THE UNINTED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION AND CULTURE

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

133/2 **BIOLOGY 2**

Time: 2:30 Hours **ANSWERS** **Year: 1994**

Instructions:

1. this paper consists of six questions
2. answer five questions
3. Each question carries twenty marks.

1. (a) i. State the components of the Cell Theory.
- All living organisms are composed of one or more cells.
- The cell is the basic unit of structure and function in living organisms.
- All cells arise from pre-existing cells.

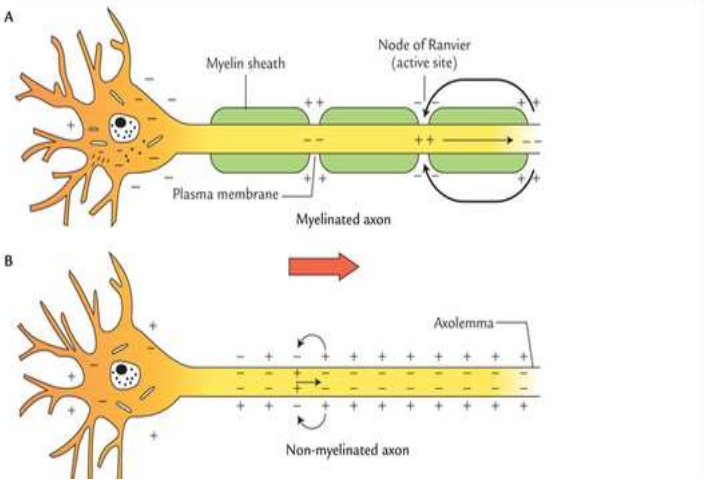
ii. What are the structural differences between prokaryotic and eukaryotic cells?
- Prokaryotic cells lack membrane-bound organelles, while eukaryotic cells have them (e.g., nucleus, mitochondria).
- Prokaryotic cells have a single circular DNA molecule, while eukaryotic cells have multiple linear chromosomes within a nucleus.
- Prokaryotic cells are smaller and simpler, while eukaryotic cells are larger and more complex.

(b) Giving reasons state where in the body of a mammal you would find a large number of lysosomes and mitochondria.
- Lysosomes: Found in abundance in white blood cells, where they digest pathogens.
- Mitochondria: Found in muscle cells, where high energy is required for contraction.

(c) How is the epidermis of a dicot leaf adapted for the functions it performs?
- It has a waxy cuticle to reduce water loss.
- Contains stomata for gas exchange.
- Transparent to allow light to reach the mesophyll for photosynthesis.

(d) i. By means of labelled T.S. diagrams only, show the differences between structures of myelinated and non-myelinated nerve fibres.

The structural differences between myelinated and non-myelinated nerve fibers can be illustrated through transverse (cross-sectional) diagrams.



Myelinated Nerve Fiber:

i. Axon: The central core of the nerve fiber, responsible for transmitting electrical impulses.

ii. Myelin Sheath: A thick, insulating layer surrounding the axon, composed of multiple concentric layers of lipid-rich membrane. This sheath is produced by Schwann cells in the peripheral nervous system and oligodendrocytes in the central nervous system.
iii. Schwann Cell Nucleus (in PNS): Located at the periphery of the myelin sheath, containing the genetic material of the Schwann cell.
iv. Endoneurium: A delicate layer of connective tissue surrounding individual nerve fibers.

Non-Myelinated Nerve Fiber:
i. Axon: Similar to myelinated fibers, it serves as the pathway for electrical impulses.

ii. Schwann Cell Cytoplasm (in PNS): In non-myelinated fibers, multiple axons are embedded within the cytoplasm of a single Schwann cell, without the formation of a myelin sheath.
iii. Endoneurium: As in myelinated fibers, it encases individual nerve fibers.

These diagrams highlight the key structural differences between myelinated and non-myelinated nerve fibers, particularly the presence of a myelin sheath in the former, which facilitates rapid signal conduction.

ii. State the role of the myelin sheath.
The myelin sheath insulates nerve fibers, increasing the speed of nerve impulse transmission.

2. (a) i. Explain why viruses must inevitably lead a parasitic mode of life.
Viruses lack the machinery for independent metabolism and reproduction, so they depend on host cells for replication and survival.

ii. What is the importance of the wet and dry conditions in the life cycle of a moss plant?
- Wet conditions: Enable sperm to swim to the egg for fertilization.
- Dry conditions: Aid in the dispersal of spores to new environments.

(b) Differentiate between a seed and a fruit.
- A seed is the fertilized ovule containing the embryo.
- A fruit is the mature ovary that encloses the seed and aids in its dispersal.

3. (a) i. What is a parasite?
A parasite is an organism that lives on or inside a host organism, deriving nutrients at the host's expense.

ii. List, giving common and scientific names, one parasite of man from each of the following phyla:
- Protozoa: Plasmodium (causes malaria).
- Platyhelminthes: Taenia solium (pork tapeworm).

- Annelida: Hirudo medicinalis (medicinal leech).
- Aschelminthes: Ascaris lumbricoides (roundworm).

(b) At what lowest classification rank are man, elephant, whale, and bat grouped together? What characteristics do they share at this rank?
- Rank: Class (Mammalia).
- Characteristics: Presence of mammary glands, hair or fur, and live birth in most species.

4. (a) i. Distinguish between the following terms as used in connection with enzymes:
- Co-factor: A non-protein chemical compound required for enzyme activity.
- Co-enzyme: An organic co-factor that assists enzyme function.
- Inhibitor: A substance that decreases enzyme activity.
- Activator: A substance that increases enzyme activity.

ii. How do ions of the following elements affect some enzyme-controlled reactions?
- Hydrogen: Affects pH, which influences enzyme activity.
- Calcium: Acts as a co-factor in certain enzymatic reactions.
- Mercury: Inhibits enzyme activity by binding to functional groups of enzymes.

(b) Briefly describe the role of each of the following in protein synthesis:
- Ribosomes: Sites where translation occurs, assembling amino acids into polypeptides.
- DNA: Contains the genetic instructions for protein synthesis.
- mRNA: Carries the genetic code from DNA to ribosomes.
- tRNA: Transfers specific amino acids to the ribosome during translation.

5. (a) i. Explain how living organisms are involved in nitrogen fixation.
Nitrogen-fixing bacteria like Rhizobium convert atmospheric nitrogen into ammonia, which plants can use.
ii. How is the nitrogen made available to other plants?
Decomposition of dead plants and animals releases nitrogen compounds into the soil, which are absorbed by plants.
(b) Transpiration is said to be a "necessary evil." Comment.
Transpiration causes water loss, which can lead to dehydration; however, it is essential for:
- Transporting nutrients and minerals from roots to leaves.
- Maintaining plant structure through turgor pressure.
- Cooling the plant through evaporative cooling.

6. (a) Study the graph below. Give a summary of your interpretation of the graph.
The graph shows the action spectrum of chlorophyll. It highlights the absorption of light at different wavelengths:
i. Chlorophyll absorbs light most effectively in the blue (around 450 nm) and red (around 680 nm) regions of the spectrum, as indicated by the peaks.
ii. It absorbs very little light in the green region (around 550 nm), which corresponds to the dip in the graph. This is why plants appear green, as green light is reflected rather than absorbed.

iii. The high absorption in blue and red light regions contributes significantly to photosynthesis.

(b) Give a brief account of the role of a mammalian liver in protein metabolism.

i. Deamination: The liver removes amino groups from excess amino acids, forming ammonia, which is converted to urea for excretion.
ii. Synthesis of plasma proteins: The liver produces important proteins such as albumin and clotting factors.
iii. Conversion: The liver converts amino acids into glucose (gluconeogenesis) or lipids when energy is required.
iv. Storage: The liver stores amino acids temporarily and regulates their release into the bloodstream.

7. (a) Respiration is an energy-releasing process. Explain why the first stage of glycolysis uses up ATP instead of releasing ATP.

i. The initial stages of glycolysis involve phosphorylation of glucose to glucose-6-phosphate and fructose-1,6-bisphosphate using ATP.
ii. This phosphorylation makes the sugar molecules more reactive and prevents glucose from diffusing out of the cell.
iii. It primes the glucose molecule for subsequent breakdown steps that yield a net gain of ATP.

(b) Explain why endotherms can live in cold polar climates but are not so numerous in hot desert climates where ectotherms thrive.

i. Endotherms maintain a constant body temperature by generating heat through metabolic activities. This allows them to survive in cold polar climates where external temperatures are low.
ii. However, in hot deserts, the high metabolic rate of endotherms leads to excessive heat production, making it challenging to maintain body temperature without losing significant water through sweating or panting.
iii. Ectotherms, on the other hand, rely on external heat sources and conserve water, making them more suited to hot desert climates.

8. (a) How does the failure to secrete insulin and anti-diuretic hormone (ADH) affect the amount and composition of urine secreted in man?

i. Insulin failure:
- Leads to high blood glucose levels (hyperglycemia).
- Excess glucose is filtered into the urine (glycosuria), increasing its volume as water follows glucose osmotically.

ii. ADH failure:
- Causes the kidneys to reabsorb less water, leading to the production of large volumes of dilute urine (diabetes insipidus).

(b) i. True growth is not simply an increase in size. State three different ways in which growth can be expressed.
- Increase in cell number (e.g., cell division in tissues).
- Increase in cell size (e.g., enlargement of muscle cells).
- Increase in body mass or volume (e.g., weight gain in organisms).

ii. How does light availability influence growth in plants?
- Light affects the rate of photosynthesis, which provides energy and nutrients for growth.
- Plants grown in low light may become etiolated, with elongated stems and pale leaves.
- Adequate light intensity promotes chlorophyll synthesis and overall healthy plant development.

9. (a) i. To what sub-class of angiosperms would the flower belong? Give reasons for your answer.
The flower belongs to the subclass Dicotyledonae because it has features such as:
- Floral parts arranged in multiples of four or five.
- Presence of a broad leaf with reticulate venation.

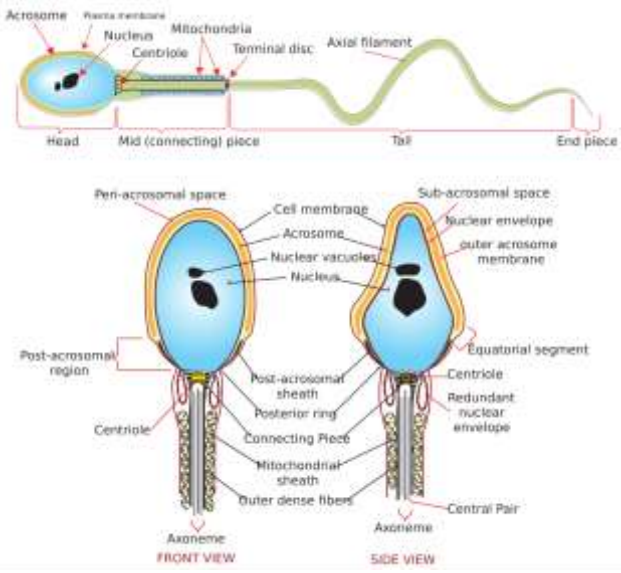
ii. Write the possible floral formula for the flower.
Floral formula: ♂ K(5) C5 A5 G(2)

(b) i. Draw a well-labelled diagram of a human spermatozoan.
A human spermatozoon is a highly specialized cell designed for fertilization. It consists of three main parts:

- Head: Contains the nucleus, which houses the genetic material (DNA). The acrosome, a cap-like structure over the anterior half of the head, contains enzymes crucial for penetrating the outer layers of the ovum.

- Midpiece: Packed with mitochondria that generate the energy required for the sperm's motility.

- Tail (Flagellum): A long, whip-like structure that propels the sperm forward, enabling it to navigate through the female reproductive tract to reach the egg.



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ii. State why testes in man are located external to the body cavity.
Testes are located external to the body cavity in the scrotum to maintain a temperature slightly lower than the body temperature, which is essential for spermatogenesis.

10. (a) i. Briefly explain how a nerve impulse is transmitted along a nerve fibre.
- A nerve impulse is initiated by a stimulus causing depolarization of the neuron membrane.
- Sodium ions rush into the neuron, reversing the charge (action potential).
- This depolarization travels along the axon as a wave.
- The myelin sheath (in myelinated fibers) speeds up the transmission by allowing the impulse to jump between nodes of Ranvier (saltatory conduction).

ii. What is meant by "adaptations of receptors"?
Adaptations of receptors refer to the ability of sensory receptors to decrease their response to a sustained stimulus, enabling the organism to focus on changes in the environment.

(b) i. What are gibberellins?
Gibberellins are plant hormones that promote growth by stimulating stem elongation, seed germination, and flowering.

ii. Differentiate between tactic and nastic responses in plants.
- Tactic responses: Directional movements in response to a stimulus, such as phototaxis in algae.
- Nastic responses: Non-directional movements in response to a stimulus, such as the closing of Mimosa leaves when touched.

11. (a) i. The diagram below shows part of a polynucleotide chain. Name the chemical groups labelled A, B, and C.
- A: Phosphate group
- B: Deoxyribose sugar
- C: Nitrogenous base

ii. If the sequence of bases found in a strand of DNA which serves as a template for the synthesis of mRNA is adenine-guanine-cytosine-thymine, what will be the sequence of bases found in the newly synthesized mRNA?
The sequence will be uracil-cytosine-guanine-adenine.

(b) i. Explain how variation may arise in asexually reproducing organisms.
Variation may arise due to mutations, which are changes in the genetic material during DNA replication or due to environmental factors.

ii. Why are most mutations recessive?
Most mutations are recessive because their effects are masked by the presence of a dominant allele in heterozygous individuals.

12. (a) i. Distinguish between primary and secondary ecological succession.
- Primary succession: Occurs in lifeless areas with no initial soil, such as bare rocks.
- Secondary succession: Occurs in areas where an ecosystem previously existed but was disturbed, leaving the soil intact.

ii. Distinguish between ecosystem and community.
- Ecosystem: Includes all living organisms (biotic factors) and their interactions with non-living components (abiotic factors).
- Community: Refers only to the interacting populations of different species in an area.

(b) i. Organisms in two totally unrelated taxa may resemble each other in certain features.
This resemblance, known as convergent evolution, occurs because unrelated organisms adapt to similar environmental conditions, leading to analogous structures.

ii. Homology is evidence for divergent evolution.
Homologous structures indicate that different organisms evolved from a common ancestor, adapting these structures for various functions.