# Study Mania Scenario Examiner

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**Time Allowed: 240 minutes**

## Biology

### Constants / Useful Information

No subject-specific constants required for this paper.

### Examination Rules

1. Attempt all questions.
2. Avoid unnecessary noise or distractions in the exam room.
3. Use a non-programmable calculator only where applicable.
4. Write clearly and present your work in an organized way.
5. Follow every instruction in each task carefully.
6. Manage time well and leave a short review window at the end.
7. Support your conclusions with evidence from the scenario.
8. Do not use unauthorized materials or external assistance.

# Scenario Items

## Item 1: Carbohydrates and Lipids

### Metabolic Shift in Migratory Birds

A species of migratory bird in the Albertine Rift prepares for a long-distance flight. Before departure, the bird consumes large quantities of nectar (rich in sucrose) and seeds. Biologists observe that the bird converts these sugars into triglycerides stored in adipose tissue rather than storing them as glycogen. During the flight, the bird relies on the oxidation of these fats. The energy yield of fat is approximately 38 kJ/g, while carbohydrates yield about 17 kJ/g. The bird's metabolic rate increases significantly, requiring efficient oxygen transport and water conservation. The school debate team presents three evidence sources on Carbohydrates and Lipids, and each source supports a different explanation for the same event.

Task A: As a student of Biology, explain the chemical process by which the sucrose from the nectar is converted into a storage form, and justify why the bird prefers triglycerides over glycogen for long-distance flight based on the provided energy values.

Task B: As a student of Biology, using the general formula for a fatty acid CH_3(CH_2)_nCOOH, discuss how the saturation level of these stored lipids might affect the fluidity of cell membranes in birds flying at high, cold altitudes.

Task C: As a student of Biology, analyze the role of 'metabolic water' produced during the oxidation of fats in the bird's survival during periods where liquid water is unavailable.

Task D: Describe a simple biochemical test the biologists could use to distinguish between the reducing sugars and non-reducing sugars found in the bird's initial nectar diet.

## Item 2: Proteins and Enzymes

### Enzymatic Malfunction in Industrial Fermentation

A fruit processing plant in Kasese uses a specific enzyme, Pectinase, to clarify juice. The enzyme operates optimally at a temperature of 37^°C and a pH of 4.5. During a power surge, the cooling system failed, causing the temperature to rise to 70^°C for 30 minutes. Even after the temperature was restored to 37^°C, the juice remained cloudy, and the reaction rate V followed the relationship V approx 0. The engineers noted that the primary structure of the enzyme remained intact, but its catalytic ability was lost. The school debate team presents three evidence sources on Proteins and Enzymes, and each source supports a different explanation for the same event.

Task A: As a student of Biology, explain the effect of the temperature rise on the various chemical bonds (hydrogen, ionic, and disulfide bridges) that maintain the tertiary structure of Pectinase.

Task B: As a student of Biology, distinguish between the 'Lock and Key' hypothesis and the 'Induced Fit' model to explain how the substrate interacts with the enzyme's active site under normal conditions.

Task C: As a student of Biology, justify why the enzyme failed to function even after the temperature was returned to 37^°C, referring to the concept of irreversible denaturation.

Task D: The plant manager suggests adding a competitive inhibitor to stabilize the enzyme. Evaluate the scientific validity of this suggestion regarding its impact on the V_max and K_m of the reaction.

**Romans 8:5**

"God showed his love for us in that while we were still sinners, Christ died for us."