BIOLOGY
Paper 1
(Theory)
July/Aug. 2026
3 hours

HOIMA DIOCESE EXAMINATIONS BOARD

UACE Mock Examination, 2026

BIOLOGY
Paper 1
(Theory)
3 hours

INSTRUCTIONS TO CANDIDATES

This examination paper consists of **two** *sections;* **A** *and* **B**. *It has* **six** *items.*

Section **A** *has* **two compulsory** *items.*

Section **B** *has* **two** *parts:* **I** *and* **II**. *Respond to* **one** *item from* **each** *part.*

Respond to **four** *items in* **all.**

Any additional item(s) responded to will **not** *be scored.*

All responses must be written in answer booklet(s) provided.

SECTION A

Attempt **both** *items in this section*

Item 1

At a hospital in Kampala, Dr. Nkenga is studying why some young adults develop heart problem even without common risk factors. One patient, Musa (32), shows symptoms such as irregul heartbeat, and weak muscles. Musa has been exposed for a long time to polluted air containi high levels of Arsenic (carcinogen), which may have damaged his heart cells. Laboratory analys of cellular and tissue changes revealed the information in **Table 1.**

Table 1: Data table

Parameter	Healthy heart tissue	Diseased heart tissue
Arsenic levels (ppm)	0.012	6.248
DNA condition	Stable	Damaged
Fibrosis (scar tissue)	Very little	Much → tissue becomes stiff
Average number of cristae on the mitochondria (ppm)	20.6	12.4
Ribosome activity	Normal	First increases, then becomes faulty.

Dr. Nkenga, after critical analysis of the above data, proposed three management interventions which are due for evaluation to choose a suitable one that can improve Musa's condition:

- Regular cardiac exercise
- Gene therapy
- Dietary adjustments including oxygen-rich glucose intravenous supplements.

Task

(a) Analyse the data and explain the effect of air pollution on cellular and tissue structures in Musa in relation to the observed symptoms.

(b) Evaluate the effectiveness of Dr. Nkenga's management interventions in improving Musa's condition.

Item 2

Diana established a peppermint (*Mentha piperita*) farm in the Eastern region of Uganda. The region experiences extreme environmental conditions. A team of Agricultural scientists formed two groups of peppermint plants *A* and *B* and subjected them to different conditions for several days.

Table 2

Peppermint group	Conditions
Group *A*	8 hours of light Moderate levels of Abscisic acid (ABA) Moderate temperature.
Group *B*	6 hours of light High levels of ABA Moderate temperature.

The Agricultural scientists then investigated how the environmental conditions and plant hormone affected plants. **Table 3** shows their findings.

Table 3

Measured parameter/observation	Peppermint plant group	
	Group A	Group B
Photosynthetic rate	High	Low
Wilting	Moderate	Severe
Flowering	Flowering	No flowering

The scientists concluded that the environmental conditions in Eastern region increased stress in the peppermint plants, leading to reduced productivity. They therefore proposed two interventions to increase productivity of the plants:

- Routine watering of the plants especially during hot days
- Increasing the soil salinity by adding ash in the gardens.

Tasks

(a) Analyze how the conditions subjected to the peppermint plant groups influence productivity in the plants.

(b) Evaluate the effectiveness of the interventions proposed by the scientists and give strategic guidance.

SECTION B

PART I

Attempt **one** *item from this part*

Item 3

During a high-stakes football tournament in Kampala, three players used different strategies to manage performance and injury:

Player 1: First time player, who completed a structured warm-up before play.

Player 2: Seasoned player, given a local anaesthetic injection after sustaining a muscle injury and continued playing.

Player 3: Seasoned player, applied ice-cold treatment immediately after injury and returned to play shortly after.

After the match, the team physiologist raised concerns that some of these interventions may have improved short-term performance but increased the risk of body physiological damage and impaired body temperature regulation. Important homeostatic, nervous and circulatory parameters were therefore assessed in the three players.

Table 4: Data provided

Parameter	Player 1	Player 2	Player 3
Synaptic transmission efficiency	High	Reduced	Moderate
Reaction time (ms)	160	260	210
Heart rate after play (bpm)	150	138	132
Skin temperature (°C)	38.2	36.4	32.5

Task

(a) Analyze the data and account for the differences in the physiological parameters assessed in the three players.

(b) Evaluate each player strategy and assess which one balances performance and physiological safety.

Item 4

Last month, Okello and Musa were involved in a road accident. Okello was admitted in a nearby clinic while Musa was taken to a referral hospital and each of them was handled as shown below:

- Okello was administered all recommended antigen vaccines a week before surgery morphine pain killer.
- Musa was given no vaccination before surgery and also no pain killer due to allergic conditions.

Note: Morphine is a pain killer that bind to receptors in the presynaptic membrane of a cholinergic synapse and prevent entry of calcium ions in the presynaptic knob.

Table 5: Patient's condition during and after surgery.

Parameter	Okello	Musa
Pain-perception during surgery	Less	Much
Condition after 10 days	Healing was successful	No healing yet, secondary infections at the site of surgery and fever.
Cardiac output at day 10 (dm^3 per minute)	5.2	6.8

Some medical interns later advised that to ensure Musa recovered faster one of the following strategies could have been taken.

(i) Administer Musa with lidocaine (a regional nerve block that blocks sodium ion channels in nerve axons) instead of morphine and also given passive vaccines with specific antibodies on the day of the surgery.
(ii) Give Musa oral mild pain killer one hour to surgery and administer antibacterial drugs after visible signs of inflammation.

Task

(a) Using the information provided, analyse the patient's condition during and after surgery.

(b) Evaluate the strategies given by the medical interns and choose one which would have been effective in bringing about faster recovery in Musa.

PART II

Attempt **one** *item in this part*

Item 5

The diamondback moth, *Plutella xylostella*, is a major pest of cabbage crops in tropical agricultural regions. Rising global temperatures and the widespread use of synthetic pesticides have increased the challenge of controlling this pest. Scientists investigated the inheritance of pesticide resistance and wing morphology under different environmental conditions.

Two inherited genes were studied:
Gene 1: Pesticide resistance (R - Resistant, r - Susceptible, to pesticide)
Gene 2: Wing morphology (W - Long wings, w = Wrinkled wings)

A true-breeding resistant, long-winged moth was crossed with a true-breeding susceptible, wrinkled-winged moth. All F_1 offspring were resistant and long-winged with genotype.

To investigate whether environmental temperature affects patterns of inheritance, adult F_1 moths were divided into two groups and acclimatized to different temperatures before each group was test-crossed with homozygous recessive moths.

- Condition A: Test cross conducted at 22°C (baseline temperature).
- Condition B: Test cross conducted at 32°C, simulating prolonged global warming.

The test cross results are shown in **Table 6:**

Table 6: Phenotypic distribution of test-cross offspring

Phenotype	Condition A (22°C)	Condition B (32°C)
Resistant, long-winged	470	500
Susceptible, wrinkled-winged	468	500
Resistant, wrinkled-winged	32	0
Susceptible, long-winged	30	0

Over a 10-year period, farmers repeatedly sprayed a synthetic chemical pesticide. Ecologists monitored the frequency of pesticide resistance allele (R) in the moth population and the population size of a native predatory beetle that naturally controls the moth population. The results are as shown in **Table 7**

Table 7: 10-year trends in resistance and predator population.

Year	Frequency of resistant allele (R)	Predator population (per km^2)
1	0.05	1200
4	0.22	650
7	0.58	110
10	0.95	0

Ecologists need to find strategies to restore this ecosystem.

Task

(a) Analyse the effect of increased temperature and continuous pesticide application on the inheritance patterns of the moth, frequency of resistant allele and predator population.
(b) Propose and evaluate three strategies to restore this ecosystem and increase crop productivity.

Item 6

In the semi-arid rangelands of Kotido District, pastoralists keep indigenous Zebu cattle adapted to harsh environmental conditions. Heat tolerance and water-retention ability in these cattle are controlled by a multiple allele system (T^H, T^M, T^S), where T^H (extreme tolerance) is dominant over T^M (moderate tolerance), and both are dominant over T^S (sensitivity).

However, increasing herd sizes have led to severe overgrazing, causing a shift in vegetation from nutritious perennial grasses (*Themeda triandra*) to invasive, unpalatable weeds (*Sporobolus pyramidalis*). Ecologists have carried out several investigations on the cattle genetics, daily water intake or requirement and body mass loss and survival features and comparisons have been done on the land affected by overgrazing.

Tables 8A and 8B show a summary of the findings.

Table 8A: Cattle genotype frequencies and survival metrics during extreme drought.

Cattle genotype	Population frequency (Genotype)	Mean daily water intake or requirement (*l*)	Body mass loss (%)
$T^{H}T^{H}$	0.05	12	4
$T^{H}T^{S}$	0.15	14	6
$T^{M}T^{M}$	0.30	25	15
$T^{M}T^{S}$	0.40	28	19
$T^{S}T^{S}$	0.10	45	35

Table 8B: Rangeland ecological succession metrics across grazing gradients

Grazing pressure zone	Dominant plant species	Net primary productivity ($g/m^2/yr$)	Soil erosion rate (tons/ha/yr)
Light grazing	*Themeda triandra* (Perennial)	500	0.5
Moderate grazing	Mixed grasses and herbs	200	4.2
Heavy overgrazing	*Sporobolus pyramidalis* (Weed)	110	38.0

As part of the ecologists' implementation strategies, they intend to roll out mass culling program targeting to remove any cattle showing traits of the $T^{S}T^{S}$ genotype, dividing the grazing land into paddocks for rotational grazing and clearing the *Sporobolus pyramidalis* weed using broad-spectrum herbicides to allow native grasses to grow back.

Task

(a) Using **Table 8A** data, analyse the relationship between cattle genotype and heat tolerance explain the inheritance pattern of heat tolerance in cattle and the selective pressures acting on each genotype.

(b) Evaluate the long-term sustainability and effectiveness of the ecologists' implementation strategies.

END