P530/1
BIOLOGY
Paper 1
(Theory)
Aug. 2026
2 hours

REGINA PACIS HIGH SCHOOL – MUKONO

Uganda Advanced Certificate of Education

BIOLOGY

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INSTRUCTIONS:

- *ATTEMPT **ALL** ITEMS IN THIS PAPER*

ITEM 1

A medical team from the Ministry of Health recently investigated a cluster of severe health complaints among workers at a textile chemical plant in Jinja. The affected workers reported chronic muscle weakness, rapid weight loss, and extreme heat intolerance. This occurred after accidental exposure to an unknown airborne industrial toxin. To manage the workers' condition, the factory's health board proposed two actionable interventions:

- Intervention 1: Administering continuous intravenous (IV) glucose therapy.
- Intervention 2: Mandating that affected workers spend their breaks in a pressurized, oxygen-enriched recovery room.
- Intervention 3: Administering bicarbonate buffers.

Table 1: Cellular and biochemical parameters of plant workers

Parameter/variable measured	**Healthy workers**	**Affected workers**
Normal mitochondrial cristae density (%)	92.0	24.0
Intracellular ATP concentration (mmol/l)	4.8	0.9
Blood lactate concentration (mmol/l)	1.2	6.8
Cytoplasmic ribosome density (arbitrary units)	75.0	22.0
Cytoplasmic pH	7.35	6.85

Tasks:
(a) Analyse how the structural destruction of the mitochondria and the depletion of ribosomes cause the observed changes in the affected workers.
(b) Evaluate the biological viability of the solutions proposed by the health board to reverse the energy deficit and tissue wasting, based on the cellular data provided.

Item 2
In Masindi District, a vegetable farming community uses a nearby swamp for dumping organic domestic wastes and some farmers use its water for irrigating their nearby gardens. Recently, a soap and textile factory was constructed upstream and began releasing untreated hot waste water into the stream flowing through the swamp. After a few months, the community started complaining about accumulation of undecomposed wastes producing a foul smell and also farmers that use the swamp water for crop irrigation complained about stunted growth and poor root development of the crops. Environmental officers from NEMA carried out investigations and made the following reports; presented in the Table 2.
Table 2: Effects of contaminated irrigation water on crop roots and microbial activity

Parameter	**Normal water**	**Affected swamp water**
Water temperature (^oC)	20-29	45
pH	6-8	4
Root cell ATP (%) in plants irrigated with swamp water	99	10
Root cell mitotic activity (%) in plants irrigated with swamp water	100	18

The officers further noted that the water contained colchicine, a chemical that prevents spindle fiber formation in root cells and also contained inhibitors of enzyme cytochrome oxidase.
They recommended the farmers to use organic manure because it contains enzyme activators and the factory to treat and cool its waste water.
Task:
a) Explain how the data obtained by the NEMA officers from the gardens is related to the farmer's complaints.
b) Evaluate the effectiveness of the officers' recommendations to the farmers and the factory.

Item 3

In Kapchorwa district, Ms. Chemutai manages a coffee plantation located on the slopes of Mount Elgon. In recent years, farmers complained of poor bean development, reduced aroma quality, and low yield. They also observed that some sections of the plantation exposed to direct sunlight throughout the day performed worse than partially shaded areas.

Following the complaints, plant physiologists from Uganda Coffee Development Authority (UCDA) carried out investigations and obtained the measurements shown in **table 3**

Table 3: Effects of light exposure on photosynthesis and coffee bean development

Parameter	**Partially Shaded**	**Full Sun**
Average stomatal aperture (μm)	14	6
Net photosynthetic rate (relative units)	100	55
Aroma oil concentration (%)	8.5	3.2
Mature bean weight (g/100 beans)	180	95

The scientists recommended maintaining shade trees, conserving soil moisture through mulching, and selecting varieties adapted to local climatic conditions.

Task:

a) Examine how the data obtained from the coffee plantation is related to the farmers' complaints.
b) Justify the effectiveness of the recommendations proposed by the scientists.