Name.....Signature.....

UGANDA ADVANCED CERTIFICATE OF EDUCATION
S.6 BIOLOGY
PAPER 1
TIME: 2 ½ hours

Instructions

- Attempt all questions in this paper
- All questions carry equal marks

ITEM 1

Residents living near charcoal-burning sites in Fort Portal often complain of fatigue and recurrent chest infections. Health workers investigated possible links between carbon monoxide (CO) exposure, blood oxygen transport, and immune performance.

Parameter	**Control Group**	**Exposed Residents**
Oxyhaemoglobin (%)	96	78
Carboxyhaemoglobin (%)	0.5	15
White blood cell count (cells/μL)	6,800	4,500
Respiration rate (breaths/min)	16	24
CO concentration (ppm)	0	120

Reference: *Environmental and Human Health Research (2023). "Carbon Monoxide Interference in Oxygen Transport and Immune Suppression."*

Task:

a) Analyse how carbon monoxide affects oxygen transport and weakens immune protection.

b) Suggest biological and public-health strategies to prevent and manage such exposure while maintaining respiratory and immune health.

ITEM 2

In an agricultural biotechnology project, students tested how temperature affects enzyme activity in the photosynthetic process. They compared PEP carboxylase (C4 enzyme) and Rubisco (C3 enzyme) at different temperatures.

Temperature(°C)	**PEP Carboxylase activity (relative units)**	**Rubisco activity (relative units)**
20	75	85
25	90	100
30	98	90
35	100	60
40	90	30

At 35°C, maize plants maintained high photosynthetic rates, while wheat plants showed reduced growth and curled leaves.

Task:

a) Analyse the data to explain why C4 plants outperform C3 plants at high temperatures.

b) Using the clues, propose strategies farmers could apply to sustain food security amid rising global temperatures.

ITEM 3

"Bloom Uganda," a horticultural company in Mukono, specializes in growing roses (a long-day plant), chrysanthemums (a short-day plant), and tomatoes (day-neutral but sensitive to ethylene) for export. The new farm manager is reviewing data from last season. She notes that while auxin application promoted stem elongation in roses, it also inhibited lateral bud growth, increasing the need for pruning. The use of ethylene gas in the tomato greenhouse successfully ripened fruits uniformly for a large order, but it also caused premature yellowing and abscission of older leaves. Workers have suggested installing energy-efficient LED lights that can be programmed to emit specific red and far-red wavelengths.

***Table**: Growth Parameters and Hormonal Application in Controlled Environments*

Crop	**Photoperiod(Hours Light)**	**Hormone Application**	**Resulting Effect**	**Commercial issue**
Rose	14	Auxin Spray	Taller stems, delayed lateral flowering	High pruning costs, uneven flower batches
Chrysanthmum	9	Cytokinin Spray	Mulitple flower buds,bushier growth	Some buds too small for market
Tomato	12	Ethylene Gas	Uniform fruit ripening	Leaf yellowing and drop

Reference: Taiz, L., Zeiger, E., Møller, I.M., & Murphy, A. (2018). *Plant Physiology and Development* (6th ed.). Sinauer Associates.

Task:

(a)

(i) Analyse the role of photoperiodism in triggering flowering in the rose and chrysanthemum.

(ii) Explain the opposing effects of auxin and cytokinins on plant growth, as demonstrated in the data.

(iii) Explain the dual role of ethylene in the tomato greenhouse as both a ripening hormone and a stress hormone.

(b) To improve profitability and sustainability, propose integrated strategies for the farm manager. Your strategies should optimize the use of light and hormones to improve yield quality, reduce negative side-effects, and lower energy costs. Justify each proposal using the data.

ITEM 4

A smallholder farmer in Mbale observed unusual seed variations in his hybrid bean plants (Phaseolus vulgaris). He initially crossed pure yellow–round seeds (YYRR) with pure green–wrinkled seeds (yyrr). In the F_2 generation, the farmer noted unexpected ratios that deviated slightly from the classical 9:3:3:1.
To understand the inheritance pattern, a biology class replicated his experiment and obtained the following F_2 results from 160 seeds:

Phenotype	**Number of seeds**
Yellow round	88
Yellow-wrinkled	32
Green round	30
Green wrinkled	10

Task:
a) Analyse the results and determine whether the genes for seed colour and shape are linked. Calculate the recombination frequency.
b) Explain the significance of crossing over in producing the observed phenotypes.
c) Propose sustainable strategies the farmer could apply to improve seed genetic diversity and maintain desirable traits.

END