BAWALA ALLANZ
0779220446
0751583371

P530/2
BIOLOGY
(Theory)
Paper 2
AUGUST, 2024
$2\frac{1}{2}$ *hours*

JINJA JOINT EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

MOCK EXAMINATIONS – AUGUST, 2024

BIOLOGY

(THEORY)

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

Answer question ONE in section A plus three others from section B.

Candidates are advised to read questions carefully, organize their answers and present them precisely and logically.

Illustrate, whenever necessary, with well labelled diagrams.

 Turn Over

SECTION A (40MARKS)

1. A study was carried out on a typical C4 plant kept in conditions of constant light intensity and temperature while water supply was varied. Changes in the water potential, concentration of abscissic acid and stomatal resistance were recorded over time. Study the figure 1 below and answer the questions that follow.

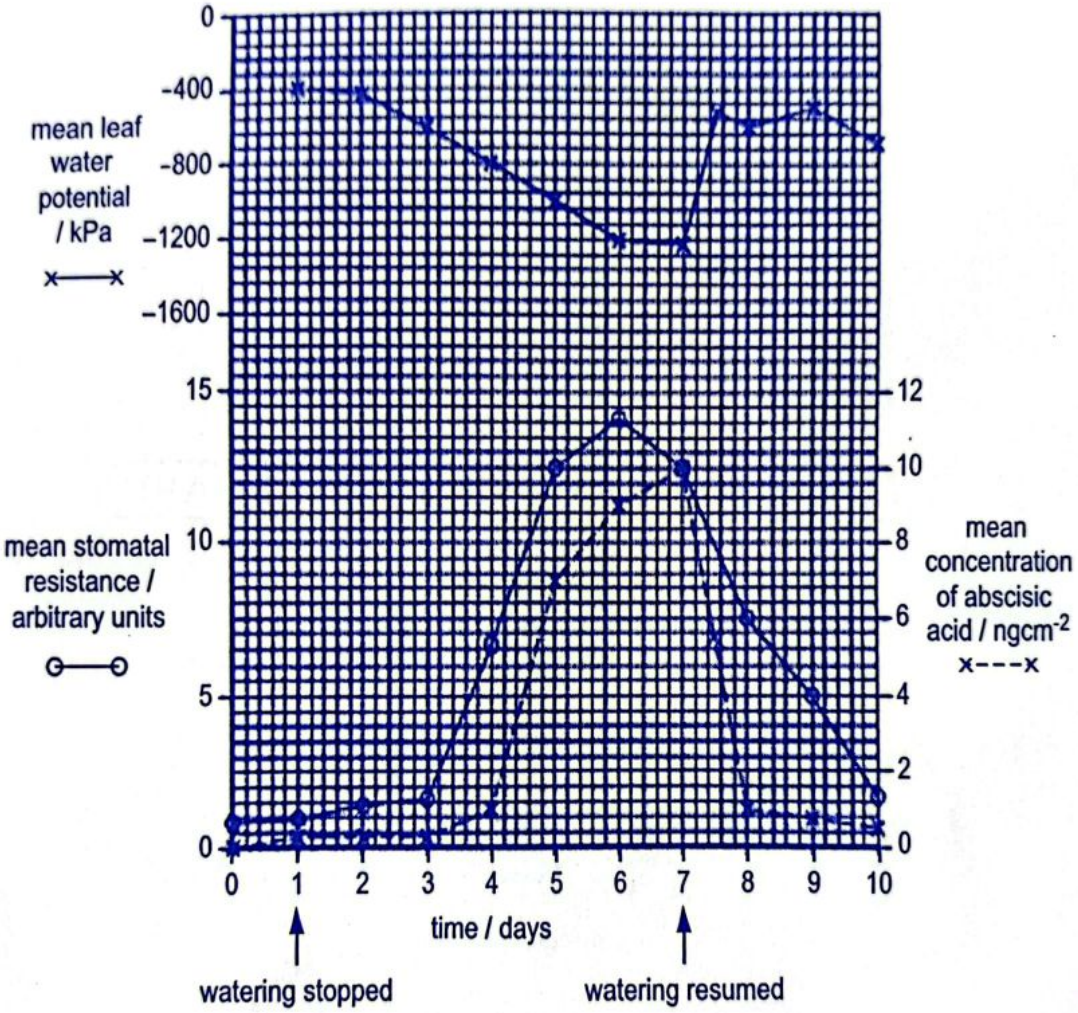

Figure 1

(a) Describe the variation in the;

(i) Mean leaf water potential (04 marks)

(ii) Mean concentration of abscissic acid. (04 marks)

(iii) Mean stomatal resistance. (04 marks)

(b) Explain the relationship between water potential, abscissic acid and stomatal resistance. (10 marks)

(c) Suggest what would be the effect of extreme light intensity and temperature on the experimental results from the beginning of the experiment. (06 marks)

(d) Explain;

(i) The ecological significance of the changes described in (c) above to a C4 plant growing in dry areas. (04 marks)

(ii) How increase in stomatal resistance can affect photosynthetic efficiency of the above plant. (03 marks)

(e) How is transpiration important in plants? (04 marks)

SECTION B: (60 MARKS)

2. (a) Describe the interactions of various species of organisms in an ecosystem. (08 marks)

(b) Explain the ecological significance of each of the following components of an ecosystem.

(i) Parasitism. (04 marks)

(ii) Competition. (04 marks)

(c) Explain how direct competition between different species of organisms is reduced. (04 marks)

3. (a) Explain how the human body responds to a change in the air temperature from $30^{o}c$ to $20^{o}c$. (06 marks)

(b) Describe the functioning of the counter current exchange mechanism in terrestrial mammals that permit water conservation. (08 marks)

(c) Compare hair pin counter current multiplier and counter current heat exchange system. (06 marks)

4. (a) Describe what happens to the end product of glycolysis during;

(i) Lactate fermentation. (04 marks)

(ii) Alcohol fermentation. (06 marks)

(b) Describe the significance of Kreb's cycle. (05 marks)

(c) How is oxidative phosphorylation different from photophosphorylation? (05 marks

5. (a) Explain how each of the following affect allele frequency of a population.

(i) Genetic load. (04 marks)

(ii) Natural selection. (04 marks)

(iii) Gene flow. (04 marks)

(b) In drosophila, the genes for wing length and eye colours are sex linked. Normal wings and red eyes are dominant to miniature wing and white eyes. In a cross between a miniature wing and red eyed male and a normal winged white eyed female. Explain the F1 and F2 generations assuming there was complete linkage. (08 marks)

6. (a) Compare nervous and endocrine system. (08 marks)

(b) Describe how the secretion of the following hormones is controlled.

(i) Thyroxine. (06 marks)

(ii) Aldosterone. (06 marks)

 End

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UACE MOCK EXAMINATIONS 2024

BIOLOGY PAPER 2

P530/2

PROPOSED MARKING GUIDE

SECTION A: (40 MARKS)

1. (a) Description of changes

(i) Mean leaf water potential

From 1 to 2 days, the mean leaf water potential remained constant; from 2 to 6 days water potential decreased gradually; to a minimum; and from 6 to 7.0 days remained constant;

From 7.0 days to 7.6th day water potential increased rapidly; to a peak; Acc ± 0.05

From 7.6 to 8th day water potential decreased gradually; from 8 to 8.8thnday water potential increased gradually; to a peak; then from 8.8 to 10th day water potential decreased gradually; *@½ mark; max 04mark*

(ii) Mean concentration of abscissic acid.

From 0 to 1 day mean concentration of abscissic acid increased gradually; from 1 to 3 days the mean concentration of abscissic acid remained constant; from 3 to the 4th day mean concentration of abscissic acid increased gradually; from 4 to the 5th day mean concentration of abscissic acid increased rapidly; from 5 to 7.0 days concentration of abscissic acid increased rapidly; to a peak/maximum;

From 7.0 to 8th day the mean concentration of abscissic acid decreased rapidly; and then decreased gradually from 8 to 10th day; *@½ mark; max 04marks*

(iii) Mean stomatal resistance.

From 0 to 1 day, stomatal resistance remained constant; from 1 to 2nd day stomatal resistance increased gradually; from 2 to the 3rd day stomatal resistance remained constant; from 3 to 5th day stomatal resistance increased rapidly; and then from 5 to 6th day stomatal resistance increased gradually; to a peak/maximum;

From 6 to 7.0 days stomatal resistance decreased gradually; and from 7.0 to 10 days stomatal resistance decreased rapidly; *@½mark; max 04marks*

beyond 7 Award once rapid.

(b) **Explanation for the relationship**

From 0 to 3 days as water potential was high stomatal resistance and abscissic acid secretion was low; this is because as mean stomatal resistance increases gradually; due to the high water potential of leaf cells inhibiting secretion of abscissic acid to induce stomatal closure;

Between 3 and day 6; as stomatal resistance and abscissic acid secretion increased to a peak mean water potential decreased; this because stopping watering, water potential of cells was lowered; stimulating secretion of high concentrations of abscissic acid; which binds on cell surface receptors; inhibiting hydrogen ion pump; stimulates a ~~metabolic pump to actively secrete~~ potassium ions out of the guard cells; turgidity of guard cells is lowered; increasing stomatal resistance;

Beyond 6 days as mean water potential increased, stomatal resistance and concentration of abscissic acid concentration decreased; this is because resumption of watering, increases water potential of cells; inhibiting further secretion of abscissic acid; and the stomata remained open reducing stomatal resistance; *max 10 marks*

(c) **Effect of extreme light intensity and temperature**

At extremely low light intensity and temperature, the mean concentration of abscissic acid reduces; lowering the stomatal resistance; but mean leaf water potential increases; few stomata will open;

At extremely high light intensity and temperature; the mean concentration of abscissic acid increases; rising the stomatal resistance to minimise water loss; mean leaf water potential increases throughout the experimental time; max 06 marks

(d) **Explanation**

(i) **Ecological significance of the changes**

In dry/arid conditions, plants experience excess water loss through transpiration; plants are under conditions of physiological water stress; thus increased stomatal resistance; lowers rate of transpiration/excessive water loss; eventually preventing wilting; max 04 marks (ii)

ii) **Effect of increase in stomatal resistance in photosynthetic efficiency**

Closure of stomata reduced uptake of carbon dioxide; carbon dioxide concentration will limit rate of photosynthesis; thus decreasing rate of photosynthesis; 03 marks

(e) **Significance of transpiration in plants**

- It brings about cooling of the plant due to evaporation of water from the leaf surface, excess heat of vaporization results into a cooling effect;
- It allows uptake of absorbed mineral salts within the xylem vessels from roots to leaves;
- It allows the uptake of water from the roots to leaves in form of transpiration stream due to transpiration pull created in leaves and shoot;
- It brings about mechanical support in herbaceous/non-woody plants due to water uptake which provides turgidity of parenchyma cells of stem and leaves;

04 marks

SECTION B: (60 MARKS)

2. (a) **Interactions in an ecosystem**

- **Predation;** where the predator hunts and feeds on another organism called a prey;
- **Competition;** an interaction between organisms of the same (intraspecific); or different species (interspecific); where the organisms struggle for the limited resources;
- **Mutualism;** an association between two organisms of different species where both benefit from the relationship;
- **Commensalism;** an association between organisms of different species where one organism gains/benefits while the other/host neither gains nor loses;
- **Parasitism;** an interaction between organisms of different species in which one organism/parasite lives in or on another organism called the host where it obtains (all) its nutrients; the parasite gains while the host losses/harmed;
- **Alleloparthy/antibiosis;** an interaction in which one organism produces a chemical substance which has a harmful effect on another organism of different species;
- **Protective colouration;** where animals bear striking resemblance to a plant for protection against predators; *@½marks; max 08 marks*

• plants → animal pollinators & dispersal agents)

(b) **Ecological significance**

(i) **Parasitism**

- Reduces competition;
- Used as biological control agents to eradicate harmful organisms;
- Causes parasites to be distributed to areas where their hosts are most abundant;
- May lead to development of resistant strains to parasites/harmful effects to the host;
- Many parasites occupy strategic locations in the host to ensure maximum utilization of the resources/increasing their chances for survival, ~~avoid competition among hosts;~~ *max 04 marks*

(ii) **Competition**

- Enables organisms of same species to evolve into different distinct species of organisms; in order to exploit resources in different ecological niches due to migration;
- It leads into polymorphism;
- Controls population of organisms at carrying capacity/population control;
- It leads to colonization of a wide range of habitats;
- Better adapted species of organisms develop; *max 04 marks*

(c) **How organisms avoid direct competition**

Through resource partitioning; where different species specialize to make use of different resources; through specialisation of morphology and behaviour for different foods; vertical stratification such as canopy dwellers and forest floor dwellers; and horizontal separation through occupation of different microhabitats; max. 04 marks

3. (a) **Response of body to a drop in air temperature**

Drop in air temperature is detected by the cold thermo receptors in the skin; and send impulses to the heat gain centre; in the posterior hypothalamus; which together with stimulation by cold blood passing through capillaries and brain; triggers motor impulses to effectors; superficial/skin arterioles vasoconstrict (with dilation of shunt vessels); reducing the amount of blood flowing near the skin surface; reducing heat lost; hair erector pilli muscles contract; raising the hair on the surface of skin to trap air insulating against heat loss; increased muscular activity/shivering generating more heat; reduced sweating; increased metabolic rate; generating more heat increasing the body temperature;

@ ½ mark; max. 06 marks

(b) **Counter-current exchange in water conservation**

The ascending limb of the loop of Henle is impermeable to water; but sodium ions are actively transported out of it and deposited into the interstitial tissues of the medulla of the kidney; from the fluid flowing upwards the ascending limb; sodium ions concentration in the deeper part of the medulla tissues is raised very high; causing water to be withdrawn by osmosis; from the renal fluid flowing downwards in the descending loop of Henle; from distal convoluted tubules and collecting ducts; the water is then carried back into the blood stream;

Renal fluid in the descending loop and ascending limbs of loop of Henle flow in opposite directions maintaining higher salt concentrations in the descending loop than ascending loop; causing more water to be reabsorbed back into the blood stream;

Max. 08 marks

(c) **Comparison of hair pin counter-current multiplier and counter current heat exchange system**

Similarities

- In both systems fluid flow in opposite directions;
- In both exchange of materials occur by diffusion;
- In both there is increase in concentration in one system while in the other system there is decrease in concentration of the same substance;
- Both involve blood vessels;

Any 3.

In both there is exchange of materials between the two systems of fluids;

Differences

Hair-pin counter current multiplier	Heat exchange counter current system
• For maximum water conservation • The two systems involved are the descending and ascending limb of loop of Henle • Occurs in the kidney • The systems are filled with ~~blood~~ renal fluid • Exchange of materials occur by diffusion and active transport • Involves exchange of salts	• For temperature regulation; • The two systems involved are blood vessels arteries and veins; • Occurs in the body extremities; • The systems are filled with blood; as fluid; • Exchange of heat takes place by diffusion; • Involves exchange of heat;

any 3.

MAX 06 marks

4. (a) **Anaerobic respiration**

(i) **Lactate fermentation**

Pyruvate is reduced directly by NADH/$NADH_2$; to form **lactic acid** as the end product; catalysed by **lactate dehydrogenase**; No carbon dioxide is released; *04 marks*

oxidised NAD

04.

Acc Illustrations

Pyruvate + $NADH_2$; ~~Lactate dehydrogenase~~; Lactic acid; + NAD^+;

($CH_3COCOOH$) ($CH_3CHOHCOOH$)

(ii) **Alcohol fermentation**

Pyruvate is decarboxylated to yield carbon dioxide; which is converted to a 2 carbon compound **acetaldehyde/ethanal**; Catalysed by pyruvate decarboxylase enzyme; Ethanal is then reduced by NADH/$NADH_2$; to **ethanol**; and NAD^+; *06 marks* in sequence

+ alcohol dehydrogenase enzyme;

06.

Acc. Illustrations

Pyruvate ~~Pyruvate decarboxylase~~; Ethanal; + Carbon dioxide;

($CH_3COCOOH$) (CH_3CHO)

Ethanal + $NADH_2$; ~~Alcohol dehydrogenase~~; Ethanol; + NAD^+;

(CH_3CH_2OH)

No ATP is produced;

(b) **Significance of Kreb's cycle (S. Toole pg 195)**

- It breaks down macromolecules into simpler ones; pyruvate is broken down into carbon dioxide;
- It produces hydrogen atoms that are carried by NAD and FAD to the electron transport chain for oxidative phosphorylation and ATP production; providing metabolic energy to the cells;
- It regenerates oxaloacetate/starter material which would otherwise be completely used up;
- It is a source of intermediate compounds used by cells in the manufacture of other important substances; such as fatty acids/amino acids/chlorophyll;

05 marks

(c) **Comparison of oxidative phosphorylation and photophosphorylation**

Oxidative phosphorylation	Photophosphorylation
• Energy utilized from oxidation of organic compounds	• Energy utilized comes from the sun/ sunlight;
• Utilizes oxygen	• Releases oxygen;
• Products are ATP and water	• Products are ATP in cyclic and oxygen, ATP and NADPH2 in noncyclic;
• Electrons only come from hydrogen atoms	• Electrons come from water (noncyclic) and chlorophyll (cyclic);
• Final electron acceptor is oxygen	• Final acceptor is chlorophyll (cyclic) and NADP (non-cyclic);
• Involves only cyclic phosphorylation	• Involves both cyclic and non-cyclic phosphorylation;
• Takes place in organisms respiring aerobically	• Takes place in green plants and photosynthetic bacteria;
• Occurs throughout the day & night	• Occurs only during day;

Max 05 marks

5. (a) **Change in allele frequency**

(i) Genetic load; existence within the population of disadvantageous alleles in heterozygous state; the heterozygous genotype have a selective advantages over the

homozygous in certain environmental conditions; The heterozygotes are favoured and are selected for by the environment; whereas the homozygotes are less adapted and are eliminated from the population changing the allele frequency; e.g, sickle cell trait. *04 marks*

(ii) **Natural selection;** is where the genotype frequency of a particularly more adapted individual increase more than those of less advantaged individuals; the allele determining advantageous characteristics are transmitted to the next generation; whereas the alleles for less adapted characteristics are wiped out of the population; and their genotypes become non-existent decreasing their allele frequency; *04 marks*

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(iii) **Gene flow;** this is the transfer of alleles from one population to another resulting from interbreeding between members of the two populations; Gene flow alters the allele frequency in both populations which leads to genetic variation; Gene flow also distributes mutant alleles throughout all the populations; and the populations share a common gene pool that reduces variation between the populations; and preventing the process of formation of new species; So when gene flow is prevented, each population creates new alleles seperately in each population; ~~and new species will be formed by natural selection.~~ *04 marks*

(b) Let N represent allele for normal wing;
Let n represent allele for miniature wing;
Let R represent allele for red eyes;
Let r represent allele for white eyes;
Let XX represent female fly;
Let XY represent male fly;

Deny if no X indicated in phenotype.

Parental phenotype; miniature wing red eyed male X Normal wing white eyed male;

Parental genotype: $X^{nR}Y$ X $X^{Nr}X^{Nr}$;
Meiosis
Gametes: X^{nR} Y X^{Nr} X^{Nr};
Radom fertilisation:
F1 genotypes: $X_{nR}X_{Nr}$ $X_{nR}X_{Nr}$ $X_{Nr}Y$ $X_{Nr}Y$;
F1 phenotype: 2 normal winged red eyed males 2 normal winged white eyed females;

Selfing F1

Parental phenotype: normal winged red eyed males X normal winged white eyed females;

Parental genotype: $X^{Nr}Y$ X $X^{nR}X^{Nr}$;

Meiosis without Crossing over

Gametes: X^{Nr} Y X^{nR} X^{Nr};

Random fertilisation:

F2 genotype: $X^{Nr}X^{nR}$ $X^{Nr}X^{Nr}$ $X^{nR}Y$ $X^{Nr}Y$;

F2 phenotype; Normal winged red eyed female,
Normal winged white eyed female,
Miniature winged eyed normal male,
Normal winged white eyed male;

Note: *only award gametes when circled* *08 marks*

6. (a) **Comparison of nervous and endocrine system**

Similarities

- Both are affected by change in stimulus;
- Both cause a response;
- Both provide a means of coordination in the body;
- Both systems transmit messages/both are systems of communication;

Any 03

Differences

Nervous system	Endocrine system
• Nerve impulses are electrical • Responses are fast as the impulses are carried fast • Impulses go along a nerve fibre	• Impulses are chemical; • Responses are slow but long lasting in effect; • Impulses are carried in blood;

• Effect is more localized/specific	• Effect is wide spread in the whole body;
• Stimulus arises from any part of the body where sensory receptors are localized	• Stimulus arises from specific places only e.g. endocrine system;
• Response involves short-term changes	• Response involve long term changes;
• Effects in most cases temporal and reversible.	• Effect is permanent and irreversible;
• Causes muscles to contract and induce gland secretion	• Causes changes in metabolic activities;

Any 5 marks; max 08 marks

(b) **Control of secretion of;**

(i) **Thyroxine**

Thyroxine is controlled by negative feedback mechanism;

When the level of thyroxine hormone in blood is below normal; the hypothalamus is stimulated; to secrete thyrotrophin releasing hormone (TRH); which stimulate the anterior lobe of the pituitary gland to secrete thyroid stimulating hormone (TSH) into blood; The TSH stimulates the thyroid gland; to secrete thyroxine hormone;

When the level of thyroxine is above normal; the hypothalamus and anterior lobe of the pituitary gland are inhibited from secreting TRH and TSH respectively; and as a negative feedback the thyroid is inhibited from secreting thyroxine hormone reducing its concentration back to normal;

@1mark; Max 06 marks

(ii) **Aldosterone**

Aldosterone is controlled by negative feedback mechanism;

When the sodium ion levels in blood is below the normal; renin is secreted by the juxta glomerular cells of the kidney; to activate angiotensinogen to angiotensin; angiotensin stimulates the adrenal cortex; to secrete aldosterone hormone into blood stream; that increases the reabsorption of sodium ions in blood back to normal;

When sodium ion levels increases above normal; renin secretion is decreased causing decreased angiotensinogen formation; a reduced level of angiotensin and thus aldosterone decreases tubular reabsorption of sodium of water; thus increasing the kidneys excretion of sodium ions;

@1mark; Max 06 marks