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: 2023.**

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 Form Five student studied the features of various organelles within an animal cell. After the study, the student said, "A mitochondrion can be regarded as a cell within the cell." Justify this statement by giving four points.

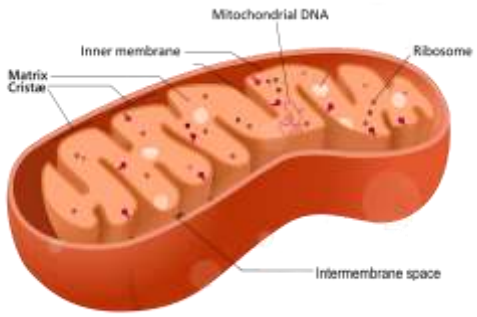
i. Double membrane: The mitochondrion is enclosed by an inner and outer membrane, resembling the structure of a typical cell, which provides compartmentalization for its biochemical processes.

ii. Own genetic material: Mitochondria have their own circular DNA, similar to prokaryotic cells, enabling them to synthesize some of their proteins independently of the nuclear genome.

iii. Ribosomes for protein synthesis: Mitochondria contain ribosomes, which allow them to translate specific proteins required for their function, emphasizing their semi-autonomous nature.

iv. Self-replication: Mitochondria can replicate independently of the cell by binary fission, a characteristic of prokaryotic cells, highlighting their resemblance to a "cell within a cell."

(b) Draw the diagram of a mitochondrion and label six parts.
A mitochondrion is a double-membrane-bound organelle found in most eukaryotic cells, often referred to as the "powerhouse" of the cell due to its role in energy production. Its structure is highly specialized to facilitate its functions.



key components of a mitochondrion:
- Outer membrane is a smooth membrane that encloses the entire organelle, containing proteins known as porins which allow the passage of ions and small molecules.

- Intermembrane space is the region between the outer and inner membranes, playing a role in the process of oxidative phosphorylation.
- Inner membrane is a membrane with numerous folds called cristae, increasing the surface area for chemical reactions. It contains proteins involved in the electron transport chain and ATP synthesis.
- Cristae are the folds of the inner membrane that increase its surface area, enhancing the mitochondrion's ability to produce ATP.
- Matrix is the innermost compartment filled with a gel-like substance containing enzymes, mitochondrial DNA, and ribosomes, where the citric acid cycle (Krebs cycle) occurs.
- Mitochondrial DNA (mtDNA) is genetic material found within the matrix, encoding proteins essential for mitochondrial function.
These structures work together to produce adenosine triphosphate (ATP), the cell's main energy currency, through processes such as the citric acid cycle and oxidative phosphorylation.

2. (a) What will happen if a pleural membrane is severely damaged? Give three points.
i. Loss of lubrication: The pleural membrane produces a fluid that reduces friction during breathing. Damage to the membrane leads to increased friction between the lungs and chest wall, causing pain during respiration.

ii. Impaired lung expansion: Damage to the pleural membrane can result in conditions like pneumothorax (air in the pleural cavity), which collapses the lungs and prevents proper lung expansion during inhalation.

iii. Inflammation and infection: Damage to the pleura may cause inflammation (pleuritis) or increase susceptibility to infections, leading to respiratory complications such as reduced oxygen exchange.

2. (b) The mammalian lungs are made up of sac-like structures called alveoli, which are very efficient in gaseous exchange. Why are the alveoli very efficient? Briefly explain by giving seven points.

Answer:

i. Large surface area: The alveoli provide an extensive surface area to facilitate maximum gas exchange, supporting the high oxygen demand of the body.

ii. Thin walls: The walls of the alveoli are only one cell thick, minimizing the diffusion distance and allowing rapid exchange of gases between air and blood.

iii. Rich blood supply: Alveoli are surrounded by dense capillary networks, ensuring a continuous supply of blood for oxygen uptake and carbon dioxide removal.

iv. Moist lining: The inner surfaces of alveoli are moist, allowing gases to dissolve and diffuse efficiently across the respiratory membrane.

v. Elasticity: Alveoli are highly elastic, enabling them to expand and recoil during breathing, which maintains ventilation and gas exchange.

vi. Close proximity to capillaries: The short distance between alveoli and capillaries ensures efficient diffusion of gases between the air and blood.
vii. High partial pressure gradient: The difference in oxygen and carbon dioxide concentrations between alveolar air and blood facilitates rapid diffusion of gases.

3. (a) A young scientist wrote the scientific name of a human being as *homo sapiens*. Identify two mistakes which were made by the scientist.

Answer:

i. Improper capitalization: The genus name "Homo" should begin with an uppercase letter, while the species name "sapiens" should be in lowercase.

ii. Incorrect formatting: Scientific names must be italicized or underlined when handwritten to distinguish them from other text.

3. (b) Figure 1 consists of organisms labeled A, B, C, D, E, F, G, and H. Use the provided key to identify the organisms by writing down the number of the true statement for the organism until you arrive at the correct name.

Organism A:
1a. Antennae present → Go to 2
2a. Wings absent → Go to 4
4b. Body without legs → Go to 5
5a. Legs two pair → Cestoda

Organism B:
1a. Antennae present → Go to 2
2b. Wings present → Go to 3
3a. Wings stretched/open → Anostraca

Organism C:
1a. Antennae present → Go to 2
2b. Wings present → Go to 3
3a. Wings stretched/open → Anostraca

Organism D:
1a. Antennae present → Go to 2
2a. Wings absent → Go to 4
4a. Body with legs → Go to 5
5b. Legs four pair → Scorpiones

Organism E:
1b. Antennae absent → Go to 6
6b. Body without segmentation → Go to 8
8a. Dorsal fin present → Teleostei

Organism F:
1b. Antennae absent → Go to 6
6a. Body with segments → Cestoda

Organism G:
1a. Antennae present → Go to 2
2b. Wings present → Go to 3
3b. Wings not stretched/closed → Orthoptera

Organism H:
1a. Antennae present → Go to 2
2b. Wings present → Go to 3
3b. Wings not stretched/closed → Orthoptera

4. (a) Calculate the magnification of the specimen if its linear dimension is 2 cm and the linear dimension of its drawing is 6 cm.

Magnification is calculated using the formula:
Magnification = Linear dimension of the drawing / Linear dimension of the specimen.
Magnification = 6 cm / 2 cm = 3.
Thus, the magnification is 3×.

4. (b) A Form Two student drew a diagram of a fish as seen in Figure 2. Observe the diagram carefully and identify four principles of biological drawing which were violated by the student.

i. Proportions are incorrect: The diagram does not maintain accurate proportions between different parts of the fish, such as the size of the fin, operculum, and eye.
ii. Unclear labels: The labeling lines are not straight and do not precisely point to the respective structures, which violates the principle of clarity in biological drawings.

iii. Lack of simplicity: The diagram includes unnecessary shading, which is not recommended in biological drawings.

iv. Irregular outlines: The outlines of the fish are not smooth and clean, making the drawing appear untidy and unprofessional.

4. (c) State two purposes of recording by biological drawing.

i. Accurate documentation: Biological drawings provide a clear and accurate visual representation of specimens, aiding in the study and analysis of their structures.

ii. Communication of findings: Drawings serve as a universal medium for scientists to share observations and findings with others in the scientific community.

5. (a) Arrange the labeled A, B, C, D, E, and F in a correct sequence starting from the first to the last stage of oogenesis.

The correct sequence is: F → B → A → C → D → E.

5. (b) Why is it not advisable to undergo a surgical operation which involves removal of the structure represented by Figure 3 for the first three weeks of pregnancy? Give four points.

i. Hormone production: The structure (likely the corpus luteum) secretes progesterone, which is essential for maintaining the uterine lining and supporting early pregnancy.

ii. Risk of miscarriage: Removal of this structure can result in insufficient hormone levels, leading to the detachment of the embryo and miscarriage.

iii. Incomplete placental development: During the first three weeks, the placenta is not fully functional, and the corpus luteum plays a crucial role in hormone production.
iv. Impaired implantation: Progesterone from the corpus luteum supports the implantation process, and its removal can hinder the successful attachment of the embryo.
6. (a) Carbon dioxide and water are the raw materials of photosynthesis while sunlight energy, chlorophyll, and optimum temperature are the important conditions for effective photosynthesis. Under which condition does each of the following factors limit the process of photosynthesis?

(i) Temperatur
Temperature limits photosynthesis when it is either too low or too high. At low temperatures, enzyme activity slows down, reducing the rate of photosynthesis. At excessively high temperatures, enzymes may denature, disrupting the photosynthetic process.

(ii) Carbon dioxide concentratio
Carbon dioxide concentration limits photosynthesis when it is insufficient. Low levels of carbon dioxide reduce the substrate availability for the Calvin cycle, leading to a decreased production of glucose.

6. (b) A certain person encountered a motorcycle accident which severely damaged his Brunner's gland. State six digestive processes which will be impaired in that person.

i. Neutralization of stomach acid: Brunner's glands secrete alkaline mucus, which neutralizes acidic chyme entering the duodenum. Damage to the glands would impair this process.

ii. Protection of the duodenal lining: The glands produce mucus that protects the duodenum from the corrosive effects of stomach acid. Damage increases the risk of duodenal ulcers.

iii. Enzyme activation: The glands help create an optimal pH for pancreatic enzymes. Impairment disrupts the activation of enzymes like trypsin and amylase.

iv. Digestion of carbohydrates: Reduced enzyme activity affects the breakdown of carbohydrates into simple sugars.
v. Digestion of proteins: Impaired activation of proteolytic enzymes hinders protein digestion.

vi. Fat digestion: Inefficient neutralization of acid affects bile salt function, disrupting fat emulsification and digestion.

7. (a) Coordination in human beings involves both the endocrine and nervous systems. How do endocrine and nervous coordination differ? Provide five points.

Answer:

i. Mode of transmission: The nervous system utilizes electrical impulses transmitted through neurons to convey messages rapidly. In contrast, the endocrine system releases hormones into the bloodstream, allowing them to reach target organs more slowly.
ii. Speed of response: Nervous coordination is characterized by swift responses, often occurring within milliseconds, due to the rapid transmission of nerve impulses. Endocrine coordination, however, typically involves slower responses, as hormones must travel through the circulatory system to reach their destinations.

iii. Duration of effect: The effects of nervous system activation are usually short-lived, ceasing quickly once the stimulus is removed. Conversely, the endocrine system often induces longer-lasting effects, as hormones can remain active in the bloodstream for extended periods.
iv. Specificity of action: Nervous coordination targets specific cells or tissues through direct neural connections, leading to precise and localized effects. Endocrine coordination affects a broader range of cells and tissues, as hormones circulate systemically and can influence multiple organs simultaneously.
v. Type of processes regulated: The nervous system primarily manages rapid, short-term processes such as muscle contractions and sensory perceptions. In contrast, the endocrine system regulates slower, long-term processes including growth, metabolism, and reproductive functions.

7. (b) How are nervous tissues adapted for their roles? Provide five points.

i. Specialized cells: Nervous tissue comprises neurons, which are specialized cells designed to transmit electrical impulses efficiently. Their unique structures, including dendrites and axons, facilitate the reception and transmission of signals.
ii. Myelination: Many neurons possess a myelin sheath, a fatty insulating layer that surrounds the axon. This sheath enhances the speed of electrical impulse conduction along the neuron by allowing impulses to "jump" between nodes in a process called saltatory conduction.
iii. Synaptic connections: Neurons form synapses, which are specialized junctions that enable them to communicate with other neurons, muscle cells, or glands. These synapses allow for the precise transmission of signals, ensuring coordinated responses throughout the body.
iv. Supportive glial cells: Nervous tissue includes glial cells that provide structural and metabolic support to neurons. Glial cells maintain the extracellular environment, supply nutrients, and assist in repairing nervous tissue, thereby ensuring optimal neuronal function.
v. Excitability and conductivity: Neurons exhibit high excitability, allowing them to respond rapidly to stimuli by generating electrical impulses. Their conductive properties enable these impulses to travel along

the length of the neuron and communicate with other cells, facilitating immediate responses to environmental changes.
These adaptations collectively enable nervous tissue to perform its critical role in rapid communication and control within the human body.

8. Describe the structure of mammalian lungs. Use nine points.
i. Bilateral structure: The lungs are paired organs located in the thoracic cavity, with the right lung typically having three lobes and the left lung two lobes to accommodate the heart.

ii. Pleural membranes: Each lung is enclosed by a double-layered pleural membrane. The outer parietal pleura lines the chest wall, while the inner visceral pleura covers the lung surface. Between them is the pleural cavity, which contains fluid that reduces friction during breathing.

iii. Bronchial tree: The lungs contain a network of branching tubes called the bronchial tree. This includes the primary bronchi, which divide into secondary and tertiary bronchi, and eventually into smaller bronchioles.

iv. Alveoli: The terminal bronchioles lead to alveoli, which are small, air-filled sacs. Alveoli are the primary sites for gas exchange, with walls composed of a single layer of squamous epithelial cells.

v. Vascular supply: The lungs are richly supplied with blood vessels. Pulmonary arteries bring deoxygenated blood to the lungs for oxygenation, while pulmonary veins carry oxygenated blood back to the heart.

vi. Cartilaginous support: The trachea and larger bronchi have cartilaginous rings that prevent collapse during inhalation, ensuring an open airway.

vii. Elastic tissue: The lungs contain elastic fibers that allow them to expand and recoil during inhalation and exhalation, facilitating ventilation.

viii. Ciliated epithelium: The respiratory tract is lined with ciliated epithelial cells that trap and remove dust and microorganisms, keeping the airways clear.

ix. Surfactant: The alveoli are coated with a surfactant, a lipid-protein substance that reduces surface tension, preventing alveolar collapse during exhalation.

9. The transport of materials in an organism may be passive or active. How do active and passive transportation of materials differ? Give seven points.

i. Energy requirement: Active transport requires energy in the form of ATP to move substances against their concentration gradient. Passive transport does not require energy, as it relies on the natural movement of substances down their concentration gradient.

ii. Direction of movement: Active transport moves substances from areas of low concentration to high concentration. Passive transport moves substances from areas of high concentration to low concentration.

iii. Examples: Active transport includes processes like the sodium-potassium pump and endocytosis. Passive transport includes diffusion, osmosis, and facilitated diffusion.

iv. Involvement of carrier proteins: Active transport often requires specific carrier proteins or pumps to facilitate the movement of molecules. Passive transport may or may not involve carrier proteins, depending on the type (e.g., simple diffusion vs. facilitated diffusion).

v. Speed of process: Active transport is relatively slower due to the energy-dependent mechanisms. Passive transport is usually faster, as it depends solely on concentration gradients.

vi. Dependency on metabolic state: Active transport depends on the metabolic activity of the cell, as ATP is required. Passive transport is independent of the cell's metabolic state.

vii. Examples in organisms: In plants, active transport is used to absorb mineral ions into root hair cells. Passive transport is used during gas exchange in the alveoli of lungs, where oxygen diffuses into the blood.

10. Describe the process which leads to the formation of embryo and endosperm in flowering plants.

The process involves double fertilization, a unique characteristic of flowering plants, and occurs as follows:

i. Pollination: Pollen grains from the male anther are transferred to the female stigma. This can occur through wind, water, or animal agents.

ii. Germination of pollen: Upon reaching the stigma, the pollen grain germinates to form a pollen tube, which grows down through the style toward the ovary.

iii. Entry into the ovule: The pollen tube enters the ovule through the micropyle, carrying two male gametes into the embryo sac.

iv. Fusion with the egg cell: One male gamete fuses with the haploid egg cell, forming a diploid zygote. This zygote develops into the embryo.
v. Fusion with polar nuclei: The second male gamete fuses with the two polar nuclei in the central cell of the embryo sac, forming a triploid cell. This triploid cell develops into the endosperm.

vi. Development of embryo: The zygote undergoes mitotic divisions to form the embryonic tissues, which include the cotyledons, shoot apex, and root apex.

vii. Formation of endosperm: The triploid endosperm cell undergoes repeated mitotic divisions, forming a nutritive tissue that provides sustenance to the developing embryo.

viii. Seed maturation: The embryo and endosperm are enclosed within the seed coat, and the seed matures, ready for dispersal and germination.

This process ensures the successful development of the seed and provides nourishment for the embryo during its initial stages of growth.