

**P530/1**  
**BIOLOGY**  
**Paper 1**  
**2026**  
3 hours



**UGANDA NATIONAL EXAMINATIONS BOARD**  
**Uganda Advanced Certificate of Education**

**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**.*

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

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

## SECTION A

Respond to **both** items in this section.

### Item 1

John was persistently wheezing and feeling fatigue. He was then taken to a specialized hospital for medical care. Basing on his signs and symptoms, the doctor suspected a condition affecting the epithelial tissue lining John's respiratory system.

Normally, the cell membrane of the epithelial cells of the tissue contains a protein that regulates water movement in and out of the epithelial cell. The synthesis of the protein is controlled by a gene called cystic fibrosis transmembrane conductance regulator (CFTR) gene.

A defect in the CFTR gene can affect the protein function. Since the doctor suspected a defect in the protein, the he requested for a CFTR gene test and other parameters.

The Laboratory report from the doctor's request is shown in **Table 1**.

**Table 1:** Showing John's laboratory report

Parameter	John's results	Normal range
<i>Sequence of CFTR gene</i>	ATG, GCT, TTT, GAC, ACA	ATG, GCT, CTT, GAC, ACA
<i>Rate of water movement out of epithelial cells</i>	Low	High
<i>Mitochondrial activity</i>	Low	High
<i>Thickness of mucus on epithelial cells</i>	Very thick	Thin
<i>Status of airways</i>	Blocked	Open

The doctor recommended that John takes a supplement of a coenzyme for fatigue, then either gene therapy or dilators for persistent wheezing (*dilators act on the muscle cells of the bronchioles making them relax and widen for some time*).

Your classmates saw John's laboratory report and the doctor's recommendations and would wish to understand what they mean in relation to human health.

### Task:

- Analyse the laboratory report in relation to John's signs and symptoms.
- Assess the effectiveness of the doctor's recommendation.

## Item 2

Due to frequent changes in climatic conditions that lead to poor crop yields, farmers have been advised to start using greenhouses for tomato growing. A greenhouse is a house-like structure covered with a transparent/translucent roof and walls that create a controlled environment for growing crops.

To determine the suitable conditions to be used in the greenhouses, the farmers hired an agricultural officer who carried out trial tomato-growing using four greenhouses. Each greenhouse had different conditions and the results of the trial are as shown in **table 2**.

**Table 2:** Showing tomato growing under different greenhouse conditions

Growth and physiological traits	Greenhouse and its conditions			
	Greenhouse 1 (32°C + auxins)	Greenhouse 2 (32°C + gibberellins )	Greenhouse 3 (25°C + auxins)	Greenhouse 4 (25°C + gibberellins)
Germination rate (%)	Moderate	Moderate	Moderate	High
Photosynthetic rate ( $\mu$ mol CO <sub>2</sub> /m <sup>2</sup> /s)	High	High	Low	Low
Number of branches	Few	Very many	Few	many

For good yields, the agricultural officer recommended that the conditions of the greenhouse should **not** be kept constant all through. The farmers need to know how to implement the recommendation.

### Task:

- Analyse the relationship between the conditions of the greenhouse and the growth and physiological traits of tomatoes.
- Justify the recommendation of the agricultural officer and advise the farmers.

## SECTION B

### Part I

Respond to **one** item from **this** part.

#### Item 3

Aisha, a young adult managing Type-one Diabetes mellitus, attends regular medical check-ups including getting vaccinations at a local health centre.

Following a recent vaccination for hepatitis **B** that she received, her blood showed a successful immune response: her antibody concentration rose from 50 units per 100 ml to 275 units per 100 ml of blood.

Since Type-one Diabetes management involves dealing with metabolic and immune challenges, her doctor also reviewed the impact of her body temperature on oxygen-carrying capacity and antibody production.

**Table 3:** Showing the effects of body temperature on oxygen carrying capacity and antibody production

Body Temperature (°C)	Oxygen carrying capacity of Blood ( <i>ml of O<sub>2</sub>/100ml of blood</i> )	Antibody Production
38	0.38	High
37	0.40	Moderate
35	0.46	Low

The medical doctor is suggesting any one of the following interventions to address Aisha's health condition;

- i. Aisha eliminates carbohydrate from her diet
- ii. Takes insulin injections 30 minutes after every carbohydrate meal
- iii. Takes a lipid rich diet.

Aisha needs to understand the effectiveness of each intervention before making a choice.

#### Task:

- a) Analyse how vaccination and changes in body temperature affected the functioning of Aisha's body.
- b) Evaluate the effectiveness of each intervention by the doctor in management of Aisha's condition.

#### Item 4

A study was conducted to determine the effects of high altitude on the physiological functioning of an athlete. An athlete was chosen to participate in the study. Study team recorded the resting heart rate of the athlete at low altitude. He was then moved to high altitude.

Upon arrival at high altitude site, the medical team noted that the athlete's resting heart rate had increased to 80 beats per minute from his normal low altitude value of 60 beats per minute. Two days later, as required by the study, the athlete underwent a rigorous running session to evaluate his physiological response to the new altitude during running.

During the running session, the athlete's heart rate increased further, the blood pH lowered below 7.5 and his performance during that training was poor. The physiological state of the athlete was recorded two hours before the running session, 30 minutes into the run and two hours after the running session. After running, the pH normalized. The data was then recoded in Table 4.

**Table 4:** The Athlete's physiological changes while in high-altitude site.

Parameter	before and after the running session	During the running session
Blood to skeletal muscle ( $cm^3/minute$ )	500	1000
Blood to intestines and liver ( $cm^3/minute$ )	400	200
Heart rate ( <i>beats per minute</i> )	80	90
Temperature ( $^{\circ}C$ )	37	37.8

It was concluded that high altitude did not help the athlete perform well in the running session. The study team need ways of using altitude to improve performance of athletes in running activities.

**Task:**

- a) Analyse the physiological changes in the athlete's body in the study
- b) Propose measures the study can use to ensure altitude benefits Athletes.

## Part II

Respond to **one** item from this part.

### Item 5

A conservation body introduced **two** pure breeding breeds of birds **A** and **B** belonging to the same bird species into a woodland ecosystem. The breeds had pure contrasting characteristics and also interbred freely. The woodland contained abundant hard seeds, insect larvae in hardwood tree logs, flying insects and all these served as food to the birds. For two years, the bird characteristics remained the same.

*Table 5 Shows the bird populations and their characteristics.*

<i>Bird breed</i>	<i>No. of birds introduced</i>	<i>No. of birds after 2 years</i>	<i>Characteristics</i>
A	58	187	Hard beaks, long wings
B	62	46	Soft beaks, short wings

**Two** years after introduction of the birds, leaf-eating caterpillars invaded the woodland. To control the invasion, the conservation body sprayed the area with an insecticide. The birds fed on the dead caterpillars and later traces of the insecticide were detected in the birds' bodies.

Ten years after spraying, a new bird offspring with a new combination of characteristics emerged from **A** and **B**. The conservation body labeled the new offspring *breed C* and it had characteristics; hard beaks and short wings.

The population of insect larvae in the woodland decreased greatly **two** years after spraying, but became more abundant 10 years after spraying.

*Table 6 showing changes in bird populations and bird characteristics over time*

<i>Bird breed</i>	<i>No. of birds 2 years after spraying</i>	<i>No. of birds 10 years after spraying</i>	<i>Bird Characteristics</i>
A	23	16	Hard beaks, long wings
B	46	12	Soft beaks, short wings
C	87	269	Hard beaks, short wings

Based on the changes in the woodland, the conservation body **recommends** that for any future caterpillar invasion; other methods should be used instead of insecticides. There is need to evaluate the effectiveness of the methods before use so that the woodland ecosystem can be conserved.

#### **Task:**

- Analyse the inheritance patterns and population changes of organisms in the woodland.
- Evaluate the effectiveness of the recommendation of the conservation body in relation to ecosystem stability.

### Item 6

A mountain ecosystem with a climax community was destroyed by a severe landslide after heavy floods. Bare rocky grounds remained and the natural recovery process took **20 years**.

Table 7 shows a record of various organisms and other components of the ecosystem up to **20 years** after the heavy floods.

**Table 7** Showing the variation

<i>Years after the heavy floods</i>	<i>Dominant vegetation type</i>	<i>Soil nitrates( ppm)</i>	<i>Amount of energy/Biomass (units)</i>	<i>No. of rabbits &amp; climbing squirrels</i>	<i>No. of wolves</i>
3	Mosses	2.1	0.5	0	0
7	Grasses	5.5	20.6	10	06
13	Shrubs	9.2	86.7	64	18
20	Forest	16.8	186.7	72	09

The climbing squirrels feed on tree fruits and spend most of the time in trees, while rabbits feed on vegetation.

The ecosystem is often disturbed by rampant soil erosion and animal grazing.

Scientists also studied the changes in the two varieties of mosses in the ecosystem for a number years and the findings are shown in **table 8**.

**Table 8:** Population of varieties of mosses over time

<i>Years after the flood</i>	<i>Population of Mosses</i>	
	<i>with thin walled cells</i>	<i>with thick walled cells</i>
3	110	962
7	246	426
13	864	124
20	1180	96

There is a need to improve the productivity of the ecosystem.

### Task:

- Analyse the changes in the population of different organisms and also the change in dominant vegetation in the ecosystem over the **20-year** period.
- Devise justified ways to improve biomass of the mountain ecosystem.