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: 1999**

Instructions:

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

1. (a) (i) Name the cells labeled P, Q, and R.
- P: Xylem vessel
- Q: Phloem sieve tube
- R: Companion cell

(ii) Draw the cells as they would appear in the transverse section along the dotted line X—Y.
[For this part, a labeled diagram showing a transverse section of the stem should be drawn, highlighting the arrangement of xylem, phloem, and companion cells in a vascular bundle.]

(b) (i) Give the name of the tissue which comprises the cells shown in the diagram.
The tissue is vascular tissue, specifically the vascular bundle.

(ii) Explain how cells P, Q, and R adapt this tissue to its function(s).
- P (Xylem vessel): Xylem vessels have thick, lignified walls to provide mechanical support and to conduct water and minerals efficiently from roots to other parts of the plant.
- Q (Phloem sieve tube): Phloem sieve tubes lack nuclei and are connected end-to-end by sieve plates, enabling the efficient transport of nutrients like sucrose.
- R (Companion cell): Companion cells have a dense cytoplasm and numerous mitochondria to provide the energy necessary for active transport of nutrients into and out of the phloem sieve tubes.

2. (a) Mention any five types of membranes and state one function of each.
i. Plasma membrane: Regulates the movement of substances into and out of the cell.
ii. Nuclear membrane: Encloses the nucleus and controls exchange between the nucleus and cytoplasm.
iii. Mitochondrial membrane: Facilitates the production of ATP through oxidative phosphorylation.
iv. Chloroplast membrane: Allows photosynthesis-related materials to pass in and out of chloroplasts.
v. Vacuolar membrane (tonoplast): Regulates substances entering or exiting the vacuole.

(b) Why are chloroplasts and mitochondria said to be "cells within cells?"
Chloroplasts and mitochondria are referred to as "cells within cells" because they possess their own DNA, ribosomes, and double membranes, enabling them to produce some of their own proteins and enzymes independently of the nucleus.

3. (a) Study the following characteristics of monocots and dicots. Identify whether the features are characteristic of monocots, dicots, or both.
i. Single cotyledon: Monocots
ii. Food storage in cotyledon: Dicots
iii. Petals in multiples of three: Monocots
iv. Food absorption by cotyledon: Dicots
v. Scattered vascular bundles: Monocots
vi. Cambium: Dicots
vii. Both tracheids and vessel elements: Both
viii. Persistent endosperm: Monocots
ix. Covered seeds: Both

x. Heterosporous: Both

(b) (i) Using common names, give one example of an organism belonging to each of the following groups:
- Protozoa: Amoeba
- Chilopoda: Centipede
- Arachnida: Spider
- Compositae/Asteraceae: Sunflower
- Rubiaceae: Coffee
- Malvaceae: Cotton

(ii) State four features of birds that have contributed to the success of this group.
i. Feathers for insulation and flight
ii. Lightweight, hollow bones to reduce body weight for flight
iii. A highly efficient respiratory system to support high metabolic demands during flight
iv. A four-chambered heart for efficient circulation of oxygen-rich blood.

4. (a) Explain why it is important that active transport is employed in the absorption of foodstuffs: monosaccharides, dipeptides, and amino acids.
Active transport is essential for the absorption of monosaccharides, dipeptides, and amino acids because:
i. It enables movement of these nutrients against their concentration gradients, ensuring efficient absorption even when their concentrations in the intestine are lower than in the cells.
ii. It maintains a steady supply of nutrients to the body, crucial for energy production and protein synthesis.
iii. It facilitates nutrient uptake in areas of high demand, such as growing tissues.

(b) State the features of the respiratory surfaces which are common to all vertebrates and briefly explain the importance of each feature.
i. Large surface area: Enhances the rate of gas exchange by allowing more oxygen and carbon dioxide to diffuse simultaneously.
ii. Thin membrane: Reduces diffusion distance, speeding up the exchange of gases.
iii. Moist surface: Dissolves gases, facilitating their diffusion across membranes.
iv. Rich blood supply: Ensures efficient transport of oxygen to tissues and removal of carbon dioxide.

5. (a) What is meant by:
(i) Peptide linkage?
A peptide linkage is a chemical bond formed between the carboxyl group of one amino acid and the amino group of another, with the release of a water molecule.

(ii) Conjugated protein?
A conjugated protein is a protein that is combined with a non-protein group, known as a prosthetic group, such as heme in hemoglobin.

(b) Give the role in protein synthesis of each of the following:
(i) DNA

DNA contains the genetic code, which is transcribed into mRNA. This code directs the sequence of amino acids in protein synthesis.

(ii) Ribosome
Ribosomes are the sites of protein synthesis. They translate the mRNA sequence into a polypeptide chain by facilitating the assembly of amino acids in the correct order.

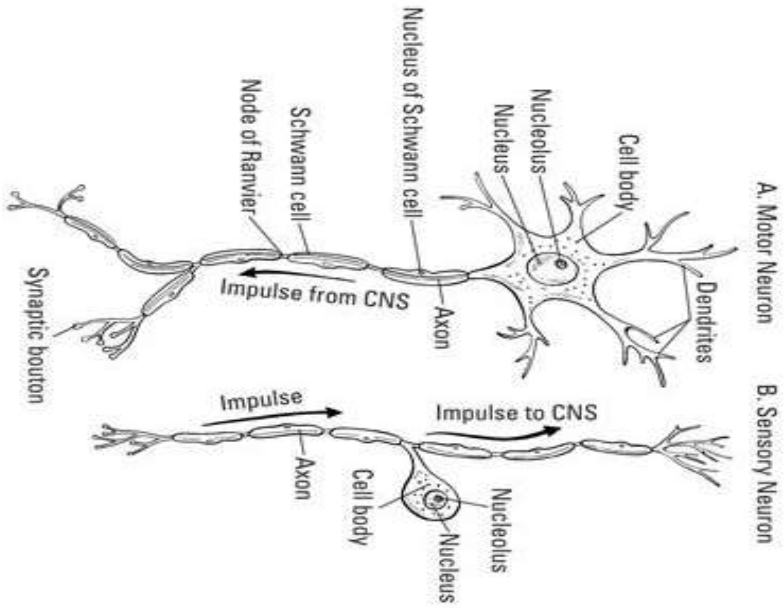
6. Three plants, X, Y, and Z, were placed in varying conditions of light and temperature. In the first experiment, the plants X, Y, and Z were illuminated with white light, blue light, and green light, respectively. In the second experiment, all three plants were placed in bright daylight but at different temperatures. Plant X was kept at 11°C, Y at 22°C, and Z at 31°C. Assuming all other conditions were kept the same and the plants were of the same species:

(a) State with reasons which of the plants would be likely to show:
(i) The slowest rate of photosynthesis:
Plant Z, due to being illuminated with green light. Green light is least effective for photosynthesis as it is reflected by chlorophyll rather than absorbed.

(ii) The fastest rate of photosynthesis:
Plant X, exposed to blue light. Blue light is highly effective for photosynthesis as it is absorbed efficiently by chlorophyll and stimulates the production of carbohydrates.
(b) Comment on the effect of the differences in temperature that would have on the rate of photosynthesis in the second experiment.
Photosynthesis is temperature-dependent due to its reliance on enzymes. At 11°C (plant X), the rate of photosynthesis would be slow because enzyme activity is reduced at low temperatures. At 22°C (plant Y), photosynthesis would occur at an optimal rate as enzymes function most efficiently. At 31°C (plant Z), the rate may decrease due to enzyme denaturation and increased water loss through transpiration.

7. (a) By means of labeled diagrams only show the differences between a motor neurone and a sensory neurone.

Motor neurons and sensory neurons differ in structure and function. Below are labeled diagrams illustrating these differences:



Key Differences:

i. Cell Body Location: In motor neurons, the cell body is located at one end of the neuron, within the central nervous system (CNS). In sensory neurons, the cell body is situated along the axon, often in the dorsal root ganglion outside the CNS.

ii. Dendrites and Axons: Motor neurons have multiple dendrites and a single long axon, facilitating the transmission of impulses from the CNS to muscles or glands. Sensory neurons typically have a single long dendrite and a short axon, transmitting sensory information from receptors to the CNS.

iii. Function: Motor neurons carry signals from the CNS to effector organs, such as muscles and glands, initiating action. Sensory neurons transmit sensory information from peripheral receptors to the CNS for processing.

(b) In an experiment, thin pieces of mica were inserted into three tips of coleoptiles as shown in Fig. 7.0.

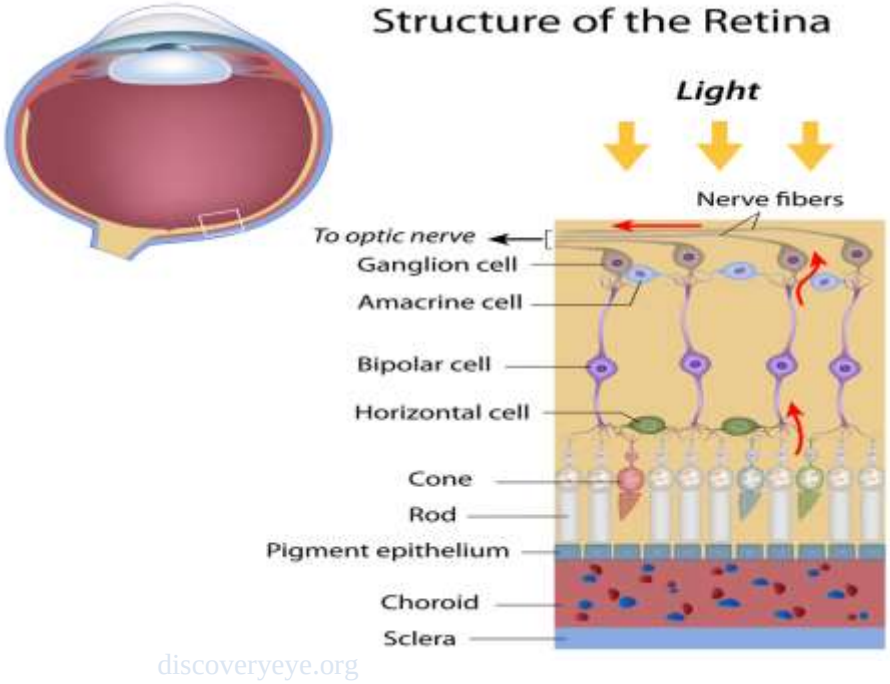
In the light of the auxin theory, predict with a full explanation the results of experiments A, B, and C in Fig. 7.0.

i. In experiment A, the tip is intact, so auxin will move down the shaded side of the coleoptile, causing elongation and bending toward the light.

ii. In experiment B, the piece of mica blocks the transmission of auxin to the shaded side, preventing bending. The coleoptile will remain straight.

iii. In experiment C, auxin is able to move laterally but is obstructed on one side by mica, resulting in uneven distribution and causing bending away from the side with the mica.

8. (a) Draw a diagram to show the cellular structure of the retina of a mammalian eye.



The retina is a complex, multilayered structure located at the back of the mammalian eye, responsible for converting light into neural signals. Below is a diagram illustrating the cellular structure of the retina:

Key Layers and Cells of the Retina:

i. Retinal Pigment Epithelium (RPE)
A single layer of pigmented cells that nourishes retinal visual cells and is firmly attached to the underlying choroid and overlying retinal visual cells.
ii. Photoreceptor Layer
Contains the outer segments of rods and cones, which are responsible for detecting light.
iii. Outer Nuclear Layer
Houses the cell bodies of the photoreceptors.
iv. Outer Plexiform Layer
Region where photoreceptor cells synapse with bipolar and horizontal cells.
v. Inner Nuclear Layer
Contains the cell bodies of bipolar cells, horizontal cells, and amacrine cells.
vi. Inner Plexiform Layer
Area where bipolar cells synapse with ganglion cells and amacrine cells.
vii. Ganglion Cell Layer
Comprises the cell bodies of ganglion cells, which transmit visual information to the brain via their axons.
viii. Nerve Fiber Layer
Consists of the axons of ganglion cells that converge to form the optic nerve.

ix. Inner Limiting Membrane
The innermost layer, forming a boundary between the retina and the vitreous humor.

(b) How does the eye control the amount of light entering it?
The eye controls the amount of light entering through the iris, which adjusts the size of the pupil:
i. In bright light, circular muscles contract while radial muscles relax, reducing pupil size (constriction).
ii. In dim light, radial muscles contract while circular muscles relax, increasing pupil size (dilation).

9. (a) Figure 9.0 below illustrates gametogenesis in a flowering plant.

(i) What structure in the diagram corresponds to a mammalian spermatozoan?
Structure S (the generative nucleus).

(ii) Name a structure in a mammalian testis that corresponds to the pollen grain mother cell.
Spermatogonium.

(iii) Explain how structure S is formed from structure R.
Structure S (the generative nucleus) is formed through mitotic division of the microspore nucleus, resulting in two nuclei: one vegetative and one generative. The generative nucleus represents structure S.

10. (a) One of the hormones secreted by the anterior lobe of the pituitary gland is called growth hormone.

(i) What are the effects of this hormone in the body?
Growth hormone stimulates cell division, protein synthesis, and bone growth, contributing to overall body growth and metabolism regulation.
(ii) What are the effects of oversecretion of this hormone?
Oversecretion leads to gigantism in children and acromegaly in adults, characterized by abnormal growth of bones and tissues.
(b) Name two other hormones secreted by the anterior lobe of the pituitary and give one function of each.
i. Prolactin: Stimulates milk production in mammary glands.
ii. Follicle-stimulating hormone (FSH): Stimulates the development of follicles in ovaries and spermatogenesis in testes.

11. (a) State the laws of heredity as postulated by Gregor Mendel.
i. Law of Segregation: Each organism carries two alleles for each trait, which segregate during gamete formation, with each gamete receiving one allele.
ii. Law of Independent Assortment: Genes for different traits are inherited independently of one another, provided they are on separate chromosomes.

(b) In Drosophila melanogaster, the gene for greyness (E) is dominant to the gene for ebony color (e).

(i) What would be the F1 phenotypes if the parental flies were both heterozygous for body color?
The phenotypic ratio would be 3:1, with 75% grey and 25% ebony.

(ii) If the male fly were homozygous grey and the female fly heterozygous, what would be the F1 offspring phenotypes?
All offspring would show the grey phenotype because they inherit at least one dominant allele (E).

12. (a) What is meant by biological control?
Biological control is the use of natural predators, parasites, or pathogens to regulate populations of harmful pests in agriculture and ecosystems.

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

Advantages:
i. Environmentally friendly: Reduces the use of harmful chemical pesticides.
ii. Long-term solution: Sustains control as predators or parasites establish populations.
iii. Cost-effective: Once established, minimal maintenance is required.

Disadvantages:
i. Slow action: Biological control takes time to reduce pest populations.
ii. Risk of imbalance: Introduced species may become invasive or affect non-target species.
iii. Limited scope: Not all pests have effective biological control agents.