UNIVERSITI KUALA LUMPUR

MALAYSIAN INSTITUTE OF CHEMICAL AND BIO-ENGINEERING TECHNOLOGY

FINAL EXAMINATION

OCTOBER 2025 SEMESTER

COURSE CODE	:	CBB20303
COURSE TITLE	:	BIOCHEMISTRY
PROGRAMME NAME	:	BACHELOR OF CHEMICAL ENGINEERING TECHNOLOGY (BIOPROCESS) WITH HONOURS
DATE	:	02 FEBRUARY 2026
TIME	:	9:00AM - 12:00PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Answer ALL questions for Section A.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet. ☐ *Tick if applicable*
9. Refer to the attached Formula/ Appendies. ☐ *Tick if applicable*

THERE ARE 6 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

Question 1

Water plays a fundamental role in maintaining chemical equilibrium and biological function, particularly in aqueous systems such as the human body and environmental ecosystems. Henderson-Hasselbalch equation is useful to relate the pH of a solution to the concentration of an acid and its conjugate base.

(a) By using the dissociation constant expression, proof that the pH value of water is 7.

(4 marks)

(b) Given the acid is HA, derive the Henderson-Hasselbalch equation from the acid dissociation constant expression.

(8 marks)

(c) Using the Henderson-Hasselbalch equation, provide the calculation to prepare 100 mL of an acetate buffer solution at pH 5.00 using 0.1 M acetic acid and 0.1 M sodium acetate, given that pKa of Acetic Acid (CH_3COOH) is 4.76.

(8 marks)

Question 2

Amino acids are organic molecules that serve as the basic building blocks of proteins. Each amino acid contains an amino group, a carboxyl group, and a unique side chain (R group). Proteins, composed of one or more polypeptide chains, play vital roles in biological systems, including catalyzing biochemical reactions, maintaining structural support, and facilitating cellular communication.

(a) Classify the 20 standard amino acids into appropriate groups based on the properties of their side chains (nonpolar, polar uncharged, acidic, and basic). Provide at least one example for each group.

(10 marks)

(b) Explain in detail the hierarchical organization of protein structure by describing the primary, secondary, tertiary, and quaternary levels, with hemoglobin used as a representative example.

(10 marks)

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

Carbohydrates are a fundamental class of biological macromolecules that are essential for metabolic activities and contribute to structural integrity in a wide range of organisms.

(a) Describe in detail the different categories of carbohydrates, their functions in living systems, and provide one example for each category.

(10 marks)

(b) Compare and contrast starch and glycogen by describing their structural features, functional roles and the availability in nature in relation to their importance in living systems.

(10 marks)

Question 2

Lipids play a vital role in biological membranes by providing structural integrity and facilitating a wide range of cellular functions.

(a) Explain the similarities and differences in the structures of phospholipids, cholesterol, and glycolipids, including their characteristic features and roles in biological membranes. Support your discussion with illustrations of each molecule.

(10 marks)

(b) Illustrate diagram of lipid bilayer structure showing phospholipids, glycolipids, glycoproteins, cholesterol molecule and embedded membrane proteins. Explain the orientation of hydrophilic and hydrophobic regions and describe the roles of these components in membrane structure and cellular functions.

(10 marks)

Question 3

A student investigates the kinetics of lactate dehydrogenase (LDH) using varying substrate concentrations in the absence and presence of caffeine, an inhibitor. The initial velocities were measured at each substrate concentration without and with inhibitor. Table 1 presents data on the initial reaction velocity (V_0) measured at different substrate concentrations ([S]).
Refer Below - Table1 : Substrate concentration against Initial Reaction Velocity without and with inhibitor .

Table 1: Substrate concentration against Initial Reaction Velocity without and with inhibitor

Substrate, [S] (mM)	Initial velocity, V_0 without inhibitor (µmol/min)	Initial velocity, V_0 with inhibitor (µmol/min)
0.1	11.00	4.60
0.2	18.86	8.61
0.5	33.00	18.00
1.0	44.00	28.29
2.0	52.80	39.60
5.0	60.00	52.11
10.0	62.86	58.24

(a) Plot the Michaelis-Menten graph ([S] vs V_0) for both conditions on the same axes.

(7 marks)

(b) Transform the data and plot a Lineweaver-Burk graph (1/[S] vs 1/V_0) for both conditions on the same axes.

(7 marks)

(c) Analyze the graphs to identify the type of inhibition and explain in detail how Vmax and Km are affected through the changes reflected in the graphs.

(6 marks)

Question 4

Cellular respiration consists of two principal processes which are substrate-level phosphorylation and oxidative phosphorylation. Both processes are crucial for producing ATP, the cell's main energy currency.

(a) Explain the oxidative phosphorylation process in producing a high yield of ATP by examining the roles of NADH and $FADH_2$ in the electron transport chain and ATP synthase in utilizing the resulting proton gradient to synthesize ATP.

(10 marks)

(b) Analyze glycolysis in cellular energy production by examining ATP consumption and generation, NADH formation, and the role of glucose breakdown in providing metabolic intermediates.

(10 marks)

END OF EXAMINATION PAPER