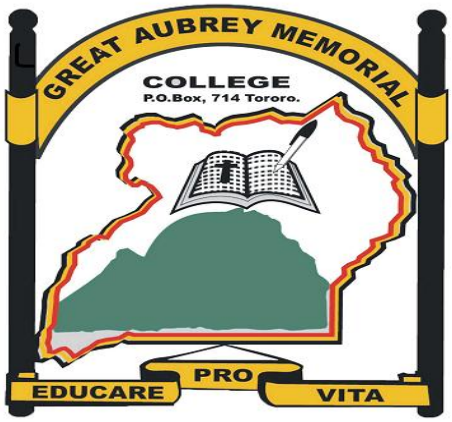
P530/2 **MR. GUIDE**
BIOLOGY
(Theory)
Paper 2
$2\frac{1}{2}$ *hours*



Uganda Advanced Certificate of Education
Pre-Promotional exam term III

BIOLOGY

(THEORY)

Paper 2

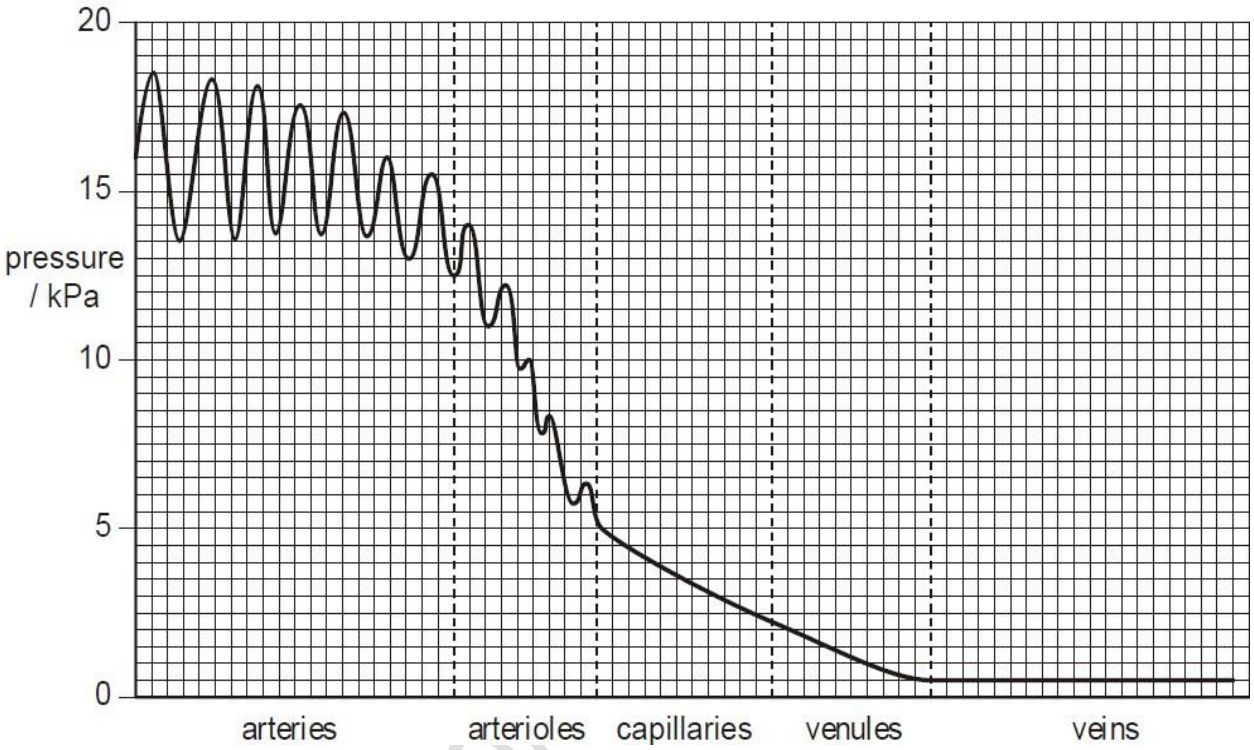
2 hours 30 minutes

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*
- *Answers to each question should start from a fresh page*

SECTION 'A' (40marks)

1. The graph below shows the pressure of blood as it flows through arteries, capillaries and veins



a) Describe through the vessels the changes in pressure of the blood as it flows

(04marks)

As blood flows along the arteries, blood pressure is high; but falls gradually; As blood flows along the arterioles, blood pressure falls very rapidly; As blood flows from arterioles to capillaries, blood pressure falls rapidly; As blood flows along the capillaries to venules, blood pressure falls gradually; As blood flows along the veins, blood pressure is low and constant; Along arteries and arterioles; blood pressure fluctuates (continues to rise and fall);

b) Explain what causes the rise and fall in pressure across arteries. (03marks)

The heart / ventricle / cardiac muscles are involved; peaks coincide with systole / contraction; troughs coincide with diastole / relaxation. (Stretch-recoil effect of heart muscles)

c) What causes the drop in blood pressure as it flows from arteries to veins?

(04marks)

With increasing distance from heart; blood pressure falls due to a drop in blood volume; increasing friction / resistance to blood flow; less / no stretch-recoil effect; increasing volume/surface area of arterioles / capillaries; large capillary bed; branching nature of large blood vessels into many smaller vessels

d) Explain why it is important that the pressure is lower by the time blood reaches the capillaries? (05marks)

To stop damage to capillaries/ stop their bursting as they can't withstand high pressure; they lack of much elasticity due to the fact they are thin / delicate/ one cell thick; lack collagen and muscle; - Slow flow rate allows time for exchange materials e.g. amino acids .

Also prevent oedema risk since high pressure might force out more tissue fluid;

e) Venous pressure seems too low. How is blood able to flow along the venous system? (05marks)

Valves prevent backflow; Action of skeletal muscle propels blood in veins by constricting them; large lumen of vein provides little resistance; negative pressure in chest / thorax / heart; gravity effect from areas above heart;

f) The table below shows the blood flow to various organs while a person is at rest and during strenuous exercise.

Organ	Blood flow at rest /cm^3 min^{-1}	Blood flow during strenuous exercise /cm^3 min^{-1}
Skeletal muscle	1200	12 500
Skin	500	1900
Kidneys	1100	600
Intestine	1400	600
Other	1600	1900
Total	5800	17 500

i) With reference to the functioning of arteries, explain how blood flow to organs such as the kidneys is decreased during strenuous exercise.

(04marks)

Because the body needs to get more blood to the muscles, it diverts blood flow from non-exercising tissues like kidneys, intestines. Muscles need more blood to account

for the new oxygen demand. The sympathetic nervous system causes vasoconstriction of the organs not needed and then sends more blood to the muscles.

ii) Suggest explanations for the pattern of changes in the blood flow to the organs during strenuous exercise. (08marks)

Blood flow to the skeletal muscles increases during exercise to supply more nutrients like oxygen and glucose to the muscle cells to provide energy for contractions, and also elimination of wastes like carbon dioxide,

Blood flow to the skin increases to eliminate the excess heat and wastes accumulated due to exercise, so there is vasoconstriction of the blood vessels

Blood flow to the kidneys and intestines decreases in order to supply more blood to the muscles, as these organs do not have immediate needs for energy, less urine output is needed during exercise, and there is need to increase blood pressure to pump more blood to skeletal muscles.

Generally, the total amount of blood increases during exercise in order to supply more nutrients to the actively respiring cells and drain wastes for if they accumulate can damage the cells.

(iii) The skeletal muscle respires much more rapidly during strenuous exercise. Explain how this results in oxyhaemoglobin unloading more oxygen to the tissue. (04$^{1}/_{2}$marks)

more heat in exercising muscle / increase in body temperature; as respiration releases some energy as heat; ATP to ADP releases some energy as heat; muscle temperature rises, above normal body temperature; so more oxygen release (from haemoglobin / RBCs);

(g) What is the significance of red blood cells being impermeable to cations?

(02$^{1}/_{2}$marks)

Protons/H+ ions accumulate; increasing acidity following dissociation of carbonic acid; leading to Bohr effect. Oxyhaemoglobin releases more oxygen/ has lower affinity for oxygen / has lower saturation of oxygen; at a certain partial pressure of oxygen; Protons buffered by haemoglobin forming haemoglobinic acid;

SECTION 'B' (60marks)

Answer any three questions

2a) what is meant by zwitter ion? (02marks)

This is a molecule with two or more functional groups; of which at least one has a positive; and one has a negative electrical charge; and the net charge of the entire molecule is zero; e.g. an amino acid;

½ mark @

b) How do inhibitors change the rate of enzyme controlled reactions?

(06marks)

Inhibitors reduce the rate of enzyme-controlled reactions;

They do so via two mechanisms: competitive inhibition and non-competitive inhibition;

Competitive inhibition.

Substances or inhibitors which are structurally similar to the substrate compete with the substrate for the active site on the enzyme; This results in fewer substrate molecules binding to the enzyme per unit time; Hence the rate of enzyme substrate-substrate complex formation and therefore the rate of reaction reduces; This type of inhibition is reversible;

Non-competitive inhibition

Substances or inhibitors bearing no structural resemblance to the substrate bind with the enzyme at a point other than the active site; This changes the shape of the active site such that either the substrate cannot bind to the enzymes; or it cannot be released from it; This type of inhibition can be reversible or irreversible;

c) **Describe the molecular structure of the triglyceride**. **(05marks)**

Three fatty acids; combined with (one) glycerol/glyceride; joined by ester bonds; fatty acids have double bonds/unsaturated/kinked; or single bonds/saturated/straight;

d) Explain how the structure of a triglyceride is related to its function.

(07marks)

High ratio of energy storing carbon-hydrogen bonds; supplying many Hydrogen atoms to oxidised NAD; forming large quantities of ATP;

Large and non-polar; insoluble in water; good for storage; does not exert osmotic effect; High ratio of hydrogen to oxygen atoms; forms much water on oxidation; source of water to desert organism;

3a) Explain the meaning of the following

i) Genetic isolation. (02marks)

Genetic isolation occurs when mating can occur but fertilization is not possible; and or even when it occurs, the product is a sterile or inferior offspring; this is due to incompatible genetic constitution between organisms of a population;

ii) Reproductive isolation. (02marks)

Reproductive isolation involves failure of interbreeding among organisms of a population; This may be as a result of lack of attractiveness between males and females or non-correspondence of genitals;

b) Explain how the gene frequency of a population may be altered.

(10marks)

Change in gene frequency of a population occurs when**:**

There is non-random mating/breeding; In such cases, sexual selection occurs; whenever the presence of one or more inherited characteristic increases the likely hood of bringing about successful fertilization of gametes; As a result, the frequency of some genes increases; while that of others reduces in the population;

The population is small and leads to genetic drift; There is usually a chance appearance; or disappearance of genes in a small population; leading to change in the frequency of the genes;

Genotypes are not equally fertile; In this case, the more advantageous (fertile) alleles are transferred to off springs at the expense of other alleles; this leads to change in the frequency of such genes;

Gene flow occurs between populations; Interbreeding between populations always leads to flow of genes within the populations involved; this causes instability in the gene frequency of the gene over generations;

Gene reshuffling occurs; During meiosis, crossing over occurs that results in new gene recombination; At fertilization, these altered alleles are transmitted to off springs and over generations; the allele frequency of a gene changes;

Mutations occur leading to random increment of some gene frequencies from generation to generation;

c) Explain the effect of industrial pollution on the frequency of the melanic allele. (06marks)

Before industrial pollution, the moth possessing the melanic allele were selected against; as they were easily spotted by the predators; in bright background; easily

preyed on; thus reducing the frequency of the melanic form; Increase in industrial pollution, modified the environment, making it dark; and the organisms possessing the melanic allele were selected for; as they could easily camouflage in a dark background; predators could not easily see and feed on them; they rapidly reproduced; increasing the frequency of the melanic allele;

4a) Describe the basic features of the cell surface membrane as postulated by Nicolson and Singer in 1972 (10marks)

Two layers of phospholipid (phospholipid bi-layer); whose lipid tails face inwardly of the membrane; while phosphate heads face outwards;

Phosphate heads are polar; hydrophilic and form hydrogen bonds with water;

Lipid tails are non-polar; hydrophobic; and are attracted to each other by hydrophobic interactions; and Van der Waals forces;

Extrinsic (peripheral) proteins are found at the inner and outer surfaces;

Some intrinsic proteins proteins are partly embedded in any one of the phospholipid layers; while others span across the two phospholipid layers;

Some transmembrane proteins are porous;

Some proteins conjugate with short; branched carbohydrates; to form glycoproteins;

Some phospholipids conjugate with short; branched carbohydrates; to form glycolipids;

In animal cells, cholesterol molecules squeeze between the phospholipid molecules;

½ mark @ 10marks

b) Explain the suitability of the cell surface membrane to its biological functions (10marks)

.	**Feature of the cell surface membrane**	**Suitability to function**	*Reject features that don't match function* *Reject incomplete answers*	**10 marks**
	Channel proteins and carrier proteins;	Selective transport of polar materials and ions across the membrane;		
	Proteins in the membranes;	Act as enzymes for specific reactions		
	Specific primary structure of proteins;	Maintains specificity for receptors of hormones and other signaling molecules;		

	□ Glycoproteins on the membrane;	Cell identity markers hence performing immune roles e.g. antigen presentation;		
	□ Glycolipids;	Act as receptor sites for signaling molecules;		
	□ Cholesterol;	Increases flexibility of the membrane; maintaining its fluidity hence transport of nonpolar molecules;		

5a) Describe the physiological adaptations of the mammalian heart to carry out its functions. (04marks)

It is myogenic; enabling the heart to function independent of the control of the central nervous system;

Generation of electrical excitations; causing the cardiac muscles to contract;

Increased surface area for rapid spread of electrical excitations across the atria and ventricle of the heart; due to myofilament crossing;

Long refractory period of the cardiac muscle; so that they contract and relax for a long period of time without fatigue;

Powerful contractions (systole) of the cardiac muscle within the atria and ventricle enables the heart; to pump blood from one heart chamber to another and to various parts of the body;

Secretion of calcium ions from the intercalated discs for muscular contraction;

b) How is the heart beat controlled in humans? (06marks)

Sino –Atrial Node (SAN); generates electrical impulses; which spreads rapidly from the right atrium towards the left atrium; causing atrial systole; passing over the electrical excitations to the Atrial-Ventricular Node (AVN); which is also stimulated to generate electrical impulses; which are transmitted via the purkinje tissue/ bundle of His downwards; transmitted towards the apex of the ventricles causing ventricular systole starting from the apex/bottom upwards.

c) Describe the nervous control of the rate of the heart beat. (10marks)

In the nervous control, stretching of aorta due to increase in stroke volume or volume of blood passing through the vessels; stimulates the release of impulses from stretch receptors in the aorta and carotids; these are sent to the cardiac inhibitory; in the medulla of the brain; in turn sending impulses via the vagus nerves; to the Sino-Atrial Node(SAN) and Atrio-Ventricular Node(AVN); decreasing the heart rate; while those from stretch receptors in the Vena cava are sent to the cardiac accelerator centre in the medulla of the brain; which in turn sends impulses via sympathetic nerves; to the SAN and AVN; increasing the heart rate;

6a) Describe how the structure of the following tissues are related to their functions.

i)Xylem (04marks)

- Its cells have no end walls and so allows unimpeded flow of water;
- Lignin in the cellulose side walls makes it impermeable to water and solutes; this prevents wastage during transportation;
- Having spiral and annular thickening gives it a high tensile strength and prevents the vessel from collapsing;
- Presence of pits allows passage of water in and out of the lumen;
- Lignin also strengthens the vessel in order to give structural support to the plant;
- Have elongated cylindrical cells for continuous flow of water;
- The torus in bordered pits acts as a plug for controlling passage of water in some plants;

ii)Parenchyma (04marks)

Structure	Function
Unspecialized tissue	Variety of functions;
Many intercellular spaces	Diffusion of gases;
Isodiametric cells	Packing material;
Thin cellulose cell walls	Permit passage of materials;
Transparent cell wall	Permits entry of light for photosynthesis;
Permeable walls	Allow water entry for turgidity ;
Large cells/large vacuoles	Provide storage space;
Chloroplasts present	Allow photosynthesis;
Leucoplasts present	To store starch ;

b) Explain the process involved in the formation of a bone from a cartilage template. (12marks)

step	Events
Bone collar formation;	a primary ossification center appears in the center of bone; This is the source of bone development; Cells secrete osteoid against wall of the diaphysis;
Cavitation;	Chondrocytes enlarge; and signal hyaline cartilage to harden into bone; They begin to die; and leave small cavities leaving small spaces for vessels;
Periosteal bud invasion;	Introduction of a nutrient highway to bone; Periosteal region is invaded by buds containing blood vessels and nerves; Osteoblasts and osteoclasts enter into cavities previously occupied by chondrocytes; They secrete matrix forming spongy bone;
Diaphysis elongation;	Cell division in the primary ossification center powers elongation;
Epiphyseal ossification;	Epiphyses develop own centers of ossification called secondary ossification centers; These undergo the same process as primary ossification centers;

……END…….

IN THE MIDDLE OF EVERY DIFFICULTY, THERE LIES AN OPPORTUNITY