Name: ……**Sign** ……..**Comb**……..

P530/1
BIOLOGY
(THEORY)

UGANDA ADVANCED CERTIFICATE OF EDUCATION
MUHABURA SHINE SECONDARY SCHOOL

S.6 BIOLOGY MID TERM ONE 2026

Paper one; theory

- ***Answer all the items in section one and one each from* each part in section B.** ***Total items answered should be 4 only***
- ***Organise your answers, then present them logically and precisely.***

SECTION A

Answer all the items in this section.

Item 1

Victoria Nile is a source of food and income for the communities living along it. However, the community near a textile factory have reported to the district authorities that the fish catches have significantly reduced over the past few months. The authorities requested Dr. Achen, a fisheries biologist from National Environmental Management Authority (NEMA) to carry out an investigation. She suspected that the cause was pollution from the factory that releases wastes containing heavy metals and cyanide into the lake.

She caged fish at two different sites; a clean control site (no pollution) and a site near the factory outflow. She investigated the effects of the heavy metals on the gill and mitochondrial structures and ATP synthesis. The data she collected is provided in table

Table 1

Fish group	ATP Concentration (μmol/g cell)	Thickness of gill squamous cells	Number of ribosomes per mitochondrion ($\times 10^6$)	Concentration of oxidised NAD(μmol/g tissue)	Space between cells gill epithelium	Amount of cyanide in river water (mg/L)	Amount of lead (Pb) in river water (mg/L)
Control (no pollution)	9.5	Thin	9.8	7.2	0.5μm	0.01	0.01
Polluted site – factory outflow	2.2	Thick	3.5	1.3	6.0μm	1.00	1.00

You are tasked with analysing her findings and proposing a course of action.

Task

Analyse how cellular and tissue changes in the fish from the polluted site affect respiration and result in reduced fish catches to propose and justify a sustainable management plan to ensure health of organisms in the river.

Item 2

Napak district is one of the agricultural areas in Uganda. It is a lowland area with high temperature, shallow soils that have limited organic matter and very low moisture. Farmers grow both native and non-native crops, however, they often get low yields from the non-native crops unlike from the native crops.

The farmers invited agricultural extension workers to study the situation and propose strategies to improve the yields. They conducted a study in the district and the data collected on native and non-native crops grown is shown in table 2.

Table 2

Condition	**Native plants**	**Non-native crops grown**
The type of leaf anatomy	Kranz anatomy present	Kranz anatomy absent
Distribution of stomata	Many stomata on lower leaf epidermis	Many stomata on upper leaf epidermis
Size of leaf cuticle	Thick	Thin
Number of hairs on the leaf	Numerous	Very few

You are part of the team invited by the agricultural extension officer to analyse the data and propose strategies to the farmers on how to improve their crop yields.

Task:

(a) Account for the difference in the yields between native and non-native crops grown in the district, and propose strategies to enhance productivity and resilience.

SECTION B

Item 3

During the District Multi-Sport Championship in Soroti district (Altitude 1130m above sea level and temperature 30°C), Alex and Chris, were among the participants in 400m race

Athlete profiles and pre-competition factors:

- Alex (400m Sprint): Trained at the Teryet National grounds in Kapchorwa, a high-altitude facility (2,200 m above sea level and temperature 21°C).
- Chris (400m Sprint): Trained at Namboole National Stadium in Wakiso, a low-altitude facility (1,128 m above sea level).

Immediately after the events, Chris showed signs of extreme fatigue, collapsed and injured his lower leg.

Chris' coach wondered why Alex did not show signs of extreme fatigue and asked the first aider to investigate since he was suspecting Alex of sports doping. The first-aid team recorded the following measurements in table 3 immediately after each event.

Table 3

Parameter	Alex	Chris
Pulse rate after race (beats/min)	115	155
Blood oxygen saturation (%)	93	85
Breathing rate (breaths/min)	18	28
Stroke volume (ml/beat)	120	100

The first aider has presented to Chris's coach and he is seeking a scientific explanation for the differences between the participants and expert advice on post-race management of Chris.

Task

Explain how the athletes' performance and observed conditions after the race were influenced by differences in training environments, explain the thermoregulatory adjustment in Alex's body on reaching Soroti and propose strategies for safe management of Chris's condition after the race.

Item 4

Brian a re-known fastest sprinter in the region has recently lost many races. This has caused him to lose self-confidence, become depressed and he also says that he feels unsteady whenever he turns his head quickly. However, he is seen to perform impressive warm-up routines during training whenever his girlfriend is around, an act his coach jokingly calls his "courtship display."

His coach noticed that Brian's reaction time to the start signal is slower than that of his peers and he sometimes staggers and leans forward when walking and running. Worried that he might be having a medical condition affecting his performance, Brian's coach referred him to a medical doctor who conducted tests and compared his results with reference values typical of healthy sprinters. Brian's laboratory and clinical results are shown in table 4.

Table 4

Parameter	**Brian's Result**	**Normal Reference (trained athletes)**
Total synaptic vesicles at the motor end-plate (vesicles per end-plate)	8.0×10^{5}	2.0×10^{6}
Acetylcholine per synaptic vesicle (molecules·vesicle^{-1})	5.0×10^{3}	1.0×10^{4}
Arteriole wall smooth muscle (media thickness) in μm	12	22
Core temperature at the onset of sweating (°C)	39.0	37.2
Whole-body sweat rate at 36 °C ambient	0.2	1.0 L·h^{-1}
Endolymph volume in vestibular apparatus μL (normal range per ear)	60	70–170
Structure of otolith organs	Increased mechanical stiffness	Normal elasticity

On receiving the test results from Brian, the coach could not understand them. You have been tasked with interpreting the results for the coach.

Task:

Account for the physiological mechanisms underlying Brian's observed symptoms and behaviours, explain their survival value, and propose strategies to improve his performance.

Part II

Answer only one item from this section

Item 5

Farmers in Kayunga District use a pesticide to control beetles that destroy the flowers of coffee plants. However, over the past five years, the pesticide has become less effective, as the beetle population has continued to increase.

Findings from an investigation conducted by the district research team show that 20% of the beetles possess a recessive pesticide-resistance allele leading to a decline in coffee yields and pollinator population , while bird populations feeding in the fields increased.

You have been tasked to analyse these findings and help the district officials on how to manage pests.

Tasks

(a) Explain the increase in pesticide-resistant beetles and predict the population of those with pesticide resistant allele, resistant beetles and non-resistant beetles in a population 20000beetles, evaluate the effects of changing pollinator and bird populations on coffee yields, and propose a biologically justified, integrated pest management strategy for the district

Item 6

In western Uganda, communities around Budongo Forest Reserve report increasing native rodent species invasions into crop gardens. The National Forestry Authority (NFA) directed an investigation into the complaints of communities. The investigation showed that the population of native rodent species in the forest declined, while that of non-native rodent species increased. The non-native rodents have stronger limbs, larger incisors, and a higher reproductive rate. The native species therefore, are outcompeted by the non-native species and end up in crop gardens.

The investigation further showed that deforestation and farming have degraded and fragmented the forest into three isolated patches, each with distinct conditions. Unlike before the formation of the patches, the native rodent species are unable to move throughout the forest restricting interbreeding within patches only. The breeding experiments between native rodent species from the different patches A, B and C showed that those from:

- A can not mate with those from B at all
- B can mate with C, but their offspring are infertile
- C and A can mate but a zygote never forms

Tasks

Analyse the ecological and evolutionary interactions in the forest to propose a management plan for Budongo Forest that restores the forest, controls the invasive rodents, and conserves native biodiversity while supporting local livelihoods.

END;

THE DIFFERENCE LIES IN OUR MOTIVATION AND PRIORITY