Student's Name:.....

Signature.....

Random No.						Personal No.		

BIOLOGY
PAPER 1
(Theory)
2 Hours 30 minutes

END OF CYCLE EXAMINATIONS TERM I 2026

BIOLOGY

Paper 1

(Theory)

2 HOURS 30 Minutes

INSTRUCTTIONS TO CANDIDATES:

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

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

Section **B** *has* **two** *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 **THREE** *items in all.*

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

SECTION A

Attempt all items in this section

ITEM 1

In Soroti District, a group of farmers introduced a new fast-growing tomato variety in a greenhouse system. Initially, the plants showed rapid growth and high fruit production, but after some weeks, the plants began to show leaf wilting, reduced fruit size, and soft stems.

Closer observation revealed that the greenhouse had high humidity and temperature, and the plants were frequently sprayed with pesticides. Laboratory analysis showed that enzymes involved in respiration were denatured, and cells had leaky plasma membranes.

Microscopic examination showed collapsed parenchyma cells and poorly developed vascular tissues. Some plants recovered slightly when ventilation was improved.

Table: Environmental and Cellular Observations in Tomato Plants

Condition	Temperature (°C)	Enzyme activity (% normal)	Membrane integrity	Tissue condition	Yield
Optimal greenhouse	25	100	Intact	Healthy	High
Poor ventilation	35	55	Leaky	Weak tissues	Low
After ventilation	28	80	Improved	Recovering	Moderate

Task

(a) Explain how high temperature, enzyme denaturation, and membrane damage affect respiration, cell structure, tissue strength, and plant productivity.

(b) From the situation described, indicate how the challenges experienced in the greenhouse can be effectively controlled to improve yield.

(a) Explanation of observed changes

- *High temperature disrupts the optimum conditions required for enzyme activity. When temperature rises to 35°C, enzymes involved in respiration lose their functional shape (denature), reducing their catalytic ability. This slows down respiration, leading to reduced ATP production, which limits energy available for growth and fruit development.*
- *Enzyme denaturation alters the active site of enzymes, preventing substrate binding. As a result, metabolic reactions such as breakdown of glucose in respiration are reduced, leading to low energy release and poor physiological performance.*
- *Damage to the plasma membrane affects its fluid mosaic structure, increasing permeability. This causes leakage of ions and cellular contents and disrupts selective transport of nutrients and water. Consequently, cells fail to maintain internal balance, leading to loss of turgidity and wilting.*
- *Collapsed parenchyma cells result from loss of turgor pressure due to membrane damage and water imbalance. These cells normally provide support and storage; when they collapse, tissues become weak and soft.*
- *Poorly developed vascular tissues reduce transport of water, minerals (xylem), and food (phloem). This limits distribution of nutrients and sugars, reducing growth and fruit size.*

(b) Strategies to improve greenhouse productivity

- *Improve greenhouse ventilation to reduce excessive heat, maintaining optimal temperature and preventing enzyme denaturation, thereby restoring normal respiration and growth.*

- *Regulate pesticide use to avoid chemical damage to plasma membranes, preserving membrane integrity and proper transport of substances in cells.*
- *Maintain optimal temperature conditions through shading or cooling systems to ensure enzymes function efficiently, supporting metabolic processes and productivity.*
- *Monitor and control humidity levels to prevent excessive water loss or tissue weakening, maintaining proper turgor pressure and cell stability.*
- *Use heat-tolerant plant varieties that can maintain enzyme function and membrane stability under higher temperatures, improving resilience and yield.*
- *Carry out regular environmental monitoring and control to detect and correct unfavorable conditions early, ensuring stable internal greenhouse conditions for optimal plant growth.*

ITEM 2

In Kasese District, miners working in a dusty environment reported frequent cases of breathing difficulty, fatigue, and chest pain. Medical examination showed that lung tissues had damaged epithelial cells and reduced surface area for gas exchange.

Further tests revealed that cells in affected individuals had low ATP production, and enzymes involved in respiration were functioning below normal levels. Some workers showed thickened lung tissues and accumulation of particles.

Microscopic analysis indicated that alveolar walls were damaged, and there was reduced diffusion efficiency.

Table: Physiological and Cellular Observations in Workers

Parameter	Normal individuals	Affected workers
Oxygen uptake	High	Low
ATP production	High	Low
Enzyme activity	High	Reduced
Lung tissue structure	Normal	Damaged

Task

(a) Explain how damage to lung tissues affects gas exchange, enzyme activity, ATP production, and overall body function.

(b) Suggest practical measures that can reduce the effects of the mining environment on workers' health.

(a) Explanation of observed changes

- *Damage to alveolar epithelial cells reduces the surface area available for gas exchange. The alveoli normally provide a large, thin surface for diffusion of oxygen into blood and carbon dioxide out. When walls are damaged and thickened, the diffusion distance increases and efficiency decreases, leading to low oxygen uptake.*
- *Accumulation of dust particles causes inflammation and thickening of lung tissues, further reducing permeability of the alveolar membrane. This slows diffusion of gases, resulting in reduced oxygen supply to body cells.*
- *Low oxygen availability limits aerobic respiration in cells. Oxygen is the final electron acceptor in the electron transport chain; when it is insufficient, respiration rate decreases. As a result, enzyme activity in respiration pathways is reduced because reactions slow down due to lack of substrates and suitable conditions.*

- *Reduced enzyme activity leads to decreased ATP production since enzymes catalyze steps in glycolysis, Krebs cycle, and oxidative phosphorylation. Low ATP means less energy for muscle contraction and cellular processes, causing fatigue and weakness.*

(b) Strategies to reduce health effects

- *Provide protective masks to reduce inhalation of dust particles, preventing accumulation in lungs and protecting epithelial tissues from damage.*
- *Improve ventilation in mines to increase oxygen availability and reduce dust concentration, enhancing gas exchange and supporting normal respiration.*
- *Carry out regular medical check-ups to detect early signs of lung tissue damage, allowing timely treatment and prevention of severe respiratory problems.*
- *Reduce exposure time in dusty environments to limit accumulation of harmful particles in lung tissues, reducing long-term damage and maintaining lung function.*
- *Educate workers on safety practices to promote proper use of protective equipment and awareness of risks, preventing unnecessary exposure to harmful conditions.*
- *Enforce workplace safety regulations to ensure proper standards of ventilation, protective gear, and working conditions, improving overall worker health and reducing disease risk.*

SECTION B

Attempt one item from this section

ITEM 3

In Kampala City, a fast-food restaurant was investigated after several customers developed severe diarrhoea, vomiting, and dehydration. Laboratory analysis identified contamination with a strain of bacteria found in improperly stored meat.

Further studies showed that the bacteria had high enzyme activity, rapid reproduction, and a protective cell wall. Tissue samples from affected patients revealed damage to intestinal epithelial cells, leading to poor absorption.

Some bacteria survived even after heating, suggesting they may have characteristics similar to extremophiles.

Table: Observations in Bacteria and Patients

Parameter	Normal condition	Contaminated condition
Bacterial growth rate	Low	Very high
Enzyme activity	Moderate	High
Epithelial tissue integrity	Intact	Damaged
Nutrient absorption	Efficient	Reduced

Reference: *"Foodborne Bacterial Infections and Intestinal Tissue Damage" – Journal of Medical Microbiology*

Task

(a) Explain how bacterial cell structure, enzyme activity, and rapid reproduction lead to epithelial tissue damage and reduced nutrient absorption in humans.

(b) Using the information provided, describe how such infections can be prevented and controlled in the community.

(a) Explanation of observed changes

- *Bacterial cell structure, especially the presence of a rigid cell wall, protects the bacteria from harsh conditions such as heat and digestive enzymes. This allows some bacteria (including extremophile-like strains) to survive cooking and reach the intestine alive, where they cause infection.*
- *High enzyme activity in bacteria increases their metabolic rate and ability to produce toxins. These enzymes break down host cell components and interfere with normal cellular functions, leading to destruction of intestinal epithelial cells.*
- *Rapid reproduction through binary fission leads to a rapid increase in bacterial population. A large number of bacteria produce more toxins and exert greater damage on epithelial tissues, overwhelming the body's defense mechanisms.*
- *Damage to intestinal epithelial cells disrupts the lining responsible for absorption. The epithelial cells normally provide a large surface area and contain transport proteins for nutrient uptake. When damaged, absorption of water and nutrients is reduced, leading to diarrhoea and dehydration.*
- *Loss of epithelial integrity also increases permeability, allowing more toxins and pathogens to pass into tissues, worsening the condition.*

(b) Strategies to prevent and control infections

- *Store food properly under refrigeration to lower temperature and slow bacterial growth and reproduction, reducing contamination levels in food.*
- *Ensure thorough cooking of food to denature bacterial enzymes and kill most microorganisms, preventing survival of harmful bacteria.*
- *Maintain proper hygiene during food handling to avoid introduction and spread of bacteria onto food, reducing risk of contamination.*
- *Conduct regular inspection of food outlets to enforce safety standards and identify unhygienic practices early, preventing outbreaks.*
- *Promote public health education to increase awareness on safe food preparation and handling practices, reducing infection risk at community level.*
- *Ensure proper waste disposal to eliminate breeding grounds for bacteria and reduce environmental contamination, limiting spread of pathogens.*

ITEM 4

In a hospital in Mbarara, patients in the intensive care unit developed infections that were difficult to treat. Laboratory tests identified bacteria that were resistant to antibiotics.
Further analysis showed that these bacteria had different cell membrane compositions and enzymes that neutralized drugs. Some were identified as archaea-like organisms, able to survive harsh conditions.
Affected patients showed damage to epithelial tissues in the lungs, leading to impaired gas exchange.
Table: Observations in Resistant Bacteria and Patients

Parameter	Normal bacteria	Resistant bacteria
Antibiotic response	Sensitive	Resistant
Enzyme activity	Normal	High (drug breakdown)
Cell membrane structure	Standard	Modified
Lung epithelial condition	Normal	Damaged

Reference: *"Antibiotic Resistance and Microbial Adaptation in Clinical Settings" – Clinical Microbiology Reviews*

Task

(a) Explain how differences in bacterial cell structure and enzyme activity contribute to antibiotic resistance and epithelial tissue damage in patients.

(b) Suggest practical ways that can reduce the spread and impact of resistant infections in hospitals.

(a) Explanation of observed changes

- *Modified bacterial cell membrane structure reduces permeability to antibiotics. Changes in lipid composition and membrane proteins prevent drugs from entering the cell or reduce their uptake, allowing bacteria to survive treatment.*
- *Some bacteria possess enzymes that break down or modify antibiotics (e.g., drug-inactivating enzymes). High enzyme activity neutralizes the drug before it can reach its target, making the antibiotic ineffective.*
- *Archaea-like characteristics enable survival in harsh conditions such as high temperature, low oxygen, or presence of toxic substances. Their unique membrane composition increases stability and resistance to chemical damage, contributing to persistence in hospital environments.*
- *Rapid survival and multiplication of resistant bacteria increase infection severity. As bacteria accumulate, they produce toxins and trigger inflammation, damaging lung epithelial tissues.*
- *Damage to lung epithelial tissues reduces the efficiency of gas exchange. The epithelial lining becomes thickened or destroyed, increasing diffusion distance and lowering oxygen uptake, leading to impaired respiration in patients.*

(b) Strategies to reduce spread and impact of resistant infections

- *Ensure proper use of antibiotics by prescribing correct doses and completing treatment courses, reducing selection pressure that leads to development of resistant bacteria.*
- *Maintain strict hygiene in hospitals through handwashing and sanitation practices, preventing transmission of resistant bacteria between patients.*
- *Isolate infected patients to limit contact with others, reducing spread of resistant strains within the hospital.*
- *Carry out regular sterilization of medical equipment to destroy microorganisms, preventing cross-contamination and infection spread.*
- *Implement monitoring and surveillance systems to detect resistant strains early, allowing timely intervention and control measures.*
- *Promote research and use of new or alternative drugs to overcome resistance mechanisms, improving effectiveness of treatment against resistant bacteria.*

END