THE OPENUNIVERSITY OF SRI LANKA

B.Sc. DEGREE PROGRAMME / STAND ALONE COURSE 2016/2017

LEVEL 5-FINAL EXAMINATION

CMU 3124/CME 5124
CHEMISTRY OF BIOMOLECULES

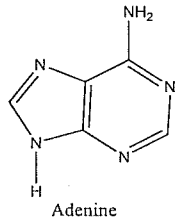
DURATION: 2 HOURS

09th August 2017 1.00 p.m. - 3.00 p.m.

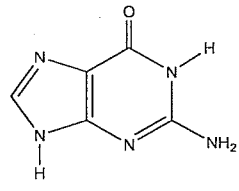
Answer any FOUR questions only.

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

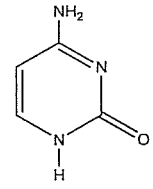
1. (a) (i) What are the components of the biopolymer deoxyribonucleic acid (DNA)?
   (ii) DNA consists of two polynucleotide chains which are in a double helix. On hydrolysis, it is found that the ratios of C:G and A:T are always 1:1. How are these ratios consistent with the double helix concept?
   (iii) How do the complementary bases interact with one another?
   (iv) Draw structures to show how base pairing accounts for the ratio of bases in the above question.



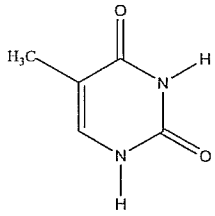
Adenine



Guanine



Cytosine



Thymine

(50 marks)

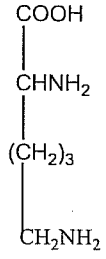
(b)Explain briefly the importance of water in a living cell.

(20 marks)

(c)Explain briefly the functions of nucleic acids

(30 marks)

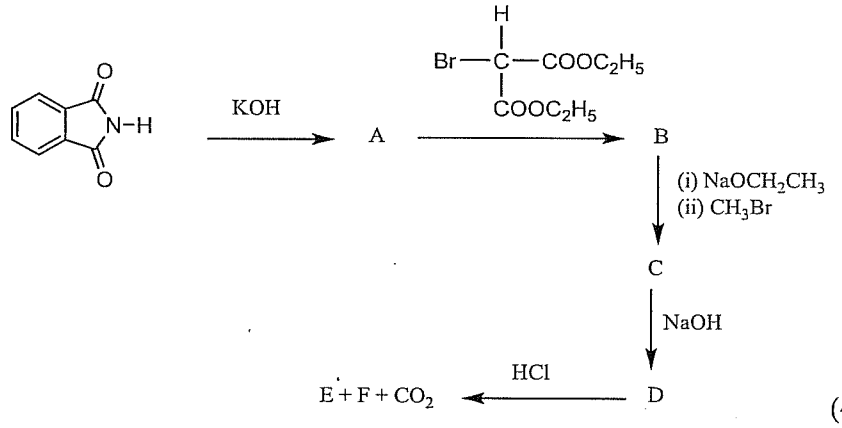
2. (a) Write equilibrium equations for the dissociation of lysine, a basic amino acid and calculate its isoelectric point given that pKa_1=2.18, pKa_2=8.95 and pKa_3=10.53.



Lysine

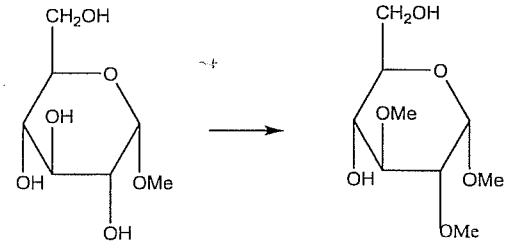
(30 marks)

b) Identify the products (A – F) of the following reaction scheme.



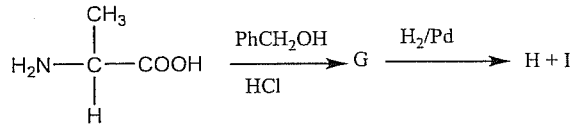
(40 marks)

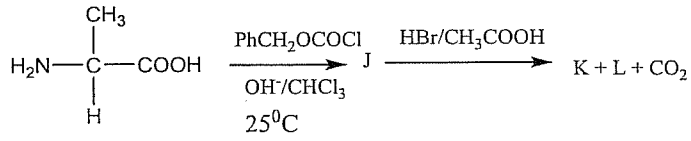
c) How would you effect the following conversion?



(30 marks)

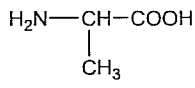
3. (a) Draw the structures of the products (G-L) you would expect in the following reactions.

(i) 

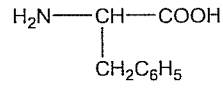
(ii) 

(30 marks)

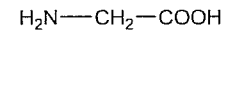
(b) Write the structure of the pentapeptide Ala.Gly.Lys.Phe.Gly. Give the structure only of the DNP derivative obtained when the pentapeptide Ala.Gly.Lys.Phe.Gly. is treated with 2,4-dinitroflurobenzene and then hydrolysed with 6N HCl. What is the structure of the product obtained when the pentapeptide is treated with phenylisothiocyanate followed by mild acid hydrolysis? Give the mechanism for this reaction.



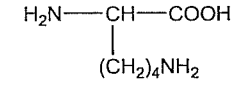
Alanine



Phenylalanine



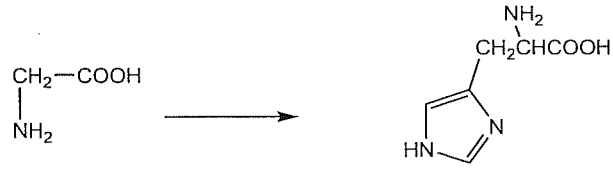
Glycine



Lysine

(40 marks)

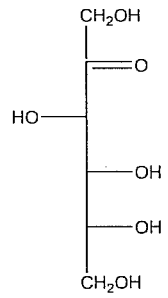
(c) How would you effect the following transformation? Give the necessary reagents and write the mechanism for the reaction.



Glycine — Histidine

(30 marks)

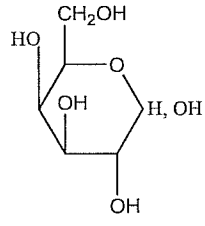
4. (a) Draw the Haworth projection of the anomer of D-fructofuranose.



D-fructose

(10 marks)

(b) The disaccharide lactose $C_{12}H_{22}O_{11}$ is hydrolysed by β-gycosidase and reduces Fehling's solution. Methylation followed by hydrolysis of lactose yielded 2,3,6-tri-O-methy-D-glucose and 2,3,4,6-tetra-O-methy-D-galactose. Deduce the structure of lactose.



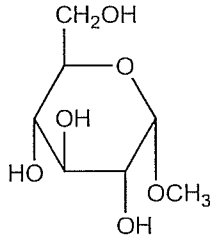
D-galactose

(30 marks)

(c) Draw the structures of the major product when methyl α-D-glucopyranoside is treated with

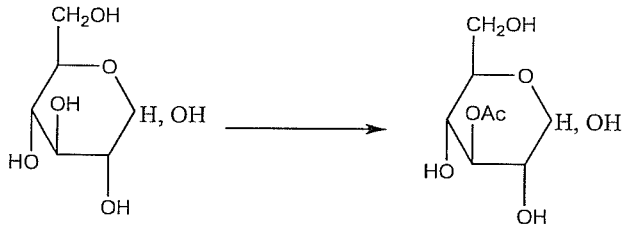
(i) $PhCH_2Br/NaH/DMF$

(ii) $(CH_3)_3SiCl/Pyridine$



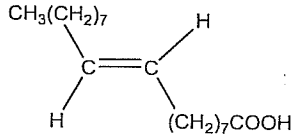
methyl α-D-glucopyranoside (30 marks)

(d) How would you effect the following conversion?



(30 marks)

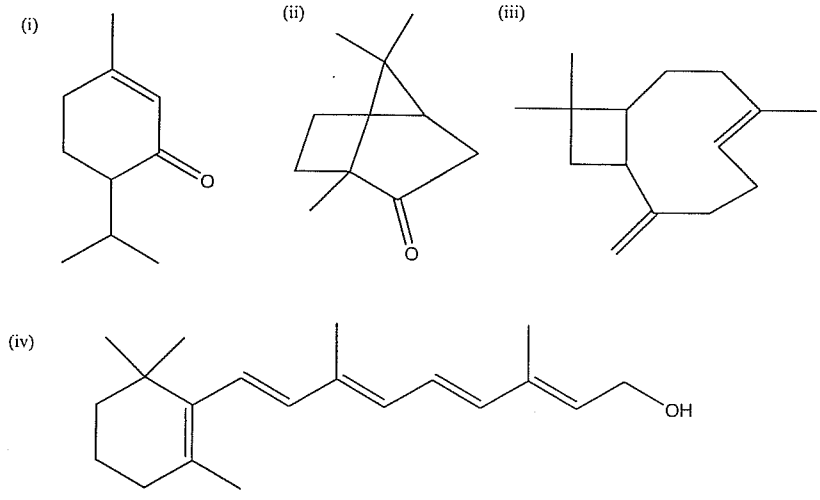
5. (a) (i) Give the IUPAC name of the following structure.



(ii) Draw the structure of 20:5 (n-3) fatty acid.

(20 marks)

(b) Dissect the following terpenes into head-tail linkage and deduce the number of isoprene units in it. Depending on the number of isoprene units indicate the class of terpene.



(30 marks)

(c) Write a brief account on autoxidation of fatty acids.

(20 marks)

(d) Give reasons to show why the following steroids are biologically active.
(i) Cholesterol
(ii) Bile acids
(iii) Adrenal corticoids

(30 marks)

6.

(a) Metabolic reactions can be classified according to (a) product formation or (b) energy involved.

i. Indicate the main types of metabolic reactions under each category (a) and (b).

ii. The following isomerization reaction takes place in glycolysis.

Equilibrium ratio of GAP to DHAP is 0.0475 at 25°C and pH 7. Show that this reaction is not spontaneous under these conditions. ($R = 1.987x10^{-3}$ kcal mol^{-1} K^{-1})

(25 marks)

(b) Enzymes act as catalysts in biological reactions by lowering activation energy.

i. What is meant by activation energy?

ii. What is specificity in enzyme action on substrates? Explain giving different types of specificities shown by enzymes.

iii. Describe the advantages and disadvantages of enzyme specificity.

(25 marks)

(c) Pyridoxal -5'- phosphate(PLP) is a form of vitamin B_6 which plays a main role in amino acid metabolism.

i. Give major reactions that take place in amino acid metabolism.

ii. List down the health issues caused by vitamin B_6 deficiency.

iii. Describe why a high dose of vitamin B_6 is not recommended.

(25 marks)

(d) Biocytin is a co-enzyme that contains the prosthetic group biotin.

i. What is the difference between a prosthetic group and a co-substrate?

ii. Give the mechanism of action of biocytin in carboxylation reactions.

iii. What is the impact that raw eggs can make on biotin?

(25 marks)