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: 2018.**

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) Describe the features of the cell membrane.

The cell membrane, also known as the plasma membrane, is a semi-permeable structure that surrounds the cell, providing a barrier between the internal environment and the external surroundings. It is primarily composed of a phospholipid bilayer with embedded proteins. The hydrophobic tails of the phospholipids face inward, while the hydrophilic heads face outward, creating a hydrophobic interior. The proteins embedded in the membrane serve various functions, such as transport, signal reception, and enzymatic activity. The membrane also contains cholesterol, which adds stability and fluidity, and carbohydrate chains, which contribute to cell recognition and adhesion.

(b) Assess the suitability of the structure of a mitochondrion to its function. Give five points.

The mitochondrion is well-suited to its function as the powerhouse of the cell due to its structural features.
Firstly, the double membrane system, with an outer membrane and an inner folded membrane (cristae), increases the surface area for energy production through the electron transport chain.
Secondly, the matrix contains enzymes for the Krebs cycle, enabling efficient breakdown of metabolic products to generate ATP.
Thirdly, the intermembrane space facilitates the accumulation of protons, creating a gradient essential for ATP synthesis.
Fourthly, the presence of mitochondrial DNA and ribosomes allows the organelle to produce some of its own proteins, supporting its semi-autonomous nature.
Finally, its elongated shape ensures a large surface area-to-volume ratio, optimizing energy production and distribution within the cell.

2. (a) State three importance of each of the following groups of carbohydrates in living things:
(i) Pentose
Pentose sugars, such as ribose and deoxyribose, are crucial components of nucleotides, which form the backbone of RNA and DNA, respectively. They play a role in cellular energy transfer by being part of molecules like ATP. Additionally, pentoses are intermediates in metabolic pathways such as the pentose phosphate pathway, which produces NADPH and ribose-5-phosphate for biosynthesis.
(ii) Hexose
Hexose sugars, such as glucose, serve as the primary source of energy in cellular respiration. Fructose, another hexose, is a component of fruits, providing energy and contributing to flavor. Hexoses also act as building blocks for disaccharides and polysaccharides like sucrose and glycogen.

(iii) Disaccharide
Disaccharides like sucrose serve as transportable energy sources in plants, while lactose provides nutrition in mammalian milk. Maltose is an intermediate product in the digestion of starch and glycogen, facilitating energy release.

(b) Explain the role of the following chemical reagents in testing carbohydrates:

(i) Dilute hydrochloric acid

Dilute hydrochloric acid hydrolyzes disaccharides and polysaccharides into their monosaccharide components. This reaction is essential in testing for non-reducing sugars, as it breaks them down into reducing sugars that can then react with Benedict's solution.

(ii) Dilute sodium hydroxide
Dilute sodium hydroxide is used to neutralize the solution after hydrolysis with hydrochloric acid, ensuring that the pH is suitable for the Benedict's test to proceed effectively.

3. (a) Distinguish between the following:

(i) Nervous and hormonal coordination. Give four points.
Nervous coordination involves the transmission of electrical impulses through neurons, while hormonal coordination relies on chemical messengers (hormones) transported via the bloodstream. Nervous responses are typically fast and short-lived, whereas,
hormonal responses are slower but longer-lasting. Nervous coordination is specific to target cells with synaptic connections, while hormones can affect multiple target cells with appropriate receptors.
Lastly, nervous coordination is crucial for immediate responses, while hormonal coordination regulates long-term processes such as growth and reproduction.

(ii) Positive and negative feedback of body temperature regulation process. Give two points.

Positive feedback amplifies a response, such as shivering to generate more heat when body temperature drops.
Negative feedback reduces deviations from the norm, such as sweating to cool the body when it overheats.
Positive feedback typically destabilizes the system temporarily, while negative feedback stabilizes it.

(b) Examine four properties of a hormone which enable it to accomplish its function.

Hormones are highly specific, acting only on target cells with corresponding receptors.
They are effective in small concentrations, ensuring efficient use of resources.
Hormones are also stable, allowing them to travel through the bloodstream without being degraded.
Additionally, they are versatile, influencing a wide range of physiological processes, from metabolism to growth and reproduction.

4. (a) Study the photosynthesis equation given below and answer the questions which follow:
$6CO_2 + 6H_2O$ ----------> $C_6H_{12}O_6 + 6O_2$

(i) Give two reasons to justify the fact that this equation is not correct although it is balanced.

The equation oversimplifies the process of photosynthesis by not accounting for the intermediate steps, such as the formation of ATP and NADPH in the light-dependent reactions. Additionally, it does not specify that the oxygen released comes from the splitting of water, not from carbon dioxide.

(ii) Identify two types of reaction that take place in the photosynthesis process and state specifically where in the cell does each reaction take place.

The light-dependent reaction occurs in the thylakoid membranes of chloroplasts, where sunlight is used to produce ATP and NADPH. The light-independent reaction, also known as the Calvin cycle, occurs in the stroma of chloroplasts, where carbon dioxide is fixed into glucose.

(b) Explain how each of the following factors affects the rate of photosynthesis:

(i) Temperature
Temperature affects enzyme activity in the photosynthesis process. At low temperatures, enzymes become less active, slowing down the reactions. At high temperatures, enzymes may denature, causing a decline in the photosynthetic rate.

(ii) Inorganic ions
Inorganic ions such as magnesium and manganese are essential cofactors for enzymes involved in photosynthesis. Magnesium, for instance, is a component of chlorophyll, while manganese is crucial for the photolysis of water.

5. (a) Identify two categories of carbohydrates.

The two categories of carbohydrates are simple carbohydrates (monosaccharides and disaccharides) and complex carbohydrates (polysaccharides).

(b) Using one example in each case, describe six functions of carbohydrates in organisms.
Carbohydrates are essential biomolecules that perform a variety of critical functions in living organisms. Here are six key functions, each illustrated with an example:

(i) Primary Energy Source
Carbohydrates serve as the main energy source for daily activities. For instance, glucose, a simple sugar, is metabolized to produce ATP, the energy currency of cells. This energy fuels various bodily functions, including muscle contractions and brain activity.

(ii) Energy Storage
Organisms store energy in the form of complex carbohydrates. In animals, glycogen is stored in the liver and muscles, providing a readily available energy reserve during increased physical activity. In plants, starch serves a similar storage function, accumulating in roots and seeds to support growth and reproduction.

(iii) Structural Support
Certain carbohydrates provide structural integrity to cells and tissues. Cellulose, a polysaccharide found in plant cell walls, imparts rigidity and strength, enabling plants to maintain their shape and withstand various

environmental stresses. Similarly, chitin, found in the exoskeletons of arthropods and the cell walls of fungi, provides structural support.

(iv) Component of Nucleic Acids
Carbohydrates are integral components of nucleic acids. Ribose, a five-carbon sugar, is a constituent of RNA, while deoxyribose is found in DNA. These sugars form the backbone of nucleic acid structures, playing a crucial role in genetic information storage and transmission.

(v) Cell Recognition and Signaling
Carbohydrates on cell surfaces are involved in cell recognition and signaling processes. Glycoproteins and glycolipids, which have carbohydrate groups attached, are essential for immune responses, hormone function, and interactions between cells. For example, blood group antigens are glycoproteins that determine blood types and compatibility during transfusions.

(vi) Prevention of Protein Degradation
In situations where carbohydrate intake is insufficient, the body may break down proteins for energy. Adequate carbohydrate consumption spares proteins from being used as an energy source, allowing them to perform their primary functions, such as tissue repair and enzyme production. This protein-sparing effect is vital for maintaining muscle mass and overall health.

6. (a) What is phytohormone?

A phytohormone is a naturally occurring organic compound produced in plants in small quantities that regulates growth, development, and responses to environmental stimuli. These hormones act as chemical messengers, influencing processes such as cell division, elongation, and differentiation, as well as responses to stress and stimuli.

(b) Outline three roles of each of the following phytohormones:

(i) Auxins
Auxins play a critical role in plant growth and development. They promote cell elongation in stems and roots, enabling plants to grow towards light (phototropism) or gravity (gravitropism). Auxins also regulate apical dominance by suppressing the growth of lateral buds, ensuring that the main shoot grows more vigorously. Additionally, auxins stimulate root initiation and development, which is crucial for the establishment of new plants in propagation.

(ii) Gibberellins
Gibberellins are essential for promoting stem elongation, allowing plants to increase their height. They also play a role in breaking seed dormancy, enabling seeds to germinate under favorable conditions. Furthermore, gibberellins stimulate flowering and fruit development, enhancing the reproductive success of plants.

(iii) Cytokinins
Cytokinins promote cell division, which is vital for plant growth and tissue repair. They also delay leaf senescence, prolonging the photosynthetic activity of plants. Additionally, cytokinins work in conjunction with auxins to regulate organ development, such as the formation of roots and shoots in tissue culture.

7. (a) For each organism, identify the observable features only and put a tick (✓) if the characteristic is present or a cross (X) if the characteristic is absent in Table 1.

Organism	Wings two pair	Antennae present	Legs three pair	Legs four pair
S3	✓	✓	✓	X
S4	X	✓	X	✓
S5	X	X	X	✓
S6	✓	✓	✓	X
S7	X	✓	X	✓

(b) Use the characteristics you have filled in Table 1 to construct a simple bracketed key.

1. (a) Wings present ..... Go to 2
   (b) Wings absent ..... Go to 3

2. (a) Two pairs of wings S3
   (b) One pair of wings S6

3. (a) Legs three pairs S4
   (b) Legs four pairs ..... Go to 4

4. (a) Antennae present S7
   (b) Antennae absent S5

8. Explain the following concepts as used in the movement of materials in the body of an organism:

(a) Active transport.
Active transport is the movement of substances across a cell membrane against their concentration gradient, from a region of lower concentration to a region of higher concentration. This process requires energy, typically in the form of ATP, and involves the use of carrier proteins or pumps. Active transport is essential for maintaining ion gradients, nutrient absorption, and waste elimination in cells.

(b) Closed circulatory system.
A closed circulatory system is a system in which blood is confined within vessels, creating a continuous circuit throughout the body. Blood flows from the heart through arteries, capillaries, and veins, ensuring

efficient transport of oxygen, nutrients, and waste products. This system enables higher blood pressure and more efficient nutrient delivery, as seen in vertebrates.

(c) Symplast.
The symplast refers to the interconnected cytoplasm of plant cells connected through plasmodesmata, small channels that allow the direct movement of water, ions, and solutes between cells. This pathway facilitates the transport of nutrients and signaling molecules throughout the plant without crossing cell membranes.

(d) Apoplast.
The apoplast refers to the non-living components of a plant, including cell walls and intercellular spaces. Water and solutes move through this pathway without crossing the cell membrane, traveling along the cell walls and spaces between cells. The apoplast pathway is crucial for rapid water movement in plants.

9. Describe the events which comprise the mechanism of fertilization in mammals.

Fertilization in mammals begins with the process of ovulation, during which a mature egg is released from the ovary and enters the fallopian tube. During copulation, sperm is deposited in the female reproductive tract and travels toward the egg, guided by chemical signals.

Upon reaching the egg, the sperm must penetrate the protective layers surrounding the egg, including the corona radiata and the zona pellucida. The acrosomal reaction occurs, during which enzymes are released from the sperm's acrosome to digest these protective layers.

Once a sperm successfully penetrates the zona pellucida, it fuses with the egg's plasma membrane, and the sperm nucleus enters the egg. This triggers the cortical reaction, which prevents additional sperm from fertilizing the egg by altering the structure of the zona pellucida.

The sperm and egg nuclei fuse, forming a diploid zygote. The zygote begins cell division as it travels down the fallopian tube toward the uterus, where it will implant and develop into an embryo.

10. (a) (i) Define the term respiratory quotient.

The respiratory quotient (RQ) is the ratio of the volume of carbon dioxide produced to the volume of oxygen consumed during cellular respiration. It is used to determine the type of substrate (carbohydrates, fats, or proteins) being metabolized for energy.

(ii) For each metabolic pathway listed in Table 2, name the specific location in the cell it occurs, substrates used, and products formed under each.

Metabolic Pathway	**Precise Location**	**Substrates**	**Products**
Glycolysis	Cytoplasm	Glucose	Pyruvate, ATP, NADH
Krebs Cycle	Mitochondrial matrix	Acetyl-CoA	ATP, NADH, FADH2, CO2
Alcoholic Fermentation	Cytoplasm	Glucose	Ethanol, CO2, ATP

(b) Briefly explain how each of the following factors affect the rate of respiration:

(i) Temperature.
Temperature influences the rate of respiration as it affects enzyme activity. At low temperatures, enzymes are less active, slowing down respiration. As the temperature increases, the rate of respiration also increases until an optimal temperature is reached. Beyond this point, high temperatures may denature enzymes, leading to a decline in respiration rates.

(ii) Size of an organism.
The size of an organism affects the rate of respiration due to differences in metabolic demands. Smaller organisms typically have a higher metabolic rate and require more energy per unit of body mass, resulting in a higher rate of respiration. Larger organisms, on the other hand, have lower metabolic rates relative to their size, leading to slower respiration rates.