MARK SCHEME- A'LEVEL PAPER 2 (S.6)-2024

N.B – QUESTION ONE IS COMPULSORY TO ALL CANDIDATES.

1. **Fig 1.0.0-Tufted ducks** (Aythya fuligula) are found in Lake Victoria. They eat molluscs, insects and plants, sometimes from the surface but mostly by diving under the water. The graph shows how the heart rate of a tufted duck changes when diving under the water.

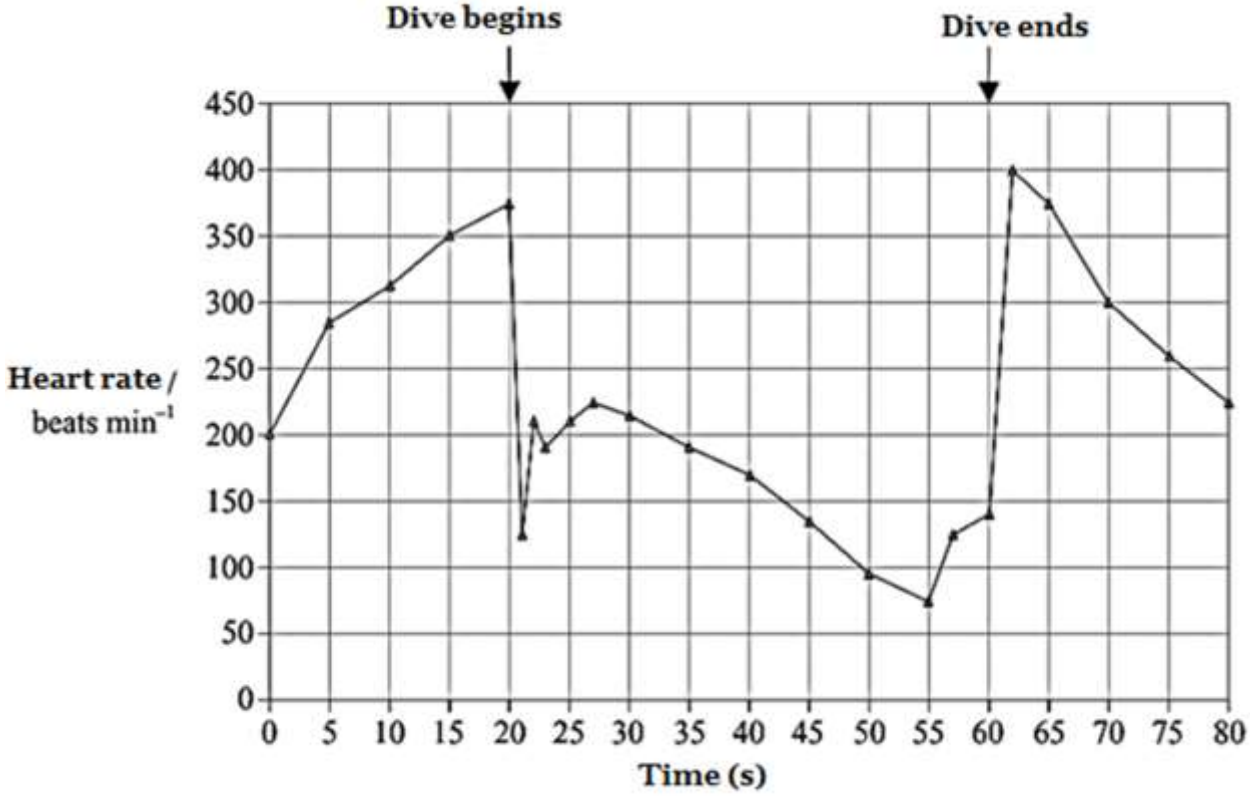

Fig 1.0.0

Transforming Biology pedagogical skills.

Fig 2.0.0- shows the variation of the blood supply to different parts of the tufted duck according to whether it is swimming at normal speed or maximum speed.

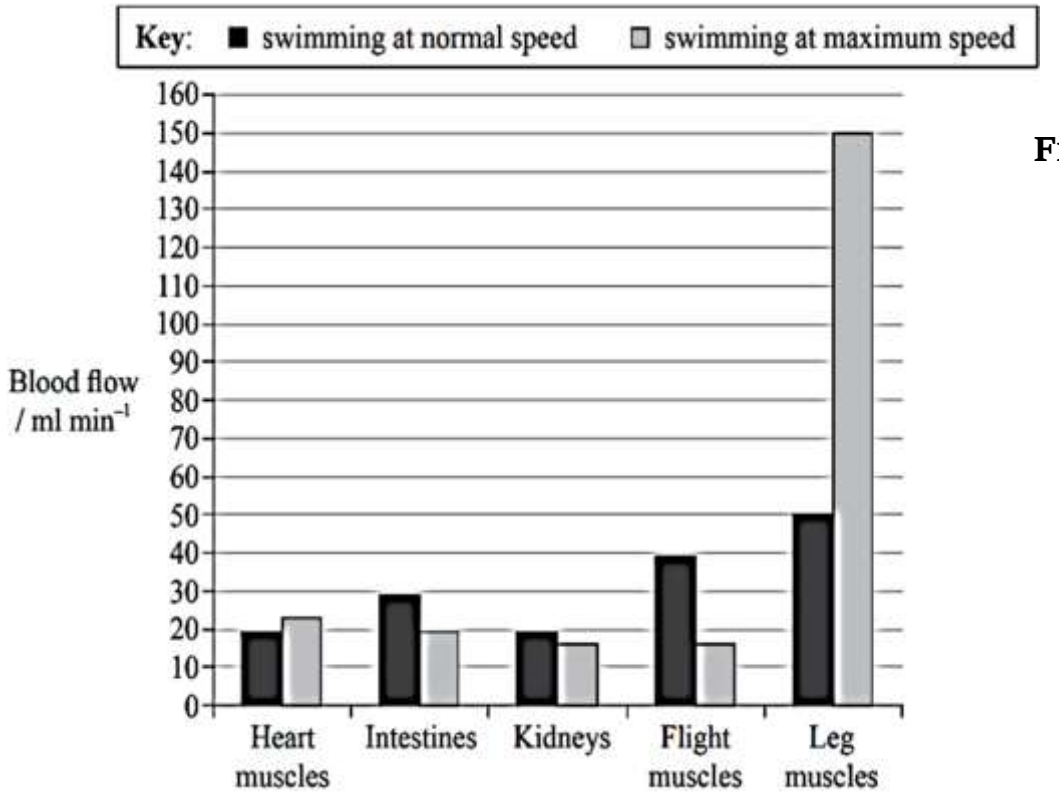

Fig 2.0.0

a) From **Fig 1.0.0.**

(i) Describe the changes in the heart rate during the dive.

(06 marks)

From 20s to 21 s, heart rate decreased rapidly;
From 21s to 23.5 s, heart rate increased rapidly;
From 23.5 s to 24.3 s, heart rate decreased rapidly;
From 24.3 s to 25.5 s, heart rate increased gradually to maximum or peak;
From 25.5 s to 55 s, heart rate decreased gradually to minimum;
From 55s to 56 s, heart rate increased rapidly;
Beyond 56 s, heart rate increased gradually; 06

(ii) Account for the changes in the heart rate during the dive.

(07 marks)

From 20s to 21 s, heart rate decreased rapidly due to activity of Vagus/inhibitory/parasympathetic nerves; nerve terminals secrete acetylcholine which binds to receptors on the SAN/Sino-atrial node; reduces/decreases cardiac output so that oxygen and nutrients are slowly used by (Vital/key) organs that cannot withstand anoxia or hypoxia; to prevent their permanent/irreversible damage; Accept- reduced metabolic rate.

From 21 s to 23.5 s, heart rate increased rapidly because sympathetic/accelerator nerve; nerve terminals secrete noradrenaline/norepinephrine/adrenaline/epinephrine which binds with the receptors on the SAN; blood attains required hydrostatic pressure to reach vital organs that urgently need oxygen and nutrients;

From 23.5 s to 24.3s, heart rate decreased rapidly due to vagus nerve activity

From 24.3 s to 25.5 s, heart rate increased gradually to peak, due to sympathetic nerve activity;

From 25.5 s to 55.5 s, heart rate decreased gradually to minimum because due to activity of Vagus nerve to prevent rapid exhaustion of oxygen and nutrients by the key organs; (heart and brain and part of nervous system)

From 55s to 60 s, heart rate increased because of activity of sympathetic nerves to maintain pressure required for continuous distribution of oxygen and nutrients to the key organs; 07

(iii) Account for the heart rate **before** and **after** the dive.

(05 marks)

Before the dive.

The heart rate increased to generate large/high force to pump blood to large blood vessels and internal tissues that function as reservoirs/storage of oxygenated blood/to increase amount of oxygenated blood in body tissues; to be available to key/vital organs

that cannot endure anoxia/oxygen deprivation; also oxygenated blood sent to their leg muscles/skeletal muscles for respiration to provide enough ATP for initiation of swimming process;

03

After the dive.

Increases rapidly to supply adequate oxygen to muscles to meet the high metabolic demands of breakdown of lactic acid accumulated due to anaerobic respiration;

Decreases rapidly because oxygen supply exceeds demand; after returning to water surface. 02

b) (i) Explain the adaptations of diving animals to longer submersions in water. (07 marks)

Well pointed out and explained adaptation is one mark.

Blood makes up greater proportion of the body mass to carry enough oxygen/increase oxygen carrying capacity; 01

Increased concentration of red blood corpuscles/cells to transport enough/much oxygen to tissues; 01

Higher concentration of haemoglobin in red blood cells to increase bloods affinity for oxygen; 01

During diving the heart beat slows down automatically/bradycardia to conserve oxygen; 01

Blood pressure maintained by constriction of the arteries through contraction of smooth muscles; 01

Blood is distributed to vital organs during dive by constriction of the veins that drain less important organs such as kidneys; 01

Higher concentration of myoglobin in muscles to store oxygen;

Higher concentration of lactic acid in muscles can be tolerated due to reduced sensitivity to P^H; 01

Larger blood vessels function as reservoirs for oxygenated blood; to avoid anoxia/hypoxia; 01

Larger tidal volume to rapidly breathe in large volumes of air to break down lactic immediately after the dive; 01

Lungs collapse to increase surface area for exchange of gases;

Cartilaginous rings in the bronchioles to prevent their collapse due to pressure experienced during the dive; 01

Expulsion of air out of the lungs to prevent much nitrogen from dissolving into blood/nitrogen narcosis; 01
Closure of nostrils to prevent entry of water into lungs; 01

07

c) Suggest explanations for the following observations.

(i) With reasons, the type of respiration used by the tufted duck during the dive. (02 marks)

Both aerobic (at the beginning) and anaerobic (at the end);
Aerobic because tufted duck uses stored oxygen in Myoglobin and Haemoglobin;
Anaerobic because tufted duck cannot ventilate/breathe under water;
To award [1] mark the reason must be given. 02

(ii) With reasons, the colour of the **Leg** muscles. (03 marks)

Leg muscles are red in colour; due to higher concentration of Myoglobin; that constantly supplies oxygen to the contracting muscles; 03
Accept- Higher density of mitochondria; which contain pigments, Cytochromes; involved in harnessing energy from protons;

d) From **Fig 2.0.0.**

(i) Compare the blood flow to the heart muscles with the blood flow to the flight muscles when changing from swimming at normal speed to swimming at maximum speed. (02 marks)

Heart muscle	Flight muscle
Swimming at maximum speed causes increase in blood flow to heart muscles;	Swimming at maximum speed causes decrease in blood flow to flight muscles; 01
Swimming at normal speed, less blood flows to the heart muscle; or swimming at maximum speed, more blood flow to heart muscle;	Swimming at normal speed, greater blood flow to flight muscles; or swimming at maximum speed, less blood flow to flight muscles; 01
Small change in blood flow to heart muscles when changing speed;	Big change/almost half amount of blood flow to flight muscles when changing speed; 01
02	

(ii) Calculate the percentage increase in blood flow to the leg muscles when the tufted duck changes from swimming at normal speed to swimming at maximum speed. (02 marks)

Change = 150-50

= 100. $= \frac{100}{50} \; x \; 100\%$; **=200 (%)**; 02

(iii) Explain the changes in blood flow that occur when swimming at maximum speed. (05 marks)

Blood flow to the heart increases; to supply enough oxygen and nutrients to avoid irreversible damage to the heart due to anoxia; or more blood to pump faster; 02

Blood flow to the intestine, kidneys and Flight muscles decreases; due to diversion of blood to only vital organs; 02

Blood flow to leg muscles increases because leg muscles need more ATP for fast swimming; need more blood to provide adequate oxygen and glucose for energy; Leg need more blood to remove Co2; 01

(iv) Predict, with reference to both graphs, what would happen to the blood flow to the heart muscles when the tufted duck is diving. (02 marks)

Blood flow decreases as heart rate is seen to decrease in the first graph; as lower heart rate means less requirement for 02 and nutrients; 02

SECTION B (60 MARKS)

CHOOSE THREE QUESTIONS FROM THIS SECTION.

2a)(i) Explain the significance of the distribution of **tissues** in the respiratory system of human beings. (15 marks)

Cartilage; rigid to prevent collapse of trachea/bronchus/bronchioles; when air pressure fall inside them during inspiration/breathing in; Flexible allows trachea/bronchus/bronchioles to stretch and extend due to neck movements; 03

Smooth muscle tissue; change internal diameter to regulate air flow into trachea/bronchus/bronchioles and finally to alveoli; 02

Connective tissues; ie elastic fibres; are flexible and recoil regulating flow of air through the trachea/bronchus/bronchioles; allows

distention of lungs during inspiration and return to normal size after exhalation; and Collagen; which give strength and flexibility; 06
Ciliated epithelium tissue; with goblet cells; epithelium lines bronchioles/bronchus/trachea with cilia; which move in synchronized manner to transport dirt laden mucus produced by goblet cells; 04

(ii)Suggest why smokers get **more infections** of the respiratory system than non-smokers? (05 marks)

Tobacco contains tar which is deposited on the airways and alveoli; causing inflammation due to irritation of mucous membrane; producing much mucus; tar thickens the epithelium and paralyses the cilia on the surface; consequently cilia cannot remove the mucus laden with dust and microorganisms which accumulate in the lungs leading to infection and damage; 05

3a)(i) Explain the **genetic basis** of continuous and discontinuous variation. (05 marks)

Continuous variation.

Controlled by combined effect of several genes; (polygenes) random assortment/independent assortment; ensures individual possess range of alleles from any polygenic complex; 03

Discontinuous variation.

Controlled by single gene; with two or more alleles; 02

(ii) Describe the different mechanisms that cause **variations** in populations. (07 marks)

Priority given to mutation, crossing over, fertilization and independent assortment.

Crossing over; blocks of genes are swapped between pairs of chromosomes at chiasmata; bringing some genes together and separating others/creating new genetic combinations; 03

Independent assortment; homologous chromosomes randomly arrange on the equator; combination of chromosomes which goes into daughter cells is random/independent segregation hence several combinations result in the gametes; 03

Fertilization; joins gametes from two separate individuals to form genetically unique zygote; 02
Mutation; introduces new alleles different from already existing ones; 02
Environmental factors; such as light/diet/temperature/disease
Out breeding; by crossing genetically distinct organism; 02
Balanced polymorphism; due to presence of two or more phenotypically distinct forms of trait; 02

b) Explain how **adaptive radiation** results into **genetic diversity** in populations. (08 marks)

Adaptive radiation occurs when individuals colonise a new area; with many geographic and ecological conditions available/vacant ecological niches/niches not fully exploited; entered niches have different environmental conditions; selection pressures differ; homologous structures are differentiated/modified to fill variety of ecological niches; geographical barriers prevent interbreeding which leads to divergence of gene pools; Mutations and genetic drift further cause gene pools to diverge; multitude of species form. 08

4a) Describe evidences that show **photosynthesis** has both the light and dark stage. (10 marks)

Evidence from temperature co-efficient; photochemical or light reaction temperature co-efficient (Q_{10}=1.0) or is unity; for dark reaction doubles or triples; (Q_{10}=2/3) because dark reactions are affected by temperature or temperature sensitive while photo-chemical reactions are not; 04
Intermittent or discontinuous light supply or alternate light and dark periods; intermittent light yields more photosynthetic products than continuous light supply of light of the same intensity; in continuous light, products of light stage accumulate and inhibit the dark stage; periods of darkness allows the Calvin cycle to slowly use up the products of the light stage and so speed up the overall process; 03
Evidence from Co2 reduction in dark stage; using tracer technique after supplying heavy carbon or radioactive carbon in carbondioxide (^{14}c02) to plant; leaves placed in light showed reduction of Co2 to

carbohydrates while leaves placed in dark did not reduce Co2 to carbohydrates; 03

b) Explain the different **Holozoic** feeding strategies in animals.

(10 marks)

Advice to the examiner- student should mention examples from all the three categories (i) Microphagous feeder/small particles (ii) Macrophagous feeders/large particles (iii) Fluid feeders. Mark the mechanism of feeding with example(s) of organisms mentioned. Halves are awarded.

Food type	Mechanism	Description
Microphagous 04 well explained	Pseudopodial Eg amoeba;	Pseudopodia encloses food vacuole in which digestion occurs;
	Flagellate Eg euglena;	Beating flagellum directs food particle to region of ingestion of food;
	Cilliary Eg paramecium;	Cilia creates currents carrying food particles to region of food ingestion;
	Tentacular Eg sea cucumber;	Mucus on tentacles trap food;
	Setous/setae/setose Eg Daphnia;	Chitinous setae on appendages trap food particles;
	Mucoid Eg molluscs;	Mucus forms veil to trap food and later swallowed;
	Others eg basking shark, flamingo and whales;	Filter out food from water eg basking shark use gills; flamingo use beak; and whales keratinous plates;
Macrophagous 04 well explained	Swallowing inactive food Eg lumbricus and arenicola;	Non selective swallowing of mud, silt and sand;
	Scraping and boring Eg helix, teredo;	Molluscs use radula, insects mandibles;
	Seizing and swallowing Eg cnidarian, nereis, dog fish;	No chemical or mechanical digestion before swallowing;
	Seizing and masticate before swallowing Eg squid, crabs;	Specialized organ reducing size of food particles before swallowing;
	Seize and digest externally before	Enzymatic digestive juices over to make

	swallowing; **Eg star fish, spiders;**	**food particles small for swallowing;**
Fluid or soft tissues. **02 well explained**	**Piercing and sucking** **Eg leeches, hook worms;**	**Mouth parts modified for piercing and sucking;**
	Sucking only **Eg nematodes, lepidoptera;**	**live on plant secretion like nectar or as endo-parasites surrounded by food;**
	Absorption through general body surface **Eg monocystis, cestoda;**	**Only animals permanently bathed in fluid nutrient medium with no real feeding mechanism;**
	Max 10	

5a) what is meant by **ecological succession**? (03 marks)

Change in structure; and species composition of a community over time; Succession occurs until a climax community is reached/community reaches equilibrium with its environment;

b) Explain why

(i) **Efficiency** in the transfer of energy between primary producers to primary consumers and from herbivores to carnivores vary.

(10 marks)

Efficiency of energy transfer from primary producers to primary consumers is low; because plants contain high proportion of cellulose and lignin; which are relatively indigestible/no animal enzymes to digest lignin and cellulose; much of plant materials are not consumed by herbivores; eg roots being inaccessible; high respiration rate and photorespiration; 06

Efficiency of energy transfer from herbivores to carnivores is high; because animal tissues are more digestible than plant tissues; animal tissues have high calorific value; carnivores are more specialized for prey consumption; 04

(ii) Nitrification and denitrification occur in different soil aeration conditions. (07 marks)

Nitrification – occurs in well aerated/oxygenated soils; ammonia is converted to nitrates through oxidation reactions;

Carried out by chemosynthetic/chemo-autotrophic bacteria; which obtain respiratory energy used to make organic compounds; 04
Denitrification- occurs in water logged soils/low soil oxygen/aeration; anaerobic bacteria use nitrates as an oxidizing agent/electron acceptor and nitrates are reduced to gaseous nitrogen and oxygen; Oxygen formed is used in respiration of carbohydrates; 03

6a) Describe the **structural** adaptations of the following Bio-molecules to their role.

(i) Starch. (05 marks)

Spiral/helical to coil into more compact shape for storage in small space; 01
Long and large chains making it insoluble hence no osmotic effects within; hence cannot diffuse out of cells; 01
Amylopectin is highly branched/brush-like structure with many terminal ends where hydrolysis by amylase can start/begin; 01
Chemical/glycosidic bonds easily broken to release alpha glucose molecules respired to release ATP; 01 has hydrogen atoms oxidized during oxidative phosphorylation to form ATP; 01

(ii) Cellulose. (05 marks)

Hydrogen bonds/crosslinking which binds microfibrils into fibres with great tensile strength and rigidity; 01
Microfibrils are arranged in layers giving cell wall support and strength; 01
Cellulose cell wall has spaces making it fully permeable to water and solutes; 01
Beta glycosidic bonds broken by cellulase and the beta glucose respired to release energy; 01
Lignin and xylan deposited giving it more tensile strength; 01

b)(i) Describe the functioning of **Biological pumps** in transport of polar molecules across the cell membrane. (05 marks)

Biological pump/carrier proteins span the whole width of the cell membrane/trans-membrane /intrinsic/integral proteins;
Particles (molecules or ions) to be transported binds/combines with receptor sites/binding sites on the pump; binding stimulates

phosphorylation of the carrier protein; Conformational change/protein changes shape and carries particle to inside of cell membrane;
Dephosphorylation/release of phosphate from protein causes protein to revert to the original shape ready for the process to repeat; 05
Accept discussions of

- **(i) Symport/co-transporter proteins, counter transport/anti-porters and uniporter carrier proteins functioning.**
- **(ii) Primary and secondary active transports.**
- **(iii) Accept if learner specifies eg sodium potassium ATPase pump.**
- **(iv) Accept annotated drawing.**

(ii) Explain the significance of the **phospholipid bi-layer** in the cell membrane. (05 marks)
Lipid bilayers form a barrier/hydrophobic core to entry of polar, charged and large molecules; resulting into selectivity of the cell membrane;
Provide membrane with potential to bud into vesicles; fusion of membranes during exocytosis; imparts fluidity giving cell membrane flexibility; insulation in nerves by myelin sheath;

END

Contributions made by Mugwe Martin

CC- comprehensive Biology transformation Initiative.

Transforming Biology Pedagogy.