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: 2015.**

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) Differentiate between eukaryotic and prokaryotic cells based on the following criteria:

Criteria	***Prokaryotic cells***	***Eukaryotic cells***
Cell division	Occurs by binary fission	Occurs by mitosis and meiosis
Genetic material	No nucleus; genetic materials is in the nucleoid	Enclosed within a nucleus
Cell wall	Composed of peptidoglycan (in bacteria	Composed of cellulose (plants) or absent
flagella	Simple, made of flagellin	Complex, made of microtubules
respiration	Occurs in the cytoplasm	Occurs in mitochondria
photosynthesis	Occurs in thylakoids (if present)	Occurs in chloroplasts (plants)
Nitrogen fixation	Performed by specialized prokaryotes	Not common

(b) What is cell differentiation?

Cell differentiation is the process by which a less specialized cell becomes more specialized in structure and function. This process allows cells to perform specific roles in the organism, such as muscle cells for contraction and nerve cells for signal transmission.

2. (a) What are the chemical compositions of proteins?

Proteins are composed of carbon, hydrogen, oxygen, nitrogen, and sometimes sulfur. They are polymers of amino acids linked by peptide bonds.

(b) State supporting and storage functions of carbohydrates using one example in each case.
i. Supporting function: Cellulose provides structural support in plant cell walls, maintaining their rigidity.
ii. Storage function: Starch acts as a storage form of glucose in plants, providing energy when needed.

3. (a) Identify steps used to construct simple taxonomic keys.

i. Observe and identify distinguishing features of the organisms.
ii. Group organisms based on shared characteristics.
iii. Develop contrasting statements (couplets) based on observed features.
iv. Test the key for clarity and accuracy.
v. Finalize and publish the key.

(b) Rules used in binomial nomenclature.

i. The scientific name is written in Latin and italicized or underlined.
ii. The genus name starts with a capital letter, and the species name starts with a lowercase letter.
iii. The name must be unique and universally accepted.
iv. The genus name may be abbreviated to the first letter after the full name is mentioned once.

v. Priority is given to the earliest published name.

4. (a) Explain three characteristics of nerve impulse.
i. Nerve impulses are unidirectional, moving only from the presynaptic neuron to the postsynaptic neuron.
ii. They are all-or-nothing responses, meaning a threshold stimulus is required to trigger the impulse.
iii. Nerve impulses are transmitted rapidly due to the myelination of axons, which facilitates saltatory conduction.

(b) Why do myelinated axons of frogs having a diameter of 3.5 micrometers conduct impulse at 30 m/s, whereas axons of the same diameter in cats conduct impulses at 90 m/s?
The difference is due to the efficiency of myelination. Myelination in cats is more advanced, allowing faster saltatory conduction compared to frogs.

5. (a) Write a balanced equation of photosynthesis and from the equation, state which factors and conditions are likely to affect the rate of photosynthesis.

Balanced equation:
$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Factors affecting the rate:
i. Light intensity
ii. Carbon dioxide concentration
iii. Temperature
iv. Availability of water

(b) Explain events which take place during dark reaction.

The dark reaction (Calvin cycle) occurs in the stroma of chloroplasts. It involves carbon fixation, where CO_2 combines with ribulose-1,5-bisphosphate (RuBP) to form 3-phosphoglycerate (3-PGA). ATP and NADPH from the light-dependent reaction are used to convert 3-PGA into glyceraldehyde-3-phosphate (G3P), which is then used to synthesize glucose and regenerate RuBP.

6. (a) Give the meaning of basal metabolic rate.

Basal metabolic rate (BMR) refers to the minimum amount of energy required by an organism to maintain basic physiological functions, such as breathing, circulation, and cellular metabolism, while at rest in a neutral environment.

(b) Describe the fate of pyruvic acid under anaerobic respiration.

Under anaerobic respiration, pyruvic acid is converted into lactic acid in animals through the lactic acid fermentation pathway, or into ethanol and carbon dioxide in plants and yeast through alcoholic fermentation.

This process occurs in the absence of oxygen and helps regenerate NAD+ for glycolysis, allowing ATP production to continue.

7. (a) What do you understand by the term double fertilization as applied in angiosperms?

Double fertilization is a unique process in angiosperms where two sperm cells from the pollen grain fertilize different structures within the ovule. One sperm cell fuses with the egg cell to form a diploid zygote, while the other fuses with two polar nuclei to form a triploid endosperm, which provides nourishment to the developing embryo.

(b) Figure 1 represents a spermatozoan cell.

(i) What is the role of the cell?
The sperm cell plays a crucial role in fertilization by delivering the male genetic material (haploid nucleus) to the egg cell for the formation of a zygote.

(ii) Name the structures labeled T, W, and X.

T: Head
W: Midpiece
X: Tail

(iii) What are structural adaptations shown by the cell to its function?

i. The head contains a haploid nucleus and an acrosome, which releases enzymes to penetrate the egg membrane.
ii. The midpiece is packed with mitochondria to provide energy for motility.
iii. The tail (flagellum) is long and whip-like, enabling the sperm to swim towards the egg.

8. (a) (i) Name the structure represented in Figure 2.

The structure represented is a flower.

(ii) Name the parts labeled A to I.

A: Stigma
B: Style
C: Ovary
D: Ovule
E: Petal
F: Sepal
G: Anther
H: Filament

I: Receptacle

(iii) Name a plant from which the structure could have been obtained.
The structure could have been obtained from a hibiscus plant.

(b) State one role of each part labeled A to I.

A: Stigma – Receives pollen during pollination.
B: Style – Provides a passage for pollen tubes to grow towards the ovary.
C: Ovary – Houses ovules and develops into fruit after fertilization.
D: Ovule – Contains the female gametes and develops into seeds after fertilization.
E: Petal – Attracts pollinators with its color and scent.
F: Sepal – Protects the flower bud before it opens.
G: Anther – Produces pollen grains containing male gametes.
H: Filament – Supports the anther and positions it for effective pollen dispersal.
I: Receptacle – Supports and holds the flower parts together.

9. Describe categories of proteins based on their structures and functions.

Proteins are classified into the following categories based on their structures and functions:

i. Structural proteins. These provide support and shape to cells and tissues, such as collagen in connective tissue and keratin in hair and nails.
ii. Enzymatic proteins. These act as biological catalysts, speeding up biochemical reactions, such as amylase for starch digestion.
iii. Transport proteins. These help in the transport of substances, such as hemoglobin carrying oxygen in the blood.
iv. Defensive proteins. These protect the organism from pathogens, such as antibodies in the immune system.
v. Hormonal proteins. These regulate physiological processes, such as insulin controlling blood sugar levels.
vi. Contractile proteins. These facilitate movement, such as actin and myosin in muscle contraction.

10. Explain the process of nerve impulse along the axon and across the synapse of the neuron.

The propagation of a nerve impulse along the axon occurs through an action potential. When a stimulus exceeds the threshold, voltage-gated sodium channels open, causing sodium ions to enter the axon. This depolarizes the membrane, creating an action potential. The action potential moves along the axon by depolarizing adjacent regions, while repolarization restores the resting membrane potential.

At the synapse, the nerve impulse triggers calcium ion influx into the presynaptic neuron. This causes synaptic vesicles to release neurotransmitters into the synaptic cleft. The neurotransmitters bind to receptors

on the postsynaptic membrane, opening ion channels and generating a new action potential in the postsynaptic neuron.

11. (a) (i) Name the process illustrated by Figure 3.
The process illustrated in Figure 3 is the Calvin cycle (light-independent reactions of photosynthesis).

(ii) Name the steps in the process indicated by letter U, V, W, and X.
U: Carbon fixation
V: Reduction of glycerate-3-phosphate to triose phosphate
W: Conversion of triose phosphate into carbohydrates and proteins
X: Regeneration of ribulose bisphosphate (RuBP)

(b) Explain Hatch-Slack pathway in C4 plants.

The Hatch-Slack pathway is an adaptation in C4 plants to minimize photorespiration. It involves the initial fixation of carbon dioxide into a four-carbon compound (oxaloacetate) in mesophyll cells. This compound is converted to malate, which is transported to bundle-sheath cells. In the bundle-sheath cells, malate releases carbon dioxide, which enters the Calvin cycle. This pathway concentrates carbon dioxide around RuBisCO, enhancing photosynthetic efficiency under high light intensity and temperature.