THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

133/2 **BIOLOGY 2**

(For Both School and Private Candidates)

Time : 2:30 Hours **ANSWERS** **Year : 2006**

Instructions

1. This paper consists of section A, B and C.
2. Answer **five (5)** questions including at least one question from each section.
3. Communication devices and any unauthorised materials are **not** allowed in the examination room.
4. Write your **Examination Number** on every page of your answer booklet(s).

1. (a) (i) Identify figure 1 and describe its role in an eukaryotic cell.

Figure 1 is a mitochondrion.

Its role is to act as the powerhouse of the cell by carrying out aerobic respiration to produce ATP, which supplies energy for cellular processes such as active transport, muscle contraction, and biosynthesis.

(ii) Identify eight (8) of the structures labelled a, b, c, d, e, f, g, h, i, j, k and l.

a – Cristae

b – Ribosome

c – Outer membrane

d – Inner membrane

e – Cristae fold

f – Matrix

g – DNA loop

h – Granules

i – Golgi apparatus (in figure 2)

j – Vesicle

k – Transport vesicle

l – Lysosome

(iii) State the roles of structures b and h.

b (Ribosome): Site of protein synthesis in the mitochondrion.

h (Granules): Store calcium and magnesium ions and help in regulating the ionic balance within the mitochondrion.

(b) (i) Explain what is taking place in figure 2.

Figure 2 shows the process of protein synthesis and packaging. Ribosomes produce proteins, which are transported through the rough endoplasmic reticulum, modified and packaged by the Golgi apparatus into vesicles, and secreted out of the cell.

(ii) What role will structure f play when the cell dies?

Structure f (matrix containing DNA and enzymes) will release enzymes that contribute to autolysis, breaking down the cell contents during programmed cell death (apoptosis).

2. (a) Describe the characteristic features of viruses.

Viruses are acellular and lack cellular organelles.

They consist of nucleic acid (DNA or RNA) enclosed in a protein coat (capsid).

Some viruses have an additional lipid envelope derived from the host membrane.

They are obligate intracellular parasites, meaning they can only replicate inside host cells.

They are very small, usually ranging from 20–300 nm.

They show host specificity, infecting only particular cells.

(b) With the aid of well labelled diagrams show the life cycle of a bacteriophage.

Two main cycles are described:

Lytic cycle:

- Virus attaches to bacterial cell wall (attachment).
- Injects its DNA into the host (penetration).
- Viral DNA directs host machinery to synthesize viral proteins and replicate DNA (replication).
- Viral components assemble into new phages (assembly).
- Host cell bursts releasing new viruses (lysis).

Lysogenic cycle:

- Viral DNA integrates into host DNA forming a prophage.
- Prophage DNA replicates with host DNA during cell division.
- Under stress, prophage may become active and enter the lytic cycle.

3. Specialized regions of the body that detect stimuli are called receptors. Identify the main types of receptors and state their location and roles in the mammalian body.

Photoreceptors: Located in the retina of the eye. They detect light stimuli and enable vision.

Thermoreceptors: Found in the skin and hypothalamus. They detect changes in temperature and help maintain homeostasis.

Chemoreceptors: Located in the tongue (taste buds) and nose (olfactory epithelium). They detect chemical stimuli such as taste and smell.

Mechanoreceptors: Found in the skin, ears (cochlea), and muscles. They detect pressure, touch, vibration, and sound waves.

Nociceptors: Present in the skin and organs. They detect pain due to harmful stimuli and trigger protective reflexes.

4. With the use of diagrams discuss the relationship between structure and function of the epithelial tissue involved in digestion.

Simple columnar epithelium lines the stomach and intestines, with tall cells that increase surface area for absorption and secretion.

Goblet cells within the epithelium secrete mucus, lubricating and protecting the lining.

Microvilli on the intestinal epithelium greatly increase surface area for nutrient absorption.

Ciliated epithelium in some parts (like fallopian tube) help in moving substances, though in digestion it is less significant.

Stratified epithelium in the oesophagus protects against mechanical abrasion.

Diagram should show: intestinal villi lined with columnar epithelial cells, goblet cells, and microvilli.

5. What are the common disorders of the urinary system in humans? Discuss their cause, effects, and preventive measures.

Urinary tract infections (UTIs): Caused by bacterial infection. Effects include pain during urination and frequent urination. Prevented by proper hygiene and adequate water intake.

Kidney stones: Caused by accumulation of salts like calcium oxalate. Effects include severe pain, blood in urine. Prevented by drinking enough water and avoiding excess salts.

Kidney failure: Caused by chronic diseases like diabetes or high blood pressure. Leads to accumulation of wastes in blood. Prevented by healthy lifestyle and medical management of conditions.

Glomerulonephritis: Caused by infection or autoimmune reactions. Effects include swelling, high blood pressure. Prevented by early treatment of infections.
Prostate enlargement (in males): Causes obstruction of urine flow. Prevented by regular medical checkups.

6. (a) Describe how respiratory gases (O_2 and CO_2) in the blood are transported from the tissues to the respiratory surface and vice versa.

Oxygen transport: About 98% is carried bound to haemoglobin as oxyhaemoglobin, and 2% is dissolved in plasma.
Carbon dioxide transport: About 70% is transported as bicarbonate ions, 23% bound to haemoglobin as carbaminohaemoglobin, and 7% dissolved in plasma.
At tissues: Oxygen dissociates from haemoglobin due to low partial pressure of oxygen, while CO_2 diffuses into blood.
At lungs: Oxygen diffuses into blood and binds haemoglobin, while CO_2 diffuses from blood into alveoli for exhalation.

(b) Apart from transporting respiratory gases, what are the other transport functions of blood?
Transport of nutrients such as glucose and amino acids from digestive tract to tissues.
Transport of hormones from endocrine glands to target organs.
Transport of metabolic wastes like urea to kidneys.
Transport of heat for thermoregulation.
Transport of immune cells and antibodies for defense.

7. Using a diagram, describe the structure of the cardiac muscle and explain how it is adapted to its role.

Structure:

- Cardiac muscle consists of branched fibers connected end to end by intercalated discs.
- It has centrally located nuclei.
- Fibers are striated with myofibrils for contraction.

- Rich supply of mitochondria for continuous energy.
- Supplied with blood capillaries to provide oxygen and nutrients.

Adaptations:

- Intercalated discs allow synchronization of contraction.
- Rich in mitochondria to meet high energy demand.
- Involuntary contraction ensures continuous pumping of blood without fatigue.
- Striations allow strong and coordinated contractions.
- Branched fibers spread the impulse efficiently across the heart.

8. (a) There are three types of ecological pyramids.

(i) **Identify and name them.**
Pyramid of numbers.
Pyramid of biomass.
Pyramid of energy.

(ii) **Show how they are constructed.**
Pyramid of numbers: Constructed by counting the number of individual organisms at each trophic level.
Pyramid of biomass: Constructed by measuring the total dry mass of organisms at each trophic level.
Pyramid of energy: Constructed by calculating the total energy flow through each trophic level over a period of time.

(b) What are the advantages and disadvantages of each of the pyramids identified in 8(a)?

- **Pyramid of numbers**
  Advantage: Easy to construct since it involves simple counting of organisms.

Disadvantage: Does not take into account the size of organisms, so a single large producer like a tree may make the pyramid look inverted.

- **Pyramid of biomass**
  Advantage: Shows a more accurate picture of the mass of living matter at each trophic level.
  Disadvantage: Requires destructive sampling, and biomass may vary seasonally making it unreliable.

- **Pyramid of energy**
  Advantage: Most accurate as it shows actual energy transfer and cannot be inverted.
  Disadvantage: Difficult to measure because it requires detailed data collection over time.

9. (a) Show why it is not possible to use a homozygous dominant organism in a back cross or test-cross experiment to determine the genotype of organisms showing the dominant phenotype.

A homozygous dominant (AA) organism crossed with a recessive (aa) will produce all heterozygous offspring (Aa) showing the dominant trait.
A heterozygous (Aa) crossed with a recessive (aa) gives a 1:1 ratio of dominant to recessive.
Since homozygous dominant crossed with recessive always gives the same dominant phenotype, it is impossible to distinguish between homozygous dominant and heterozygous using this method.

(b) Name three (3) genetic disorders involving whole chromosomes in humans and explain how they are brought about.

Down syndrome – caused by trisomy of chromosome 21 (extra copy of chromosome 21 due to nondisjunction).
Turner's syndrome – caused by monosomy X (only one X chromosome in females, XO).
Klinefelter's syndrome – caused by trisomy of sex chromosomes in males (XXY instead of XY).