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UGANDA ADVANCED CERTIFICATE OF EDUCATION

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S.6 BIOLOGY EXAMINATION

Paper 1

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Time: 1 hour 40 minutes

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INSTRUCTIONS TO CANDIDATES

- This paper consists of two sections: A and B.
  - Section A consists of two compulsory items. Answer ALL items in this section. All answers for Section A MUST be written in the spaces provided in this question paper.
  - Section B consists of two items. Answer only ONE item from this section. Answers for Section B MUST be written on the answer sheets provided.
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## SECTION A

Answer ALL items in this section. Write your responses in the spaces provided.

### ITEM 1

A dairy processing factory in Mbarara produces lactose-free milk for the regional market. The factory uses lactase enzymes extracted from yeast to break down lactose into glucose and galactose. During a recent quality audit, the production manager noticed that if the milk pasteurisation temperature was accidentally allowed to exceed 45 °C before the enzyme was added, the yield of lactose-free milk dropped drastically. Furthermore, the laboratory team discovered that a chemical contaminant (Compound X) from a cleaning detergent had leaked into one of the reaction vats. The team conducted an experiment to analyse the rate of lactose breakdown under different conditions. The results are shown in Table 1.

Table 1: Rate of lactose breakdown under different conditions

Lactose Concentration (mmol/L)	Rate without Compound X ( $\mu\text{mol}/\text{min}$ )	Rate with Compound X ( $\mu\text{mol}/\text{min}$ )
2.0	12.0	4.5
4.0	22.0	9.0
6.0	30.0	15.0
8.0	35.0	22.0
10.0	38.0	28.0
12.0	40.0	34.0
14.0	40.0	38.0
16.0	40.0	40.0

Tasks:

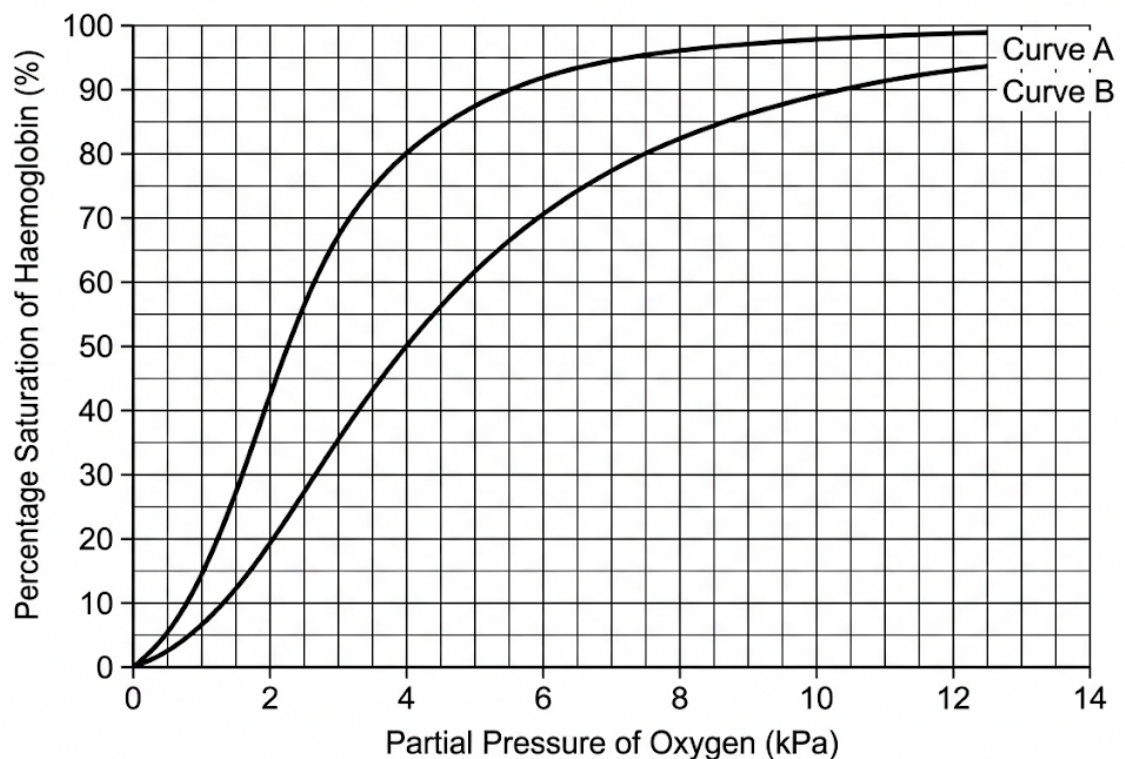
- Explain why the yield of lactose-free milk dropped drastically when the milk pre-treatment temperature exceeded 45 °C. (6 scores)
- Analyse the data in Table 1 to deduce the type of inhibition caused by Compound X. Justify your answer. (8 scores)
- Propose an evidence-based biological strategy the factory can use to sustain optimal enzyme activity and overcome the inhibitory effects of Compound X without buying new enzymes. (6 scores)



## ITEM 2

A group of elite long-distance athletes from a low-altitude region in Uganda travelled to Kapchorwa (high altitude) for an intensive three-week training camp. During their first week, many athletes complained of rapid fatigue, shortness of breath, and headaches during mild exercise. However, by the end of the third week, their endurance had improved significantly. A sports physiologist drew the oxygen dissociation curves for the athletes' haemoglobin on their first day (Curve B) and compared it with the curve of native high-altitude dwellers (Curve A).

**FIGURE: COMPARISON OF OXYGEN DISSOCIATION CURVES FOR HIGH-ALTITUDE NATIVE AND UNACCLIMATISED LOW-LANDER**



Tasks:

- Compare the oxygen affinities of haemoglobin represented by Curve A and Curve B, and explain how Curve A is an adaptive advantage for native high-altitude dwellers. (8 scores)
- Assess the physiological changes that would occur in the athletes' cardiovascular systems and blood parameters by the end of the three-week training camp. (6 scores)
- Propose an ethical and evidence-based strategy for the athletes to maintain their high aerobic efficiency when they return to a low-altitude region for the national competition. (6 scores)



## SECTION B

**Answer only ONE item** from this section. Write your responses in the spaces provided.  
**Additional items or answer sheets will NOT be considered**

### ITEM 3

A local clinic in Jinja received a patient who had suffered a deep laceration on the forearm from a workplace accident and was in a lot of pain. To stitch the wound without causing more pain, the medical officer injected a local anaesthetic (Lidocaine), which is a sodium channel blocker, around the wound site and after a minute, the patient was no longer feeling any pain.

Tasks:

- (a) Describe the events that lead to the pain perception by the patient before and after application of the local anaesthetic to the wound. (8 scores)
  - (b) Propose an evidence-based and ethical post-operative strategy to manage the patient's pain safely once the effects of the local anaesthetic wear off. (2 scores)
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#### ITEM 4

A commercial floriculture farmer near Lake Victoria in Entebbe specializes in exporting a specific species of ornamental flower (Species Y) to the European market. The farmer needs Species Y to flower exactly in February to meet the high demand for Valentine's Day. However, natural day lengths in Uganda are roughly equal (12 hours light and 12 hours dark) throughout the year. The farmer noticed that under normal natural light conditions, Species Y remains vegetative and does not flower. The agricultural extension officer set up a trial to investigate the effect of varying periods of light and darkness on the flowering percentage of Species Y. The findings are summarised in Table 3.

Table 3: Flowering response of Species Y to different light treatments

Treatment	Light Period (hours)	Dark Period (hours)	Flowering Percentage (%)
1	14	10	95
2	12	12	0
3	10	14	0
4	14 (with 15-min dark flash)	10	90
5	11	13 (with 15-min light flash)	85

Tasks:

- Based on the data in the Table, deduce whether Species Y is a short-day plant or a long-day plant. Explain your reasoning using the concept of critical night length. (8 scores)
- Analyse the physiological mechanism by which phytochrome (Pr and Pfr) controls the flowering response in Species Y. (6 scores)
- Propose an effective, ethical, and sustainable agricultural strategy the farmer can employ to force Species Y to flower in February using artificial lighting. (6 scores)

