

UNIVERSITY OF SWAZILAND

SUPPLEMENTARY EXAMINATION PAPER: JULY 2017

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) The following questions concern pH and its calculation.
- (i) Calculate the pH of a solution of 0.015 M NaOH. (1 mark)
- (ii) Define  $pK_a$  for a weak acid in the following two ways: (1) in relation to its acid dissociation constant,  $K_a$ , and (2) by reference to a titration curve for the weak acid. (2 marks)
- (iii) Draw the titration curve for a weak acid, HA, whose  $pK_a$  is 3.2. Label the axes properly. Indicate with an arrow where on the curve the ratio of salt ( $A^-$ ) to acid (HA) is 3:1. State the pH at this point. (5 marks)
- (iv) Calculate the pH of a solution if 1.0 mol of a weak acid, HA ( $pK_a = 5.2$ ) is dissolved together with 0.2 mol of NaOH in one liter of water. (2 marks)
- (v) Explain how changes in pH alter the conformation of a protein. (2 marks)

- (b) (i) The hydrolysis of ATP is highly exergonic:



However, the conversion of glucose into glucose 6-phosphate, which must occur in the breakdown of glucose, is thermodynamically unfavorable (endergonic):



Explain how cells overcome this problem and hence, use the above equations to calculate the standard free-energy change ( $\Delta G^\circ$ ) for the phosphorylation of glucose. (3 marks)

- (ii) If a 0.08 M solution of glucose 1-phosphate is incubated at 25°C with a catalytic amount of phospho-glucomutase, the glucose 1-phosphate is transformed to glucose 6-phosphate until equilibrium is reached. At equilibrium, the concentration of glucose 1-phosphate is  $4.5 \times 10^{-3}$  M and that of glucose 6-phosphate is  $8.6 \times 10^{-2}$  M. Write the expressions for the calculation of  $K'_{eq}$  and  $\Delta G^\circ$  for this reaction, hence calculate  $K'_{eq}$  and  $\Delta G^\circ$ , given that the universal gas constant  $R = 8.315 \text{ J/mol}\cdot\text{K}$ . (4 marks)

- (c) A student measured the initial rate, ( $V_0$ ), of an enzyme-catalyzed reaction as a function of substrate concentration,  $[S]$ , in the presence (+In) and absence (-In) of an inhibitor. Results are shown in the table below.

$[S]$ (mM) ( $\times 10^{-4}$ )		1	2	5	10	20	50	100	200	500	1000
$V_0$ (mmol/s) of product	-In	33	50	71	83	91	96	98	99	100	100
	+In	17	29	50	67	80	91	95	98	99	100

Without using any graph, estimate the values of  $V_{max}$  and  $K_m$  in the absence and presence of inhibitor. Hence, deduce the type of inhibitor that is involved and explain its mechanism of action. (6 marks)

**[Total Marks = 25]**

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**Section B**

Answer any three questions from this Section.

**Question 2**

- (a) Briefly describe the usefulness of each of the following reagents in the analysis of protein structure:
- (i) Phenylisothiocyanate, (2 marks)
  - (ii) Chymotrypsin, (2 marks)
  - (iii)  $\beta$ -mercaptoethanol, (2 marks)
  - (iv) Carboxypeptidase. (2 marks)
- (b) A biochemist wishes to determine the sequence of a protein that contains 173 amino acid residues. After treatment with  $\beta$ -mercaptoethanol and cyanogen bromide (CNBr), it is anticipated that less than ten conveniently sized peptides will be obtained in the resulting solution. You are then tasked to take over and complete the remaining amino acid analysis steps. Outline and explain the steps you would take to determine, unambiguously, the sequence of amino acid residues in the original protein. (17 marks)

**Question 3**

Critique the assertion that 'Vitamins of the B-complex are indispensable elements of cellular metabolism'. (25 marks)

**Question 4**

Discuss the DNA replication, highlighting the roles of the various proteins/enzymes at the replication fork.. (25 marks)

**Question 5**

Discuss how photosynthetically harnessed energy is aerobically transduced to mitochondrial ATP in an animal cell. (25 marks)

**Question 6**

Examine how, in an animal, excess nitrogen is disposed of, indicating organ(s) and/or cellular compartment(s) where this occurs. (25 marks)

**END OF EXAMINATION PAPER**