# UNIVERSITY OF SWAZILAND

## FINAL EXAMINATION PAPER: MAY 2015

TITLE OF PAPER: BIOCHEMISTRY & CELL BIOLOGY

COURSE CODE: B203

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:
1. ANSWER QUESTION 1 (COMPULSORY) AND ANY THREE OTHER QUESTIONS.
2. ANSWER A TOTAL OF 4 (FOUR) QUESTIONS
2. EACH QUESTION CARRIES TWENTY FIVE (25) MARKS
3. ILLUSTRATE YOUR ANSWERS WITH LARGE AND CLEARLY LABELLED DIAGRAMS WHERE APPROPRIATE

SPECIAL REQUIREMENTS:

1. CANDIDATES MAY USE CALCULATORS

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATORS

[PLEASE TURN OVER]

**Section A: Compulsory** (Answer all questions in this section)

**Question 1**

(a) (i) Calculate the pH of a solution of 0.001 M NaOH. (1 mark)

(ii) One amino acid can exist in protonated ($XH^+$) and unprotonated (**X**) states. The $pK_a$ for the protonation of amino acid **X** to form $XH^+$ is 6. What fraction of total amino acid will be in the protonated form at pH 7.0? (4 marks)

(b) Consider the β-oxidation of 1 mol of fatty acid palmitate (C16:0).

(i) In what cellular compartment does this process occur? (1 mark)

(ii) What is the final product of this process? (1 mark)

(iii) Determine moles of this final product produced per mole of C16:0. (1 mark)

(iv) Explain then development of a pathological condition caused by failure of the utilization of this product during extreme starvation/fasting. (5 marks)

(c) (i) For the reaction A → B, $\Delta G^{\circ} = -60$ kJ/mol. The reaction is started with 10 mmol of A; no B is initially present. After 24 hours, analysis reveals the presence of 9.5 mmol of B, 0.5 mmol of A. Explain these observations. (2 marks)

(ii) In glycolysis, the enzyme pyruvate kinase catalyzes this reaction:

**Phosphoenolpyruvate + ADP → pyruvate + ATP**

Use the data below to calculate the equilibrium constant for this reaction at 25°C. (2 marks)

*Reaction 1) ATP → ADP + $P_i$,* $\Delta G'^{\circ} = -30.5$ *kJ/mol*

*Reaction 2) phosphoenolpyruvate → pyruvate + $P_i$,* $\Delta G'^{\circ} = -61.9$ *kJ/mol*

*R = 8.315 J/mol·K*

(c) Innocentia measured the initial rates of an enzyme-catalyzed reaction as a function of substrate concentrations in the presence and absence of an unspecified inhibitor. Results are shown in the table below.

| [S]/M | $V_0$ (mmol product/second) | |
|---|---|---|
| | Inhibitor absent | Inhibitor present |
| 0.001 | 15 | 9 |
| 0.002 | 25 | 15 |
| 0.005 | 35 | 25 |
| 0.01 | 41 | 33 |
| 0.02 | 45 | 40 |
| 0.05 | 48 | 45.5 |
| 0.1 | 49 | 47 |
| 0.2 | 49.5 | 49 |
| 0.5 | 50 | 49.5 |
| 1 | 50 | 50 |
| 2 | 50 | 50 |

Without drawing any graph, use the data above to elucidate the $V_{max}$ and $K_m$ in the absence and presence of inhibitor. Hence, deduce the type of inhibitor present and explain the mechanism of its inhibitory action. (8 marks)

**[Total Marks = 25]**

## Section B

Answer **any three** questions from this Section.

**Question 2**

(a) Using annotated diagrams, discuss the semi-conservative replication of DNA, highlighting the roles of different proteins involved in the process. (10 marks)

(b) Discuss eukaryotic gene expression and its control. (15 marks)

**Question 3**

With reference to five methods, discuss the principles and technicalities involved during protein purification. (25 marks)

**Question 4**

Examine and illustrate how energy is metabolically extracted from carbohydrates, triglycerides and proteins, indicating the cellular compartmentalization of such extraction(s). (25 marks)

**Question 5**

Knowledge of nutrients and human nutrition is essential to mankind. Critique this assertion. (25 marks)

**Question 6**

Explain the production of ATP and NADPH in green plants, illustrating how these molecules are central to carbohydrate anabolism. (25 marks)

**END OF QUESTION PAPER**