes on three different ways in which a protein may be denatured.

(c) 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) The rate of metabolic pathways is regulated by controlling (1) the amounts of enzymes, (2) the catalytic activities of enzymes and (3) the accessibility of substrates. Write brief notes on each of these three control strategies. [7 marks]

(b) Write an essay on glycolysis, including a discussion of the mechanisms used to control the rate of the pathway. [12 marks]

Q6. (a) What are sterioisomers / enantiomers? Give a simple example. [3 marks]

(b) Although lactose exists as two anomeric forms, no anomeric forms of sucrose exist. Explain why, and name a chemical test that will distinguish between lactose and sucrose. [6 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. [10 marks]

Q7. (a) Describe how DNA is packaged to fit within the nucleus. [4 marks]

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

a. structure of ribosomes and tRNA

b. initiation

c. chain elongation and formation of the peptide bond, and

d. termination and post-translational modification. [15 marks]

Q8. (a) List the four types of non-covalent interaction that are important in protein structure. Explain why these weak non-covalent bonds allow an enzyme/receptor protein to bind specifically with its substrate/ligand and not with any other molecule present in its environment. [6 marks]

(b) Draw a diagram illustrating the condensation of two amino acids to form a dipeptide. Explain how the properties of the peptide bond contribute to the overall structure of a protein. [6 marks]

(c) Write notes on the four levels of protein structure. [7 marks]