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: 2006.**

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) What do you understand by a dichotomous identification key?

A dichotomous identification key is a tool used to identify and classify organisms or objects based on a series of choices that lead the user to the correct identification. Each step in the key provides two contrasting statements (choices), guiding the user to the next step until the organism is identified.

(b) From your knowledge of classification, construct a simple numbered dichotomous key which could be used to identify the classes of the phylum chordata Mammalia, Aves, Reptilia, Amphibia, Chondrichthyes, and Osteichthyes. Use the following features: hair, skeleton type, scales, fins, and feathers.

1. (a) Has hair – Mammalia
   (b) Does not have hair – Go to 2

2. (a) Has feathers – Aves
   (b) Does not have feathers – Go to 3

3. (a) Has scales – Go to 4
   (b) Does not have scales – Amphibia

4. (a) Has a cartilaginous skeleton – Chondrichthyes
   (b) Has a bony skeleton – Osteichthyes

2. Refer to the following list of organisms labeled A, B, C, D, and E to answer questions 2(a) and 2(b):
A - Protozoan
B - Bacterium
C - Mould
D - Bryophyte
E - Flowering plant

(a) (i) In which organism(s) would reproduction be entirely asexual?
B - Bacterium

(ii) Which organisms produce spores at some stage in their life history?
C - Mould, D - Bryophyte, E - Flowering plant

(iii) Which organisms possess mitochondria?
A - Protozoan, C - Mould, D - Bryophyte, E - Flowering plant

(iv) Which organism may fix nitrogen?
B - Bacterium

(v) What are the two main structural differences between D and E?
- D (Bryophyte) lacks true vascular tissues, while E (Flowering plant) has vascular tissues.

- D reproduces via spores, while E reproduces via seeds.

(b) What kingdoms are represented by the organisms labeled A to E?
A - Kingdom Protista
B - Kingdom Monera
C - Kingdom Fungi
D - Kingdom Plantae
E - Kingdom Plantae

3. (a) Explain the roles of the following in photosynthesis:
(i) Ribulose bisphosphate
Ribulose bisphosphate (RuBP) is a five-carbon compound that acts as a carbon dioxide acceptor during the Calvin cycle. It combines with CO_2 to form 3-phosphoglycerate, starting the process of carbon fixation.

(ii) NADP
NADP acts as an electron carrier in photosynthesis. It is reduced to NADPH during the light-dependent reactions and provides the necessary electrons and hydrogen for the Calvin cycle to synthesize glucose.

(b) (i) Why are C_4 plants more efficient in photosynthesis than C_3 plants?
C_4 plants are more efficient because they have a specialized mechanism to fix CO_2, minimizing photorespiration and allowing photosynthesis to proceed efficiently even in low CO_2 and high oxygen conditions.

(ii) What would be the effect of raising oxygen concentration on C_3 photosynthesis?
Raising oxygen concentration increases photorespiration in C_3 plants, reducing the efficiency of photosynthesis because oxygen competes with carbon dioxide for the active site of the enzyme RuBisCO.

4. (a) Mention one role played by each of the following in the release of energy during aerobic respiration:

(i) Mitochondria
Mitochondria are the sites of aerobic respiration where the Krebs cycle and oxidative phosphorylation occur, generating ATP.

(ii) Oxygen
Oxygen acts as the final electron acceptor in the electron transport chain, allowing the production of water and ATP.

(iii) Cytochrome
Cytochromes are electron carriers in the electron transport chain that transfer electrons and contribute to the generation of a proton gradient for ATP synthesis.

(iv) Glucose
Glucose provides the initial substrate for glycolysis, breaking down into pyruvate and generating ATP and NADH.

(b) Explain the possible effects of a decrease in environmental temperature on the rate of gas exchange in:
(i) A well-illuminated foliage leaf.
A decrease in temperature reduces the rate of photosynthesis and respiration in the leaf, leading to lower gas exchange as stomatal activity decreases.

(ii) A small mammal.
A decrease in temperature increases metabolic rate in a small mammal as it works to maintain body heat, leading to an increase in oxygen consumption and carbon dioxide production.

5. (a) What are the main differences between negative and positive feedback?
Negative feedback maintains homeostasis by reversing a deviation from a set point (e.g., temperature regulation), while positive feedback amplifies a response until a specific outcome is achieved (e.g., childbirth contractions).

(b) How do organisms:
(i) Gain heat?
Organisms gain heat through metabolic activities, absorption of sunlight, and conduction from warmer surroundings.

(ii) Lose heat?
Organisms lose heat through evaporation (sweating), radiation, convection, and conduction to cooler surroundings.

6. (a) State Mendel's first law of inheritance.
Mendel's first law, the Law of Segregation, states that during gamete formation, the alleles for each gene segregate, so that each gamete carries only one allele for each gene.

(b) Carefully study the pedigree given below (Fig. 1) showing the inheritance of a certain trait:

(i) Determine the genotypes and phenotypes of individuals numbered 1, 2, 3, 4, 5, and 6.
This requires analyzing the pedigree, which I cannot see in detail.

(ii) What type of inheritance is displayed in the pedigree above?
Likely sex-linked or autosomal inheritance, depending on the trait pattern shown.

(iii) Suggest two human traits transmitted in a manner similar to the pedigree above.
Color blindness and hemophilia (if sex-linked); albinism and cystic fibrosis (if autosomal recessive).

(iv) What is the nature of the gene controlling the trait being investigated in the pedigree?

7. (a) Explain briefly the meaning of selective breeding.

Selective breeding is the process by which humans intentionally breed plants or animals with desirable traits to produce offspring that inherit those traits. It involves selecting individuals with specific characteristics to act as parents for the next generation.

(b) The occurrence of homologous and vestigial structures is often used to explain the theory of organic evolution. Explain this statement.

Homologous structures are anatomical features in different organisms that have a similar structure but may serve different functions, suggesting a common ancestry. For example, the forelimbs of humans, bats, and whales are structurally similar but adapted for different purposes such as grasping, flying, and swimming. Vestigial structures are body parts that have lost their original function through evolution but still exist in an organism. Examples include the human appendix and the pelvic bones in whales. These structures provide evidence of evolutionary change and a shared ancestry.

8. (a) Define ecological succession.

Ecological succession is the gradual process by which ecosystems change and develop over time. It involves the sequential replacement of one community of organisms by another, eventually leading to a stable climax community.

(b) State the merits and demerits of using a pyramid of numbers and a pyramid of biomass in ecological studies.

Merits of a pyramid of numbers:
- Simple to construct and interpret.
- Provides a quick estimate of population sizes in an ecosystem.

Demerits of a pyramid of numbers:
- Does not consider the size of organisms, which can distort the representation.
- May not accurately reflect energy flow or biomass.

Merits of a pyramid of biomass:
- Provides a more accurate representation of energy flow in an ecosystem.
- Accounts for the actual mass of organisms at each trophic level.

Demerits of a pyramid of biomass:
- Difficult to measure accurately, especially in aquatic ecosystems.
- Biomass may fluctuate over time, leading to less precise representations.

9. (a) Describe the structure of a typical amino acid.

A typical amino acid consists of a central carbon atom (alpha carbon) bonded to four groups:
- An amino group ($-NH_2$)
- A carboxyl group (-COOH)
- A hydrogen atom (-H)
- A variable side chain (R-group) that determines the properties of the amino acid.

(b) With the help of a relevant illustration, show how two amino acids can be condensed to form a known product.

When two amino acids undergo condensation, the amino group of one reacts with the carboxyl group of the other, forming a peptide bond and releasing a molecule of water. The product is a dipeptide.

10. (a) What are the useful contributions of Jean Baptiste Lamarck in the study of evolution?

Jean Baptiste Lamarck proposed the theory of inheritance of acquired characteristics, suggesting that organisms could pass on traits acquired during their lifetime to their offspring. He emphasized that organisms adapt to their environment through use and disuse of organs, leading to evolutionary changes over time.
(b) What did Weismann conclude after his experiment of breeding mice and cutting their tails over many successive generations?

Weismann concluded that acquired traits (such as cutting tails) are not inherited. His experiments demonstrated that changes in an organism's body during its lifetime do not affect its genetic material and cannot be passed to the next generation.

11. (a) Copy the table below and fill in the missing information:

Phytohormone	Site of synthesis	Three functions
Auxins	Shoot apical meristems	Promotes cell elongation, regulates phototropism and gravitropism, inhibits abscission.
Gibberellins	Shoot apical meristems	Promotes cell elongation, regulates phototropism and gravitropism, inhibits abscission. |
Ethene	Ripening fruits	Promotes fruit ripening, stimulates leaf abscission, induces flowering in some plants.

(b) Compare, in respect to each other, tropisms, taxes, and nastic movements in plants.
- Tropisms are directional growth responses to external stimuli such as light (phototropism) or gravity (gravitropism).
- Taxes are directional movement responses of whole organisms toward or away from stimuli (e.g., phototaxis in algae).
- Nastic movements are non-directional responses to stimuli, such as the closing of Mimosa leaves when touched.

12. The release of energy from a glucose molecule occurs in three stages namely: glycolysis, Krebs cycle, and electron transfer. Give the summary of the essential features of two of these stages.

(i) Glycolysis:
- Occurs in the cytoplasm.
- Breaks down one molecule of glucose into two molecules of pyruvate.
- Produces 2 ATP molecules and 2 NADH molecules.

(ii) Electron transfer:
- Occurs in the inner mitochondrial membrane.
- Electrons from NADH and $FADH_2$ are transferred through the electron transport chain.
- Produces a proton gradient that drives ATP synthesis, resulting in approximately 32-34 ATP molecules.

13. (a) The oxygen dissociation curves of oxyhemoglobin are shown in the sketch graph below (Fig. 2), plotted from data obtained at different levels of carbon dioxide concentration. Curves A, B, and C represent dissociation of oxygen when the partial pressure of carbon dioxide is 15 mm Hg, 42 mm Hg, and 72 mm Hg respectively.

(i) Give a general statement with respect to oxygen loading or unloading to/from hemoglobin in the presence of carbon dioxide.
Oxygen unloading from hemoglobin increases as the partial pressure of carbon dioxide increases. Conversely, oxygen loading onto hemoglobin decreases under high carbon dioxide concentration.

(ii) How is the change observed in the sketch graph achieved?
The change is achieved through the Bohr effect, where an increase in carbon dioxide concentration lowers blood pH, reducing hemoglobin's affinity for oxygen and promoting oxygen release to tissues.

(iii) What is the general term given to the observed phenomenon?
The observed phenomenon is called the Bohr effect.

(iv) What is the advantage of such behavior of oxygen loading with respect to increased partial pressure of carbon dioxide?
This behavior ensures efficient oxygen delivery to tissues with high metabolic activity, where carbon dioxide concentration is high, and oxygen is needed the most.

(b) Explain the fate of glucose in the glomerular filtrate as it is not normally found in urine passed out in man.
Glucose in the glomerular filtrate is reabsorbed in the proximal convoluted tubule of the nephron through active transport. Special carrier proteins transport glucose back into the blood. If the glucose concentration exceeds the renal threshold (e.g., in diabetes mellitus), some glucose will not be reabsorbed and will appear in urine.

(c) Write down four functions of the mammalian blood in relation to transport and defense.

- Transport of oxygen from the lungs to body tissues and carbon dioxide from tissues to the lungs.
- Transport of nutrients such as glucose, amino acids, and vitamins to cells.
- Transport of waste products like urea to excretory organs.
- Defense against infections through white blood cells, antibodies, and clotting mechanisms to prevent blood loss.

14. (a) What do you understand by the term growth?

Growth is the irreversible increase in size, mass, or number of cells in an organism. It involves cell division, enlargement, and differentiation, resulting in physical and functional development.

(b) Carefully examine the growth curves of mice in Fig. 3 below and answer the questions that follow.

(i) Did the mice (both females and males) increase in weight faster at any time during the four-week period?
Yes, both male and female mice increased in weight faster during the first two weeks (0–14 days), as the curves show a steeper gradient during this period compared to the later weeks.

(ii) What is the weight of the female and male mice after 14 days of growth?
From the graph, the weight of male mice after 14 days is approximately 18 grams, while the weight of female mice is approximately 16 grams.

(iii) What is the relationship between the growth rate of mice tails and bodies?
The growth rate of the tails is proportional to the growth rate of the bodies. As the body weight increases, tail length also increases, although at a slower rate compared to body weight.

(iv) What conclusion can you draw from the growth rates of both sexes of mice?
Male mice grow faster in both weight and tail length compared to female mice. This indicates a difference in growth patterns and rates between the sexes, with males generally achieving larger sizes.

15. (a) Distinguish complete metamorphosis from incomplete metamorphosis.

- Complete metamorphosis involves four distinct stages: egg, larva, pupa, and adult. The larva differs completely in form and function from the adult (e.g., butterfly).
- Incomplete metamorphosis involves three stages: egg, nymph, and adult. The nymph resembles the adult but lacks fully developed features like wings (e.g., grasshopper).

(b) Explain hormonal control of metamorphosis (molting) in insects.

Metamorphosis in insects is regulated by hormones, primarily juvenile hormone (JH) and ecdysone:
- Ecdysone, secreted by the prothoracic gland, triggers molting by promoting the shedding of the old exoskeleton and the formation of a new one.
- Juvenile hormone (JH), secreted by the corpora allata, determines the nature of the molt. High levels of JH result in the production of another juvenile stage (larva or nymph), while low levels allow the insect to transition into the next developmental stage (pupa or adult).
- The interaction between these hormones ensures proper timing and progression of metamorphosis.