

S.5 BIOLOGY MID TERM I SAMPLE ASSESSMENT ITEMS 2026



ITEM 1

In Jinja District, a sugar processing factory has recently expanded its operations. Workers living near the plant have reported increased cases of fatigue, weight loss, and abdominal discomfort. Medical examinations show liver cell damage and reduced metabolic activity.

Investigations revealed that untreated wastewater containing organic solvents and heavy metals is released into nearby water sources. These chemicals are known to interfere with enzymes and membrane structures.

Further laboratory studies were conducted on liver tissue samples from affected individuals and a control group.

Table: Cellular and Biochemical Indicators in Liver Cells

Sample group	Enzyme activity (Catalase %)	Mitochondrial density (per cell)	Cell membrane integrity (%)	Average cell size (μm)
Control	100	120	95	25
Exposed group	50	70	60	18

Microscopic observations showed disrupted membranes, fewer mitochondria, and accumulation of lipid droplets in affected cells. Bacterial contamination was also detected in water samples.

Task

- Analyse how enzyme inhibition, membrane damage, and mitochondrial changes explain the observed symptoms in affected individuals.
- Using the information provided, outline practical approaches that could address both the cause and effects of the problem in this community.

Expected scoring points

(a) Analysis

- Heavy metals act as enzyme inhibitors (non-competitive, alter active site shape)
- Reduced catalase activity as a result of accumulation of toxic hydrogen peroxide
- Membrane damage (fluid mosaic disruption) leads to leakage of cell contents
- Lipid accumulation causes impaired metabolism (lipid storage due to enzyme failure)
- Reduced mitochondria, less ATP production leading to fatigue
- Smaller cell size, loss of cytoplasm and organelles
- Water as solvent affected, poor metabolic reactions

(b) Application (explained)

- Treat industrial wastewater
- Reduce chemical discharge
- Use clean water sources
- Protective measures for workers
- Environmental monitoring

ITEM 2

Health centers in Kampala have reported increasing cases of bacterial infections that do not respond to commonly used antibiotics. Patients show prolonged fever and slow recovery.

Laboratory tests reveal that bacteria from these patients have altered cell structures and enzyme systems. Some antibiotics were found to bind poorly to bacterial enzymes, while others were blocked by cell membrane changes.

Microscopic analysis was carried out.

Table: Bacterial Cellular and Enzyme Characteristics

Bacterial strain	Cell wall thickness (nm)	Enzyme activity (%)	Membrane permeability (%)	Growth rate
Non-resistant	20	100	90	High
Resistant	35	60	40	Moderate

Further analysis showed differences between prokaryotic bacterial cells and human cells in ribosome structure and membrane composition.

Task

- Explain how changes in bacterial cell structure and enzyme activity contribute to antibiotic resistance.
- Suggest appropriate measures that could reduce the spread and impact of resistant bacteria in the community.

(a) Explanation

Expected scoring points

- Thicker cell wall; prevents antibiotic entry
- Reduced membrane permeability: limits drug diffusion
- Enzyme alteration: antibiotics cannot bind (lock & key disrupted)
- Possible competitive inhibition failure
- Differences between prokaryotic and eukaryotic cells exploited
- Ribosome differences: antibiotics target bacteria specifically
- Reduced enzyme activity but survival advantage

(b) Application

Expected strategies (Explained)

- Proper antibiotic use
- Complete dosage
- Improve hygiene
- Limit misuse in agriculture
- Research new drugs

ITEM 3

Farmers in Mbale region have reported reduced maize yields despite adequate rainfall. The plants show stunted growth, yellowing leaves, and reduced biomass.

Soil tests reveal the presence of chemical residues that affect enzyme activity in plant cells. These chemicals interfere with protein function and membrane transport.

Microscopic examination of plant tissues showed fewer chloroplasts and damaged mitochondria.

Table: Plant Cellular and Enzyme Indicators

Sample	Enzyme activity (%)	Chloroplast number	Mitochondrial activity (%)	Cell size (µm)
Healthy plants	100	50	100	40
Affected plants	55	30	60	28

Water analysis indicated reduced solvent efficiency affecting nutrient transport.

Task

- (a) Analyse how enzyme disruption, organelle damage, and water properties affect plant growth and productivity.
- (b) From the scenario, describe ways through which the farmers could restore plant health and improve yield.

Expected responses

(a) Explanation

Expected scoring points:

- *Chemicals inhibit plant enzymes; reduced metabolic reactions*
- *Fewer chloroplasts; reduced photosynthesis*
- *Damaged mitochondria; less ATP for growth*
- *Water properties altered, poor nutrient transport*
- *Enzyme-substrate interaction affected (induced fit failure)*
- *Reduced cell size; poor growth*
- *Proteins denatured, enzyme inactivity*

(b) Application

Expected strategies explained

- *Reduce chemical use*
- *Improve soil quality*
- *Use organic fertilizers*
- *Proper irrigation*
- *Crop rotation*

ITEM 4

Athletes at a training center in Kampala have reported early muscle fatigue during exercise. Despite good nutrition, their performance has declined.

Medical investigations show reduced ATP production, enzyme inefficiency, and altered muscle cell structure.

Microscopy revealed fewer mitochondria and disrupted muscle fibers.

Table: Muscle Cell Performance Indicators

Group	ATP production (%)	Enzyme activity (%)	Mitochondrial number	Muscle fiber integrity (%)
Healthy athletes	100	100	150	95
Affected athletes	60	65	90	70

Task

- (a) Explain how reduced enzyme activity and mitochondrial function lead to muscle fatigue.
- (b) Using evidence from the scenario, suggest strategies that could improve athletic performance.

(a) *Expected scoring points:*

- *Reduced mitochondria; less ATP production*
- *Enzyme inhibition; slower respiration reactions*
- *Poor enzyme-substrate binding; reduced efficiency*
- *Muscle fibers damaged; reduced contraction strength*
- *Proteins (enzymes) affected, slower metabolism*
- *Oxygen use reduced, less aerobic respiration*
- *Lipids used inefficiently as energy source*

(b) *Expected strategies (Explained)*

- *Balanced diet*
- *Proper rest*
- *Avoid inhibitors*
- *Improve oxygen supply*
- *Hydration*

ITEM 5

Communities around Lake Victoria have reported fish deaths and reduced fish quality. The fish appear weak and show poor growth.

Water analysis shows high levels of pollutants affecting cellular processes.

Microscopy of fish tissues revealed damaged membranes and reduced organelles.

Table: Fish

Location	Enzyme activity (%)	Membrane integrity (%)	Mitochondrial function (%)	Oxygen uptake
Clean area	100	95	100	High
Polluted area	45	50	55	Low

Bacterial presence in water was high, indicating contamination.

Task

- (a) Analyse how pollution affects enzyme activity, membrane structure, and energy production in fish.
- (b) Based on the situation described, propose measures that could restore the aquatic ecosystem.

(a) *Expected scoring points:*

- *Pollutants inhibit enzymes, reduced metabolism*
- *Membrane damage: loss of selective permeability (fluid mosaic disrupted)*
- *Reduced mitochondria; less ATP*
- *Oxygen uptake reduced, less respiration*
- *Bacteria increase, competition for oxygen*
- *Water properties altered, poor diffusion*
- *Protein denaturation due to toxins*

(b) *Expected strategies (Explained):*

- *Control pollution*
- *Treat wastewater*
- *Reduce bacterial contamination*
- *Protect water bodies*
- *Environmental awareness*

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