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: 2019.**

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)(i) The structure represented by Figure 1 is a bacterial cell.

(ii) The parts labeled U, V, W, and X are as follows:
- U: Capsule
- V: Cell wall
- W: Plasma membrane
- X: Cytoplasm

(iii) The roles of each part are:
- U (Capsule): Protects the bacterial cell from desiccation and shields it from the host immune system.
- V (Cell wall): Provides structural support and protects the cell from mechanical damage and osmotic lysis.
- W (Plasma membrane): Regulates the transport of substances into and out of the cell, maintaining homeostasis.
- X (Cytoplasm): Serves as the site for biochemical reactions and houses cellular components such as ribosomes and genetic material.

(b) The bacterial cell plays important roles, including the following:
- Protection: The capsule and cell wall provide protection against physical and chemical damage.
- Reproduction: The cytoplasm contains DNA necessary for replication and cellular processes.
- Nutrient acquisition: The plasma membrane facilitates nutrient absorption and waste removal.
- Metabolism: The cytoplasm contains enzymes for metabolic processes, including energy production and biosynthesis.

(b) Enumerate four roles played by the structure represented by Figure 1.

The bacterial cell plays the following roles:
- It is involved in nutrient cycling and decomposition, breaking down organic matter in ecosystems.
- It participates in symbiotic relationships, such as nitrogen fixation in legumes, which supports plant growth.
- It serves as a model organism in scientific research, contributing to our understanding of molecular biology and genetics.
- Some bacterial cells are used in biotechnology and industrial processes, such as fermentation and the production of antibiotics.

2. (a) Explain the procedure for testing non-reducing sugar in a given solution.

To test for non-reducing sugar, the solution is first tested for reducing sugars using Benedict's solution. If no precipitate forms, the solution is treated with dilute hydrochloric acid and heated to hydrolyze glycosidic bonds, breaking non-reducing sugars into their reducing components.
After cooling, the solution is neutralized with sodium hydroxide. Benedict's solution is then added to the neutralized mixture and heated again. A brick-red precipitate indicates the presence of non-reducing sugars.

(b) Analyze the chemical composition of the following food substances:
(i) Lipids
(ii) Proteins

- Lipids are composed primarily of carbon, hydrogen, and oxygen.
  They are hydrophobic molecules, often forming long hydrocarbon chains or rings.
  Lipids serve as energy reserves, structural components of cell membranes (phospholipids), and signaling molecules (steroids).

- Proteins are composed of amino acids linked by peptide bonds, containing elements such as carbon, hydrogen, oxygen, nitrogen, and sometimes sulfur. They perform diverse functions, including acting as enzymes, providing structural support, facilitating transport, and serving as signaling molecules.

3. (a) (i) Identify the lowest taxon.

The lowest taxon in biological classification is the species.
(ii) Illustrate the taxonomic hierarchy of human beings.

The taxonomic hierarchy of humans is:
Domain: Eukarya
Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Primates
Family: Hominidae
Genus: Homo
Species: sapiens

(b) (i) Why classification of organisms is needed? Give three points.

Classification of organisms is needed to organize the vast diversity of life forms, making it easier to study and identify species. It helps scientists understand evolutionary relationships by grouping organisms with shared ancestry. Additionally, it facilitates communication and consistency in naming organisms across the scientific community.

(ii) Analyze three differences between natural and artificial systems of classification.

Natural classification groups organisms based on evolutionary relationships, while artificial classification focuses on observable characteristics such as size or color. Natural systems provide insight into evolutionary history, whereas artificial systems are often simpler but less informative. Lastly, natural classification is universally applicable to diverse organisms, while artificial systems may group unrelated species based on superficial traits.

4. (a) Identify four main types of receptors and state the role of each.

The four main types of receptors are mechanoreceptors, chemoreceptors, thermoreceptors, and photoreceptors. Mechanoreceptors detect mechanical changes, such as pressure, vibration, or touch. Chemoreceptors respond to chemical stimuli, such as changes in blood pH or the presence of specific molecules. Thermoreceptors detect temperature changes, while photoreceptors respond to light stimuli, enabling vision.

(b) Describe the effect of the following factors in the transmission of nerve impulses:
(i) Axon diameter
(ii) Myelin sheath

Axon diameter affects the speed of impulse transmission; larger-diameter axons conduct impulses more rapidly due to reduced electrical resistance.
The myelin sheath increases the speed of nerve impulses by allowing saltatory conduction, where the signal jumps between nodes of Ranvier, bypassing the myelinated sections of the axon.

5. (a) (i) Identify the type of tissue represented by the Figure 2.

The tissue represented by Figure 2 is the epithelium of the small intestine, specifically the villus structure lined with columnar epithelial cells.

(ii) Examine the digestion role played by the tissue.

The tissue plays a critical role in digestion and absorption. The villi increase the surface area for absorption, enabling the efficient uptake of nutrients such as glucose, amino acids, and fatty acids. The epithelial cells on the villi secrete enzymes that aid in the final stages of chemical digestion, breaking down macromolecules into smaller absorbable units.

(iii) Elaborate how the structure of the tissue relates to its function.

The structure of the tissue is highly specialized for its role. The villi are finger-like projections that significantly increase the surface area for absorption. Each villus is covered with microvilli, forming a brush border that further enhances nutrient uptake. The epithelial cells are rich in mitochondria, providing energy for active transport mechanisms. Additionally, the presence of a rich capillary network within the villi ensures that absorbed nutrients are quickly transported into the bloodstream for distribution to the rest of the body.

(b) (i) Examine three features of the ileum which increases its surface area.

The ileum has several features that enhance its surface area for absorption. Firstly, it contains villi, which are small finger-like projections extending into the lumen of the intestine. These structures greatly increase the absorptive surface area. Secondly, the epithelial cells of the villi possess microvilli, forming a dense

brush border that further amplifies the surface area. Lastly, the ileum has folds called plicae circulares, which are circular ridges that slow down the movement of food and increase the time for absorption.

(ii) Why is it an advantage for the ileum to have a large surface area? Give two reasons.

A large surface area in the ileum is advantageous as it maximizes the absorption of nutrients, ensuring that the body obtains the essential components required for energy production and growth. Additionally, the increased surface area facilitates the rapid uptake of water and electrolytes, maintaining the body's fluid and electrolyte balance.

6. (a) State the function of each of the following neurons:

(i) Motor
Motor neurons transmit impulses from the central nervous system to effectors such as muscles and glands, enabling responses such as movement or secretion.

(ii) Sensory
Sensory neurons carry signals from sensory receptors, such as those in the skin or eyes, to the central nervous system, allowing the body to perceive and respond to stimuli.

(iii) Relay
Relay neurons, also known as interneurons, connect sensory and motor neurons within the central nervous system. They play a key role in processing information and generating appropriate responses.

(b) (i) Explain how the receptors of the nervous system communicate with effectors.

Receptors detect changes in the internal or external environment, such as pressure, temperature, or light, and generate electrical impulses. These impulses are transmitted to sensory neurons, which carry the signals to the central nervous system. The CNS processes the information and sends commands via motor neurons to effectors like muscles or glands, which then execute the appropriate response.

(ii) Briefly describe how the structure of the synapse ensures that the signals can only pass through it in only one direction.

The structure of the synapse ensures one-way signal transmission through the presence of neurotransmitter vesicles on the presynaptic neuron and specific receptors on the postsynaptic neuron. Neurotransmitters are released into the synaptic cleft when an electrical impulse reaches the axon terminal. These chemicals bind to receptors on the postsynaptic membrane, initiating a response. Since neurotransmitters are only released by the presynaptic neuron and receptors are located only on the postsynaptic neuron, the signal can only move in one direction.

7. Evaluate the importance of light and dark reaction processes of photosynthesis to life.

Photosynthesis is a fundamental biological process that sustains life on Earth by converting light energy into chemical energy stored in glucose. The light reaction, which occurs in the thylakoid membranes of chloroplasts, captures solar energy and converts it into ATP and NADPH. These energy carriers are essential for driving the dark reaction, also known as the Calvin cycle, which occurs in the stroma of the chloroplasts.

The light reaction is crucial for producing oxygen, a by-product released into the atmosphere during the photolysis of water. This oxygen is vital for aerobic respiration in most living organisms. The ATP and NADPH generated during the light reaction provide the energy and reducing power required for the dark reaction to synthesize glucose.

The dark reaction plays a key role in carbon fixation, converting atmospheric carbon dioxide into organic molecules like glucose. This process forms the basis of the food chain, as plants serve as primary producers. The glucose produced during the dark reaction is not only used by plants for growth and energy but also provides a source of energy for herbivores and, indirectly, carnivores.

In conclusion, the light and dark reactions of photosynthesis are interdependent processes that sustain life by providing energy, oxygen, and organic matter essential for growth and survival.

8. (a) State three roles of oestrogen hormones in reproduction.

Oestrogen plays a critical role in reproduction by performing several functions.
Firstly, it stimulates the thickening of the endometrial lining in the uterus during the menstrual cycle, creating a suitable environment for the implantation of a fertilized egg. This process ensures the successful establishment of pregnancy.
Secondly, oestrogen promotes the development and maturation of ovarian follicles, which contain eggs, making it essential for ovulation.
Finally, oestrogen plays a vital role in the development of secondary sexual characteristics in females, such as the growth of mammary glands and the widening of the hips, which are crucial for reproduction and childbirth.

(b) Identify and describe three stages of birth.

The three stages of birth are as follows:

The first stage is the dilation stage, during which the cervix dilates and effaces (thins) to allow the baby to pass through. Contractions of the uterus begin, becoming more frequent and intense over time. This stage ends when the cervix is fully dilated to about 10 cm.

The second stage is the expulsion stage, which involves the actual delivery of the baby. Powerful uterine contractions and maternal efforts push the baby through the birth canal. The baby's head emerges first, followed by the rest of the body.

The third stage is the placental stage, during which the placenta, umbilical cord, and other membranes are expelled from the uterus. This occurs shortly after the baby is delivered and is accompanied by mild contractions to ensure complete expulsion.

9. With the help of a diagram, describe the structure of stomata.

Stomata are microscopic openings primarily located on the epidermis of plant leaves and stems, playing a crucial role in gas exchange and transpiration. Each stoma (singular of stomata) is flanked by two specialized guard cells that regulate its opening and closing.

Structure of Stomata.

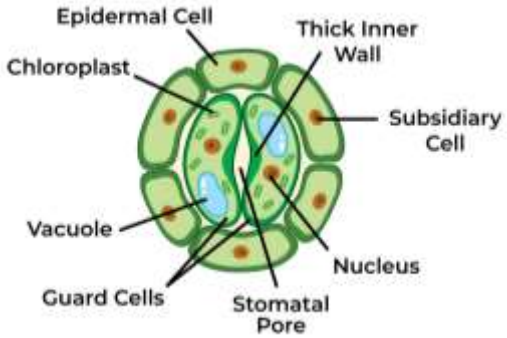
Guard Cells. These are two kidney-shaped (in dicots) or dumbbell-shaped (in monocots) cells that surround the stomatal pore. Guard cells contain chloroplasts, enabling them to perform photosynthesis. Their inner walls are thicker and less flexible than their outer walls, a feature that is essential for the opening and closing mechanism of the stomata.

Stomatal Pore. The central opening between the guard cells through which gas exchange occurs.

Subsidiary Cells. These are the epidermal cells adjacent to the guard cells. They assist in the functioning of guard cells by providing structural support and contributing to the regulation of stomatal movements.

Epidermal Cells. These cells form the outermost layer of the leaf or stem and surround the stomata and subsidiary cells. They provide protection and support to the internal tissues of the plant.

Diagram of Stomata.



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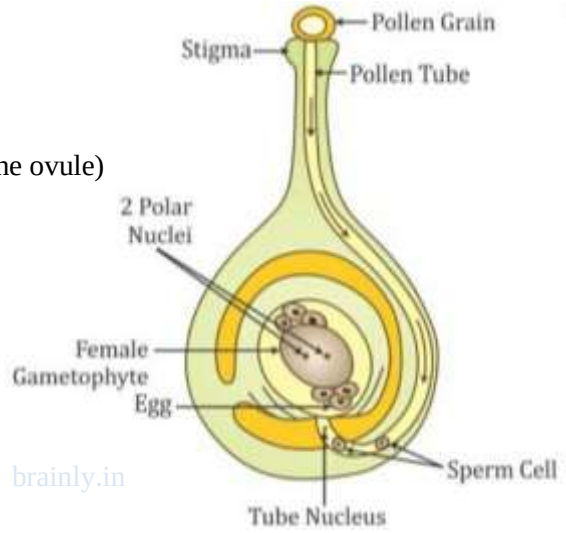
Functioning of Stomata

The primary functions of stomata include:
- Gas Exchange. Stomata facilitate the exchange of gases by allowing carbon dioxide to enter the leaf for photosynthesis and oxygen, a byproduct of photosynthesis, to exit.
- Transpiration. Through the opening and closing of stomata, plants regulate water loss by transpiration, which helps in cooling the plant and maintaining nutrient uptake.
- Regulation of Internal Gas Concentrations. By controlling the aperture of the stomatal pore, guard cells help maintain optimal internal concentrations of gases, which is essential for efficient photosynthesis and respiration.

- The opening and closing of stomata are regulated by the turgor pressure within the guard cells. When guard cells take up water and become turgid, the stomatal pore opens. Conversely, when they lose water and become flaccid, the pore closes. This mechanism is influenced by various environmental factors, including light, carbon dioxide concentration, and internal plant signals.

10. (a) Draw a longitudinal section of a matured carpel at its fertilization stage and indicate the parts which carry out each of the following roles using roman numbers:

(i) Receives pollen grain: Stigma
(ii) Transfers pollen grain to the ovule: Style
(iii) Fuse with male gamete to form zygote: Ovule (egg cell within the ovule)
(iv) Attaches ovule to the ovary: Funiculus
(v) Protects egg cell: Ovary wall
(vi) Controls growth of pollen tube: Style
(vii) Fertilizes female gametes: Pollen tube nucleus
(viii) Fuses with male nucleus to form endosperm: Polar nuclei



A carpel is the female reproductive structure of a flower, comprising the stigma, style, and ovary. At the fertilization stage, the carpel facilitates the union of male and female gametes, leading to seed formation.
- Stigma. The receptive tip of the carpel where pollen grains land during pollination.
- Style. A slender stalk connecting the stigma to the ovary; it provides a pathway for pollen tubes to grow toward the ovule.
- Ovary. The enlarged basal portion of the carpel containing one or more ovules; it develops into the fruit after fertilization.

- Ovule. Located within the ovary, each ovule houses the female gametophyte and, upon fertilization, becomes a seed.
- Pollen Tube. A tubular structure that grows from a germinated pollen grain through the style to the ovule, allowing the sperm cells to reach the egg cell.

- Egg Cell. The female gamete located within the ovule; it fuses with a sperm cell during fertilization to form a zygote.
- Polar Nuclei.Two nuclei in the central cell of the ovule; they fuse with a second sperm cell to form the triploid endosperm, which nourishes the developing embryo.

During fertilization, pollen grains adhere to the stigma and germinate, forming pollen tubes that extend down the style toward the ovary. Each pollen tube carries two sperm cells. Upon reaching an ovule, one sperm cell fuses with the egg cell to form a diploid zygote, which will develop into the embryo. The other sperm cell fuses with the two polar nuclei to form the triploid endosperm, providing nourishment to the developing embryo. This process, known as double fertilization, is unique to flowering plants and ensures the coordinated development of the embryo and its food supply.

(b) Describe the events leading to double fertilization in plants.

Double fertilization is a unique process in flowering plants involving two sperm cells. After pollination, the pollen grain germinates on the stigma, forming a pollen tube that grows down the style toward the ovule. The tube nucleus controls the growth of the pollen tube, guiding it through the micropyle of the ovule.

Once the pollen tube reaches the ovule, it releases two sperm cells into the embryo sac. One sperm cell fuses with the egg cell to form a zygote, which develops into the embryo. The second sperm cell fuses with the two polar nuclei in the central cell to form a triploid cell, which develops into the endosperm, a tissue that nourishes the developing embryo. This process ensures the coordinated development of the embryo and its food supply, making double fertilization critical for seed formation.