BioClass HUB

HOLIDAY PACKAGE: A-LEVEL BIOLOGY 2025

BioClass HUB is a premier educational platform dedicated to providing high-quality biology education for O-Level and A-Level students. Our mission is to enhance understanding, develop practical skills, and prepare students for examinations through interactive and engaging learning methods.

Vision:
To become the leading biology learning hub in East Africa, nurturing curiosity and excellence in life sciences.

Mission:
To provide accessible, comprehensive, and practical biology education that equips students with knowledge, skills, and confidence to excel academically and beyond.

Goals:
1. Strengthen understanding of biology concepts for secondary school students.
2. Improve practical and theoretical examination skills.
3. Promote critical thinking and problem-solving in biological sciences.
4. Foster interest and passion for biology through engaging learning experiences.

Services Offered:
- Online and in-person biology tutorials.
- Practical biology demonstrations and laboratory simulations.
- Exam preparation workshops with focus on past papers and practicals.
- Interactive learning materials, including videos, quizzes, and scenario-based questions.
- Guidance on scientific projects and research for advanced students.

Target Audience:
- A-Level students preparing for national and regional biology examinations.
- Schools seeking supplementary biology teaching resources.
- Students aiming to strengthen practical skills and conceptual understanding in biology.

ITEM SECTION

ITEM 1

A detergent company tests a bacterial enzyme (*Lipase-X*) that breaks down oil stains. During trials, adding a surfactant reduces stain removal. The enzyme works best at 40°C and pH 7. Lab results show how temperature, pH, and the surfactant affect enzyme activity.

Data:

Condition	Enzyme Activity (%)	Stain Removal Score (/10)
40°C, pH 7, no surfactant	100	9
40°C, pH 7, with surfactant	45	4
60°C, pH 7, no surfactant	20	2
40°C, pH 9, no surfactant	30	3

Microscopy confirms the bacteria producing the enzyme are prokaryotic with many ribosomes.

Adapted: *Industrial Biotechnology for Schools* (2023). "Enzymes in Detergents."

Task:

(a) Explain why the surfactant lowers enzyme activity and why temperature or pH changes reduce performance.

(b) Suggest how to reformulate the detergent to improve stain removal without harming enzyme function.

ITEM 2

A biotech firm produces insulin using genetically modified *E. coli*. Some batches yield little insulin due to errors in DNA replication. Data compares plasmid copy numbers, insulin yield, and DNA polymerase mutation rates across batches.

Data:

Batch	Plasmid Copies per Cell	Insulin Yield (mg/L)	DNA Polymerase Error Rate (%)
A	50	120	0.1
B	15	30	5.2
C	45	110	0.3

Electron microscopy shows abnormal nucleoid regions and fewer ribosomes in low-yield batches.

Adapted: *Basic Biotechnology Review* (2023). "Insulin Production Using GM Bacteria."

Task:

(a) Explain how DNA replication errors reduce insulin production.

(b) Propose quality checks to ensure consistent insulin yields.

ITEM 3

Coral reefs are bleaching due to industrial pollution containing cyanide, which inhibits mitochondrial respiration. Researchers expose coral fragments to cyanide and measure ATP production, oxygen use, and bleaching.

Data:

Cyanide (ppm)	ATP Production (%)	O_2 Use (mg/L/h)	Bleaching Observed?
0	100	8.5	No

0.5	60	4.8	No
2.0	20	1.9	Yes
5.0	5	0.5	Yes

Microscopy shows swollen mitochondria with damaged cristae in bleached coral.
Adapted: *Marine Science for Schools* (2023). "Cyanide Pollution in Coral Reefs."

Task:
(a) Explain how cyanide reduces ATP production and leads to coral bleaching.
(b) Suggest a monitoring and prevention plan to protect reefs from cyanide pollution.

ITEM 4
Scientists develop a flu vaccine by inserting a viral protein gene into tobacco plants. Some GM plants produce little vaccine protein despite high mRNA levels. Data show mRNA levels, protein yield, and chloroplast health in different plant lines.
Data:

Plant Line	Vaccine mRNA Level	Vaccine Protein (mg/g leaf)	Chloroplast Health (%)
Normal	10	0	98
GM Line 1	85	12	95
GM Line 2	15	1	70
GM Line 3	90	0.5	40

Microscopy reveals damaged chloroplasts in low-protein GM lines.
Adapted: *Plant Biotechnology Journal* (2023). "Molecular Farming in Plants."

Task:
(a) Explain why high mRNA does not always lead to high protein yield in GM plants.
(b) Recommend changes to improve vaccine production without damaging plant health.

ITEM 5
A wastewater plant's bacteria are struggling to break down organic waste due to a new pollutant that inhibits a key respiratory enzyme. The table shows how pollutant concentration affects enzyme activity, ATP production, and bacterial growth.
Data:

Pollutant (mg/L)	Enzyme Activity (%)	ATP Production (%)	Cell Division Rate (/h)
0	100	100	0.8
10	70	75	0.6
50	30	35	0.2
100	10	12	0.05

Microscopy shows irregular cell shapes and incomplete division in affected bacteria.
Adapted: *Water Treatment Basics* (2023). "Enzyme Inhibition in Wastewater Bacteria."

Task:
(a) Explain how the pollutant reduces enzyme activity and slows bacterial growth.
(b) Propose a method to restore wastewater treatment efficiency.

ITEM 6
A genetic disorder prevents breakdown of lipids in nerve cells due to a mutation in the *HEXA* gene. The mutation introduces a premature stop codon. Data compare DNA sequences, enzyme activity, and lipid buildup in patients.
Data:

Sample	DNA Sequence (Exon 5)	Enzyme Activity (%)	Lipid Buildup (Scale 1–5)
Normal	5' ATG CCG TAC 3'	100	1
Patient 1	5' ATG CCG TAA 3'	15	5
Patient 2	5' ATG CCG TAG 3'	20	4

Adapted: *Genetics for Students* (2023). “Genetic Disorders and Gene Therapy.”
Task:
(a) Explain how the mutation reduces enzyme function and causes lipid accumulation.
(b) Suggest a genetic-based treatment and discuss one ethical consideration.

ITEM 7
GM potatoes with a bacterial antifreeze gene survive frost but grow poorly. Tests show their root cells have fewer mitochondria with reduced cristae surface area. Data compare mitochondria count, ATP levels, yield, and frost resistance.
Data:

Potato Type	Mitochondria per Cell	ATP per Cell (%)	Yield (kg/plant)	Frost Survival (%)
Normal	150	100	2.5	40
GM FrostSafe	80	50	1.0	90

Adapted: *Crop Science Journal* (2023). “Engineering Cold-Tolerant Crops.”

Task:
(a) Explain why fewer mitochondria and cristae reduce growth and yield.
(b) Recommend how to maintain frost resistance while improving tuber production.

ITEM 8

In the Karenga Dryland Research Plot, S.5 students compared the performance of three crop species, maize, sunflower, and amaranthus, grown under natural field conditions.

The area experiences:

- Strong sunlight (12–13 hours/day)
- High temperature (30–34 °C)
- Sandy soils with low organic matter
- Prolonged water shortage

Occasional dust-laden winds, which partially cover leaves with a thin layer of dust

Wild succulents such as Euphorbia and Aloe grow naturally in the area.

The students recorded the following data:

Parameter	Maize	Sunflower	Amaranthus
Leaf anatomy	C4 (Kranz)	C3	C3
Stomatal opening (midday)	Partially closed	Mostly open	Closed
ABA levels	Elevated	Moderate	Very high
Growth rate	Moderate	Poor	Very poor
Leaf wilting	Slight	Severe	Severe
Oil/protein synthesis	Moderate oil	High oil	High protein

Reference: "Photosynthetic Pathways and Water Stress Responses, Plant Physiology Online (ASPBB)"

TASK

(A) Explain the differences in photosynthesis, stomatal behaviour, and growth among the three crops.

(B) Suggest strategies farmers in Karenga can apply to improve crop productivity.

ITEM 9

A horticulture project in Fort Portal Highlands investigated why certain fruit trees—avocado, passion fruit, and lemon, grow differently despite similar care.

The region has:

- Cool temperatures (17–20 °C)
- High rainfall
- Deep, moist soils
- Frequent fog in early morning reducing light intensity
- Slopes that expose plants to uneven sunlight angles
- Natural vegetation dominated by shade-tolerant shrubs.

Measurements:

Parameter	Avocado	Passion Fruit	Lemon
Leaf type	Broad mesophyte	Mesophyte	Semi-xerophyte
Light response	High	Moderate	High
Stomatal density	Moderate	High	Low
Growth rate	High	Moderate	Slow
Phototropism response	Strong	Moderate	Weak

ABA levels during dry spells	Low	Moderate	High

Adapted: "Light Environment and Plant Growth in Highland Ecosystems, Journal of Mountain Plant Biology"

TASK

(A) Explain why growth performance differs among the three fruit plants.

(B) Suggest management strategies to optimise fruit production in Fort Portal Highlands.

ITEM 10

A seed company in Nebbi District evaluated three bean varieties for germination and early growth.

The area experiences:

- Alternating wet and dry spells
- Clay soils that retain water
- Irregular cloud cover
- High night temperatures promoting respiration losses
- Natural vegetation including moisture-loving hydrophytes along riverbanks.

Varieties tested:

Parameter	Variety A	Variety B	Variety C
Seed dormancy	High	Low	Moderate
Water uptake	Low	High	Moderate
Germination %	40	90	60
Cytokinin activity	Low	High	Moderate
Early growth	Slow	Fast	Moderate
Leaf anatomy	C3	C3	C4-like traits

Adapted: "Seed Dormancy and Environmental Cues, Plant Biology Research Network"

TASK

(A) Explain how seed dormancy, hormonal activity, and photosynthetic traits caused the observed differences.

(B) Propose strategies to improve germination and establishment of crops in Nebbi.

ITEM 11

In Kumi Irrigation Scheme, farmers noticed inconsistent growth of rice, cassava, and sorghum.

The irrigation water:

- Has high salinity during dry season
- Comes from canals that heat up to 33–35 °C
- Contains algae that partially shade plant bases
- Creates waterlogged patches in some plots

Natural vegetation includes Typha (hydrophyte) and acacia shrubs (xerophyte).

Collected data:

Parameter	Rice	Cassava	Sorghum
Leaf anatomy	Hydrophytic	Xerophytic	C4
Stomatal behaviour	Always open	Mostly closed	Partially open
Salt tolerance	Low	High	Moderate
ABA levels	Low	High	Moderate
Growth performance	Uneven	Good	Moderate
Root oxygen availability	Very low	Moderate	Moderate

Adapted: "Soil Salinity and Plant Water Relations, FAO Land & Water Bulletin"

TASK

(A) Explain the differences in stomatal behaviour, photosynthesis, and salt tolerance.

(B) Suggest management strategies to improve yield in the irrigation scheme.

ITEM 12

Students in Kasese Lowlands conducted an experiment on sunflower, millet, and pumpkin to determine how light intensity and temperature affect photosynthesis and product formation.

Environmental conditions:

- High temperature (31–33 °C)
- Strong sunlight with peak UV at midday
- Occasional ash particles from nearby crater activity reduce sunlight for short periods
- Soils moderately dry
- Native C4 grasses dominating wild fields.

Measurements:

Parameter	Sunflower	Millet	Pumpkin
Pathway	C3	C4	C3
Leaf wilting	Moderate	None	Severe
Stomatal opening	Partially open	Mostly closed	Closed
Lipid synthesis	High	Low	Low
Protein synthesis	Moderate	High	Low
Growth rate	High	Moderate	Poor

Adapted: "Photosynthesis Under High Light Stress, Frontiers in Plant Science"

TASK

(A) Explain the differences in stomatal response, photosynthetic efficiency, and biochemical product formation.

(B) Suggest strategies to improve crop growth in Kasese Lowlands.

ITEM 13

In Mityana Agro-Forestry Zone, mixed cropping of grevillea trees, beans, and coffee produced unexpected patterns of shading, growth, and hormone production.

Environmental conditions:

- Alternating heavy rain and dry spells
- Tree canopy causing shifting shade patterns
- Soil organic matter high

• Morning temperatures low (15–17 °C)
• Natural understory plants include ferns and shade-adapted herbs.
Data:

Parameter	Grevillea	Beans	Coffee
Phototropism	Strong	Moderate	Weak
Leaf adaptation	Mesophyte	C3	Shade-tolerant
Cytokinin levels	High	Moderate	Low
Growth rate	Fast	Moderate	Slow
ABA (dry spell)	Low	Moderate	High
Secondary growth	Strong	Absent	Weak

Adapted: "Agroforestry and Plant Physiological Interactions, ICRAF Research Series"

TASK
(A) Explain how light availability, hormone activity, and structural adaptations caused the observed growth patterns.
(B) Suggest practices farmers can use to optimise mixed-cropping performance.

ITEM 14
A research team in Soroti Dry Savanna assessed cassava, okra, and papaya under natural field stress.
Environmental conditions:
• High temperatures (34–36 °C)
• Erratic rainfall
• Dust storms reducing leaf surface moisture
• Soils low in nitrogen
• Naturally occurring latex-producing plants (e.g., *Euphorbia tirucalli*) dominate the wild.
Recorded data:

Parameter	Cassava	Okra	Papaya
Leaf type	Xerophytic	Mesophytic	Mesophytic
Latex/chemical exudates	High	Low	Low
Stomatal activity	Mostly closed	Moderate	Mostly open
ABA levels	High	Moderate	Low
Growth rate	Moderate	Slow	Fast
Protein synthesis	Low	Moderate	High

Adapted: "Plant Adaptations and Survival in Semi-Arid Regions – Journal of Arid Environments"

TASK
(A) Explain the differences in stomatal behaviour, stress tolerance, and metabolic activity.
(B) Suggest ways farmers in Soroti can enhance sustainable crop production.

ITEM 15

During a three-day expedition in Queen Elizabeth National Park, S.4 learners trekked long distances in heat, collected water-quality data, and conducted night observations.

Environmental conditions included:

- Midday temperatures 34–36 °C
- Dusty paths
- Water samples with high solute concentration and low dissolved oxygen
- Night temperatures 18 °C
- Packed lunch with low water content

Three learners, Ruth, Moses, and Daniel showed different physiological responses:

Parameter	Ruth	Moses	Daniel
Pulse after trek (beats/min)	160	148	170
Core temperature (°C)	38.5	36.9	39.4
Sweat rate (mL/h)	50	180	20
Blood O_2 (%)	94	90	85
Urine volume (mL/day)	450	900	200
Reaction time (night)	Normal	Slow	Very slow

Daniel developed itchy eyes and sneezing in dusty areas. Ruth felt unusually cold at night. Moses urinated frequently.

Adapted: "Environmental Physiology of Humans in Hot and Cold Climates, NCBI"

TASK

(A) Using the data, explain the differences in thermoregulation, water balance, heartbeat, and reaction time among the learners.

(B) Predict problems the learners may face if the expedition continues.

(C) Suggest strategies the teachers can apply to maintain healthy physiological functioning during fieldwork.

ITEM 16

At Lira Modern Aquatic Centre, learners performed:

- 30-second breath-hold
- Reaction-time test
- Balance test on wobble board

Three students—Annette, Brian, Shafik—recorded:

Parameter	Annette	Brian	Shafik
Breath-hold (s)	18	32	10
CO_2 after surfacing	Low	Moderate	High
Heartbeat	Regular	Slightly irregular	Very fast
Reaction time (s)	0.19	0.24	0.40
Balance score (%)	85	70	40
Skin temperature (°C)	33	36	35

Shafik reported lip numbness. Brian felt "off-balance" after water entered his ear.
Adapted: "Human Physiology of Diving and Breath-Hold, University of Wisconsin Research Archive"

TASK
(A) Explain the differences in breath-hold duration, heartbeat pattern, reaction time, and balance.
(B) Suggest ways Shafik can improve his performance.

ITEM 17
During school bush-fire mitigation drills in Mbale, learners encountered:
- Uphill running
- Smoke with high CO levels
- Heat exposure
- Low water availability

Three participants, Sarah, Joel, Timothy showed:

Parameter	Sarah	Joel	Timothy
Pulse (beats/min)	120	165	150
CO exposure	Short	Long	Moderate
Blood O_2 (%)	95	82	88
Sweat rate	High	Moderate	Very low
Core temp (°C)	37.2	38.0	39.2
Coordination	Excellent	Good	Poor

Timothy's eyes became watery and itchy. Joel felt dizzy.
Adapted: *"Carbon Monoxide Exposure and Human Physiology, WHO Technical Report"*
TASK
(A) Explain how oxygen transport, CO effects, temperature control, and nervous coordination produced the observed differences.
(B) Propose strategies instructors should implement to improve safety and physiological performance.

ITEM 18
During a wildlife club visit to Lake Mburo National Park, students monitored three zebras near a shrinking warm waterhole (35 °C, low oxygen, dry grass, frequent predator chases).

Parameter	Zebra A	Zebra B	Zebra C
Blood lactate	3	7	9
Heart rate	90	120	140
Sweating	Normal	Excessive	Very low
Recovery from sedation	Quick	Moderate	Slow
Water intake (L/day)	12	5	3

Zebra C staggered after short runs; Zebra B rested frequently.

Adapted: “Heat Stress and Water Scarcity Effects on African Herbivores, African Wildlife Ecology Journal”

TASK

(A) Explain the differences in temperature regulation, oxygen transport, hydration, and coordination.

(B) Suggest strategies managers can use to improve zebra survival during dry seasons.

ITEM 19

At Fort Portal High School, S.6 students investigated neural and sensory function using:

- Hot–cold discrimination
- Rod–cone response
- Simple reflex measurement
- Hydration test

Data:

Parameter	Lydia	Henry	Paul
Skin temp (°C)	33	36	35
Reaction to heat (s)	0.25	0.18	0.40
Rod response	Strong	Normal	Weak
Cone response	Normal	Strong	Very weak
Urine concentration	Dilute	Normal	Very concentrated
Balance	Excellent	Good	Poor

Paul had used a numbing throat spray. Henry drank 2 L of water before the practical. Lydia stayed in a cold room earlier.

Adapted: “Neural Transmission and Sensory Adaptation Cambridge Biology Education Review”

TASK

(A) Explain differences in sensory receptor function, nerve impulse transmission, and osmoregulation.

(B) Suggest strategies to improve accuracy of future sensory experiments.

ITEM 20

In Moroto District, students studied camel adaptations. Conditions included 38 °C day, 17 °C night, dust storms, sparse vegetation, and water given every 48 hours.

Parameter	X	Y	Z
Body temp (°C)	37.5	39.0	40.2
Water intake/day (L)	8	4	3
Respiration rate	12	18	25
Heart rate	45	60	75
RBC count	High	Moderate	Low
Behaviour	Active	Rests often	Weak, easily startled

Z had persistent eye irritation. Y produced highly concentrated urine.

Reference: “Desert Animal Physiology and Water Conservation, Journal of Arid Zone Biology”

TASK
(A) Explain differences in thermoregulation, oxygen transport, osmoregulation, and behaviour.
(B) Suggest strategies to sustainably improve camel health on the farm.

ITEM 21
At Gulu Senior School, S.5 students conducted a mixed practical on immunity, gas exchange, and neural processing. They exposed three volunteers, Mary, Jacob, and Linda to:
• A mild dusty environment
• A visual-reaction test
• A rapid COVID-like antigen test demonstration
• A hydration assessment
Data collected

Parameter	Mary	Jacob	Linda
Pulse after dust exposure	118	135	150
Sneezing/eye irritation	None	Mild	Severe
Blood O_2 (%)	97	92	88
Reaction time (s)	0.20	0.25	0.38
Urine concentration	Normal	Dilute	Very concentrated
Rapid test strip response	Normal	Strong	Weak

Linda has a long-standing dust allergy. Jacob drank 1.5 L of water before the experiment. Mary had already developed immunity to a past viral infection.
Adapted: "Immunity, Allergy, and Human Physiological Responses, Nature Education"

TASK
(A) Explain the differences in oxygen transport, immunity, allergy response, and neural processing among the students.
(B) Predict possible effects on the three learners if dust exposure becomes prolonged.
(C) Suggest strategies teachers can apply to support students with varying immunity and sensitivity during such practicals.

ITEM 22
For the last six years, Kidepo Savanna has experienced prolonged droughts and rising temperatures. A population of ground rodents (a key prey for jackals) shows rapid changes in inherited fur-density traits.

- Fur density is controlled by incomplete dominance.
- Thick-fur homozygotes overheat and die more frequently during hot months.
- Light-fur homozygotes are vulnerable to cold nights and predators.

- Medium-fur heterozygotes survive best under fluctuating temperatures.
- ackal numbers have declined, altering predation pressure.

Researchers collected data from three sampling zones:

Table. Rodent Population Changes in Kidepo (6-Year Trend)

Zone	% Thick-Fur	% Medium-Fur	% Light-Fur	Population Density (/ha)	Jackal Sightings	Avg. Temp (°C)
A (semi-dry grass)	22	58	20	140	Low	31
B (rocky slope)	10	70	20	115	Very Low	33
C (valley edge)	30	50	20	160	Moderate	29

Adapted: *Climate-Driven Selection in Small Mammal Populations*

Task

(a) Explain how incomplete dominance and climate conditions shaped the fur-trait distribution across zones.

(b) Analyse how declining jackal numbers and zone-specific temperatures may affect future rodent population stability and evolutionary direction.

(c) Suggest strategies to maintain ecological balance and prevent rodent overpopulation.

ITEM 23

A highland district depends on Irish potatoes and beans as staple crops. Over the last six years, farmers noticed a sharp increase in a beetle species that feeds on potato leaves. The beetle recently invaded the area after temperatures rose by 1.8°C, making the environment suitable for its reproduction.

The beetle shows dihybrid inheritance for body colour and mandible size. Mandible size affects feeding efficiency. Ground birds that previously preyed on the beetle have declined as shrubs increased due to secondary succession on abandoned fields.

Data: F_2 Offspring (Body Colour × Mandible Size) 324 Beetles

Phenotype	Number
Black, large mandibles	180
Black, small mandibles	60
Brown, large mandibles	60
Brown, small mandibles	24

Adapted: *“Effects of Warming on Insect Herbivore Dynamics in Highland Croplands.”*

Task

(a) Explain how genetics, climate change and succession contributed to the beetle’s rapid population increase.

(b) Analyse how predator decline and mandible-size variation influence crop productivity and ecological balance.

(c) Suggest strategies to control beetle numbers while maintaining food security.

ITEM 24

A floodplain rice-farming community observed a sharp rise in a weevil species damaging stored grain. A study revealed that two genes grain-boring ability and exoskeleton hardness are linked, giving a distorted ratio in laboratory crosses.

Quadrat sampling showed weevil density increasing steadily, and capture–recapture data indicated that storage rooms provide ideal breeding sites. Repeated pesticide use has accelerated resistance allele frequencies.

Data: Linked Gene Cross (Hard Exoskeleton × High Boring Ability)

Phenotype	Proportion
Hard exoskeleton + high boring ability	68%
Hard exoskeleton + low boring ability	12%
Soft exoskeleton + high boring ability	15%
Soft exoskeleton + low boring ability	5%

Adapted: *"Genetic and Ecological Drivers of Storage-Pest Expansion."*

Task

(a) Explain how genetic linkage, meiosis, and selection pressure contributed to weevil dominance.

(b) Analyse how population estimation results reflect risks to food availability and storage stability.

(c) Suggest strategies to reduce weevil damage and improve food security.

ITEM 25

A lowland forest reserve that supports ecotourism is experiencing declining butterfly populations. A dominant invasive vine now covers large areas, reducing host plants for larvae. The native butterfly shows codominant wing-pattern genes, useful for monitoring genetic diversity.

Carbon-footprint measurements show increased charcoal production around the reserve, accelerating deforestation and altering succession patterns from mature forest to open bushland.

Data: Butterfly Monitoring

Indicator	Value
Wing patterns (codominant forms)	Striped, dotted, plain
Population estimate (last year)	8,400
Current estimate	4,900
Habitat type	Bushland (secondary succession)
Larval host-plant cover	40% reduction

Adapted: *"Landscape Change and Butterfly Diversity in East African Forests."*

Task

(a) Explain how codominance helps track genetic diversity and how environmental change affects allele distribution.

(b) Analyse how deforestation, carbon emissions, and succession impact butterfly survival

and ecosystem stability.
(c) Propose strategies to restore butterfly populations and reduce carbon impacts.

ITEM 26

A lakeshore community relies on tilapia fishing and small vegetable gardens. Increasing algal blooms have reduced water clarity and oxygen levels, affecting fish growth. A native fish species shows incomplete dominance for fin shape, influencing swimming efficiency in murky water.
Biologists tested whether the fin-shape allele frequencies were in Hardy–Weinberg equilibrium, revealing strong deviations due to environmental stress.
Data: Fin-Shape Phenotypes (400 Fish)

Phenotype	Number
Long-finned (LL)	160
Intermediate (L M)	200
Short-finned (MM)	40

Additional Data	Value
Dissolved oxygen	Low
Algal cover	High
Fishing intensity	High

Adapted: *“Eutrophication and Evolutionary Responses in Freshwater Fish.”*

Task
(a) Explain how incomplete dominance and environmental stress altered allele frequencies.
(b) Analyse how algal blooms, oxygen drop, and fishing pressure influence population dynamics.
(c) Suggest strategies to restore the lake ecosystem while safeguarding food resources.

ITEM 27

A mountainous region hosts two closely related rodent species that feed on young maize. Recent landslides created deep gullies separating populations. One rodent species shows multiple alleles for coat colour, useful for tracking gene flow. Farmers report increasing crop losses as rodents spread into higher fields.
Data: Rodent Coat-Colour Alleles

Allele	Dominance Rank
A^1	Highest
A^2	Intermediate
A^3	Lowest

Population Indicators	Value
Distance between separated populations	Increased
Maize field attacks	40% rise
Genetic mixing	Reduced

Adapted: *“Isolation Mechanisms and Speciation in Mountain Rodents.”*
Task

(a) Explain how isolation mechanisms and multiple alleles affect rodent population structure.
(b) Analyse how habitat separation and food availability influence speciation and crop loss.
(c) Suggest strategies to protect maize fields while conserving biodiversity.

ITEM 28
A lakeside community depends on fish, livestock, and vegetables. A new aquatic weed invaded irrigation channels, altering water flow and succession from open water to marshland. Farmers applied herbicides, but residue tests show bioaccumulation in aquatic insects and small fish. A mosquito species breeding in the marsh shows rising resistance alleles.
Data: Resistance Allele Frequency (Mosquito Population)

Year	Frequency (R)
0	0.10
2	0.28
4	0.46

Food Pyramid Impacts	Observation
Small fish	High toxin levels
Predatory fish	Declining
Birds	Declining

Adapted: *"Chemical Pollution and Trophic Dynamics in Tropical Freshwaters."*

Task
(a) Explain how herbicide use, resistance evolution, and succession changed ecosystem structure.
(b) Analyse how bioaccumulation affects energy flow, predator–prey balance, and community food security.
(c) Suggest strategies to reduce resistance, restore the food chain, and protect human health.

ITEM 29
A savanna rangeland supports cattle and wildlife. Overgrazing and frequent burning reduced perennial grasses, lowering carbon sequestration. An invasive shrub expanded rapidly, altering soil structure. A grasshopper species feeding on cattle fodder shows independent assortment between body size and feeding-leg length. A test cross was performed to understand its spread.
Data: Test-Cross Results (Body Size × Leg Length), 200 Grasshoppers

Phenotype	Number
Large body, long legs	52
Large body, short legs	49
Small body, long legs	48
Small body, short legs	51

Environmental Indicators	Value
Grass cover	35%
Shrub cover	Increasing
Carbon sequestration	Reduced

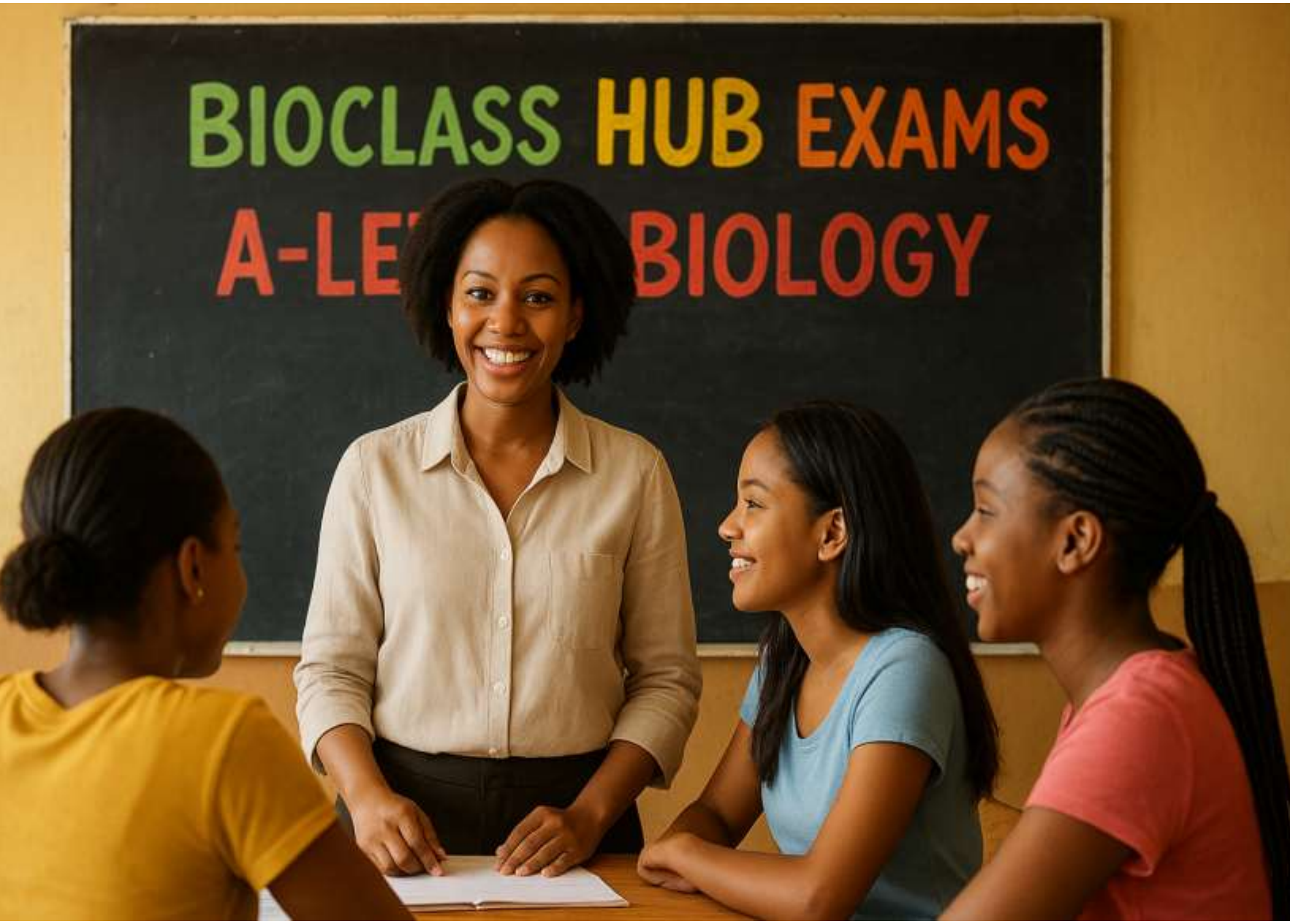
Adapted: *"Grassland Degradation and Insect Dynamics in East African Savannas."*

Task

(a) Explain how independent assortment and grazing practices influence grasshopper evolution.

(b) Analyse how reduced grass cover, carbon loss, and shrub invasion affect rangeland stability.

(c) Suggest strategies to restore grassland productivity and reduce grasshopper damage.



END