A-LEVEL BIOLOGY SEMINAR

Examination Success Guide & Construct 1

MESSAGE FROM THE PRESIDENT, ABE

Greetings from the President of the Association of Biology Educators (ABE). On behalf of the Association, I warmly welcome you to this A-Level Biology Seminar. As you prepare for your examinations, remember that success begins with understanding exactly what the item writer is asking. Always read the task before reading the scenario and identify the action verb, such as Analyse, Evaluate or Explain how. Then read the scenario while looking for evidence related to the specific concepts being assessed. For analysis, explain what happened, why it happened, how it happened biologically and the outcome. For evaluation, assess the effectiveness of a strategy or response by explaining its mechanism, strengths, limitations and possible improvements. Use evidence from both the scenario and the data table to support your conclusions, and avoid merely copying statements from the question.

PRACTICAL WORK: KEY AREAS OF COMPETENCE

MICROSCOPY SKILLS

DISSECTION SKILLS

MEASUREMENT OF STRUCTURES

DATA ANALYSIS

WRITING PROCEDURES (MICROSCOPY & DISSECTION) LEADING TO FINAL DRAWING

BIOLOGICAL DRAWING

CONSTRUCT 1

A medical biotechnology laboratory in Arua District is developing human insulin using recombinant DNA technology. During quality assessment, scientists found that residues from laboratory chemicals interfered with **DNA polymerase** during semi-conservative **DNA replication**. Investigations also established that a metabolic toxin inhibited **pyruvate kinase** during **glycolysis**. In addition, researchers discovered that contaminants introduced during **transcription** prevented **RNA polymerase** from moving effectively along DNA strands. As production continued, laboratory personnel recorded poor **insulin production**.

To improve operations, managers introduced the following interventions:

- selected nucleotides and primers are incorporated into production systems.
- selected functional vector cells are retained for future production.
- transcription-contaminant screening is carried out before gene expression begins.

TASK

(a) Analyse how the recorded changes in DNA replication efficiency, ATP production and transcription efficiency contributed to the decline in insulin production.

(b) Evaluate the effectiveness of the proposed interventions in improving insulin production.

CONSTRUCT 2

A sunflower production programme in Lira District was established to improve household incomes and food security. During routine field assessments, researchers discovered that some long-day C_4 sunflower varieties were planted during periods when daylight hours were shorter than those required for normal flowering. As a result, the production and movement of florigen from leaves to shoot apices were affected.

Further investigations revealed that several farms experienced prolonged periods of low early-morning temperatures. Researchers found that these conditions interfered with the activity of PEP carboxylase, an enzyme involved in the initial fixation of carbon dioxide in C_4 plants. In addition, farmers also experienced periods of drought.

Field officers reported delayed flowering and declining yields.

To improve productivity, the following interventions were proposed:

- farmers plant long-day sunflower varieties during seasons with suitable day lengths.
- farmers apply mulch materials around crops.
- farmers carried out irrigation.

Table 1: Investigation Findings

Parameter	Normal	Affected
Phytochrome far red (%)	100	43
PEP carboxylase activity (%)	96	47
Leaf water concentration (%)	88	60
Abscisic acid (%)	low	High

TASK

(a) Analyse how florigen concentration at shoot apices, PEP carboxylase activity and leaf water concentration contributed to poor declining yields.

.....

(b) Evaluate the effectiveness of the proposed interventions in improving sunflower productivity and sustainability.

CONSTRUCT 3

Volleyball academy in Kabale District conducted an investigation into declining player performance during preparations for an inter-regional tournament. Part of the training programme was conducted at a high-altitude venue in the surrounding hills. Coaches observed that several athletes experienced fatigue and reduced endurance during training sessions.

In cold temperature, athletes would take long to execute some training drills with reduced reaction speed. Further investigations revealed that some athletes regularly consumed alcoholic drinks after training. Researchers found that alcohol affected the secretion of antidiuretic hormone (ADH).

As preparations continued, reaction speed declined, endurance reduced and match performance became poor. Athletes experienced increased breathing rate and depth during training at high altitude, skin blood vessels constricted in exposed body parts during cold conditions and would often feel thirsty and take water frequently.

TASK

(a) Analyse the causes of reduced performance among the athletes.

.....

(b) Evaluate the athletes body interventions in an attempt to restore normal body processes.

CONSTRUCT 4

Coffee farmers in Kayunga District became concerned when flower-damaging beetles continued to increase while coffee production declined. In addition, many coffee flowers failed to develop into mature berries despite normal flowering.

To identify the cause of the problem and develop a long-term solution, the farmers investigated whether traits associated with beetle survival were inherited. They selected beetles that survived field control measures and crossed them with beetles that lacked the survival traits. The offspring were then test-crossed to determine how the genes controlling the traits were transmitted and to identify beetle groups that could be used to guide future control programmes.

Out of 1,000 offspring produced, 440 had survival traits with long antennae, 430 lacked both characteristics, 65 had survival traits with short antennae and 65 lacked survival traits but possessed long antennae.

Agricultural officers warned that continued spread of beetles carrying survival traits could further reduce coffee productivity if effective management measures were not adopted.

Table 1: Farm Assessment Data

Parameter	Before the Problem	After the Problem
Coffee yield (kg ha^{-1})	2,400	1,350
Resistant beetle population (per 100 plants)	20	140
Non-resistant beetle population (per 100 plants)	180	60
Insect-eating bird population	60	125
Pollinating butterfly population	150	85

TASK

(a) Analyse the observed changes in the table.

.....

(b) **(i)** Propose and evaluate strategies that can be adopted to improve coffee productivity.

.....

(ii) Evaluate the farmers' intervention of crossing beetles and carrying out a test cross as a strategy for understanding beetle inheritance patterns and improving beetle management.

ITEM 2

In crowded suburbs of Kampala, poor garbage disposal has led to an increase in rats (Specimen A). Environmental workers observed that these rats feed mainly on the contaminated dry, fibrous seeds and tough stems of the invasive **Black Jack plant (Specimen X)**, which grows aggressively over the waste piles.

Conversely, a small native toad survives poorly in these dry areas. The toad are found surviving around the dense, water-retaining stems of **Coco yam (Specimen Y)** found in moist drainage channels, where it seeks shelter from dehydration and feeds on insects attracted to the damp microclimate.

Scientists suspect that differences in both animal internal organs and plant tissue anatomy explain how these organisms form interdependent survival pairs:

The rat thrives on the dry, fibrous tissues of **Specimen X.**

The toad is restricted to the moist, succulent habitats provided by **Specimen Y.**

The scientists further dissected a toad and measured its alimentary canal, stomach, duodenum, ileum, liver lobe length and kidney width. He now wants to compare these with specimen A.

Table 1

Parameter	Measurements /mm
alimentary canal length	**260**
Stomach	48
Duodenum	32
Ileum	150
Body length (snout to vent/ cloacal opening)	75
Liver length (longest lobe)	28
Combined kidney width (left + right)	12

He also wants to identify the structural appearance of the tissues of specimen **X** using Phloroglucinol staining. The scientists needs to verify his assumption

Part (a) – Animal organ investigation

TASK

You are provided with freshly killed **specimen A** (a freshly killed rat).

a) i) Describe the diagnostic procedures/ steps you would follow to dissect **specimen A** to expose the alimentary canal structures and the measured internal structures.

.....

ii) Proceed to measure and record the structural parameters of Specimen A's organs matching those provided for toad. Present your findings in table 2 below.

Table 2

Parameter	Measurements /mm
alimentary canal length	
Stomach	
Duodenum	
Ileum	
Body length (snout to vent/ tail excluded)	
Liver length (longest lobe)	
Combined kidney width (left + right)	

b) Calculate the ratio for both specimens A and that of toad:

i) Ratio of total alimentary canal length to body length

.....

ii) Ratio of ileum length to body length

.....

iii) Basing on your findings, explain how the digestive tract and excretory/water conservation organs of Specimen A (rat) enable it to tolerate and digest the contaminated, dry, fibrous food items provided by Specimen X better than Specimen B (toad).

.....

c) Make a simple labelled drawing of the alimentary canal and associated organs of specimen A showing the parts measured.

Part (b) – Plant microscopic investigation

d(i) Describe the procedures you would follow to prepare very thin transverse sections (T.S.) of the stems of Specimen X (Black Jack) stained using phloroglucinol and Specimen Y (Coco yam), stained using iodine, and observe under a light microscope.

.....

(ii) Make a labelled drawing of the tissue layout observed in a transverse section of Specimen X stem to show the tissues that contribute to its fibrous nature.

.....

e) Using your microscopic observations, compare the internal structures of Specimen X and Specimen Y. Explain how the structural differences in these plants directly determine why:

i) Specimen A (rat) can use Specimen X as a food source

.....

i) Specimen B (toad) relies on Specimen Y for microclimate survival

.....