NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

BACHELOR OF SCIENCE HONOURS DEGREE EXAMINATIONS

DEPARTMENT OF APPLIED BIOLOGY AND BIOCHEMISTRY

THEORY: CHEMISTRY OF BIOMOLECULES SBB 2101

DECEMBER 2005

3 HOURS (100 marks)

INSTRUCTIONS

Answer Four (4) Questions. Each question carries 25 marks. Where a question contains subdivisions, the mark value for each subdivision is given in brackets. In multiple choice questions, some questions may have more than one correct answer and in such cases, negative marking will apply to incorrect answers. Illustrate your answer where appropriate with large, clearly labelled diagrams.

1.(a) What do you understand by the following terms:

(i) primary bond (1 mark)

(ii) secondary bond (1 mark)

(iii) hydrogen bonding (1 mark)

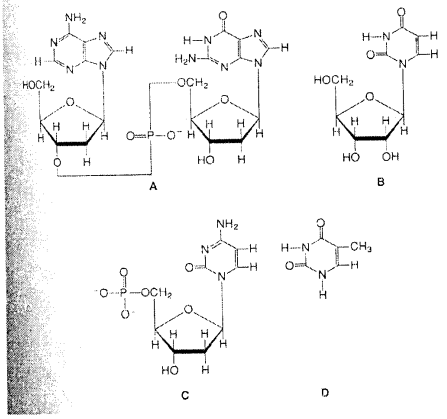
(iv) hydrophobic interaction (1 mark)

(v) ionic bonding (1 mark)

(b) The concentration of water is 55.5 M. Show how this is so. (5 marks)

(c) Water is said to be a "universal solvent". This statement is not literally true but water certainly dissolves more types of substances and in greater amounts than any other solvent. Write an account explaining why and how solutes dissolve in water. (15 marks)

2.(a)



Which of the structures above

(i) contains ribose? (1 mark)

(ii) contains a purine? (1 mark)

(iii) a phosphate monoester? (1 mark)

(iv) a nucleoside? (1 mark)

(v) would be found in RNA? (1 mark)

(b) Compare and contrast B-DNA and A-DNA structures. (8 marks)

(c) (i) If a polypeptide has 800amino acid residues, what is its approximate molecular weight? (2 marks)
(ii) Write an equation illustrating saponification. Name all the products in the equation. (4 marks)

(d) In an experiment, double stranded DNA was placed in a solution of tritiated water. It was observed that hydrogens associated with the bases readily exchanged with protons in the solution. The greater the percentage of the AT base pairs in the DNA, the greater the rate of exchange. Explain fully what these observations suggest. (4 marks)

(e) α-amylase
(i) removes glucose sequentially from the reducing end of starch.
(ii) breaks the internal α-1,6 glycosidic bonds of starch.
(iii) breaks the β-1,4 glycosidic bonds of starch.
(iv) cleaves the β-1,4 glycosidic bonds of lactose.
(v) can hydrolyze cellulose in the presence of an isomerase. (2 marks)

3.(a) Draw the structure of a tetrapeptide named aspartyllysyltyrosylisoleucine (10 marks)

(i) Give the name of the peptide drawn in (a) in the one letter abbreviation format. (2 marks)

(ii) Which amino acid absorbs light maximally at 280 nm? (1 mark)

(iii) How many peptide linkages are in the peptide (1 mark)

(b) The table below show the pK_a and pI values of some amino acids.

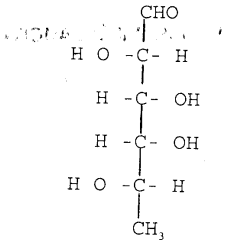
Amino Acid	$pK_{a\text{-}COOH}$	$pK_{a\text{-}NH2}$	$pK_{a\text{-}Rgroup}$	pI
Alanine	1.96	10.28	8.18	5.1
Cysteine	2.13	8.59	10.58	9.7
Lysine	2.34	9.87	-	6.1

(i) Write equations depicting the dissociation of cysteine at the different pKa values and calculate its pI. (6 marks)

(ii) Which of the amino acid will provide a suitable buffer at pH 10 when titrated with HCl and why? (2 marks)

(c) What is the pH of the resultant solution when 3 ml of 0.1 M acetic acid (pK_a=4.76) is mixed with 7 ml 0.1 sodium acetate. (3 marks)

4.(a) The structure of the deoxyaldose L (-) fucose is shown below.



Draw: (i) its enantiomer (2 marks)
(ii) the diastereomer (2 marks)
(iii) the Harworth representation of its methyi glycoside. (5 marks)

(b) A sample of bread gives a faint positive colour in the Somogyi-Nelson method for determining reducing sugars. After an equivalent bread sample has been masticated, the test becomes markedly positive. Explain these observations. (4 marks)

(c) Compare and contrast the structures of starch and cellulose (12 marks)

5.(a) Which of the following is **true**? To convert from the Fischer representation of an aldohexose to the Harworth representation.

(i) hydroxyls to the left must point upwards.
(ii) hydroxyls to the left must point downwards.
(iii) the terminal - CH_2OH group must point upwards.
(iv) the terminal - CH_2OH group must point downwards.
(v) the anomeric OH group in the α form points upwards.
(vi) the anomeric OH group in the α form points downwards.
(vii) the anomeric OH group in the β form points upwards.
(viii) the anomeric OH group in the β form points downwards. (8 marks)

(b) (i) If the region of one strand of a Watson-Crick DNA double helix has the sequence 5'ATGCTAGCAT3'. What is the sequence of the complimentary region of the other strand? (2 marks)

(ii) What is the feature of the complementary strand? (1 mark)

(c) A DNA molecule in the A-helical form is composed of 7800 base pairs.
(i) How many helical turns are present? (2 marks)

(ii) How long is the linear double helical form of this molecule (2 marks)

(d) Write notes on the bonds responsible for maintaining protein structure. (10 marks)

6.(a) The structures below show the four naturally occurring fatty acids.

(i) $CH_3(CH_2)_{14}CO_2H$

(ii) $CH_3(CH_2)_7CH{=}CH(CH_2)_7CO_2H$

(iii) $CH_3(CH_2)_4CH{=}CHCH_2CH{=}CH(CH_2)_7CO_2H$

(iv) $CH_3CH_2CH{=}CHCH_2CH{=}CHCH_2CH{=}CH(CH_2)_7CO_2H$

Give the common name and the Δ convention abbreviation for each of the fatty acids. (8 marks)

(b) Write short notes on the biological functions of lipids. (5 marks)

(c) Describe the structure and biological function of testosterone. (12 marks)

END OF EXAMINATION

even numbers