P530/2

BIOLOGY

(Theory)

Paper 2

July-August 2024

2½ Hours

UGANDA MUSLIMS TEACHERS' ASSOCIATION

UMTA JOINT MOCK EXAMINATIONS -2024

UGANDA ADVANCED CERTIFICATE OF EDUCATION

BIOLOGY

(THEORY)

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

- *This paper consists of **six** questions.*
- *Answer question **one** in **Section A** plus **three** others from **Section B**.*
- *Candidates are advised to read the questions carefully, organize their answers and present them precisely and logically with well labelled diagrams where necessary.*
- *Candidates are also advised to write on the front page of the answer sheets used, their full name, index number and indicate the questions attempted in their orders in a table as shown below,*

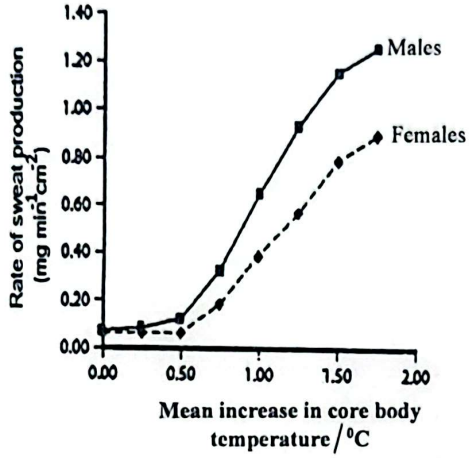
Question					**TOTAL (%)**
Marks					

SECTION A (40 MARKS)

1. **Graph A** below shows the effect of a mean increase in the body temperatures on the rate of sweat production by males and females during marathon. Female marathon runners were identified to have smaller bodies than males.

Graph B shows effect of exercise intensity on stroke volume for marathon runners. During the race, runner's exercise increased from 0 to 100%. The **table 1** below shows the effect on the runner's heart rate.

GRAPH A



GRAPH B

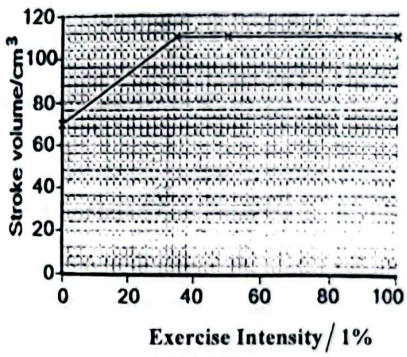


Table 1:

Exercise intensity/%	Heart rate/bpm
0	55
100	160

(a) Compare the effect of mean increase in core body temperature on the rate of sweat production in the males and females. (07 marks)

(b) Explain the effect of mean increase in core body temperature on rate of sweat production among the male runners. (09 marks)

(c) Account for the observed difference in the rate of sweat production between male and female runners. (04 marks)

(d) (i) From graph **B** and table **1** distinguish stroke volume from heart rate. (03 marks)

(ii) Using graph **B** and table **1**, calculate the change in cardiac output from rest to 30% exercise intensity. (02 marks)

(e) Explain the relationship in heart rate, stroke volume and cardiac output at varying exercise intensity. (12 marks)

(f) State any **three** other factors that will increase heart rate. (03 marks)

SECTION B (60 MARKS)

2. (a) Describe the significance of mineral nutrients to plants. (07 marks)

(b) Discuss methods that can make nitrogen in decaying organic materials in soil, available for absorption by the root hair cells of plants. (13 marks)

3. (a) Differentiate between transport of Oxygen and that of Carbondioxide in mammals. (06 marks)

(b) Explain the effect of low **pH** on;

(i) Stomatal movements. (08 marks)

(ii) Affinity of haemoglobin for oxygen and on oxygen dissociation curve. (06 marks)

4. (a) Distinguish between resting potential and action potential. (07 marks)

(b) Explain how sound of high frequency from the environment is perceived by the mammalian ear. (13 marks)

5. (a) Compare natural and artificial selection. (09 marks)

(b) Discuss how industrial melanism support modern concept of evolution by natural selection. (11 marks)

6. (a) Describe how change in **DNA** structure leads to production of malfunctional enzyme. (08 marks)

(b) Explain various factors that increase efficiency of enzyme actions. (12 marks)

END

MARKING GUIDE (DRAFT)
UMTA MOCK EXAMINATIONS 2024
UACE
BIOLOGY PAPER 2
(THEORY)

SECTION A (40 MARKS)

(a) Compare the effect of mean increase in core body temperature on the rate of sweat production in the males and females. (07 marks)

SIMILARITIES.

- In both males and females , mean increase of core body temperature of 0°C leads to the same/equal/similar rate of sweat production;
- In both males and females , mean increase in core body temperatures from 0.5°C upto 1.75°C leads to increase in rate of sweat production;
- In both males and females , mean increase in core body temperature of 1.75°C leads maximum rate of sweat production;
- In both males and females , mean increase in core body temperature of 0°C leads to low rate of sweat production;

@ 1 mark, maximum = 03 marks

DIFFERENCES.

- Mean increase in core body temperatures ~~from~~ 0°C to 2°C leads to higher rate of sweat production in males while leads to lower rate of sweat production in females;

- Mean increase in core body temperatures of 1.75°C leads to higher maximum rate of sweat production in males while in females leads to lower maximum rate of sweat production;

- Mean increase in core body temperatures from 0°C to 0.25°C leads to almost constant/more gradual increase in rate of sweat production in males while leads to constant rate of sweat production in females;

• Mean increase in core body temperatures from 0.25°C to 0.5°C leads to gradual increase in rate of sweat production in males while leads to constant rate of sweat production in females.

@ 1 mark = 04 marks.

Accept and award marks for well tabulated differences.

(b) Explain the effect of mean increase in core body temperature on rate of sweat production among the male runners. (09 marks)

Mean increase in core body temperatures from 0°C upto 0.25°C leads to/causes almost constant rate of sweat production in males because temperature of blood flowing through the hypothalamus of the brain is still at the norm/set point there is no stimulation of the heat loss center at the anterior lobe of the hypothalamus there are no impulses transmitted to stimulate sweat production by the sweat glands in the skin.

Mean increase in core body temperatures from 0.25°C to 1.75°C leads to increase /rapid increase in rate of sweat production this is because the temperatures of the blood flowing through the brain exceeds the norm this stimulates the heat loss center in the anterior lobe of the hypothalamus nerve impulses are generated and transmitted via efferent / motor nerves to the sweat glands in the skin many sweat pores are open and more sweat secreted on the skin surface evaporation of the sweat from the skin results into cooling for temperature regulations.

@ 1 mark , max = 09 marks.

(c) Account for the observed difference in the rate of sweat production between male and female runners. (04 marks)

The rate of sweat production is higher in males than in females the body of the females have relatively larger surface area while the body of the males have relatively smaller surface area females loose more heat than the males to the surrounding environment heat retained in the body is higher in males than the females during marathon.

@ 1 mark , max = 04 marks.

(d) (i) From graph B and table 1 distinguish stroke volume from heart rate.
(03 marks)

(ii) Using graph B and table 1 , calculate the change in cardiac output from rest to 30% exercise intensity. **(03 marks)**

d(i)

- Stroke volume is higher while the heart rate is lower at 0% exercise intensity,
- Stroke volume remained constant while heart rate increased/increased rapidly between 40% and 100% exercise intensity.
- stroke volume increased to a maximum and remained constant while the heart rate increased/increased rapidly through out.
- stroke volume attained a maximum at lower percentage (38%) exercise intensity while heart rate attained maximum at higher percentage (100%) exercise intensity

@ 1 mark , max = 03 marks

(ii)

y Exercise	x HR
0	55
30	x
100	160

use linear interpolation

$$\frac{30 - 0}{100 - 0} = \frac{X - 55}{160 - 55} ;$$

$$\frac{30}{100} = \frac{(X - 55)}{105} ;$$

$$(30 \times 105) = (X - 55)\,100 ;$$

$$X - 55 = \frac{30 \times 105}{100} ;$$

$$X = (31.5 + 55) ;$$

$$X = 86.5 ;$$

Cardiac out put up to 30% exercise intensity = 86.5 bpm

SV × HR

CO = 72 × 55 = 3960 cm³/min

Final = 105 × 86.5

= 9082.5 cm³/min

$\frac{y_2 - y_1}{x_2 - x_1} = \frac{160 - 55}{100 - 0} = \frac{x - 55}{30 - 0}$

Δ in C.output = F − I = 86.5

9082.5 − 3960

5122.5 cm³/min

(e) Explain the relationship in heart rate, stroke volume and cardiac output at varying exercise intensity. **(12 marks)**

As the percentage of the exercise intensity increases, the heart rate, stroke volume and cardiac output increase/increase rapidly

pH is detected by chemoreceptors in Carotid bodies and Aortic bodies; send impulses via afferent nerves to Cardio Accelatory centres in medulla; when then send impulses via efferent to SAN; that increase Heart rate;

The heart rate increases because of increase in muscular contractions leading into increased metabolic rates; large amount of carbondioxide is produced, lowering pH of blood; sympathetic nervous system is stimulated; vaso-dilation of blood vessels also occurs due to secretion of adrenaline/vasodilation of blood vessels underneath the skin due to build up of heat; vaso-constriction of arterioles in tissues less in need of oxygen like the gut/kidney/spleen; these increase venous return increasing heart rate.

Stroke volume increase as the exercise intensity increases upto 40% because of dilation of veins in muscles, increasing venous return to the heart; and the volume of blood pumped by the left ventricle per heart beat increases;
As the percentage of exercise intensity increases beyond 40%, the stroke volume remains constant. This is because venous returns causes volume of the blood filling the left ventricle to reach its maximum; the left ventricle pumps this blood per heart beat emptying the left ventricle with a high force; such volume of blood pumped does not exceed its limit at this stage and stroke volume remain constant; at this stage the diastolic and systolic pressures reduce.

Cardiac output increases as percentage of the exercise intensity increases due to increase in heart rate and stroke volume; and this increases the volume of blood pumped into general blood circulation per minute; to increase the supply of oxygen and other nutrients like glucose to the respiring tissues and enable expulsion of carbondioxide;

@ 1 mark , max = 12 marks.

(f) State any three other factors that will increase heart rate. (03 marks)

- ~~Low~~ high environmental temperatures;
- Low pH of blood;
- Growth activities;
- Small size in mammals;
- Certain drugs;
- ~~Exercise;~~
- Increased metabolism;
- Presence of certain hormones like thyroxin;
- Diseases/infections;

Ions (Na-K).

@ 1 mark , max = 03 marks.

TOTAL = 40 MARKS

SECTION B (60 MARKS)

2 (a) Describe the significance of mineral nutrients to plants. (07 marks)

- Nitrogen, sulphur are major components of proteins and amino acids ;
- Nitrogen, magnesium, zinc, copper and iron form structural components of chlorophylls ;
- Nitrogen and phosphorus are components of nucleic acids ;
- Magnesium , potassium ions, calcium ions, zinc, copper (ii) ions and manganese are activators of enzymes ;
- Calcium ions combine with pectins to form calcium pectate which is a component of middle lamella in cell walls ;
- Iron are constituents of cytochromes ;
- Boron aid germination of pollen grains ; and important in the process of mitotic cell division of meristematic cells ;
- Sodium , potassium, calcium, and chloride ions maintain salt – water balance important in osmo-regulation ;
- Chlorine play role in production of oxygen during light stage of photosynthesis ;
- Phosphorus is required for synthesis of adenosine triphosphate (ATP) ; used for phosphorylation of sugars/synthesis of phospholipids which is a component of cell membrane ;

@ 1 mark , maximum = 07 marks.

Reject an answer with no single example of a mineral element given.

(b) **Discuss methods that can make nitrogen in decaying organic materials in soil, available for absorption by the root hair cells of plants. (14 marks)**

Mycorrhizal association ; where fungi living on the surface of roots or in inside the roots of some plants ; secrete enzymes ; which catalyze breakdown of proteins in humus into amino acids ; aminoacids are further broken down to release nitrogen and phosphorus ;

Nitrification ; where proteins in the decaying organic matter are broken down ; into ammonium compounds ; by the aerobic putrefying bacteria present in the soil ; ammonium compounds formed are oxidized ; into nitrites ; by the nitrifying bacteria ; such as nitrococcus/nitrosomonas ; the nitrites are oxidized/broken down into nitrates ; by aerobic nitrifying bacteria such as nitrobacter ;

Nitrogen are absorbed as nitrate ions ; by the root hair cells by both diffusion ; and active transport ;

@ 1 mark , maximum = 14 marks.

TOTAL = 20 MARKS

3 (a) Differentiate between transport of oxygen and that of carbondioxide in mammals. (06 marks)

DIFFERENCES BETWEEN

Transport of oxygen	Transport of carbondioxide
• Is from lung capillaries into various respiratory tissues,	• Is from the respiratory tissues into the lung capillaries and then lungs ;
• Carried in blood as oxyhaemoglobin/transported in one form,	• Carried in blood as sodium hydrogen carbonate/carbonic acid/carbaminohaemoglobin ; /transported in three different form ;
• carried mainly in red blood cells/not carried in blood plasma ,	• carried in red blood cells and blood plasma ;
• Is in arteries except pulmonary artery,	• Is in veins except pulmonary veins ;
• Large quantities transported by haemoglobins in red blood cells ,	• Very small quantitites transported by haemoglobins in red blood cells ;
• Oxygen binds onto haem group in haemoglobins ,	• Carbon dioxide bind onto amino group in the polypeptide chain ;
• Oxygen diffuse from red blood cells in blood into the tissue fluids ,	• Carbondioxide diffuses from the tissue fluid into the red blood cells and plasma in the blood ;

@ 1 mark , max = 06 marks

(b) Explain the effect of low pH on ,

(i) Stomatal movements. (08 marks)

(ii) Affinity of haemoglobin for oxygen and on oxygen dissociation curve. (06 marks)

b(i)

Low pH in guard cells ; leads to stomatal closure ; this is because low pH activates the enzymes (Hexokinase and phosphorylase) ; which catalyses conversion of glucose to starch in guard cells ; accumulation of starch in guard cells causes water potential to become higher ; water is lost from the guard cells into the surrounding epidermal cells ; by osmosis ; guard cells become flaccid/the thick inner walls curve outwards and become ~~more~~ less convex ; and stomata close .

@ 1 mark = 08 marks

(ii)

Low pH lowers/decreases affinity of haemoglobin for oxygen ; and causes oxygen dissociation curve to shift downwards and more towards the right ; low pH arises from high concentrations of hydrogen ions ; the hydrogen ions combine with oxyhaemoglobins causing them to rapidly dissociate ; to release oxygen to the respiring tissues ; the haemoglobinic acids formed do not readily combine with oxygen at low oxygen partial pressures ;

@ 1 mark = 06 marks.

TOTAL = 20 MARKS

4 (a) Distinguish between resting potential and action potential. (07 marks)

DIFFERENCES BETWEEN

Resting potential	Action potential
• Is a negative potential difference,	• Is a positive potential difference ;
• Exists across polarized membrane,	• Exists across depolarized membrane ;
• Exists when receptor/an axon is at rest ,	• Exists when receptor/an axon is stimulated ;
• Achieved when potassium ions diffuse rapidly outside the membrane,	• There is no/limited diffusion of potassium ions across the membrane ;
• sodium ions actively pumped	• Sodium ions diffuse rapidly inside the

outside the membrane ,	membrane ;
• Does not lead to formation and transmission of nerve impulses,	• Lead to formation and transmission of nerve impulses ;
• Maintained by active pumping of potassium ions inside the membrane	• There is no active pumping of potassium ions across the membrane ;
• Uses more energy ,	* uses less energy ;
• Sodium-potassium pump operates ,	• Sodium – potassium pump breaks down ;
• Sodium ion gates are closed,	• Sodium ion gates are open

@ 1 mark , maximum = 07 marks

(b) Explain how sound of high frequency from the environment is perceived by the mammalian ear. (13 marks)

Pinna receives sound waves ; concentrates it and passes it in the auditory meatus ; the sound waves cause vibrations of the tympanic membrane ; the vibrations are amplified when transmitted through the ear ossicles ; from malleus, incus and stapes ; these cause vibrations of the oval window which is transmitted through the perilymph ; these vibrations are transmitted to the part of the cochlea at the base near the round window ; this part of cochlea is narrow with high tension ; resulting into vibrations of the reissner's membrane which inturn causes vibrations of the endolymph in the median canal ; vibrations of the endolymph cause displacement of the basilar membrane at this part ; when this occurs while the tectorial membrane remain rigid and fixed in one position ; the sensory hairs are stretched that will cause the shapes of the sensory hair cells to become distorted ; the sensory hair receptors are stimulated ; nerve impulses are generated and transmitted via auditory nerve fibres ; to the brain which interpretes it as sound of high frequency (pitch) ;

@ 1 mark , max = 13 marks.

TOTAL = 20 MARKS

5 (a) Compare natural and artificial selection. (08 marks)

DIFFERENCES BETWEEN

Natural selection	Artificial selection
•Environmental factors exert selection pressures,	• Humans exert selection pressures ;
•Better variations adapt to the environment ,	• Better variations are desirable to humans ;
•Individuals with unfavourable features/less adapted die,	• Individuals with unfavourable character/less adapted ones are sterilized /isolated/exterminated ;
• occurs randomly ,	• Is non-random ;
• Is non-selective ,	• Involve selective breeding ;
• Include directional , disruptive and stabilizing selections ,	• Include in-breeding and out breeding ;
• Can lead to formation of more than one new species at the same time,	• Leads to formation of mainly one new species at a time ;
• Leads to adaptations to the environment ,	• Leads to changes to populations characteristics ;
• Occurs in the wild environment ,	• Occurs within homely/domesticated environment ;

@ 1 mark , maximum = 04 marks

SIMILARITIES BETWEEN NATURAL AND ARTIFICIAL SELECTION.

- Both lead to formation of new species ;
- In both, better adapted individuals survive to reproduce ;
- In both, genes are transmitted to the next generations through reproduction ;
- Both occur gradually over many generations ;
- In both there is directional selection pressures exerted on variations ;
- In both better adapted individuals are selected for while less adapted ones are selected against ;

@ 1 mark , max = 04 marks

(b) Discuss how industrial melanism support modern concept of evolution by natural selection. (12 marks)

Long ago, there pre-existed a light type of a peppered moths in England ; sudden mutation occurred ; resulted into emergence of mutant dark (melanic) type of peppered moths ; the two variants of the light type and dark type of the peppered moths co-existed for certain period of time ; until black soot emitted from existing industries begun to blacken the environment/walls of buildings/bark of trees ; lichen on bark of the trees were destroyed by the sulphur dioxide in the soot/smoke from the industries ;

In the polluted environment, the two variants of the peppered moths, the light and dark types both suffered frequent selective predation by particular birds ; the mutant black (melanic) type of peppered moths became better adapted ; they successfully camouflaged against the blackened environment and could not be easily spotted by the predatory birds ; they survived ; and reproduced to pass their genes to the next generations ; and evolved into new distinct species of dark (melanic) peppered moths to date ; while the pre-existed light type of the peppered moths were less adapted ; they were conspicuous (easily spotted) against the blackened environment ; they were frequently eaten by the predatory birds ; and after many generations they were selected against/completely wiped out of all the major industrial areas of England to date ;

@ 1 mark , maximum = 12 marks

TOTAL = 20 MARKS

6 (a) Describe how change in DNA structure leads to production of malfunctional enzyme. (08 marks)

Gene mutation occurs ; by deletion/duplication/inversion ; insertion/substitution ; nucleotide base sequences of the deoxyribonucleic acid (DNA) that codes for specific amino acids/proteins are altered ; messenger ribonucleic acid (mRNA) copies the wrong complementary base sequence during transcription ; and mRNA transfers the altered information to the ribosomes in the cytoplasm ; this results into certain errors during translation ; resulting into synthesis of defective polypeptide chains ; with one or more amino acids missing in the polypeptide chains (nonsense translation) / or with normal amino acids substituted with other different ones in the polypeptide/ or other amino acids added in the polypeptide chain (mis-translation) ; such defective polypeptides

carrying such errors lead to synthesis of abnormal proteins ; that get transformed into non-functional enzymes.

@ 1 mark , max = 08 marks.

(b) Explain various factors that increase efficiency of enzyme actions. (12 marks)

Co-factors ; which can be activators ; these are in-organic ions such as chloride ions, calcium ions, iron (ii) ions ;

Co-factors can be prosthetic groups ; which are non-protein molecules ; such as haem groups/copper ;

Activators and prosthetic groups bind onto enzymes to cause change in shape of the enzymes and that of their active sites ; so that many active sites become available for the substrates to fit into ; resulting into many enzyme-substrate complexes and products formed ;

Co-enzymes ; are non-protein organic compounds such as NAD, NADP, cytochromes ; which transfers certain chemical groups or atoms between enzymes ;

Optimum pH and optimum temperatures ; maintain the three dimensional shape of the enzymes and that of the active sites ; many enzyme-substrate complexes and products formed.

High concentrations of the substrate molecules ; increase the chances of many substrates to bind onto the active sites of the enzymes ; to form many enzyme-substrate complexes and products.

@ 1 mark , maximum = 12 marks.

TOTAL = 20 MARKS.

END.