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MID-TERM EXAMINATIONS 2026

TERM ONE
SENIOR SIX
BIOLOGY
Paper 1
3 HOURS



INSTRUCTIONS TO CANDIDATES:

*This paper consists of **two** sections: **A** and **B**. It has **SIX** examination items.*

*Section **A** has **Two Compulsory** items.*

*Section **B** has **FOUR ITEMS**: Answer **one ITEM**.*

*Answers to section **A** must be written in the spaces provided while answers to **Section B** must be written in the answer booklet(s) provided.*

*Answer **FOUR** items in all.*

*Any additional item(s) answered will **not** be scored*

ITEM 1

A rural community relies on river water for drinking. Recently, cases of illness have increased.

Observations:

- Water appears cloudy and has an unusual smell
- High bacterial counts detected
- Presence of toxic substances inhibiting enzymes
- People report fatigue and digestive problems
- Laboratory tests show reduced enzyme activity in intestinal cells

Table: Biochemical Indicators

Parameter	Clean Water Users	Polluted Water Users
Enzyme activity (%)	100	60
ATP production (%)	100	65
Nutrient absorption (%)	100	55
Bacterial count	Low	High

Task

- (a) Explain how polluted water affects enzyme action, membrane function, and cellular respiration in humans.
- (b) Suggest ways the community could reduce health risks and improve water safety.

(a) Effects of polluted water on human biological processes

- **Enzyme action and digestion.** Polluted water contains toxic substances that inhibit **enzyme activity** by binding to enzyme **active sites** or altering their structure. Digestive enzymes such as

amylase, protease, and lipase become less effective, reducing the breakdown of food into absorbable nutrients. As a result, digestion is incomplete, leading to poor nutrient availability and symptoms such as fatigue and digestive discomfort.

- **Membrane function and nutrient absorption.** Toxins and harmful bacteria damage the **cell membrane** of intestinal epithelial cells by disrupting the **phospholipid bilayer**. This increases membrane permeability and interferes with transport mechanisms such as **active transport** and diffusion. Consequently, the absorption of digested nutrients is reduced, as shown by the lower nutrient absorption rate. This leads to malnutrition and weakness despite adequate food intake.
- **Cellular respiration and energy production.** Toxic substances inhibit key enzymes involved in **aerobic respiration**, particularly those in the **electron transport chain** such as **cytochrome oxidase**. This reduces the efficiency of oxidative phosphorylation, leading to decreased **ATP production**. With less ATP available, cells cannot perform essential functions such as active transport, repair, and maintenance. This contributes to fatigue and reduced body function in affected individuals.

(b) Ways to reduce health risks and improve water safety

- **Boil drinking water before use** to kill harmful bacteria and reduce the risk of infections affecting digestion and overall health.
- **Filter or treat water using appropriate methods** such as sand filtration or chemical treatment to remove suspended particles and toxic substances that interfere with enzyme activity.
- **Protect water sources from contamination** by preventing disposal of waste and pollutants into the river, thereby maintaining clean and safe water.
- **Promote proper sanitation and hygiene practices** such as using latrines and avoiding open defecation to reduce bacterial contamination of water sources.
- **Educate the community on safe water handling and storage** to prevent re-contamination after treatment and ensure continuous access to safe drinking water.

ITEM 2

In **Soroti District**, farmers planted sunflower and groundnuts during a prolonged dry season. The crops showed stunted growth, reduced leaf size, and some leaves turned yellow and dropped early. However, wild plants in the area remained green and continued growing.

Farmers also observed that sunflower plants bent towards sunlight during early growth but later showed poor seed formation. Some seeds failed to germinate even when planted.

Data:

Parameter	Sunflower (cultivated)	Groundnuts (cultivated)	Wild plants
Water availability	Low	Low	Low
Leaf structure	Broad	Moderate	Reduced/small leaves
Photosynthesis rate	Low	Low	Moderate
ABA level	High	High	Moderate
Seed germination (%)	40	50	80

Task

- Explain why wild plants survive better than cultivated crops using plant adaptations, hormones, and photosynthesis.
- Suggest ways farmers can improve crop survival and yield under such conditions.

RESPONSE

(a) Explanation of why wild plants survive better

- **Plant adaptations (xerophytic features).** Wild plants have reduced or small leaves, which lower surface area for transpiration, reducing water loss. Cultivated crops like sunflower with broad leaves lose more water, leading to dehydration and reduced growth.
- **Effect of ABA (abscisic acid):** Low water availability increases ABA levels in cultivated crops, causing stomatal closure to reduce water loss. This also limits carbon dioxide entry, reducing photosynthesis. Wild plants maintain moderate ABA levels, allowing partial stomatal opening and continued photosynthesis.
- **Photosynthesis.** In cultivated crops, low water and stomatal closure reduce carbon dioxide uptake, limiting the Calvin cycle and lowering glucose production. This results in poor growth, yellowing leaves, and reduced energy for seed formation. Wild plants maintain moderate photosynthesis, supporting continuous growth.
- **Phototropism.** Sunflower plants bend towards light during early growth due to auxin redistribution, promoting elongation on the shaded side. However, later stress conditions limit growth and energy production, affecting seed formation.
- **Seed formation.** Reduced photosynthesis in cultivated crops leads to less glucose available for respiration and storage, resulting in poor seed development.
- **Seed germination.** Low germination rates in cultivated crops may be due to dormancy or poor seed quality caused by stress during development. Wild plants produce viable seeds with higher germination due to better adaptation.

(b) Strategies to improve crop survival and yield

- **Grow drought-resistant crop varieties,** these crops have xerophytic features such as small leaves and deep roots, which reduce water loss and maintain photosynthesis under dry conditions.
- **Use mulching,** this conserves soil moisture by reducing evaporation and helps maintain water availability for plant uptake.
- **Apply irrigation,** this increases water availability, reduces ABA levels, and allows stomata to remain open for carbon dioxide uptake and photosynthesis.
- **Treat seeds before planting,** this breaks dormancy and improves germination by activating metabolic processes required for growth.
- **Adjust planting season to match rainfall,** this ensures crops grow under favourable water conditions, improving photosynthesis, growth, and seed formation.

SECTION B

PART I

Attempt one item from this section

ITEM 3

In **Queen Elizabeth National Park**, wildlife researchers observed that antelopes near drying water sources showed unusual behaviour.

They moved less, reacted slowly to predators, and spent more time near water at night.

Some injured animals treated with local anaesthetics showed delayed recovery and poor coordination.

Data recorded:

Parameter	Observed Value	Normal
Blood oxygen saturation (%)	88	95–100
Lactic acid level	High	Low
Body temperature (°C)	40.0	37–38
Breathing rate	High	Moderate
Reaction time	Slow	Fast

Water intake	Low	Moderate
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Additional observations: Water sources had low oxygen levels, High environmental temperature, Reduced grazing behaviour, Increased resting in shade and Slower escape responses

Task

- (a) Explain how environmental conditions affected the antelopes' physiological systems and behaviour.
- (b) Propose sustainable measures to improve animal survival without disrupting the ecosystem.

RESPONSE

*(a) Low oxygen levels in water sources reduce overall oxygen availability in the environment. This lowers blood oxygen saturation (88%), forcing antelopes to increase breathing rate to compensate. Despite this, tissues receive less oxygen, leading to **anaerobic respiration** and accumulation of **lactic acid**, which causes fatigue and reduced muscle efficiency.*

High environmental temperature raised body temperature (40.0°C), activating the hypothalamus to regulate heat. Antelopes reduced movement, rested in shade, and became more active at night to minimise heat gain. However, excessive heat impairs enzyme activity and muscle function, contributing to slow reactions.

*Low water intake leads to **dehydration**, reducing blood volume and affecting circulation. This limits oxygen and nutrient delivery to tissues, further slowing response times and increasing fatigue.*

Reduced grazing behaviour lowers energy intake, weakening muscles and reducing the ability to escape predators.

*Animals treated with local anaesthetics showed delayed recovery because anaesthetics block sodium channels in neurons, slowing or preventing **nerve impulse transmission**, leading to poor coordination and slower responses.*

Overall, reduced oxygen supply, heat stress, dehydration, and impaired nervous transmission led to slower reaction time, poor coordination, and altered behaviour such as night activity and reduced movement.

(b) Sustainable strategies

- **Provide and maintain shaded areas.** High temperatures increase heat load and disrupt thermoregulation. Shade reduces body temperature and supports normal physiological function.
- **Improve and protect water quality.** Low oxygen in water sources reduces oxygen availability and affects hydration. Protecting water bodies improves oxygen levels and supports animal survival.
- **Ensure access to reliable water sources.** Low water intake leads to dehydration and reduced blood volume. Adequate water supports osmoregulation and normal body function.
- **Minimise stress in wildlife populations.** Stress affects nervous coordination and behaviour. Reducing disturbances helps maintain normal responses and survival.
- **Limit unnecessary use of anaesthetics.** Anaesthetics slow nerve impulse transmission and coordination. Careful use supports quicker recovery and better movement.
- **Manage grazing zones sustainably.** Reduced grazing lowers energy intake and weakens animals. Proper management ensures sufficient food availability and supports energy balance.

ITEM 4

At a secondary school in **Jinja**, students participated in a night study session followed by an early morning football match.

Several students complained of blurred vision, poor coordination, and slow reaction to the ball. One student, Kevin, was hit by the ball but did not feel pain immediately. Another student, Lydia, developed sneezing, watery eyes, and nasal congestion after playing near flowering grass.

The school health team collected the following data:

Parameter	Kevin	Lydia	Normal
Reaction time (s)	0.35	0.22	0.18
Synaptic transmission efficiency	Low	Normal	High
Histamine level	Low	High	Low
Tear production	Normal	High	Moderate
Heart rate (beats/min)	130	110	60–100
Sleep hours	3	7	7–9

Additional observations:

- Students had used bright lights during night reading
- Some reported eye strain and difficulty focusing
- Kevin had earlier used a local anaesthetic for a minor injury
- Lydia had similar reactions during previous pollen seasons
- Players who slept well performed better

Reference: “*Sleep Deprivation and Neural Function in Adolescents*” – Sleep Foundation Report

Task

(a) Explain how lack of sleep, synaptic transmission, sensory receptors, and immune responses contributed to the students’ performance and symptoms.

(b) Suggest practical ways the school can improve student performance and reduce such health problems.

*Lack of sleep reduces efficiency of the nervous system. Kevin slept only **3 hours**, which lowers **synaptic transmission efficiency**, slowing the passage of impulses across synapses. This explains his delayed reaction time (**0.35 s**) and poor coordination during the match.*

*Sleep deprivation also affects brain centres responsible for vision and coordination, leading to **blurred vision and reduced focus**. Bright lights used during night study overstimulated retinal photoreceptors (rods and cones), causing **eye strain** and difficulty focusing, which further impaired performance.*

*Kevin’s earlier use of a **local anaesthetic** blocked sodium channels in neurons, reducing nerve impulse transmission. This explains why he did not feel pain immediately after being hit and why his coordination and responses were slower.*

*Lydia’s symptoms are due to an **allergic reaction**. Pollen triggered IgE-mediated activation of mast cells, releasing **histamine**. Her high histamine level caused vasodilation and increased mucus secretion, leading to **sneezing, watery eyes, and nasal congestion**. Increased tear production is part of the body’s attempt to remove the allergen.*

*Her reaction time (**0.22 s**) is slightly slower than normal due to discomfort and mild physiological stress, though better than Kevin’s because she had adequate sleep (**7 hours**) and normal synaptic transmission. Higher heart rates in both students (Kevin 130, Lydia 110) show increased physiological stress from physical activity, lack of rest, and immune responses.*

(b) Preventive strategies

- **Ensure students get adequate sleep.** Sleep improves synaptic transmission and brain function. Adequate rest enhances reaction time, coordination, and overall performance.
- **Reduce prolonged exposure to bright lights during night study.** Excess light overstimulates photoreceptors and causes eye strain. Proper lighting protects retinal function and improves visual performance.

- **Avoid unnecessary use of local anaesthetics before physical activity.** Anaesthetics block nerve impulses and reduce sensation. Avoiding them improves coordination and normal sensory responses.
- **Manage exposure to allergens such as pollen.** Pollen triggers histamine release and allergic reactions. Reducing exposure or using preventive measures limits symptoms and discomfort.
- **Schedule academic and physical activities appropriately.** Combining night study with early sports disrupts homeostasis. Balanced scheduling supports rest, recovery, and better performance.
- **Educate students on rest, recovery, and health awareness.** Understanding the importance of sleep and health helps students make better choices, improving nervous coordination and reducing risks.

PART II

Attempt one item from this section

ITEM 5

In **Jinja District**, a commercial poultry farm has expanded rapidly to meet the increasing demand for chicken meat in urban markets. However, the farmer reports that profits are declining despite increased production.

Observations from the farm include:

- Chickens now require **3.2 kg of feed to gain 1 kg body mass**, compared to 2.1 kg five years ago
- Some chicken lines grow faster but are more susceptible to disease
- A cross between fast-growing chickens (F) and disease-resistant chickens (f) produced F1 birds that were intermediate, and F2 offspring showed a **1:2:1 ratio (fast : intermediate : resistant)**
- Feed is mainly composed of fishmeal from Lake Victoria

Environmental and ecological findings:

- Fish used in feed contain traces of pesticides such as DDT
- Predatory fish have higher toxin levels than small fish
- Waste from poultry houses releases methane and ammonia
- The farm relies heavily on charcoal for brooding chicks
- Nearby crop farmers complain that chicken waste pollutes water sources

Task: Analyse how genetic inheritance, feed conversion efficiency, biomagnification, and carbon emissions affect poultry production and environmental sustainability, and propose strategies to improve productivity while reducing environmental impact.

RESPONSE

The decline in profit on the poultry farm is caused by the interaction of **genetic inheritance, poor feed conversion efficiency, biomagnification of toxins in feed, and environmental pollution from production activities.**

The feed conversion ratio has worsened from **2.1 : 1** to **3.2 : 1**. This means chickens now require more feed to produce the same body mass. As a result, production costs increase, feed is used less efficiently, and profit declines.

Some chicken lines grow faster but are more susceptible to disease. This shows a **trade-off between rapid growth and disease resistance**. Fast growth allows quick meat production, but disease susceptibility increases losses, treatment costs, and poor performance.

A cross between fast-growing chickens and disease-resistant chickens produced F1 birds with **intermediate traits**, while F2 showed a **1 : 2 : 1 ratio (fast : intermediate : resistant)**. This indicates **incomplete dominance**, where neither trait is fully dominant. It also shows genetic variation in the population, producing birds with different levels of growth and resistance.

Because of this inheritance pattern, not all birds combine the best traits. Some grow fast but are weak against disease, while others resist disease but grow slowly. This reduces overall production efficiency if selection is not carefully managed.

The feed contains fishmeal from Lake Victoria. Some fish contain pesticides such as **DDT**, and predatory fish have higher toxin levels than small fish. This is **biomagnification**, where toxin concentration increases at higher trophic levels. When poultry eat contaminated fishmeal, toxins can enter their bodies and affect health, growth, and productivity.

Biomagnified pesticides may interfere with metabolism, immunity, and normal body functions. This can contribute to poor growth, increased disease susceptibility, and inefficient feed utilisation.

Waste from poultry houses releases **methane** and **ammonia**. Methane is a **greenhouse gas** that contributes to global warming, while ammonia lowers air quality and can affect the health of birds and workers. Poor air quality can stress birds and reduce growth performance.

The farm also uses charcoal for brooding chicks. Charcoal use increases the **carbon footprint** because it releases carbon dioxide during burning and contributes to deforestation where trees are cut for charcoal production.

Chicken waste polluting nearby water sources shows poor waste management. Runoff of waste adds excess nutrients and organic matter to water, causing pollution, bad smell, and possible eutrophication. This harms ecosystems and creates conflict with neighbouring farmers.

Overall, declining profitability is due to poor feed efficiency, genetic trade-offs, toxin accumulation through feed, high carbon emissions, and environmental pollution.

Part (B): Sustainable strategies

- **Select and breed chickens with both good growth and disease resistance**

The current chicken lines show a trade-off between fast growth and resistance, and incomplete dominance produces variable offspring. Careful breeding increases birds with balanced traits, improving survival, growth, and feed conversion efficiency.

- **Use safer alternative protein sources instead of contaminated fishmeal**

Fishmeal from contaminated fish transfers pesticides into poultry through biomagnification. Replacing it with clean protein feeds reduces toxin intake, improves bird health, and supports safer production.

- **Improve feed formulation and feeding management**

A high feed conversion ratio means too much feed is used for little body gain. Balanced rations and proper feeding reduce wastage, improve nutrient use, and lower production costs.

- **Adopt biogas systems for poultry waste management**

Untreated poultry waste releases methane and ammonia into the environment. Using waste in biogas production captures methane for energy and reduces greenhouse gas emissions and farm pollution.

- **Replace charcoal with renewable brooding energy sources**

Charcoal increases carbon emissions and encourages deforestation. Using solar or other renewable energy lowers the carbon footprint and makes poultry production more sustainable.

- **Treat poultry waste before disposal or field use**

Raw waste pollutes water sources with nutrients and organic matter. Proper treatment such as composting stabilises the waste, reduces pollution, and makes it safer for agricultural use.

ITEM 6: CALL 0772-460-633 TO GET THE BOOK: SELF-STUDY A-LEVEL BIOLOGY: WITH ALIGNED SYLLABUS NOTES, TOPICAL ASSESSMENT ITEMS, TEST PAPERS AND SOLUTIONS.