(3)

The Open University of Sri Lanka
Faculty of Natural Sciences
B.Sc Degree Programme

165

Department	: Chemistry
Level	: 5
Name of the Examination	: Final Examination
Course Code and Title	**: CYU5304 (Chemistry of Biomolecules)**
Academic Year	: 2019/2020
Date	: 14/01/2019 20
Time	: 1.30 p.m to 3.30 p.m
Duration	: 2 hours
Index number	: .....

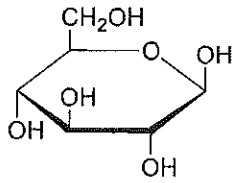
General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 4 questions in 7 pages.
3. Answer all questions.
4. Answer for each question should commence from a new page.
5. Draw fully labelled diagrams where necessary
5. Relevant log tables are provided where necessary.
6. Having any unauthorized documents/ mobile phones in your possession is a punishable offense
7. Use blue or black ink to answer the questions.
8. Circle the number of the questions you answered in the front cover of your answer script.
9. Clearly state your index number in your answer script

1. Answer Part (I) and any THREE (03) parts from (II) – (V).

Part I (Compulsory)

(I) Lactose ($C_{12}H_{22}O_{11}$) is a disaccharide composed of galactose and glucose. Its IUPAC name is β-D-Galactopyranosyl-(1→4)-D-glucose and galactose is a C-4 epimer of glucose. Answer the following questions by considering the Haworth projection formulae of D-glucose.



Haworth projection formulae of β-D-glucose

(a) What are epimers?
(b) Draw the Haworth projection formulae of C-4 epimer of β-D-glucose.
(c) Draw the Haworth projection formulae of lactose.
(d) Explain whether D-glucose and D-galactose could be distinguished by phenyl osazone formation with $PhNHNH_2$.
(e) State the reason for lactose intolerance.

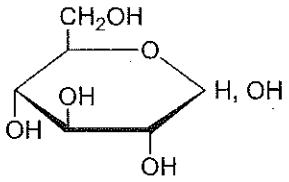
(25 Marks)

Answer any THREE (03) parts from (II) – (V)

(II) Starch is a polymer of glucose consisting two major components namely amylose and amylopectin.

(a) Draw the chemical structures of amylose and amylopectin. Clearly indicate the glycosidic linkages in both structures.

The structure of glucose is;

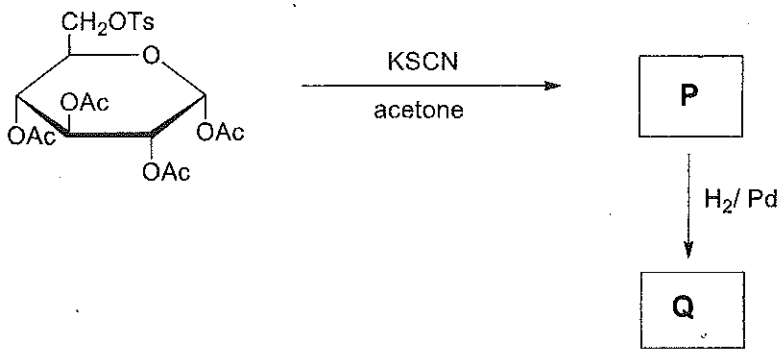


(b) What is the structural difference of amylose and cellulose in terms of glycosidic linkages?

(25 Marks)

(III) Draw the structures of the products (**P-U**) of following reactions.

(i)



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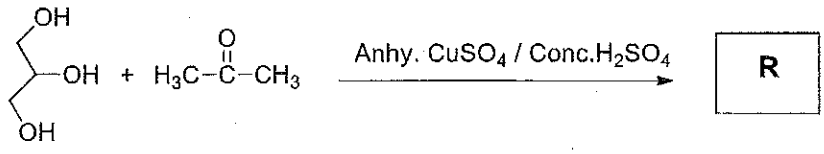
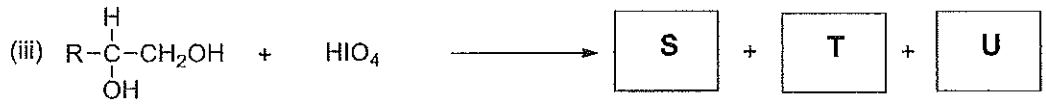


(iii)



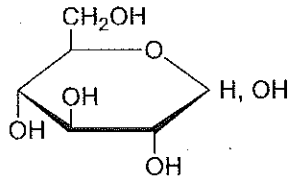
(25 Marks)

(IV) A disaccharide having a molecular formula $C_{12}H_{22}O_{11}$ is oxidized by Fehling's solution and resulted D-glucose and D-galactose as hydrolysis products. It is hydrolyzed by maltase α-glycosidase enzyme.

The methylation of the above disaccharide with excess methyl iodide and silver oxide formed 8 methyl ether groups. The methylation followed by acid catalyzed hydrolysis resulted 2,3,4,6-tertra-O-methyl-D-galactose and 2,3,4-tri-O-methyl-D-glucose.

D-galactose is a C-4 epimer of D-glucose.

The structure of D-glucose is shown below.



Deduce the structure of the above disaccharide.

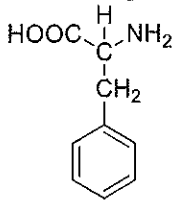
(25 Marks)

(V) How would you attempt to do the following conversion?

(25 Marks)

2. Answer parts (I), (II) and ONE from parts (III) or (IV)

(I) Consider the structure of phenylalanine (pKa values of 1.8 and 9.1) given below.



a) Draw the predominant forms of phenylalanine at the pH=0, 2, and 11.
b) Calculate the isoelectric point (pI) of phenylalanine.
c) Draw the Fischer projection formulae of D and L forms of phenylalanine.

(30 Marks)

(II) There are different enzymes and chemicals that could cleave peptide bonds.

a) Explain the function of trypsin and chymotrypsin in terms of site-specific cleavage of peptide bonds.

b) A researcher following enzyme cleavage of an unknown peptide obtained some sequences as given below.

Step 1. Treatment with trypsin yields three fragments with the following sequences (in the order of their length):

trp.gly.ala, ala.gly.thr.lys, tyr.leu.asp.arg

Step 2. Treatment with chymotrypsin gave the following three peptide fragments: **gly.ala, leu.asp.arg.trp, ala.gly.thr.lys.tyr**.

What is the sequence of the peptide? (20 Marks)

(III) Protecting the carbon and nitrogen ends of a protein is essential in polypeptide synthesis.

a) Give **Four** properties of protecting and activating groups used in polypeptide synthesis.
b) Give **TWO** methods that can be used for the protection of COOH group of an amino acid prior to polypeptide synthesis.
c) Explain **ONE** of the methods you mentioned in (b) with proper reactions indicating the introduction and the removal of the protecting group.

(50 Marks)

(IV) Suppose you have a mixture of four proteins as listed in the table below.

Protein	Protein	pI	Mol.Weight,/kDa
A	Ovalbumin	4.6	45
B	Myoglobin	7	17
C	Albumin	5	68
D	Ubiquitin	6.2	9

(a) Indicate the order in which these proteins will elute from a gel-filtration column (starting with the one that elutes first). You can use letters A-D (see table) for simplicity.

(b) Suppose that you loaded this mixture on a cation exchange column and used acetate buffer (pH 4.76) as eluent. List proteins that will appear in the flow-through (i.e. will not bind to the column).

(c) In order to elute those proteins that are immobilized on the column, you then apply a linear salt gradient, with NaCl concentration gradually increasing from 0 to 1 M. Indicate the order in which the proteins bound to the column will elute as the salt concentration increases.

(d) You repeat the same procedure as in (b) with an anion exchange column and the buffer is TRIS buffer (pH 8.0). List proteins that will appear in the flow-through (i.e. will not bind to the column).

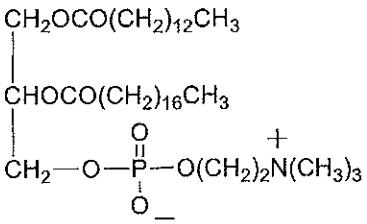
(e) You load this protein mixture and run it on the SDS PAGE. Predict the order in which the proteins will migrate on the SDS gel, starting with the fastest.

(50 Marks)

3. <u>Answer any four (4) out of (I to V).</u>

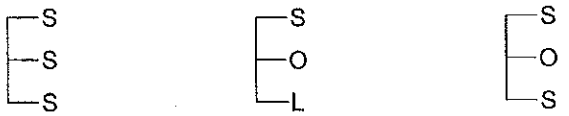
(I) (a) What are complex lipids?

(b) Draw the structures of the products formed after hydrolysis of phosphotriglyceride. Structure of phosphotriglyceride is given below.



(25 Marks)

(II) You have been provided with three triglycerides (X, Y and Z) which consist of stearic (18:0) [S], Oleic (18:1) [O] and linoleic (18:2) [L] acids. Short hand notations of X, Y and Z are given below.



X Y Z

(a) Draw the full structure of triglyceride X. (not the short hand notation)

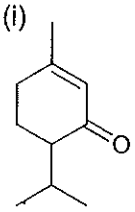
(b) Arrange these triglycerides in order of increasing melting point. Explain your answer.

(25 Marks)

(III) (a) Draw the structure of an isoprene unit and indicate the head and tail.

(b) Dissect the following terpenes into isoprene units.

(i)



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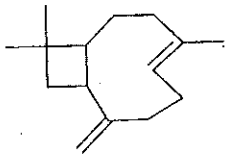

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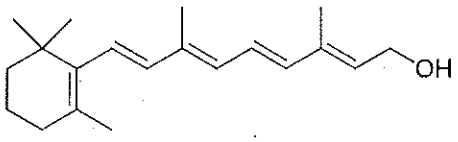


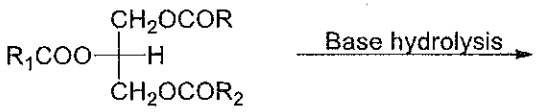
(25 Marks)

(IV) (a) What are glycoglycerolipids?

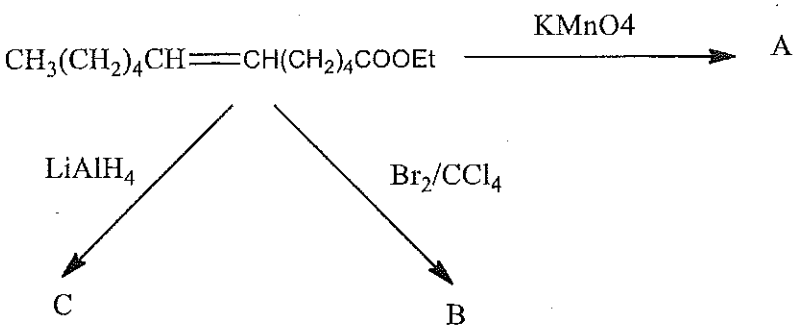
(b) Draw the structure of galactoglycerolipids formed with one molecule of β-D-galactose and two fatty acids RCOOH and R_1COOH.

(25 Marks)

(V) (a) Give the products of base hydrolysis of glyceride shown below.



(b) Give the products (A to C) from the following reactions.



(25 Marks)

(4) Answer all questions

(I) Classify the following reactions as anabolic or catabolic giving reasons.

(a) Digestion of sucrose
(b) Photosynthesis
(c) Decomposition of hydrogen peroxide

(15 Marks)

(II) Calculate the equilibrium constant (K) (at pH 7 and 25°C), for the interconversion of glucose-1-phosphate to fructose-6-phosphate which takes place in the following two successive reactions.

(Note: Showing the expression to obtain the final answer is sufficient.)

glucose-1-phosphate ⟶ glucose-6-phosphate

$\Delta G°$ at pH 7.0 and 25°C = -7.3 kJ/mol

glucose-6-phosphate ⟶ fructose-6-phosphate

$\Delta G°$ at pH 7.0 and 25°C = -1.7 kJ/mol

(25 Marks)

(III) Enzymes act as catalysts in biological reactions.

(a) State how enzymes act as catalysts.
(b) What is meant by enzyme specificity?
(c) Name four types of specificity in enzyme catalyzed reactions.
(d) How do allosteric enzymes differ from other enzymes?

(40 Marks)

(IV) Vitamin A is a fat-soluble vitamin which is an alcohol known as retinol.

(a) Explain why β-carotene is referred to as provitamin A? (8 Marks)
(b) Describe the effects of deficiency of vitamin A on epithelial cells in the body. (12 Marks)