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: 2020.**

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) Draw the structure of a generalised plant cell as seen under an electron microscope and use Roman numerals to label only the parts which are associated with the following roles:

(i) Strengthening of the cell
(ii) Controlling the exchange between the cell and its environment
(iii) Provision of energy
(iv) Protein synthesis
(v) Manufacture of food
(vi) Controlling of cell activities.

A generalised plant cell consists of several organelles that perform different functions. Below are the parts labeled with Roman numerals according to their functions:

(i) Strengthening of the cell: Cell Wall – The cell wall provides mechanical support and maintains the shape of the cell.

(ii) Controlling the exchange between the cell and its environment: Cell Membrane (Plasma Membrane) – It regulates the movement of substances in and out of the cell.

(iii) Provision of energy: Mitochondria – This organelle is the powerhouse of the cell, where cellular respiration occurs to produce energy in the form of ATP.

(iv) Protein synthesis: Ribosomes – They are responsible for synthesizing proteins required for cell functions.
(v) Manufacture of food: Chloroplasts – These organelles conduct photosynthesis, converting light energy into chemical energy.
(vi) Controlling of cell activities: Nucleus – It contains genetic material (DNA) and directs all cellular activities.

(b) Identify four structures which are found in plant cells but not in animal cells.

- Cell Wall – Provides structural support and maintains the shape of the plant cell.
- Chloroplasts – Contain chlorophyll and are responsible for photosynthesis.
- Large Central Vacuole – Stores nutrients, water, and waste products and helps maintain turgor pressure.
- Plasmodesmata – Small channels that connect neighboring plant cells, allowing the exchange of materials and communication.

(c) How are the following processes important to a cell?

(i) Phagocytosis
Answer: Phagocytosis is the process by which a cell engulfs large particles such as bacteria or dead cells. It is important because:

It helps the immune system by removing harmful microorganisms.
It aids in the digestion and breakdown of engulfed materials.

(ii) Pinocytosis
Answer: Pinocytosis is the uptake of extracellular fluids and dissolved substances into the cell. It is important because:

It helps cells absorb essential nutrients.
It plays a role in regulating the extracellular environment.

(iii) Exocytosis
Answer: Exocytosis is the process by which cells release substances into the extracellular environment. It is important because:
It allows the secretion of proteins, enzymes, and hormones.
It removes waste materials from the cell.

2. (a) (i) Identify three types of nerve cells.

- Sensory neurons – Transmit sensory information from receptors to the central nervous system.
- Motor neurons – Carry signals from the central nervous system to muscles and glands.
- Interneurons – Connect sensory and motor neurons and facilitate communication within the nervous system.

(ii) State the role(s) of each nerve cell identified in 2 (a) (i).

Sensory neurons – Detect stimuli (such as heat, pressure, or pain) and send signals to the brain or spinal cord.
Motor neurons – Control muscle movement by transmitting impulses from the brain or spinal cord.
Interneurons – Act as intermediaries, processing and relaying messages between sensory and motor neurons.

(b) Give a reason to support the fact that giant axons conduct impulses at greater velocities than thin axons.

Answer: Giant axons conduct impulses faster because their larger diameter reduces internal resistance, allowing electrical signals to travel more efficiently.

3. (a) (i) What is the scientific name of human being?
Answer: Homo sapiens

(ii) List hierarchically the major classification taxa.

1. Domain: Eukarya
2. Kingdom: Animalia

3. Phylum: Chordata
4. Class: Mammalia
5. Order: Primates
6. Family: Hominidae
7. Genus: Homo
8. Species: sapiens

(b) (i) Why are Animal, Plant, Protoctista, and Fungi considered to be Eukaryote Kingdoms while bacteria are considered to be Kingdom Prokaryotae?

Answer: Eukaryote kingdoms contain organisms with cells that have a true nucleus and membrane-bound organelles, whereas bacteria (Kingdom Prokaryotae) lack a nucleus and organelles.

(ii) State five rules that a biologist should follow in binomial nomenclature.

- The scientific name should consist of two Latin words: the genus and species.
- The genus name should begin with a capital letter, while the species name should be lowercase.
- The entire scientific name should be italicized in print or underlined when handwritten.
- The name should be universal and not change with language.
- The scientific name should be unique to each species.

4. (a) Giving reason, state a part in the body of a mammal where large number of the following organelles are found:

(i) Lysosomes – Found in white blood cells because they contain digestive enzymes for breaking down foreign substances.
(ii) Microbodies – Found in liver cells, where they help in detoxification processes.

(b) What will happen if each of the following organelles is severely damaged? Give four points in each.

(i) Nucleus
The cell will lose control over its functions.
DNA replication and repair will be disrupted.
Protein synthesis will be affected.
The cell may undergo uncontrolled division, leading to cancer.

(ii) Lysosome
Cellular waste will accumulate.
The cell will be unable to digest harmful invaders.
Cellular metabolism will be disrupted.
The cell may die due to toxic buildup.

(iii) Vacuole
The cell will lose its ability to store water and nutrients.
The plant will wilt due to lack of turgor pressure.
Waste accumulation will increase.
The cell will shrink and die.

(iv) Endoplasmic Reticulum
Protein and lipid synthesis will be affected.
Transport of materials within the cell will be disrupted.
Detoxification processes will slow down.
The cell may fail to grow properly.

5. Give explanation to support the following facts:

(a) A placenta is a structure for excretion, digestion, and respiration of a foetus.

Answer: The placenta is a vital organ that forms during pregnancy and serves as the interface between the mother and the developing foetus. It plays multiple crucial roles, including:

(i) Excretion: The placenta helps remove waste products from the foetus, such as carbon dioxide and urea, by transferring them into the mother's bloodstream for elimination through her excretory system (lungs and kidneys). This prevents toxic buildup in the foetus.

(ii) Digestion: The placenta facilitates the transport of essential nutrients such as glucose, amino acids, vitamins, and minerals from the mother's bloodstream to the foetus. These nutrients are crucial for the foetus's growth and development, as it cannot digest food independently.

(iii) Respiration: Oxygen from the mother's blood diffuses through the placenta into the foetal bloodstream, while carbon dioxide from the foetus moves in the opposite direction. This gas exchange ensures that the foetus receives an adequate oxygen supply for cellular respiration, as its lungs are not yet functional.
Thus, the placenta functions as a temporary lung, kidney, and digestive organ for the foetus, ensuring survival and development in the womb.
(b) Removal of ovaries from a three-months pregnant woman does not result in abortion.

Answer: The removal of the ovaries after three months of pregnancy does not lead to abortion because:

(i) Placenta Takes Over Hormone Production: During the first trimester, the ovaries, specifically the corpus luteum, produce progesterone, which maintains the pregnancy. However, after three months, the placenta becomes the primary source of progesterone and estrogen. These hormones continue to support the pregnancy by maintaining the uterine lining and preventing contractions.

(ii) Progesterone Maintains Pregnancy: The role of the ovaries in producing progesterone diminishes after the placenta fully develops. Since progesterone is essential for preventing uterine contractions that could lead to miscarriage, the placenta ensures its continuous supply.

(iii) Foetal Development is Independent of Ovaries: By the end of the first trimester, the foetus has developed significantly and depends more on the placenta than on ovarian hormones for its survival.

(iv) Medical Interventions Can Support Hormonal Balance: If necessary, synthetic progesterone supplements can be administered to ensure that the pregnancy continues smoothly without the ovaries.

Thus, the removal of ovaries at this stage does not affect pregnancy because the placenta has already taken over its functions.

6. (a) How do the following structures relate to their digestive role?

(i) Columnar epithelium of the stomach.

Answer: The columnar epithelium of the stomach plays a critical role in digestion through the following functions:
(i) Secretion of Mucus: The columnar epithelial cells secrete mucus, which forms a protective barrier on the stomach lining, preventing damage from the acidic environment and digestive enzymes.

(ii) Gastric Juice Secretion: Specialized epithelial cells, such as parietal cells, produce hydrochloric acid (HCl), which helps in the breakdown of food and activation of digestive enzymes like pepsinogen into pepsin for protein digestion.

(iii) Nutrient Absorption: Although most absorption occurs in the small intestine, some simple molecules like water, alcohol, and certain drugs can be absorbed through the stomach lining.

(iv) Facilitating Movement of Food: The columnar epithelium contributes to the smooth lining of the stomach, enabling easy movement of food as it mixes with gastric juices.

(ii) Columnar epithelium of the small intestine.

Answer: The columnar epithelium of the small intestine is highly specialized for digestion and absorption:

(i) Presence of Microvilli: The epithelial cells have microvilli, tiny finger-like projections that significantly increase the surface area for absorption of nutrients. This ensures efficient uptake of glucose, amino acids, and fatty acids.

(ii) Secretion of Digestive Enzymes: The epithelial cells produce enzymes such as maltase, sucrase, and lactase, which break down carbohydrates into simpler sugars for absorption.

(iii) Facilitating Nutrient Transport: The columnar epithelial cells allow the passage of digested food into blood capillaries and lacteals for distribution to body tissues.

(iv) Protection and Lubrication: Goblet cells within the epithelium secrete mucus, which protects the intestinal wall from digestive enzymes and acidic chyme.
(b) Giving two points, briefly describe the role of liver in digestion.

Answer: The liver plays a crucial role in digestion through:

(i) Production of Bile: The liver produces bile, which emulsifies fats, breaking them into smaller droplets to increase their surface area for enzyme action. This makes fat digestion more efficient.

(ii) Detoxification of Blood: The liver detoxifies harmful substances absorbed from the digestive system, such as alcohol, drugs, and toxins, ensuring they do not enter the bloodstream in harmful amounts.

7. (a) What is respiratory quotient?

Answer: The respiratory quotient (RQ) is the ratio of carbon dioxide (CO_2) produced to oxygen (O_2) consumed during cellular respiration. It is calculated using the formula:

RQ = CO_2 eliminated / O_2 consumed

The RQ value varies depending on the type of substrate (carbohydrates, proteins, or fats) being metabolized.

(b) What information does each of the following respiratory quotients (RQ) carry? Give two points.

(i) RQ = 1.0
An RQ of 1.0 indicates that carbohydrates are the primary source of energy.
(i) Carbohydrate Metabolism: This means that glucose or other carbohydrates are being completely oxidized, producing an equal ratio of CO_2 to O_2.

(ii) Aerobic Respiration: It suggests that respiration is occurring with sufficient oxygen supply, without anaerobic processes.

(ii) RQ = 0.9
- An RQ of 0.9 suggests partial carbohydrate metabolism or the oxidation of proteins.

(i) Protein Metabolism: This value is associated with the breakdown of amino acids for energy, which produces slightly less CO_2 per O_2 consumed.
(ii) Mixed Diet Utilization: It indicates that the body is metabolizing a combination of carbohydrates and proteins.
(iii) RQ = 0.7
An RQ of 0.7 indicates that fats are being used as the main energy source.

(i) Fat Metabolism: The oxidation of fats produces less CO_2 per O_2 consumed because fats contain more hydrogen atoms and require more oxygen for complete oxidation.

(ii) Prolonged Starvation or Exercise: A low RQ suggests that the body is relying on fat stores for energy, which commonly occurs during fasting or endurance activities.

(c) A baby was born with its lungs lacking surfactant. In three points, briefly describe the respiratory problem that the baby will experience.
Surfactant is a substance produced in the lungs that reduces surface tension, preventing the alveoli from collapsing. If a baby is born without surfactant, the following respiratory issues will occur:

(i) Alveolar Collapse (Atelectasis): The baby's alveoli will collapse after each breath, making it extremely difficult to inhale oxygen and expel carbon dioxide, leading to respiratory distress syndrome (RDS).

(ii) Severe Breathing Difficulty: Without surfactant, the baby will need to exert much more effort to breathe, often leading to rapid, shallow breathing and a lack of proper oxygen exchange.

(iii) Hypoxia (Low Oxygen Levels): Due to poor oxygen absorption, the baby's organs and tissues will receive insufficient oxygen, leading to potential organ failure if not treated with oxygen therapy or artificial surfactant administration.
Thus, surfactant is critical for lung function, and its absence causes severe respiratory complications in newborns.

8. (a)(i) The processes represented by letters A and B are:
A - Glycolysis.
B - Electron transport chain.

(a)(ii) The letters X and Y represent the following:

X - Oxygen, which acts as the final electron acceptor in the electron transport chain.
Y - ATP, the energy-carrying molecule produced during cellular respiration.

(a)(iii) If the processes labeled A and B are impaired, the following will happen:

If process A (glycolysis) is impaired, the cell will be unable to break down glucose into pyruvate, leading to a severe reduction in the production of ATP. This lack of energy can cause cellular functions to halt, potentially leading to cell death. Additionally, the Krebs cycle and electron transport chain cannot proceed as they rely on the products of glycolysis.

If process B (electron transport chain) is impaired, the cell will be unable to produce the majority of its ATP through oxidative phosphorylation. This impairment will result in a buildup of hydrogen ions and electrons, leading to the accumulation of reduced cofactors such as NADH and FADH2. The cell will rely solely on glycolysis for energy, which is inefficient, and may lead to lactic acid buildup under anaerobic conditions.

(b) In seven points, explain the importance of fermentation processes to human beings.
Fermentation is a metabolic process that converts carbohydrates, such as glucose, into simpler compounds like acids, gases, or alcohol in the absence of oxygen. This anaerobic process is carried out by microorganisms, such as bacteria and yeast, as well as by cells in some human tissues. Fermentation is significant to human beings for various reasons, as discussed below.

Firstly, fermentation is essential in the production of food and beverages. It is used in the manufacture of a variety of consumables, including bread, yogurt, cheese, beer, and wine. For instance, yeast ferments sugars in dough to produce carbon dioxide, which causes bread to rise. Similarly, in alcoholic beverages, fermentation produces ethanol and contributes to their flavor and texture, making it a cornerstone of the food and beverage industry.

Secondly, fermentation plays a vital role in human metabolism during oxygen-deprived conditions. For example, during intense physical activity, oxygen supply to muscle cells may become insufficient. In such situations, cells switch to lactic acid fermentation to produce ATP, providing a temporary energy supply that sustains muscle contractions until oxygen becomes available again.

Thirdly, fermentation is crucial in the preservation of food. Fermented foods, such as pickles, kimchi, and sauerkraut, are less likely to spoil because the acidic environment created during fermentation inhibits the growth of harmful bacteria. This makes fermentation a natural and effective method for extending the shelf life of food.

Fourthly, fermentation contributes to human health by enhancing the nutritional value of certain foods. During fermentation, microorganisms break down complex compounds into simpler, more digestible forms. For example, in yogurt, lactose is converted into lactic acid, making it easier for lactose-intolerant individuals to consume dairy products. Additionally, fermentation can increase the levels of vitamins, such as vitamin B12 and folate, in some foods.

Fifthly, fermentation is important in the production of pharmaceuticals. Many antibiotics, such as penicillin, are produced through fermentation processes using specific microorganisms. This method ensures a steady and efficient production of life-saving drugs, which are essential for treating various infections and diseases.

Sixthly, fermentation contributes to waste management and energy production. Organic waste materials, such as agricultural residues, can be fermented to produce biogas, a renewable energy source consisting primarily of methane. This not only provides an alternative energy solution but also helps in reducing environmental pollution.

Lastly, fermentation has cultural and traditional significance. Fermented foods and beverages are integral to many cultures around the world, playing a role in traditional cuisines, festivals, and rituals. For instance, fermented drinks like kombucha and kefir are associated with health benefits and are increasingly popular in modern dietary practices.

In conclusion, fermentation is a process of immense importance to human beings, influencing food production, health, energy generation, and even cultural traditions. Its wide-ranging applications demonstrate its integral role in daily life and the global economy.

9. (a) State where and when meiosis takes place in each of the following organisms:

(i) Moss plant
Answer: In moss plants, meiosis occurs in the spore mother cells within the capsule (sporangium) of the sporophyte. This process happens during the transition from the diploid sporophyte generation to the haploid gametophyte generation, producing haploid spores that germinate into new gametophytes.

(ii) Angiosperms
In angiosperms (flowering plants), meiosis takes place in:
The anther (in the microspore mother cells) to produce haploid microspores, which develop into pollen grains.
The ovule (in the megaspore mother cell) to produce haploid megaspores, which develop into the female gametophyte (embryo sac).
This process occurs during flower development before fertilization.

(iii) Mammals
In mammals, meiosis occurs in the reproductive organs:
Males (Testes): Meiosis takes place in the seminiferous tubules, where spermatocytes undergo meiosis to produce haploid sperm cells.
Females (Ovaries): Meiosis occurs in the ovaries, where primary oocytes undergo meiosis to form eggs. However, in females, meiosis is arrested at prophase I at birth and only resumes during ovulation and fertilization.

(b) The number of chromosomes in the radicle of certain species of flowering plant is 16. Evaluate the number of chromosomes in the following cells:

(i) Pollen tube nucleus
The pollen tube nucleus is haploid because it comes from the male gametophyte. Since the radicle (a diploid structure) has 16 chromosomes, the pollen tube nucleus will have 8 chromosomes.

(ii) Antipodal cell
The antipodal cell is part of the female gametophyte (embryo sac), which is haploid. Therefore, it contains 8 chromosomes.

(iii) Endosperm
The endosperm is triploid because it results from the fusion of one male nucleus (haploid) with two polar nuclei (haploid each). Hence, the number of chromosomes in the endosperm is 24 chromosomes (3×8).

(iv) Pollen mother cell
The pollen mother cell is diploid and undergoes meiosis to produce four haploid microspores. Since the radicle is diploid with 16 chromosomes, the pollen mother cell also has 16 chromosomes.

(c) Describe how each of the following parts of the human reproductive system is adapted to its function:

(i) Uterus
-The uterus is adapted for pregnancy and foetal development through:
-Thick muscular walls (Myometrium): These provide support and contract during childbirth to expel the baby.
-Highly vascularized endometrium: This lining thickens every menstrual cycle to provide a nourishing environment for the embryo. If fertilization occurs, the embryo implants here.
-Elasticity: The uterus can expand significantly during pregnancy to accommodate the growing foetus.

(ii) Cervix
The cervix connects the uterus to the vagina and plays vital roles in reproduction:
- Produces cervical mucus: This changes consistency during ovulation to allow or block sperm entry.
- Acts as a barrier: It prevents infections from reaching the uterus.
- Opens during childbirth: The cervix dilates to allow the baby to pass through during labor.

(iii) Ovaries
The ovaries are adapted to their reproductive function through:
- Follicle production: The ovaries contain thousands of follicles, each housing an immature egg.
- Hormone secretion: They produce estrogen and progesterone, which regulate the menstrual cycle and pregnancy.
- The ovaries release mature eggs into the fallopian tubes, where fertilization can occur.

10. With the aid of a diagram, describe the mechanism of transport of manufactured food in phloem based on Munch's mass flow hypothesis.

The mass flow hypothesis, also known as the pressure-flow hypothesis, was proposed by German plant physiologist Ernst Münch in 1930 to explain the mechanism of translocation of organic solutes, particularly sucrose, through the phloem in plants. This theory suggests that the movement of these solutes occurs en masse due to pressure gradients between the source (where sugars are produced) and the sink (where sugars are utilized or stored).

According to this hypothesis, photosynthesis in the mesophyll cells of leaves (the source) produces sugars, increasing the osmotic pressure within these cells. Consequently, water enters the mesophyll cells from the adjacent xylem vessels by osmosis, raising the turgor pressure. The sugars are then actively loaded into the sieve tube elements of the phloem through companion cells, further elevating the osmotic pressure inside

the sieve tubes. This osmotic influx of water from the xylem into the phloem generates a high turgor pressure at the source end.

At the sink, where sugars are consumed or stored, the process is reversed. Sugars are actively unloaded from the sieve tubes into the sink cells, decreasing the osmotic pressure within the sieve tubes. Water then exits the phloem and returns to the xylem, resulting in a lower turgor pressure at the sink end. The difference in turgor pressure between the source and sink creates a pressure gradient that drives the mass flow of phloem sap from regions of higher pressure (source) to regions of lower pressure (sink).

This mechanism efficiently transports nutrients throughout the plant, ensuring that energy produced in the leaves is distributed to other parts, such as roots, stems, and developing fruits. The mass flow hypothesis is supported by evidence indicating that phloem sap is under pressure and that concentration gradients of organic solutes exist between sources and sinks.