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 : 2005**

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) Draw a large diagram of a typical plant cell as seen under the electron microscope showing the cellular structures concerned with:

(i) **Cellular respiration** – Mitochondrion is the organelle responsible, containing cristae where ATP is produced during aerobic respiration.
(ii) **Protein synthesis** – Ribosomes and rough endoplasmic reticulum (RER) are the sites of protein synthesis. Ribosomes assemble amino acids into polypeptides.
(iii) **Control of cell division** – The nucleus controls division by regulating DNA replication and spindle formation.
(iv) **Photosynthesis** – Chloroplasts contain chlorophyll pigments and thylakoids where light reactions of photosynthesis take place.
(v) **Transportation of substances between two neighbouring cells** – Plasmodesmata provide cytoplasmic bridges allowing movement of substances between plant cells.

(b) Diagrams A and B represent cell organelles.

(i) **Identify organelles A and B.**
A = Mitochondrion
B = Chloroplast

(ii) **Name the structures labelled 1–9.**
1 – Outer membrane of mitochondrion
2 – Inner membrane
3 – Cristae
4 – Matrix
5 – DNA / ribosome in mitochondrion
6 – Grana (stack of thylakoids)
7 – Thylakoid
8 – Stroma
9 – Outer membrane of chloroplast

(iii) **Explain briefly how organelle B is adapted to its function.**
Chloroplast has a large surface area due to thylakoids arranged in grana, which maximizes absorption of light.
It contains chlorophyll pigments which absorb light energy for photosynthesis.

Stroma contains enzymes for the Calvin cycle, where glucose is synthesized.
It contains its own DNA and ribosomes, allowing synthesis of proteins and enzymes needed for photosynthesis.
Double membrane provides compartmentalization, separating photosynthetic processes from the cytoplasm.

2. (a) Observe figure 2 and answer questions.

(i) **Identify the organism in figure 2.**
The organism is *Tapeworm* (Taenia).

(ii) **Name the structures labelled 1, 2, 3, and 4.**
1 – Scolex (head)
2 – Suckers
3 – Hooks
4 – Proglottids

(iii) **How is the organism adapted to its mode of nutrition?**
It has hooks and suckers to attach firmly to the intestinal wall of the host.
Its body surface is covered with tegument that absorbs digested food directly from host intestine.
It lacks a digestive system since it absorbs pre-digested nutrients.
It produces large numbers of eggs to ensure survival and continuation of the species despite harsh conditions.
It has a flattened body to increase surface area for absorption.

(iv) **Outline the general characteristics of the phylum to which this organism belongs.**
The organism belongs to phylum **Platyhelminthes (flatworms)**.
Members have a dorsoventrally flattened body.
They are triploblastic with three germ layers.
They show bilateral symmetry.
They lack a true body cavity (acoelomates).
They have no circulatory system and depend on diffusion for transport.
Many are parasitic, with specialized adaptations for parasitism.

(b) Account for the argument that viruses are classified as living as well as non-living organisms.
Viruses are considered living because they can reproduce inside host cells, possess genetic material (DNA or RNA), and mutate leading to variations.
They are considered non-living because they are inert outside a host, lack cellular structures, and cannot carry out metabolic activities on their own.
Thus, viruses occupy a position between living and non-living entities.

3. (a) Draw and label the mammalian retina.
A correct diagram should include: sclera, choroid, retina, fovea, rods, cones, bipolar cells, ganglion cells, optic nerve. Labels must show arrangement of photoreceptors and nerve fibers.

(b) **Explain briefly the roles played by each of the following phyto-hormones:**

(i) **Cytokinins** – Promote cell division by stimulating cytokinesis. They delay leaf senescence by maintaining chlorophyll. They promote lateral bud growth and help in tissue culture by encouraging shoot formation.

(ii) **Abscisic acid (ABA)** – Induces stomatal closure during water stress, preventing water loss. Promotes dormancy in seeds and buds. Inhibits growth under unfavorable conditions, acting as a stress hormone.

(iii) **Gibberellins** – Promote stem elongation and leaf expansion. Stimulate seed germination by inducing enzyme synthesis (e.g. amylase). Promote flowering in some plants and break seed and bud dormancy.

4. The human body has an elaborate mechanism to ensure water content remains constant. Discuss the role of the endocrine system in maintaining water balance.
The endocrine system regulates water balance mainly through **antidiuretic hormone (ADH)**, secreted by the posterior pituitary. When water levels fall, osmoreceptors detect increased plasma osmolarity, stimulating release of ADH. ADH increases permeability of kidney collecting ducts, enhancing reabsorption of water.
Aldosterone, secreted by the adrenal cortex, promotes reabsorption of sodium ions in nephrons, leading to osmotic reabsorption of water.
Together, these hormones prevent dehydration, maintain blood pressure, and ensure osmotic balance.

5. (a) Define transpiration.

Transpiration is the process by which plants lose water vapor to the atmosphere through stomata, cuticle, or lenticels.

(b) **Explain the mechanism involved in stomata opening and closing (osmotic pressure difference theory).**

When guard cells absorb potassium ions actively, water enters osmotically, making them turgid and causing the stomatal pore to open. When potassium ions leave, water follows, guard cells lose turgor and collapse, closing the pore.

6. Diagram of Loop of Henle

(a) **Explain why there are large numbers of mitochondria in the cells between points C and D.**

Between C and D (thick ascending limb), active transport of sodium and chloride ions takes place. This requires ATP, hence abundant mitochondria to supply energy.

(b) (i) **Explain how the movement of substances changes the concentration of tubule contents between A and D.**

At A (descending limb), water moves out by osmosis but sodium chloride remains, concentrating the filtrate.

At C and D (ascending limb), sodium and chloride are actively pumped out but water cannot move out, so the filtrate becomes dilute.

(ii) **Describe the role of the collecting duct in producing urine more concentrated than body fluids.**

The collecting duct passes through a medulla with high salt concentration, allowing water to be reabsorbed osmotically under the influence of ADH. This produces hypertonic urine when the body needs to conserve water.

(c) **Small mammals in deserts produce extremely concentrated urine. How is this related to kidney structure and function?**

They have very long loops of Henle, creating a steeper osmotic gradient in the medulla, allowing maximum water reabsorption. Collecting ducts are highly responsive to ADH, further conserving water.

7. (a) Describe how the mammalian placenta carries out each of the following functions:

(i) **Nourishing the foetus** – Provides nutrients (glucose, amino acids, fatty acids, vitamins, minerals) from mother's blood to the foetus via diffusion and active transport.

(ii) **Respiration** – Facilitates exchange of gases, oxygen diffuses from mother's blood to foetus, while carbon dioxide diffuses in opposite direction.

(b) **Define Bohr effect.**
The Bohr effect is the reduction in affinity of hemoglobin for oxygen when carbon dioxide concentration or acidity increases, facilitating oxygen unloading in tissues.

(c) **Carbon monoxide is a fatal poison. Explain.**
Carbon monoxide binds irreversibly to hemoglobin with greater affinity than oxygen, forming carboxyhemoglobin. This reduces oxygen transport, leading to tissue hypoxia and death.

8. (a) What do you understand by:

(i) **Polyploid** – A condition where an organism has more than two complete sets of chromosomes in its cells, e.g. triploid (3n), tetraploid (4n). Common in plants such as wheat and bananas.

(ii) **Sex-linkage** – The inheritance of traits whose genes are located on the sex chromosomes (X or Y), e.g. colour blindness and haemophilia which are X-linked.

(iii) **Point mutation** – A change in a single nucleotide base pair in the DNA sequence. It may be substitution, insertion, or deletion, possibly leading to altered proteins.

(b) Pedigree analysis of pituitary dwarfism (X-linked recessive, allele d):

(i) **Evidence that allele for dwarfism is recessive:**

- Individual 2 is normal but has affected children (4 and 10), which shows she carried the allele in heterozygous state (Dd). This proves recessiveness since carriers appear normal.

- Affected males (4 and 12) inherited the disease from their mothers, not their fathers. This is consistent with an X-linked recessive inheritance, since males express the disease with a single recessive allele.

(ii) **Explain why the genotype of individual 10 must be a carrier.**
Individual 10 is an affected female (dd). For a female to show the disease, she must inherit one recessive allele from each parent. Since she is shaded, she has the genotype **dd**.

(iii) **Explain why the genotype of individual 11 must be normal.**
Individual 11 is a normal male. Males inherit one X from the mother and one Y from the father. If he had inherited the defective allele, he would be affected. Since he is normal, his genotype is **XD Y** (normal).

(c) Genetic counselling question

If individual 10 (dd) marries individual 11 (XD Y):

- Female children will inherit one X from the father (XD) and one from the mother (d). Thus all daughters will be carriers (XDd) but not affected.

- Male children will inherit Y from the father and d from the mother, making them affected (dY).
  Prediction: There is a **50% chance** of having an affected son and a **50% chance** of having a carrier daughter. No normal children will be born.

9. (a) Define an ecological niche.
An ecological niche is the role and position an organism occupies in its environment, including how it obtains food, interacts with other organisms, and adapts to abiotic factors.

(b) **Comment on the flow of energy through an ecosystem and discuss various ways human activities can influence it.**
Energy enters ecosystems through producers via photosynthesis. It flows in a unidirectional manner from producers to consumers and decomposers. At each trophic level, energy is lost as heat, respiration, and waste. This results in less energy being available at higher levels, limiting the number of trophic levels.

Human activities influencing energy flow include:

- **Deforestation** reduces producers, limiting energy capture.

- **Pollution** affects producers and consumers, reducing biomass.

- **Overgrazing and overfishing** reduce populations, disrupting energy transfer.
- **Introduction of invasive species** alters food chains and energy balance.
- **Agriculture and fertilizer use** can increase primary productivity but may lead to eutrophication.
- **Urbanization** reduces natural habitats, lowering overall energy flow in ecosystems.