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: 2004.**

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 taxonomist is likely to face some problems in accomplishing his/her task.

(i) Who is a taxonomist?
A taxonomist is a scientist who classifies organisms based on their similarities and differences, organizing them into hierarchical categories such as kingdom, phylum, class, order, family, genus, and species. Taxonomists use morphological, genetic, and ecological characteristics to group organisms systematically.

(ii) What problems is he/she likely to encounter?

A taxonomist may encounter several problems, including:

i. Morphological variations – Some organisms of the same species exhibit considerable morphological variations due to environmental factors, making classification difficult.
ii. Convergent evolution – Unrelated organisms may develop similar physical traits due to adaptation to similar environments, leading to misclassification.
iii. Incomplete fossil records – The classification of extinct organisms is often challenging due to gaps in fossil records, making it difficult to establish evolutionary relationships.
iv. Genetic diversity – Some species show high genetic variation, making it difficult to define clear boundaries between species and subspecies.
v. Hybridization – Some species interbreed and produce viable hybrids, creating classification challenges because they blur species boundaries.
vi. Limited molecular data – Some species have not been extensively studied at the genetic level, leading to difficulties in classification using molecular phylogeny.

2. Giving two reasons in each case, allocate the following organisms in their appropriate phyla or divisions:

(a) Earthworm
Earthworms belong to the phylum Annelida because:

i. They have a segmented body, with internal and external segmentation known as metamerism.
ii. They have a closed circulatory system, where blood is confined within vessels.

(b) Mushroom
Mushrooms belong to the division Basidiomycota of the kingdom Fungi because:

i. They reproduce by basidiospores, which are produced on a club-shaped structure called a basidium.
ii. They have chitinous cell walls, distinguishing them from plants, which have cellulose cell walls.

(c) Taenia sp
Taenia sp. (tapeworms) belong to the phylum Platyhelminthes because:

i. They have a dorso-ventrally flattened body, which is characteristic of flatworms.

ii. They are parasitic, lacking a digestive system and absorbing nutrients directly from the host.

(d) Trypanosoma sp
Trypanosoma sp. belongs to the phylum Protozoa and the class Kinetoplastida because:

i. They are unicellular, microscopic organisms.
ii. They have flagella, which aid in movement.
3. (a) What is the role of each of the following in photosynthesis?

(i) Water
Water acts as an electron donor in the light-dependent reactions of photosynthesis. During photolysis, water is split into oxygen, protons, and electrons:

The oxygen is released as a byproduct.
The electrons replace those lost by chlorophyll in Photosystem II.
The protons contribute to the formation of ATP and NADPH, which are used in the Calvin cycle.

(ii) NADP

NADP (Nicotinamide Adenine Dinucleotide Phosphate) functions as an electron carrier in photosynthesis:
It accepts electrons and hydrogen ions to form NADPH, which is used in the Calvin cycle for the reduction of carbon dioxide into glucose.
It helps store and transfer chemical energy for use in the dark reactions of photosynthesis.

(iii) Light
Light provides the energy required to drive the light-dependent reactions:
It excites electrons in chlorophyll, allowing them to move through the electron transport chain.
It enables the splitting of water (photolysis), generating oxygen and releasing electrons for ATP and NADPH formation.

(b) Give three differences between C_3 and C_4 plants.

i. Carbon fixation:
C_3 plants use the Calvin cycle directly, fixing CO_2 into a three-carbon compound (3-PGA).
C_4 plants use the Hatch-Slack pathway, first fixing CO_2 into a four-carbon compound (oxaloacetate).

ii. Photorespiration:
C_3 plants have high photorespiration, reducing efficiency under high temperatures.
C_4 plants minimize photorespiration by spatially separating carbon fixation from the Calvin cycle.

iii. Leaf anatomy:

C_3 plants lack Kranz anatomy (bundle sheath cells are not specialized).
C_4 plants have Kranz anatomy, where chloroplasts are concentrated in bundle sheath cells.

4. (a) What are the properties of respiratory surfaces?
Answer:
i. Large surface area – Facilitates maximum gas exchange.
ii. Thin walls – Reduces diffusion distance for gases.
iii. Moist surface – Gases dissolve in water before diffusion.
iv. Rich blood supply – Ensures efficient transport of gases.
v. Permeability – Allows free movement of oxygen and carbon dioxide.

(b) With the help of a simple diagram, describe how gaseous exchange occurs in the mammalian lung.

Gaseous exchange in the mammalian lung occurs at the alveoli. Oxygen diffuses from the alveolar air into the blood, while carbon dioxide diffuses from the blood into the alveoli for exhalation. I will include a diagram to illustrate this.

5. (a) Giving reasons, explain what happens when a petiole of a pawpaw leaf is partially split longitudinally into 4 pieces and immersed in distilled water for about 30 minutes.

The pieces curl outward because of differential osmotic pressure. The outer cells gain water through osmosis, expanding more than the inner cells, leading to outward bending.

6. A girl of normal vision whose father was color-blind marries a man of normal vision whose father was also color-blind. Using genetic symbols, show clearly in terms of probabilities the type of vision expected in their children.

Answer:
Since the girl is heterozygous (X^N X^n), half of her male children (XY) may inherit color blindness, while all her daughters (XX) will have normal vision but may be carriers. I will provide a Punnett square for clarity.

7. (a) What precisely do the terms "primitive" and "advanced" mean in evolution?

Primitive refers to ancestral traits that appear in early evolutionary stages, while advanced describes newly evolved, specialized traits.

(b) Outline the limitations of Darwin's theory of natural selection.

i. Lack of knowledge on genetics.
ii. Does not explain sudden mutations.
iii. Fails to account for neutral traits.
iv. Does not explain inheritance of acquired traits.

8. (a) Define the term "biological control."

Biological control is the use of natural predators, parasites, or pathogens to control pests.

(b) What are the merits and demerits of using biological control over other methods of pest control?

Merits:
i. Environmentally friendly.
ii. No chemical resistance in pests.

Demerits:
i. Slow in action.
ii. May affect non-target species.

9. (a) Account for the fact that megaspores of Drimysperm sp. are large and microspores are small.

Megaspores store nutrients for embryo development, while microspores are small for easy dispersal.

(b) Explain how denaturing an enzyme may affect its efficiency as a catalyst.
Denaturation alters the active site, preventing substrate binding and reducing enzyme activity.

10. (a) Describe the way an impulse is transmitted along an axon.

Answer:
An impulse is transmitted along an axon through a process called action potential propagation, which occurs as follows:

i. Resting potential – The neuron is at rest, with a negative charge inside (-70mV) and a positive charge outside due to the sodium-potassium pump, which actively transports Na^+ out and K^+ in.

ii. Depolarization – When a stimulus exceeds the threshold, voltage-gated sodium channels open, allowing Na^+ to rush into the axon, reversing the polarity (+40mV).

iii. Propagation of action potential – The positive charge spreads along the axon, triggering adjacent sodium channels to open, allowing the impulse to travel in a wave-like manner.

iv. Repolarization – Sodium channels close, and potassium channels open, allowing K^+ to exit, restoring the negative internal charge.

v. Hyperpolarization and return to resting potential – The membrane temporarily becomes more negative before returning to the resting state with the help of the sodium-potassium pump.

(b) Define a refractory period and state its significance.

Answer:
The refractory period is the time after an action potential during which a neuron is unable to fire another impulse.

Significance:
i. Prevents backward conduction of impulses.
ii. Ensures one-way transmission of nerve impulses.
iii. Allows neurons to recover before transmitting another impulse.

11. Discuss the adaptations to oxygen uptake shown by:

(a) Mountain dwellers.

Answer:
Mountain dwellers adapt to low oxygen levels (hypoxia) through:

i. Increased red blood cell count – More hemoglobin for efficient oxygen transport.
ii. Higher lung capacity – Enhances oxygen intake.
iii. Increased myoglobin levels – Stores more oxygen in muscles.
iv. Higher breathing rate – Increases oxygen intake per minute.

(b) Divers.

Answer:
Divers, such as whales and seals, adapt to prolonged underwater oxygen deprivation through:

i. Increased oxygen storage – More myoglobin in muscles and hemoglobin in blood.
ii. Slower heartbeat (bradycardia) – Reduces oxygen consumption.
iii. Peripheral vasoconstriction – Blood flow is restricted to vital organs.
iv. Anaerobic respiration tolerance – Reduces dependency on oxygen.

(c) Mammalian fetus.

Answer:
The mammalian fetus adapts to oxygen uptake within the womb through:

i. Fetal hemoglobin (HbF) – Has a higher affinity for oxygen than adult hemoglobin.
ii. Placental exchange – Oxygen diffuses from maternal blood to fetal blood.
iii. Increased capillary density – Enhances oxygen absorption in fetal tissues.

12. (a) Outline the evidence for transport of organic material in the phloem.

Answer:
i. Ring experiment – Removing a ring of bark (phloem) causes accumulation of sugars above the cut, proving downward transport.
ii. Radioactive labeling – CO_2 labeled with carbon-14 shows movement through the phloem when traced in plants.
iii. Aphid experiment – Aphids feed on phloem sap, confirming sugar transport in the phloem.

(b) Outline the evidence supporting the mass flow theory.
Answer:

i. High pressure in the phloem – Sap exudes when phloem is cut, indicating pressure-driven flow.
ii. Companion cells aid transport – Presence of mitochondria for ATP production supports active transport.
iii. Experiments with sucrose transport inhibitors – Blocking ATP production stops transport, proving active transport involvement.

13. (a) Examine figure X below and answer the questions that follow:

(i) Why is there an initial decrease in weight during the germination of the seed?
The seed uses stored food reserves for respiration, leading to a decrease in dry weight before the seedling becomes photosynthetic.

(ii) What will the appearance of the seedling be when positive growth occurs at P?
At P, the seedling will have developed leaves and roots, showing active growth due to photosynthesis.

(iii) What physiological process occurs at P to account for positive growth?

Photosynthesis occurs at P, leading to organic matter synthesis and increased biomass.

(iv) Account for the sudden decrease in dry mass after 20 weeks.

The decrease is due to leaf senescence and respiration exceeding synthesis, possibly due to aging or reduced photosynthetic efficiency.

(b)(i) What type of growth is exhibited in figure X?
Sigmoid (S-shaped) growth curve.

(ii) Explain briefly what happens during this type of growth.

Lag phase – Slow growth as the seed adapts.
Exponential phase – Rapid growth due to cell division and photosynthesis.
Stationary phase – Growth slows due to environmental limits.
Senescence phase – Decline in dry mass due to aging.

14. (a) Define the following terms:

(i) Sexual reproduction.
Sexual reproduction involves the fusion of male and female gametes, leading to genetically diverse offspring.

(ii) Asexual reproduction.

Asexual reproduction occurs without gamete fusion, producing genetically identical offspring.

(b) Why do you think it is true that mitosis may be defined as an equational division and meiosis as a reduction division?
i. Mitosis is called an equational division because the chromosome number remains the same in daughter cells.
ii. Meiosis is called a reduction division because it halves the chromosome number, producing haploid gametes.
(c) Identify the embryonic membranes found in mammals and state the roles of each.
i. Amnion – Encloses the embryo in amniotic fluid, providing protection.
ii. Chorion – Forms part of the placenta, facilitating nutrient and gas exchange.
iii. Yolk sac – Provides early nutrients and helps in blood cell formation.
iv. Allantois – Assists in waste removal and gas exchange.