

SECTION B: LONG QUESTIONS (Total marks 90)

Please note: Complete this section in your answer book.

CANDIDATES ARE REQUESTED, IN THEIR OWN INTERESTS, TO WRITE LEGIBLY

1. This problem explores the consequences of coupling ATP hydrolysis under physiological conditions to a thermodynamically unfavourable biochemical reaction. Because we want to explore these consequences in stages, we shall consider the hypothetical transformation, $X \rightarrow Y$, a reaction for which $\Delta G^\circ = 20 \text{ kJ/mol}$.

(a) What is the ratio $[Y]/[X]$ at equilibrium? (2)

(b) Suppose X and Y participate in a sequence of reactions during which ATP is hydrolysed to ADP and Pi. The overall reaction is: (2)
 $X + \text{ATP} + \text{H}_2\text{O} \rightarrow Y + \text{ADP} + \text{P}_i$

Calculate $[Y]/[X]$ for this reaction at equilibrium. Assume for the purposes of this calculation that the concentrations of ATP, ADP, and Pi are all 1 M when the reaction is at equilibrium.

(c) We know that [ATP], [ADP], and [Pi] are not 1 M under physiological conditions. Calculate the ratio $[Y]/[X]$ for the ATP-coupled reaction when the values of [ATP], [ADP], and [Pi] are 8.05 mM, 0.93 mM, and 8.05 mM, respectively. (5)

2. Name three enzymes that participate in glycolysis. (3)

3. Name six types of metabolic reactions. (6)

4. Write (not draw) an equation to represent the overall reaction of TCA Cycle. Include all quantities your answer. (4)

5. Why do we need oxygen to break down glucose completely by aerobic respiration? (5)

6. How does the electron transport chain convert NADH and FADH₂ into ATP? (5)

7. If enzymes do not alter thermodynamics/bioenergetics, why are they so important in the control of metabolism? (10)

8. Describe the biochemistry involved when cholera causes diarrhoea. (10)

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