THE UNINTED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION AND CULTURE

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

133/1 **BIOLOGY 1**

Time: 2:30 Hours **ANSWERS** **Year: 2001**

Instructios:

1. this paper consists of eleven questions
2. answer all questions in section A, and three questions in section B.
3. the marks allocation is indicated at the beginning of each section.

1. (a) List the seven major categories of the taxonomic hierarchy.
(b) Give two merits and three demerits of the natural system of classification.

(a) The seven major categories of the taxonomic hierarchy are:
(i) Kingdom
(ii) Phylum (or Division in plants)
(iii) Class
(iv) Order
(v) Family
(vi) Genus
(vii) Species

(b) Two merits of the natural system of classification:

(i) The natural system of classification groups organisms based on evolutionary relationships, providing a scientific basis that reflects their ancestry and genetic similarities. This ensures accuracy in understanding how organisms evolved and their connections to one another. For instance, humans and primates are classified under the same order (Primates) due to shared evolutionary traits.

(ii) It creates a universal system for naming and categorizing organisms, allowing scientists across the globe to use standardized terminology. This reduces confusion in scientific research, as all species are identified and classified consistently.

Three demerits of the natural system of classification:
(i) It requires extensive research to determine evolutionary relationships, which can be challenging if fossil records or genetic data are unavailable. For instance, some microorganisms are difficult to classify due to a lack of detailed genetic studies.

(ii) It sometimes misclassifies organisms when complete evolutionary information is not available, leading to inaccuracies. For example, certain species may be grouped incorrectly due to convergent evolution, where unrelated organisms develop similar traits.

(iii) The natural classification system is complex, making it difficult for non-specialists to understand or apply. For example, the need for detailed phylogenetic studies may deter educators or students from fully appreciating the system's depth.

2. (a) (i) Name the parts labeled A, B, C, D, E, F, G, H, I, J, K, and L.
A - Plumule
B - Cotyledon
C - Hypocotyl
D - Radicle
E - Seed coat
F - Micropyle

G - Endosperm
H - Embryo
I - Testa
J - Tegmen
K - Pericarp
L - Hilum

(ii) Mention the class of plants to which each seed belongs.
The seed in Figure 1A belongs to the class Dicotyledonae (dicots).
The seed in Figure 1B belongs to the class Monocotyledonae (monocots).

(b) One major difference and one major similarity between the two seeds:
Difference: Dicots (Figure 1A) have two cotyledons, while monocots (Figure 1B) have only one cotyledon. This distinction influences the way these plants germinate and grow.

Similarity: Both types of seeds contain essential structures such as an embryo and a seed coat, which are crucial for protecting and developing the plant.

3. (a) What is probably wrong if a healthy person develops:
(i) ulcers?
Ulcers may develop due to the erosion of the stomach lining caused by excess stomach acid, Helicobacter pylori infection, or prolonged use of certain medications such as aspirin.
(ii) "heartburn"?
Heartburn occurs when stomach acid flows back into the esophagus due to weakened or malfunctioning esophageal sphincter muscles, causing a burning sensation in the chest.

(b) Briefly describe how the conditions in (a) above can be counteracted.
Ulcers can be managed by avoiding foods and medications that irritate the stomach lining, using antacids to neutralize stomach acid, and taking antibiotics if caused by H. pylori.
Heartburn can be counteracted by eating smaller meals, avoiding trigger foods such as spicy or acidic items, and using medications like proton pump inhibitors to reduce acid production.

4. (a) What is glycolysis?
Glycolysis is a metabolic pathway that occurs in the cytoplasm of cells where glucose is broken down into two molecules of pyruvate, producing a small amount of ATP and NADH. It is the first step in cellular respiration and does not require oxygen.

(b) Summarize the essential features of glycolysis which lead to the release of energy from a molecule of glucose.
Glycolysis involves ten enzymatic steps divided into two phases:
(i) Energy investment phase: Two ATP molecules are used to phosphorylate glucose, converting it into a more reactive form.

(ii) Energy payoff phase: The six-carbon molecule is split into two three-carbon molecules (pyruvate), producing four ATP molecules (net gain of two ATP) and two NADH molecules. These products are critical for energy production in cellular respiration.

5. (a) Define the term homeostasis.
Homeostasis refers to the ability of an organism to maintain a stable internal environment despite changes in external conditions. For example, humans regulate body temperature, blood pressure, and glucose levels to ensure proper functioning of cells and organs.

(b) Point out four adaptations of marine bony fish against dehydration.
(i) Drinking seawater: Marine bony fish actively drink seawater to compensate for water loss due to osmosis.
(ii) Specialized kidneys: They produce small amounts of highly concentrated urine to minimize water loss.
(iii) Chloride cells in gills: These cells actively excrete excess salts absorbed from seawater to maintain osmotic balance.
(iv) Impermeable skin: The scales and mucus-covered skin prevent excessive water loss, aiding in water conservation.

6. (a) (i) State the numbers of all individuals who are definitely heterozygous for the gene controlling the defect.

Individuals 3, 4, 5, 8, and 9 are definitely heterozygous because they do not exhibit the albinism phenotype but are carriers of the recessive gene, as inferred from their offspring.

(ii) What is the probability that individual 6 is heterozygous?

Individual 6 has one parent who is heterozygous (individual 5) and another who is homozygous recessive (individual 9). The probability that individual 6 is heterozygous is 50%, as there is a 1:1 chance of inheriting the dominant or recessive allele from the heterozygous parent.

(b) (i) How is the inheritance of albinism similar and yet different from that of hemophilia?
Albinism and hemophilia are both genetic disorders caused by specific gene mutations. However, albinism is an autosomal recessive condition, meaning it is inherited when both parents pass on the defective allele located on autosomal chromosomes. In contrast, hemophilia is a sex-linked recessive condition, meaning it is carried on the X chromosome. This difference impacts the way each disorder is inherited and expressed, with hemophilia primarily affecting males due to their single X chromosome.

(ii) Why are men more likely to be hemophiliacs than women?

Men are more likely to be hemophiliacs because they have only one X chromosome (XY sex chromosomes). If this X chromosome carries the hemophilia allele, the male will exhibit the condition, as there is no corresponding allele on the Y chromosome to mask it. Women, on the other hand, have two X chromosomes

(XX), and the presence of a normal allele on one X chromosome can compensate for the defective one, making them carriers rather than being affected.

7. (a) (i) What do you understand by the terms continuous variations and discontinuous variations?

Continuous variations refer to differences in a trait that occur in a gradual and continuous manner, forming a range of phenotypes. These variations are usually influenced by multiple genes and environmental factors. For example, human height and skin color exhibit continuous variation.

Discontinuous variations, on the other hand, refer to traits that have distinct categories with no intermediates. These traits are often controlled by a single gene or a small number of genes. Examples include blood groups (A, B, AB, O) and the presence or absence of a trait like attached earlobes.

(ii) Give two examples for each.
Examples of continuous variations:

- Human height
- Leaf length in plants

Examples of discontinuous variations:

- Blood groups in humans
- The ability to roll the tongue

(b) State any four areas which provide evidence for evolution.

(i) Fossil records: Fossils provide chronological evidence of how organisms have changed over time, showing transitional forms and extinct species that bridge gaps between modern organisms.

(ii) Comparative anatomy: Similarities in the structure of homologous organs, such as the forelimbs of vertebrates, indicate common ancestry and divergent evolution.

(iii) Embryology: Early stages of embryonic development in different species reveal similar patterns, suggesting that they share a common ancestor.

(iv) Molecular biology: DNA and protein sequence comparisons demonstrate genetic similarities among species, supporting evolutionary relationships and common descent.

8. (a) Briefly explain what is meant by natural resources. Give four examples.

Natural resources are materials or substances that occur naturally within the environment and are used by humans for economic gain or survival. These resources are derived from the Earth and include elements that are renewable or non-renewable. Examples include:
(i) Water
(ii) Minerals

(iii) Forests
(iv) Fossil fuels

(b) Point out three ways which are essential in order to achieve sustainable exploitation of natural resources.

(i) Conservation practices: Sustainable methods, such as reforestation and habitat preservation, ensure the replenishment of renewable resources like forests and wildlife.
(ii) Use of alternative energy sources: Transitioning to renewable energy sources such as solar and wind power reduces the reliance on non-renewable resources like fossil fuels.
(iii) Enforcement of environmental laws: Strict laws regulating resource extraction and pollution help prevent overexploitation and degradation of natural resources.

9. (a) (i) Giving reasons, state whether the cell is prokaryotic or eukaryotic.

The cell is eukaryotic because it contains a well-defined nucleus (labeled N) and membrane-bound organelles such as mitochondria and endoplasmic reticulum.

(ii) Give the names of the structures labeled M, N, O, P, Q, R, S, T, U, and V.
M - Nuclear membrane
N - Nucleus
O - Mitochondrion
P - Golgi apparatus
Q - Ribosomes
R - Endoplasmic reticulum (rough)
S - Vacuole
T - Lysosome
U - Cytoplasm
V - Plasma membrane

(b) State one function of each of the structures N, R, S, and T.

N - Nucleus: Controls cellular activities and stores genetic information (DNA).
R - Endoplasmic reticulum (rough): Synthesizes and transports proteins.
S - Vacuole: Stores nutrients, waste products, and helps maintain turgor pressure in plant cells.
T - Lysosome: Breaks down waste materials and cellular debris through enzymatic digestion.

10. Using acetylcholine as a neurotransmitter, explain how an impulse is transmitted across a synapse.

When a nerve impulse reaches the presynaptic terminal, it triggers the release of acetylcholine stored in synaptic vesicles. The acetylcholine diffuses across the synaptic cleft and binds to specific receptors on the postsynaptic membrane. This binding causes ion channels to open, leading to the depolarization of the postsynaptic neuron, thereby transmitting the impulse. Acetylcholine is then broken down by the enzyme acetylcholinesterase, terminating the signal and ensuring the synapse is ready for the next impulse.

11. (a) Explain the meaning of basal metabolic rate (BMR).

Basal metabolic rate (BMR) refers to the minimum amount of energy required by an organism to maintain vital physiological functions, such as breathing, circulation, and temperature regulation, while at rest. It represents the energy expenditure necessary for sustaining life in a resting state.

(b) Compare alcohol fermentation by yeast cells with lactic acid fermentation in a vertebrate muscle cell during vigorous exercise.

Alcohol fermentation by yeast cells involves the breakdown of glucose to produce ethanol, carbon dioxide, and energy in the form of ATP under anaerobic conditions. Lactic acid fermentation in vertebrate muscles converts glucose to lactic acid and ATP without producing carbon dioxide. Both processes occur in the absence of oxygen and yield less ATP compared to aerobic respiration. However, alcohol fermentation produces ethanol as a byproduct, whereas lactic acid fermentation results in lactic acid accumulation.

12. (a) Differentiate between an open blood system and a closed blood system. Give one example for each.

In an open blood system, blood is not confined to vessels and flows freely in body cavities, directly bathing organs. For example, arthropods such as insects have an open circulatory system.
In a closed blood system, blood is confined to vessels, ensuring efficient circulation to all body tissues. For example, mammals such as humans have a closed circulatory system.

(b) How is the structure of xylem tissue suited to its function of water transport?

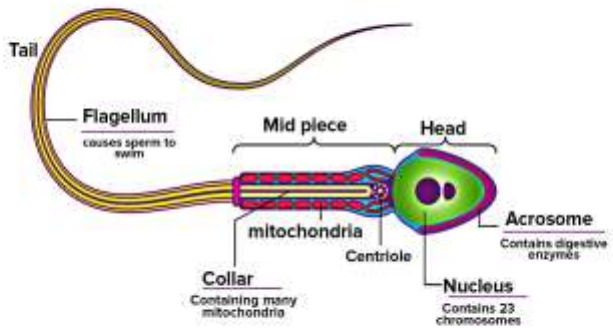
Xylem tissue is composed of long, hollow, and tubular structures such as vessels and tracheids, which allow the unimpeded movement of water. The walls of xylem cells are reinforced with lignin, providing mechanical support and preventing collapse under the tension created by transpiration. Additionally, the presence of pits in the xylem facilitates lateral water movement between adjacent cells.

13. (a) Suggest three possible reasons for the fall in growth rate after point A.

(i) Depletion of nutrients: The yeast colony exhausts the available nutrients in the medium, leading to reduced cell division and growth.
(ii) Accumulation of toxic waste products: As the yeast cells metabolize nutrients, they produce waste products that may become toxic at high concentrations, inhibiting growth.
(iii) Limited space: Overpopulation of cells in the medium leads to competition for space, restricting further growth and cell division.

(b) State two external factors which influence growth in plants and mention one effect of each.
(i) Light: Light intensity influences photosynthesis, which is essential for plant growth. Low light intensity reduces photosynthesis, slowing growth.
(ii) Water: Water availability affects turgor pressure and nutrient transport. A lack of water causes wilting and stunted growth.

14. (a) (i) Draw a large diagram of the human sperm. Label on your diagram the following parts: head, neck, middle piece, main piece, flagellum, spiral mitochondria, acrosome, nucleus, and centrioles.



A human sperm cell is a highly specialized cell designed for fertilization.
It consists of several distinct parts, each with specific functions:

- Head: Contains the nucleus, which houses the genetic material (DNA) to be delivered to the egg.
- Acrosome: A cap-like structure over the anterior part of the head, containing enzymes that help the sperm penetrate the egg's outer layers during fertilization.
- Neck: Connects the head to the middle piece and contains centrioles that play a role in cell division post-fertilization.
- Middle piece: Packed with mitochondria arranged in a spiral pattern, providing the energy required for the sperm's motility.
- Main piece (principal piece): The longest segment of the tail, responsible for the propulsion of the sperm through whip-like movements.
- Flagellum (tail): Comprises the main piece and the end piece, facilitating the locomotion of the sperm towards the egg.
- Spiral mitochondria: Located in the middle piece, these mitochondria are arranged spirally around the axial filament, supplying ATP for tail movement.
- Centrioles: Found in the neck region, centrioles are involved in the development of the flagellum and play a crucial role during the first cell division after fertilization.

(ii) Show how the structure of the human sperm is related to its function.

The human sperm is specialized for reproduction:
- The acrosome contains enzymes to penetrate the egg.
- The nucleus in the head holds genetic material to fertilize the egg.
- The spiral mitochondria in the middle piece provide energy for movement.
- The flagellum enables motility, allowing the sperm to swim toward the egg.

(b) In a certain species of flowering plants, the chromosome number of each cell in the radicle is 16. State the chromosome number in any four of the following:

(i) Pollen tube nucleus: 16 (haploid).
(ii) Antipodal cell: 16 (haploid).
(iii) Endosperm cell: 24 (triploid).
(iv) Pollen mother cell: 32 (diploid).
(v) Integument cell: 32 (diploid).