THE OPEN UNIVERSITY OF SRI LANKA

B.Sc. DEGREE PROGRAMME / STAND ALONE COURSE 2017/2018

LEVEL 5-FINAL EXAMINATION

CMU 3124/CME 5124

CHEMISTRY OF BIOMOLECULES

DURATION: 2 HOURS

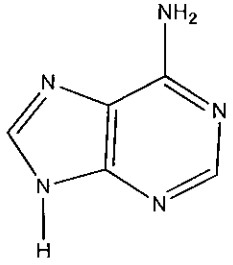
Date: 05/10/2018 2.00 p.m. - 4.00 p.m.

Answer any FOUR questions only out of given 6 questions.

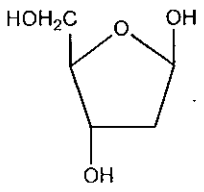
If you have answered more than four questions, only the first four answers will be marked.

1. (a) (i) Indicate the complimentary sequence in the nucleotide **AATCAG.**

(ii) Draw the structure of deoxyriboseadenosine 3′-monophosphate.



Adenine



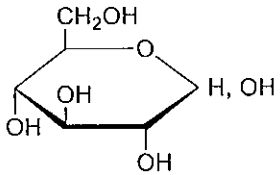
2-Deoxyribose

(iii) Giving reasons state whether the structure you have drawn in Q1(a)(ii) is a nucleoside or a nucleotide.

(30 marks)

(b) "Amylose is a polysaccharide with α (1→4) glycosidic linkages of glucose".

(i) Given the structure of glucose is as below, Draw the chemical structure of amylose.



(15 marks)

(ii) Draw the structure of α-monostearin. (stearic acid - 18:0)

(10 marks)

(c) (i) Name the two nucleic acids found in biological systems. (08 marks)

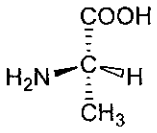
(ii) Draw the H-bonding that could form in the base pairing guanine and cytosine. (09 marks)

(iii) What other forms of nucleotides function as energy carriers for metabolic reactions? (08 marks)

(d) (i) Name the three main types of RNA. (09 marks)

(ii) Explain briefly the functions of t-RNA. (11 marks)

2. (a) The chemical structure of alanine is given below.



alanine

(i) Classify whether the above structure is D or L alanine. (06 marks)

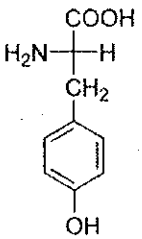
(ii) Designate the stereogenic center *(R/ S)* of above amino acid using Cahn-Ingold-Prelog system of nomenclature. (12 marks)

(iii) Explain why alanine behave as ampholytes. (12 marks)

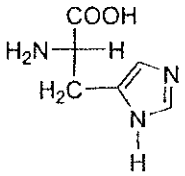
(b) Consider the all possible tripeptides made of amino acids tyrosine (tyr), histidine (his) and proline (pro), answer the following questions.

(i) Give each possible tripeptide using 3-letter code. (12 marks)

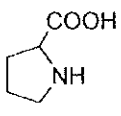
(ii) Of the tripeptides in Q2(b)(i) above, draw the chemical structure of the tripeptide which has N-terminal tyrosine and C-terminal proline at pH=0.



tyrosine (tyr)



histidine (his)

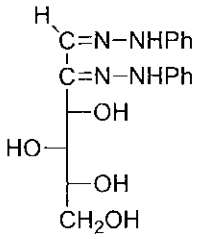


proline (pro)

(28 marks)

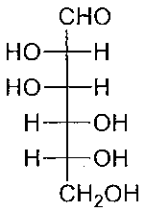
(c) (i) Name two groups of organic compounds which can react with phenylhydrazine to form the product phenylhydrazone. (10 marks)

(ii) Two aldoses gave the following osazone structure upon treatment with phenylhydrazine. Give the Fischer projection formulae of the these aldohexoses.



(20 marks)

3. (a) D-glucose is a C-2 epimer of D-mannose. The structure of D-mannose is given below.



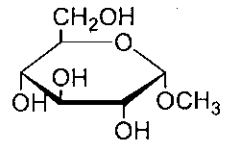
D-mannose

(i) What are epimers? (05 marks)

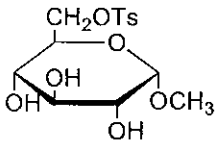
(ii) Draw the Fischer projection formula and all the possible Haworth projection formulae of D-glucopyranose. (10 marks)

(iii) Draw all the possible Haworth projection formulae of D-glucofuranose. (10 marks)

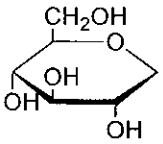
(b) Draw the structures of the products (P - T) of following reactions.

(i) 

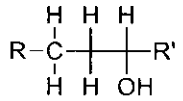
TsCl, Pyridine/ 0 oC → P

(ii) 

(i) NaN_3/ Acetone, H_2O; (ii) LiAlH4 → Q

(iii) 

(i) $CH_3SO\bar{C}H_2^+$ Na, DMSO, 5h; (ii) CH3I, 25 oC → R; 8% HCl → S

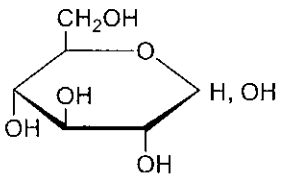
(iv) 

+ HIO_4 → T

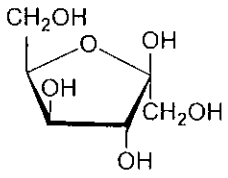
(25 marks)

(c) The disaccharide $C_{12}H_{22}O_{11}$ which does not reduce Fehling's solution is hydrolyzed by β-fructosidase. Methylation followed by hydrolysis of this disaccharide yielded 1,3,4,6-tetra-O-methyl-D-fructose and 2,3,4,6-tertra-O-methyl-D-glucose.

The structures of D-glucose and D-fructose are shown below.



D-glucose

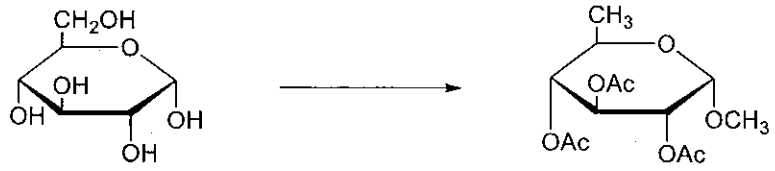


D-fructose

(i) Deduce the structure of the above disaccharide. (15 marks)

(ii) Draw the Haworth projection formulae of the hydrolyzed products of above disaccharide. (10 marks)

(d) How would you attempt to do the following conversion? Indicate the reagents and structures of each step.



(25 marks)

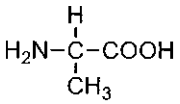
4. Amino acid titration curves give important information regarding pKa and pI of amino acids.

(a) Define pI (isoelectric point) of an amino acid.

(5 marks)

(b) Draw the predominant structural forms of alanine when the pH of the medium is changed from strongly acidic, strongly basic and iso electric point pH.

The structure of alanine is given below.



alanine

(15 marks)

(c) Following is a titration curve of an amino acid with an ionizable side chain. Identify the amino acid using the graph and information given in Table 1 with explanation.

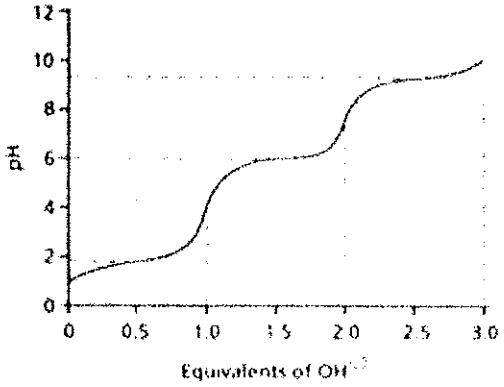


Table 1: pk_a of α-COOH, α-NH_3 and side chains of selected amino acids

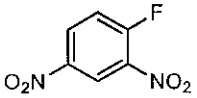
Amino acid	pk_a of α-COOH	pk_a of α-NH_3	pk_a of the side chain
Arginine	2.1	9.0	12.5
Aspartic acid	2.1	9.8	3.9
Cysteine	1.7	10.4	8.3
Glutamic acid	2.2	9.7	4.3
Histidine	1.8	9.2	6.0
Lysine	2.2	9.0	10.5
Tyrosine	2.2	9.1	10.1

(20 marks)

(d) You are provided with a mixture of three proteins with isoelectric points 3.2, 4.1 and 7.2 respectively and a cation exchange column for further purification of the mixture of proteins. Explain the elution pattern of the proteins when the column is first eluted with a buffer of pH 6.5 and then with a buffer of higher pH.

(10 marks)

(e) Explain how you would use Sanger's method with 2,4-dinitroflurobenzene for the analysis of N-terminal of an unknown protein with relevant chemical reactions.

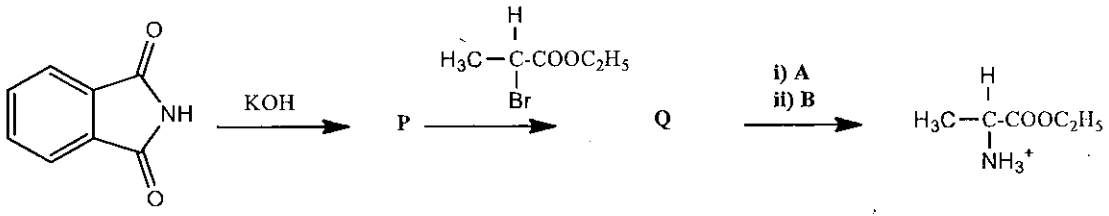


2,4-dinitroflurobenzene

(10 marks)

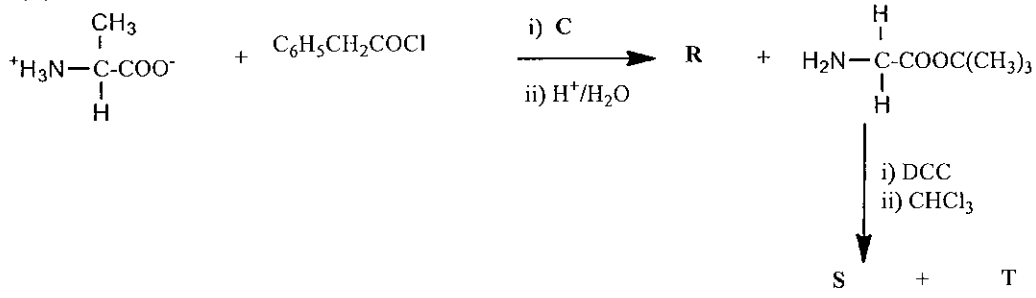
(f) Give the missing reagents (**A – C**) and products (**P – Y**) for any **TWO (02)** of the following transformations.

(i)



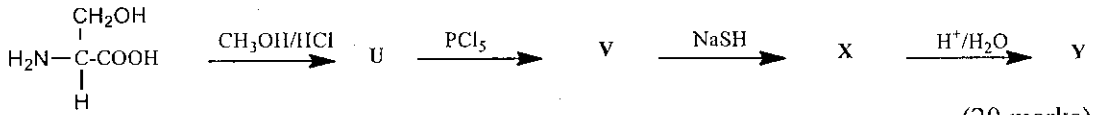
(20 marks)

(ii)



(20 marks)

(iii)



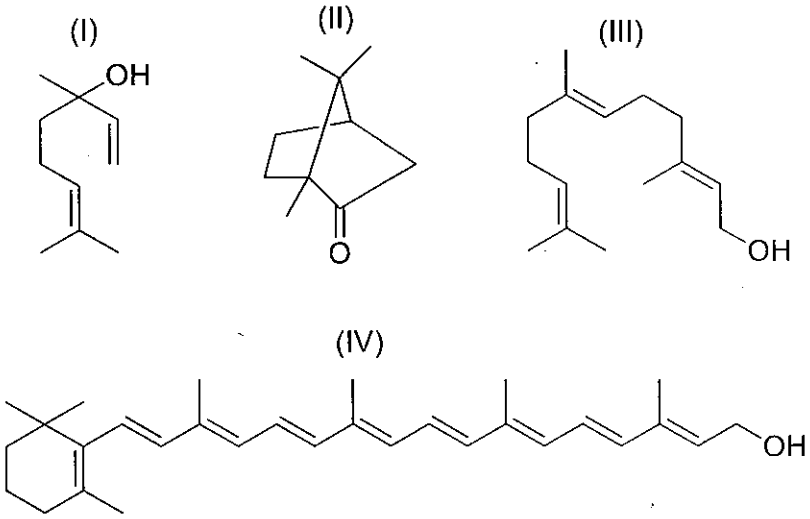
(20 marks)

5. (a) (i) Draw the structure of β-oleoyl-α-palmitylstearin, which gives one molecule of oleic acid 18:1 (n-9) and one molecule of palmitic acid 16:0 and one molecule of strearic acid 18:0 on hydrolysis. (15 marks)

(ii) Draw the short hand notation of the triglyceride you have drawn in Q5 (a) (i) above. (05 marks)

(b) (i) State the isoprene rule. (08 marks)

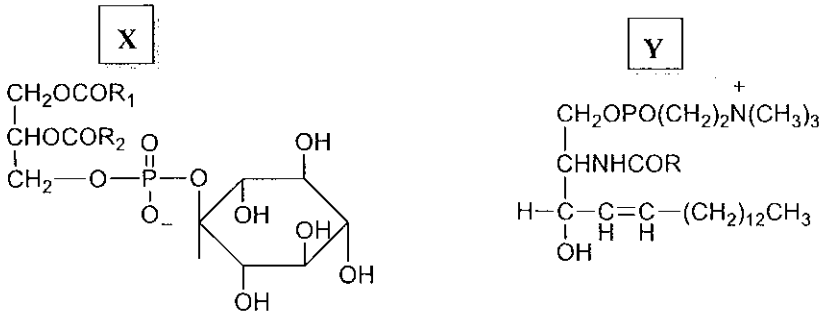
(ii) Dissect the following terpenes (I) - (IV) (by indicating the head and tail) into isoprene units. (20 marks)



(iii) State the class of terpenes of the above structures (I) - (IV). (12 marks)

(c) (i) What are glycerophospholipids? (10 marks)

(ii) Identify the products of hydrolysis of X and Y given below.



(24 marks)

(iii) Name the subgroup of phospholipid the compound Y belongs to. (06 marks)

6. (a) Answer any **one (01)** part.

(i) Describe what are anabolic and catabolic reactions giving examples.

(ii) What are endergonic and exergonic reactions? Give the relationship between them in biochemical pathways.

(30 marks)

(b) Indicate the reaction of the following coenzymes (cofactors) which are involved in the enzymatic reaction.

i. Coenzyme A

ii. Nicotinamide adenine dinucleotide (NAD^+)

iii. Pyridoxal phosphate (PLP)

iv. Thiamine pyrophosphate (TPP)

(20 marks)

(c) Compare any **two (02)** of the following pairs.

i. Noncompetitive inhibition and uncompetitive inhibition in metabolic reactions

ii. Metalloenzymes and metal-activated enzymes

iii. Co-substrate and prosthetic group

(20 marks)

(d) Answer all 04 parts.

(i) What is meant by 'hypovitaminosis'? (04 marks)

(ii) Name four vitamins that cause 'hypovitaminosis'. (08 marks)

(iii) List two important roles played by vitamin B_{12} in the body. (12 marks)

(iv) Explain why people who are solely on vegetarian diet prone to vitamin B_{12} deficiency. (06 marks)