NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES

DEPARTMENT CLINICAL OF HEALTH SCIENCES

QUALIFICATION : MEDICAL LABORATORY SCIENCES	
QUALIFICATION CODE: 08BMLS	**LEVEL:** 5
COURSE CODE: BIO521S/IBC521S	**COURSE NAME:** BIOCHEMISTRY
SESSION: DECEMBER 2025	**PAPER:** SECOND OPPORTUNITY/SUPPLIMENTARY EXAMINATION QUESTION PAPER
DURATION: 3 HOURS	**MARKS:** 130

SECOND OPPORTUNITY EXAMINATION PAPER	
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MODERATOR:	**MR HERBERT MAPIRA**

INSTRUCTIONS
ANSWER ALL THE QUESTIONS.

PERMISSIBLE MATERIALS
CALCULATOR

THIS QUESTION PAPER CONSISTS OF 4 PAGES (INCLUDING THIS FRONT PAGE)

SECTION A (75)

QUESTION 1 [45]

1.1. Define biochemistry and explain its significance as a multidisciplinary science. In your answer, discuss how principles from physics and organic chemistry are fundamental to understanding life processes at the molecular level. (8)

1.2. Outline the hierarchical structural organisation of life. Give an example of each level. (9)

1.3.

1.3.1. Compare and 1.3.2. contrast prokaryotic and eukaryotic cells (10)

1.3.3 Explain the functional advantages that the compartmentalisation found in eukaryotes. Give an example. (2)

1.4. Describe the structure and function of any TWO of the following organelles, ensuring you explicitly link their physical structure to their biological role.

1.4.1 Mitochondrion (4)

1.4.2 Endoplasmic Reticulum (4)

1.4.3 Nucleus. (4)

1.5. The "RNA World" hypothesis is a central concept in theories of the origin of life. Explain what this hypothesis proposes and describe two key pieces of evidence that support it. (8)

QUESTION 2 [30]

2.1. Explain the polar nature of the water molecule. Use the concepts of enthalpy and entropy in your answer. (7)

2.2. Hydrogen bonding is critical to life. Describe the nature of a hydrogen bond and explain its role in three distinct biological contexts: (1)

2.2.1 maintaining the secondary structure of a protein, and (2)

2.2.2 the specificity of base pairing in DNA. (2)

2.3. The Henderson-Hasselbalch equation is fundamental to biochemical practice.

2.3.1 Write the equation and define all its terms. (1)

2.3.2 You need to prepare a 0.1 M phosphate buffer at pH 7.0. Using the pKa values from the provided text ($H_2PO_4^- \rightleftharpoons H^+ + HPO_4^{2-}$; pKa ≈ 7.2), calculate the required ratio of $[HPO_4^{2-}]$ to $[H_2PO_4^-]$. Show your working. (2)

2.3.3 Explain why this buffer solution would resist a change in pH upon the addition of a small amount of strong acid. (2)

2.4. Amino acids are the building blocks of proteins.

2.4.1 Illustrate the general structure of an amino acid. (1)

2.4.2. Classify the following amino acids. Justify your classification based on their R-groups. (4)

i) Glutamate
ii) Valine
iii) Lysine
iv) Serine.

2.4.3 Explain the concept of the isoelectric point (pI) and describe how you would determine it for a triprotic amino acid. (5)

2.5 Describe the structural characteristics of the peptide bond. Explain why it is rigid and planar, and what implications this has for the three-dimensional structures that proteins can adopt. (3)

SECTION B **(32)**

QUESTION 3 **[32]**

3.1. Using haemoglobin as an example, explain how a change at the primary structure level (e.g., the glutamate to valine substitution in sickle cell anaemia) can disrupt function by affecting the quaternary structure. (5)

3.2. Protein folding is a spontaneous process, yet it results in a highly ordered state. Reconcile this apparent contradiction with the second law of thermodynamics by explaining the role of the hydrophobic effect in protein folding. (5)

3.3.1 Distinguish clearly between competitive and non-competitive inhibition using named examples. (6)

3.3.2 How does the treatment for methanol poisoning provide a therapeutic application of competitive inhibition? (4)

3.4. Allosteric regulation and zymogen activation are two crucial mechanisms for controlling enzyme activity.

3.4.1 Compare and contrast these two mechanisms. (4)

3.4.2 Describe the specific example of chymotrypsinogen activation to chymotrypsin. (4)

3.5 Coenzymes are essential for the function of many enzymes. Using NAD^+/NADH as an example, explain the mechanism of action of a coenzyme. How does it differ from a prosthetic group? (4)

SECTION C (23)

QUESTION 4 [23]

4.1. Compare and contrast the glycolytic pathway with the β-oxidation pathway for fatty acids. Your answer should address:

4.1.1 the subcellular location of each pathway (2)

4.1.2 the key input molecules and end-products (4)

4.1.3 key contrast (1)

4.2 The Citric Acid Cycle (CAC) is often described as the "central metabolic hub." Justify this statement by explaining three distinct metabolic roles of the CAC, including its amphibolic nature and its connection to electron transport. (6)

4.3. Describe the metabolic fate of pyruvate under aerobic and anaerobic conditions in a muscle cell. Explain the biochemical rationale for the shift to anaerobic metabolism during intense exercise and the resulting physiological consequences (e.g., lactate production). (6)

4.4.1 Under what metabolic conditions are ketone bodies produced, and in which organ? (2)

4.4.2 Explain the biochemical basis for ketoacidosis, a pathological condition associated with uncontrolled diabetes mellitus. (2)

END OF EXAMINATION