THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

FIRST SEMESTER EXAMINATIONS - 2021

FOOD TECHNOLOGY - SECOND YEAR DEGREE

FT 212 INTRODUCTION TO FOOD CHEMISTRY

FRIDAY 18TH JUNE, 2021 - 8:20 A.M.

**TIME ALLOWED: 3 HOURS**

**INFORMATION FOR CANDIDATES:**

1. You have 10 minutes to read the paper. You must not begin writing in the answer book during this time.

2. **ANSWER ALL QUESTIONS**

3. All answers must be written in the answer books provided.

4. Write your name and number clearly on the front page. Do it now.

5. Calculators are permitted in the examination room. Notes and textbooks are not allowed.

6. Show all workings and calculations in the answer book.

**MARKING SCHEME**

| | |
|---|---|
| QUESTION 1 | [6 MARKS] |
| QUESTION 2 | [29 MARKS] |
| QUESTION 3 | [15 MARKS] |
| QUESTION 4 | [20 MARKS] |
| QUESTION 5 | [4 MARKS] |
| QUESTION 6 | [26 MARKS] |

**ANSWER ALL QUESTIONS**

1. Write **TRUE** or **FALSE** for each sentence.

(a) The tetrahedral arrangement of carbon and other atoms around the carbon nucleus of organic molecules causes conformational changes to the structures of these molecules, which in turn affect the biological, physical and the chemical properties of these organic molecules. [½ mark]

(b) The chemical element that is most common and significant to organic molecules is nitrogen because of its part in forming the backbone structures and because it serves as a source of energy in these molecules. [½ mark]

(c) The covalent bond found in lipid monomers is called ester bond whereas those which are found in carbohydrate and protein monomers are called peptide bond and glycosidic bond respectively. [½ mark]

(d) It is the resonance structures and the overall energy due to strain (steric, torsional and angle strains), which are responsible for the stability of the ring structures of organic molecules. [½ mark]

(e) The three important non-covalent bonds found in organic molecules, which are involved in intra-molecular and intermolecular bondings are hydrogen bond, hydrophobic interactions and electrostatic interactions. [½ mark]

(f) Axial position is where the substituent groups lie in the periphery of a sugar ring. [½ mark]

(g) Native starch granule is a birefringent material due to its highly ordered crystalline structures created by packing of amylopectin and amylose into double helix. [½ mark]

(h) Retrogradation is the process in which gelatinized starch become insoluble and unstable due to re-establishment of hydrogen bonds between amylose and amylopectin molecules in starch solutions under cold conditions. [½ mark]

(i) Most amino acids exist as zwitterions in the physiological environment in nature with a net charge of 1. [½ mark]

(j) The two secondary conformations of the secondary structure of protein are as a result of the extensive network of hydrogen bonds between the amide hydrogen atoms and the carboxyl oxygen atoms of the backbone chain, not the side chains. [½ mark]

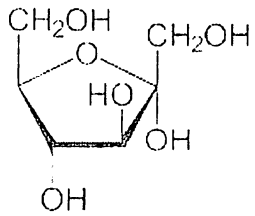
(k) Protein denaturation describes a change in a protein which causes an alteration in its physical and/or biological properties without the rupture of the peptide bonds. [½ mark]

(l) Denatured protein gets adsorbed onto aqueous-metal interface and cause fouling of heat-exchangers. [½ mark]

(Total = 6 marks)

2. (a) List THREE main classes of carbohydrate. [3 marks]

(b) (i) The α- D-fructofuranose structure is shown. Explain how this systematic name is derived. [2 marks]

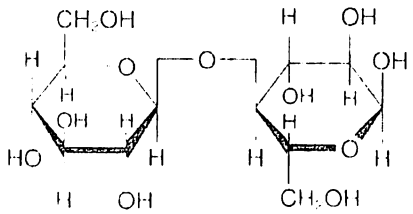



(ii) Name the enantiomer of α- D-fructofuranose in question 2 (b) (i). [1 mark]

(iii) Draw the Haworth structure of the enantionmer in question 2 (b) (ii). [2 marks]

(c) Draw the correct chair conformation of D-glucose and explain why glucose exists in this conformation. [6 marks]

(d) (i) Lactose structure is shown. Name and show the glycoside linkage in this disaccharide and its reducing and non-reducing ends. [2 marks]




(ii) Discuss whether or not lactose is a reducing sugar. [3 marks]

(e) Differentiate between ANY ONE of the following: [4 marks]

(i) Amylose and amylopectin.
(ii) Cellulose and glycogen.
(iii) Acid modified starch and pre-gelatinized starch.

(f) A 'nangu dish' was prepared by my neighbour for lunch. She began by firstly heating up the water in a saucepan. Then she gently and steadily added sago starch powder into the saucepan while continuously stirring. The solution began as a free-flowing cloudy mixture. However, as the temperature increased with continuous stirring, the solution began to

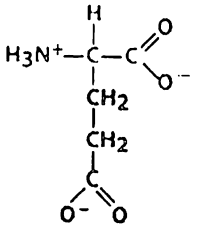
thicken and resist flow. At a temperature close to 100°C, the solution became opaque thick that it could not be stirred anymore. A few minutes later, the whole fluffy solution turned into a solid lump, which was served for lunch.
Discuss the process of what's happening to the sago starch solution at a molecular level in relation to its structure. [6 marks]

(Total = 29 marks)

3. (a) Amino acids are amphoteric. What happens when an acid or an alkali is added to their solutions? [4 marks]

(b) Polar uncharged amino acids do not have any charged ions, but they are quite soluble in water. Discuss with an example of an uncharged polar amino acid. [5 marks]

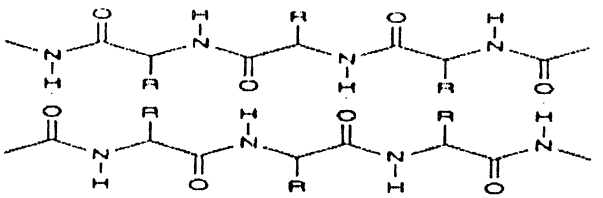
(c) Shown below is the structure of glutamic acid. Identify its side chain and explain why glutamic acid remains acidic at its physiological pH. [3 marks]



(d) List THREE classes of protein. [3 marks]

(Total = 15 marks)

4. (a) Shown is the beta (β) polypeptide chain with two strands. Identify one peptide bond, one hydrogen bond, one side chain, the backbone chain, the C-terminal and the N-terminal and label them accordingly. [3 marks]



(b) Differentiate between four levels of protein structure with a sketch of each structure. [8 marks]

(c) Describe ANY ONE of the following: [4 marks]

(i) Fibrous protein structure and give an example.
(ii) Globular protein structure and give an example.

(d) Most often raw egg is beaten first and then the whipped egg is added to the cake mixture. Dough is kneaded well before baking.
Discuss at the molecular level in relation to the structure of egg protein, what happens when egg is beaten and when the dough mixture is kneaded before baking. [5 marks]

(Total = 20 marks)

5. Write TRUE or FALSE for each sentence.

(a) The methods of fat extraction are rendering, pressing and the use of solvent extraction. [½ mark]

(b) The final product of lipid extraction process is refined oil. [½ mark]

(c) Fats and oils are processed to optimise their end-use by modifying their melting points and nutritional quality. [½ mark]

(d) Eutectic phase is the pitfall in blending which must be controlled to prevent unexpected hardening or softening of blended fats. [½ mark]

(e) One of the side reactions in partial hydrogenation with a negative effect is the migration of double bonds that effectively destroys the essential fatty acid. [½ mark]

(f) Hydrolytic rancidity is the oxidation of unsaturated fatty acids. [½ mark]

(g) Free radical is reactive intermediate in which the chemical species is one electron short of a stable configuration. [½ mark]

(h) Primary anti-oxidants are metal chelators whereas secondary anti-oxidants are chain breakers, radical scavengers and singlet oxygen quenchers. [½ mark]

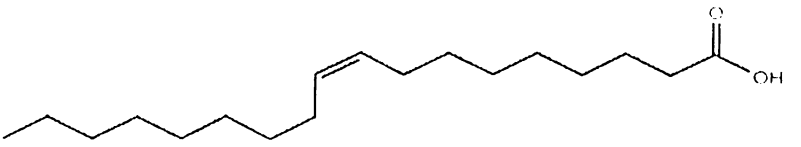
(Total = 4 marks)

6. (a) Describe the structure and composition of lipid that is most commonly found in plants and animals. [3 marks]

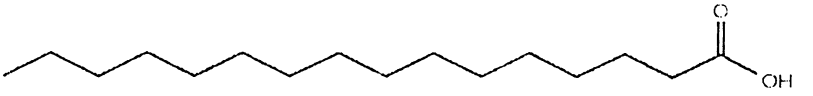
(b) A triacylglycerol molecule with a *sn*-system short hand name is *sn*-MOSt. Explain. Include the names of the isomers of *sn* MOSt in your explanation. [3 marks]

(c) Shown below are the structures of fatty acids. Name each of them and compare their similarities and differences in terms of their structures and physical properties. [5 marks]

(i)




(ii)




(d) Polymorphism of fat crystals affects quality and shelf-life of food products. Discuss why a production supervisor at Queen Emma chocolate factory must regularly monitor the tempering process. [3 marks]

(e) Explain the significance of refining process in oil production. [5 marks]

(f) Describe ANY ONE of the following methods of processing fats and oils: [3 marks]

(i) Fractionation.
(ii) Partial Hydrogenation.
(iii) Inter-esterification.

(g) Select ONLY ONE and answer. [4 marks]

(i) Describe THREE stages of lipid oxidation with the aid of chemical reactions.
(ii) Draw the curve of lipid oxidation and discuss the effects of anti-oxidant and pro-oxidant on the lag phase.
(iii) Discuss the functional uses of fats and oils in a named food system.

(Total - 26 marks)