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: 2022.**

Instructios:

1. this paper consists of sections A, and B with total of ten questions
2. answer all questions in section A, and two questions in section B.
3. Section A carries seventy marks and section B carries thirty marks.

1. (a) A scientist placed 2 cm^3 of starch solution in a test tube followed by 2 cm^3 of saliva which was boiled to 75°C. He then carried out a starch test and observed a positive result. Briefly explain the observation.

The positive result for the starch test indicates that starch was not broken down. Boiling the saliva denatured the amylase enzyme present in it, which is responsible for breaking down starch into maltose. Denaturation destroyed the enzyme's active site, rendering it inactive. As a result, the starch remained intact, leading to a positive result when tested with iodine solution.

1. (b) Eukaryotes have cells with organelles bound by membrane(s). Why is it advantageous for the organelles to be bound by the membrane(s)? Give three points.

i. Compartmentalization: Membrane-bound organelles allow specific biochemical processes to occur in isolated environments within the cell. For example, the mitochondria facilitate energy production through cellular respiration in their matrix without interference from other cellular processes.

ii. Increased efficiency: Enzymes and substrates involved in specific reactions are concentrated within organelles, improving the efficiency of biochemical processes. For example, the lysosome contains hydrolytic enzymes that function optimally in its acidic environment.

iii. Protection of genetic material: The nuclear membrane protects the DNA from damage and regulates the exchange of materials between the nucleus and the cytoplasm, ensuring proper gene expression and cell function.

2. (a) A biologist found some new insects which were supposed to be placed in the taxa. Among the tools which a biologist demanded for this work was a biological key. Why do you think a biologist needed a biological key? Give one point.

A biological key is essential for identifying and classifying organisms systematically. It helps the biologist determine the taxonomic position of new insects by comparing their physical and structural characteristics with predefined criteria.

2. (b) Suppose that you have been assigned to construct a Dichotomous Key:
(i) Describe the procedure you would follow.

i. Observation: Carefully observe the distinguishing features of the organisms to be classified, such as body shape, number of legs, and presence of wings.

ii. Listing characteristics: Identify unique and contrasting characteristics that can be used to differentiate the organisms.

iii. Grouping: Arrange the organisms into groups based on shared characteristics, ensuring that each group has at least one distinguishing feature.

iv. Formulating paired statements: Create pairs of contrasting statements for each characteristic (e.g., "Has wings" vs. "Does not have wings") to guide the user through the key.

v. Organizing hierarchy: Start with broad characteristics and progress to more specific ones to allow systematic classification of the organisms.

vi. Testing: Verify the key's accuracy by using it to classify known organisms and ensure it consistently leads to correct identification.

(ii) How would you use the key constructed to classify the organisms?

To classify organisms using the key, start by observing the organism and selecting the first pair of statements that describe its features. Follow the pathway indicated by the chosen statement, continuing through subsequent pairs of statements until the organism is identified.

3. (a) What would happen to an organism if its nervous system is severely damaged? Give four points.

i. Loss of coordination: The nervous system integrates and coordinates bodily functions. Damage can disrupt communication between the brain, spinal cord, and body, leading to uncoordinated movements or paralysis.

ii. Sensory impairments: Severe damage can affect sensory neurons, resulting in partial or complete loss of sensations such as touch, pain, or temperature.

iii. Cognitive dysfunction: Damage to the brain or central nervous system may impair memory, decision-making, or consciousness, affecting the individual's ability to perform daily tasks.

iv. Loss of reflexes: Reflex actions controlled by the nervous system may be absent, increasing the risk of injuries due to delayed or absent responses to stimuli.

3. (b) Figure 1 is a part of a neuron. Study it carefully and then answer the questions that follow:
(i) Identify the type of neuron presented in Figure 1.

The neuron presented in Figure 1 is a motor neuron.

(ii) Which feature has helped you to make identification in (i)?

The presence of multiple dendrites connected to the cell body and a long axon extending toward the effector organ suggests it is a motor neuron.

(iii) What would happen to the neuron if each of the parts labeled A and B is severely damaged? Give two points for each.

If part A (cell body) is damaged:
- The neuron may lose its ability to process incoming signals and generate action potentials, disrupting communication with other neurons or effectors.
- The cell body houses essential organelles like the nucleus. Damage can lead to the death of the neuron due to the inability to synthesize proteins and maintain cellular functions.

If part B (axon) is damaged:
- Signal transmission from the neuron to the target cell (e.g., muscle or gland) will be impaired, potentially leading to paralysis or loss of function in the affected area.
- The damage can disrupt the propagation of action potentials, leading to incomplete or failed communication with the target organ.

4. (a) The first process of photosynthesis involves trapping of light energy from the sun and then collecting it to the photosystems. How does this process take place?

The trapping of light energy occurs during the light-dependent reactions of photosynthesis, as follows:
- Chlorophyll molecules in photosystems I and II absorb light energy.
- The absorbed energy excites electrons in the chlorophyll molecules, raising them to a higher energy state.
- In photosystem II, the excited electrons are transferred to the electron transport chain, generating ATP through photophosphorylation.
- Water molecules are split (photolysis), producing oxygen, protons, and electrons to replace those lost by chlorophyll.
- In photosystem I, light energy re-excites electrons, which are used to reduce NADP+ to NADPH, a molecule required for the Calvin cycle.

4. (b) Explain how electron transport takes place in the photosystems I (PSI) and II (PSII).

Electron transport in photosystems I and II occurs as part of the light-dependent reactions:
- In PSII, light excites electrons in chlorophyll. The energized electrons are passed to the primary electron acceptor and then to the electron transport chain. This process generates ATP through chemiosmosis.
- Electrons lost from PSII are replaced by electrons from water, split during photolysis.
- In PSI, electrons from PSII are re-energized by light and transferred to a second electron transport chain. These electrons are used to reduce NADP+ to NADPH, completing the electron transport process.

Both photosystems work together to convert light energy into chemical energy stored as ATP and NADPH.

5. (a) Why is it necessary for a respiratory surface to have each of the following features?

(i) Large surface area to volume ratio

Answer:
A large surface area to volume ratio ensures that a sufficient amount of gases can be exchanged to meet the metabolic demands of the organism. For instance, in alveoli, the extensive surface area allows for the rapid diffusion of oxygen into the blood and carbon dioxide out of the blood.

(ii) Moist surface

Answer:
A moist surface is essential for the dissolution of gases. Oxygen and carbon dioxide must dissolve in a thin layer of moisture before diffusing across the respiratory membrane. This facilitates efficient gas exchange between the alveoli and blood.

(iii) Thin membrane

Answer:
A thin membrane minimizes the diffusion distance for gases, allowing oxygen to quickly enter the blood and carbon dioxide to exit. For example, the alveolar and capillary walls are each one cell thick, ensuring rapid gas diffusion.

(iv) Permeable membrane

Answer:
A permeable membrane allows gases like oxygen and carbon dioxide to pass freely across it. The permeability ensures that gases can move in and out of the blood without obstruction, maintaining the efficiency of respiration.

5. (b) Glycolysis leads to the formation of pyruvic acid. How is the pyruvic acid converted to ethanol? Explain by giving two points.

Answer:

i. Decarboxylation: Pyruvic acid undergoes decarboxylation, catalyzed by pyruvate decarboxylase, to form acetaldehyde. This process releases carbon dioxide.

ii. Reduction to ethanol: Acetaldehyde is reduced to ethanol in the presence of the enzyme alcohol dehydrogenase, using NADH as a reducing agent. This step regenerates NAD+, which is essential for glycolysis to continue.
6. (a) What would happen to a cell if its membrane lacks antigens? Give two points.

i. Loss of immune recognition: Without antigens on its membrane, the cell may not be recognized as "self" by the immune system. This can lead to the immune system attacking the cell, resulting in autoimmune reactions.

ii. Impaired communication: Membrane antigens play a role in cell signaling and communication. Their absence could disrupt interactions with other cells, affecting processes like tissue repair and immune responses.

6. (b) In what ways is water important to plants? Give four points.

i. Medium for metabolic reactions: Water serves as a solvent in which biochemical reactions take place, including photosynthesis and nutrient transport.

ii. Transport of nutrients: Water facilitates the movement of minerals from the soil to different parts of the plant through the xylem.

iii. Maintenance of turgor pressure: Water within plant cells maintains turgidity, which is essential for structural support and stomatal function.

iv. Temperature regulation: Water is lost through transpiration, which cools the plant and prevents overheating in high temperatures.

7. (a) Using the given labels:
(i) List in correct order the parts of the ovary through which the pollen tube must grow in order to reach the embryo sac.

The correct order is A → C → F → G → H → I.

(ii) Identify a part which performs a similar function as the umbilical cord in human beings.

Part G (funiculus) performs a similar function to the umbilical cord, as it provides a connection between the developing seed and the parent plant, facilitating nutrient and water transport.

7. (b) If fertilization occurs successfully:
(i) Which part of the seed/fruit would develop from each of the parts labeled B, D, G, and F?

- Part B: Develops into the seed coat (testa).
- Part D: Develops into the embryo.
- Part G: Develops into the funiculus.
- Part F: Develops into the fruit wall (pericarp).

(ii) What will be the fate of each of the parts labeled A and I?

- Part A: The stigma will wither after fertilization.
- Part I: The micropyle remains as a small opening in the seed, allowing the entry of water during germination.

8. The release of energy from a glucose molecule occurs in three stages, namely glycolysis, Krebs cycle, and electron transport chain. Identify two essential features of each stage and explain how the electron transport chain occurs in aerobic respiration.

Glycolysis:
i. Occurs in the cytoplasm: Glycolysis takes place in the cytoplasm of the cell, breaking down one glucose molecule into two molecules of pyruvate.
ii. Produces ATP and NADH: Glycolysis generates a net gain of 2 ATP molecules and 2 NADH molecules, which are crucial for subsequent stages of aerobic respiration.

Krebs Cycle:
i. Occurs in the mitochondrial matrix: The Krebs cycle takes place in the matrix of mitochondria, processing pyruvate to generate high-energy molecules.
ii. Produces energy carriers: The cycle generates NADH, FADH2, and a small amount of ATP, providing electrons for the electron transport chain.

Electron Transport Chain (ETC):
i. Occurs in the inner mitochondrial membrane: The ETC is located in the inner mitochondrial membrane, where electrons from NADH and FADH2 are transferred through a series of protein complexes.
ii. Produces ATP via oxidative phosphorylation: The movement of electrons down the chain powers the pumping of protons into the intermembrane space, creating a proton gradient. ATP synthase uses this gradient to produce ATP.

Explanation of ETC in Aerobic Respiration:
The ETC begins with NADH and FADH2 donating electrons to the protein complexes. As electrons move through the complexes, protons are pumped from the mitochondrial matrix into the intermembrane space. This creates a proton gradient, or electrochemical gradient, known as the proton motive force. At the end of the chain, electrons combine with oxygen (the final electron acceptor) and hydrogen ions to form water. The flow of protons back into the matrix through ATP synthase drives the production of ATP.

9. Why should a mammalian placenta be formed immediately after implantation? Explain by giving six points.

i. Nutrient supply: The placenta provides nutrients like glucose, amino acids, and fatty acids from the maternal blood to the developing embryo, supporting its growth and development.
ii. Oxygen delivery: The placenta facilitates the exchange of oxygen from the mother to the fetus, ensuring proper cellular respiration in the developing tissues.
iii. Waste removal: The placenta removes waste products such as carbon dioxide and urea from the fetal blood, preventing toxic accumulation.
iv. Hormone production: The placenta produces essential hormones such as progesterone and human chorionic gonadotropin (hCG), which are crucial for maintaining pregnancy.
v. Immune protection: The placenta acts as a barrier, protecting the fetus from harmful pathogens and the mother's immune system, which could otherwise recognize the fetus as foreign.
vi. Structural support: The placenta anchors the embryo to the uterine wall, providing stability and facilitating the growth of the fetus within the uterus.

10. Oxygen taken in through the human nose enters the lungs, and then it is transported to all parts of the body. Describe three ways in which oxygen is transported in the human body.

i. Dissolved in plasma: A small percentage of oxygen is dissolved directly in the blood plasma. However, this accounts for only about 1-2% of oxygen transport.
ii. Bound to hemoglobin: The majority of oxygen (approximately 98%) binds to hemoglobin in red blood cells, forming oxyhemoglobin. This is the primary method of oxygen transport, allowing efficient delivery to tissues.
iii. Diffusion at tissues: Oxygen dissociates from oxyhemoglobin in areas where oxygen concentration is low (e.g., tissues), diffusing into cells for use in cellular respiration.