



**NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY**

**Faculty of Health and Applied Sciences
Department of Health Sciences**

QUALIFICATION: BACHELOR OF MEDICAL LABORATORY SCIENCE	
QUALIFICATION CODE: 08BMLS	LEVEL: 5
COURSE: BIOCHEMISTRY/INTRODUCTION TO BIOCHEMISTRY	COURSE CODE: BIO521S/IBC521S
SESSION: JANUARY 2019	PAPER: THEORY
DURATION: 3 HOURS	MARKS: 100

SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER	Dr YAPO GUILLAUME ABOUA
MODERATOR:	Prof HABAUKA KWAAMBWA

INSTRUCTIONS	
<ol style="list-style-type: none">1. Answer all questions.2. Please write neatly and legibly.3. Do not use the left side margin of the exam answer book.4. No books, notes and other additional aids are allowed.5. Mark all answers clearly with their respective question numbers.	

Non-programmable calculator is allowed.

Attachment: Table of pK_a Values.

THIS QUESTION PAPER CONSISTS OF 7 PAGES (Including this front page)

Question 1: Multiple Choice

[10]

- 1.1 What best describes phospholipid molecules? (1)
- a. Their chemical formula is $(CH_2O)_n$
 - b. They form cell membranes
 - c. They are proteins
 - d. They are ionic
- 1.2 What structures are found in steroid molecules? (1)
- a. Molecular rings
 - b. Proteins
 - c. Waxes
 - d. Double helices
- 1.3 What monomers make up proteins? (1)
- a. Starches
 - b. Enzymes
 - c. Nucleic acids
 - d. Amino acids
- 1.4 Which of the following statements is INCORRECT? (1)
- a. Only L amino acids are found in the biological system
 - b. Glycine is optical inactive
 - c. Tyrosine is a modified amino acid
 - d. Seleno cysteine is 21st amino acid
- 1.5 Which out of the following amino acids carries a net positive charge at the physiological pH? (1)
- a. Leucine
 - b. Valines
 - c. Isoleucine
 - d. None of the above

- 1.6 Which out of the following amino acids is a precursor for a mediator of allergies and inflammation? (1)
- a. Histidine
 - b. Tyrosine
 - c. Phenyl Alanine
 - d. Tryptophan
- 1.7 Based on its structural similarity to other lipids, this lipid most likely functions as (1)
- a. A membrane component.
 - b. An energy storage molecule.
 - c. A sex hormone.
 - d. A vitamin required for vision.
- 1.8 Which is a characteristic of biological membranes? (1)
- a. Membranes contain proteins and amphipathic lipids.
 - b. Membranes have an asymmetrical micelle structure.
 - c. Membranes have hydrophobic groups on the surfaces.
 - d. Membranes contain lipids that polymerize into one large molecule.
- 1.9 Which membrane lipid contains an amide bond? (1)
- a. Cholesterol
 - b. Phosphatidylserine
 - c. Phosphatidic acid
 - d. Phingomyelin
- 1.10 Which characteristic is most likely to be shared by a cell membrane and a lipoprotein particle? (1)
- a. Both are composed of a lipid bilayer.
 - b. Both contain a high amount of triacylglycerols.
 - c. Both contain hydroxyl groups on the surface.
 - d. Both contain proteins in the interior.

Question 2: Fill the blanks only by writing down the number and the correct expression [10]

- 2.1 _____ are the nucleases that attack only the internucleotide bonds located at the ends of the nucleic acid. (1)
- 2.2 The two _____ strands of DNA separate at a site of replication to form a bubble. (1)
- 2.3 Deamination means removal of the _____ group to from amino acids. (1)
- 2.4 Amino acids which could be converted to glucose are called _____ amino acids. (1)
- 2.5 Glucokinase acts on glucose to form _____. (1)
- 2.6 Tricarboxylic acid cycle occurs in _____. (1)
- 2.7 _____ is precursor for nucleotide synthesis. (1)
- 2.8 Glycogen biosynthesis is known as _____. (1)
- 2.9 Two solutions with identical osmotic pressures are called _____. (1)
- 2.10 The proteins that are tightly embedded in the membrane are called _____. (1)

Question 3 [65]

The metabolism of carbohydrate, lipid, and protein are coordinated and well regulated to meet the bodily requirements, especially the energy need, under various conditions.

- 3.1. Food intake raises the level of the key peptide hormone insulin, which is synthesized in and secreted from the β -cells of the pancreatic islets primarily in response to glucose.
- a. Briefly discuss the reactions of the Krebs cycle. (8)
- b. Describe the multistep process (including the names of the key elements) by which epinephrine stimulates glycolysis in muscle. (8)

You may use a diagram, though this is optional.

- c. Caffeine inhibits cyclic nucleotide phosphohydrolases. What effect would this inhibition have on glycogen metabolism when epinephrine levels are dropping in the blood? (3)
- d. Blood glucose is a crucial factor in homeostasis. It is maintained at a certain level of intestines, liver, pancreas, kidney, adrenal gland, adipose tissue, and other organs. Discuss briefly four regulation processes of blood glucose. (4)

3.2. Enzymes are macromolecular biological catalysts that accelerate chemical reactions and may act on substrates to convert them into different molecules known as products. Answer the following question concerning enzymes.

- a. Explain what happens to an enzyme molecule when it is denatured by high temperatures. (3)
- b. Why does an enzyme only speed up one (or at the most a few) different chemical reaction(s)? (1)
- c. How do enzymes speed up the rate of chemical reactions? (1)
- d. Describe the effect of increasing substrate concentration on the rate of an enzyme controlled reaction. (2)
- e. Why would increasing the temperature from 15 to 25^oC increase the rate of an enzyme controlled reaction? (2)
- f. Using your knowledge of enzyme structure, explain how a non-competitive inhibitor works? (3)

3.3. Proteins in diet are from animal sources such as dairy products, meat, fish, liver and eggs and vegetable sources. Muscle protein constitutes the major reserve of amino acids. Amino acids can be divided into two classes based on their metabolism. (4)

- a. Define each class and give an example. (4)
- b. Discuss the principles of the Xanthoproteic test and Hopkins-Cole test.

- c. Draw the titration curve (with the structure) of Histidine titrated with 1M NaOH showing all the different charges. Calculate the p_i . (6)

3.4 Triglycerides stored in fat tissue are the major energy reserve of the body. Excessive triglyceride in non-adipose tissues (notably fatty liver) can cause insulin resistance and loss of metabolic function.

- a. Discuss briefly five *biological* functions of Lipids. (5)
- b. Name 4 lipid components found in biological membranes. (4)
- c. Discuss briefly the various steps involved in fatty acid biosynthesis (include the intermediates products and enzymes involved). (7)

Question 4

[15]

A solution of a certain weakly acidic substance was prepared by dissolving and diluting 2.344 g to a final volume of 100 mL. In a titration, 42.6 mL of 0.250 M NaOH solution was required to reach a successful endpoint. The shape of the titration curve was used for the assumption that the acid was monoprotic. The pH at the endpoint was 9.4.

- a. Calculate the apparent molecular weight of the unknown acid. (2)
- b. Calculate the K_a for the acidic substance. (3)
- c. Calculate the pH of the original 100 mL solution (prior to titration). (2)
- d. Calculate the pH at the midpoint of the titration (after addition of 21.3 mL of the sodium hydroxide solution). (2)
- e. 25.8 mL of 0.328 M sodium hydroxide solution are required to titrate 50.0 mL of sulfuric acid. Calculate the concentration of the acid (3)
- f. A windscreen washing liquid contains 2.00 g/L ammonia. What is the pH of this liquid? The molecular weight of $NH_3 = 17$ g/mol (3)

END OF EXAM

ANNEX

Amino acid	pK_a α-COOH	pK_a α-NH₃⁺	pK_a side chain
Alanine	2.34	9.69	—
Arginine	2.17	9.04	12.48
Asparagine	2.02	8.84	—
Aspartic acid	2.09	9.82	3.86
Cysteine	1.92	10.46	8.35
Glutamic acid	2.19	9.67	4.25
Glutamine	2.17	9.13	—
Glycine	2.34	9.60	—
Histidine	1.82	9.17	6.04
Isoleucine	2.36	9.68	—
Leucine	2.36	9.60	—
Lysine	2.18	8.95	10.79
Methionine	2.28	9.21	—
Phenylalanine	2.16	9.18	—
Proline	1.99	10.60	—
Serine	2.21	9.15	—
Threonine	2.63	9.10	—
Tryptophan	2.38	9.39	—
Tyrosine	2.20	9.11	10.07
Valine	2.32	9.62	—