THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

133/1 **BIOLOGY 1**

(For Both Private and School Candidates)

Duration: 3 Hour. **ANSWERS** **Year: 2025**

Instructions

1. This paper consists of section A and B with a total of **ten (10)** questions**.**
2. Answer all questions in section A and **two (2)** questions from section B
3. Write your **Examination Number** on every page of your answer booklet(s).

1. (a) Briefly explain how each of the following features of a mitochondrion helps in breaking down food to release energy: (i) Folded inner membrane (ii) Matrix (iii) Circular DNA (iv) Ribosomes

(i) The folded inner membrane, also known as the cristae, increases the surface area for the attachment of enzymes involved in the electron transport chain. This enhances the production of ATP, the energy currency of the cell.

(ii) The matrix contains enzymes that catalyze the reactions of the Krebs cycle. These reactions generate NADH and $FADH_2$, which are vital for the electron transport chain in producing energy.

(iii) Circular DNA carries genetic information that codes for some of the proteins and enzymes needed for energy metabolism in the mitochondrion. It enables the mitochondrion to self-replicate and maintain its function independently.

(iv) Ribosomes synthesize proteins required by the mitochondrion, including those involved in the electron transport chain and ATP synthesis. This ensures efficient production of enzymes necessary for energy release.

(b) State two importance of each of the following organelles: (i) Microtubules (ii) Golgi body (iii) Lysosomes

(i) Microtubules provide structural support, maintaining the shape of the cell. They also form the spindle fibers necessary for chromosome movement during cell division.

(ii) The Golgi body modifies, sorts, and packages proteins and lipids for transport within or outside the cell. It also plays a role in the formation of lysosomes and secretion of cell products.

(iii) Lysosomes break down waste materials, old organelles, and cellular debris using digestive enzymes. They also help in the process of autolysis, where damaged or unwanted cells self-destruct.

2. (a) Analyse five differences between yeast cells and bacterium cells.

Yeast cells are eukaryotic, meaning they have a well-defined nucleus enclosed in a nuclear membrane, while bacterium cells are prokaryotic and lack a true nucleus.

Yeast cells contain membrane-bound organelles such as mitochondria, endoplasmic reticulum, and Golgi apparatus, whereas bacteria do not have any membrane-bound organelles.

Yeast cells reproduce asexually through budding, which involves the growth of a new cell from the surface of the parent, while bacteria reproduce by binary fission, where one cell divides into two identical cells.

The cell wall of yeast is made up of chitin, whereas the bacterial cell wall is composed of peptidoglycan, a structurally different polymer.

Yeast cells are generally larger in size compared to bacteria and have a more complex internal structure.

(b) Using two points, justify the need for a plant cell to have a vacuole.

The vacuole helps maintain turgor pressure in plant cells, which is important for structural support and keeping the plant upright.

It also stores essential substances like water, nutrients, and waste products, thereby playing a key role in maintaining the internal environment of the cell.

3. (a) Study the structure of the molecule shown in the given figure and answer the questions that follow: (i) Identify the molecule. (ii) Explain three ways in which the molecule is important in human body.

(i) The molecule is Adenosine Triphosphate (ATP).

(ii) ATP provides energy for most cellular processes including muscle contraction, nerve impulse conduction, and active transport of substances across membranes.

It is involved in the synthesis of macromolecules like proteins and nucleic acids by providing the necessary energy for these reactions.

ATP also plays a role in signal transduction by acting as a substrate for kinases that phosphorylate proteins and regulate cellular processes.

(b) Analyse four features that are shared by gills and lungs.

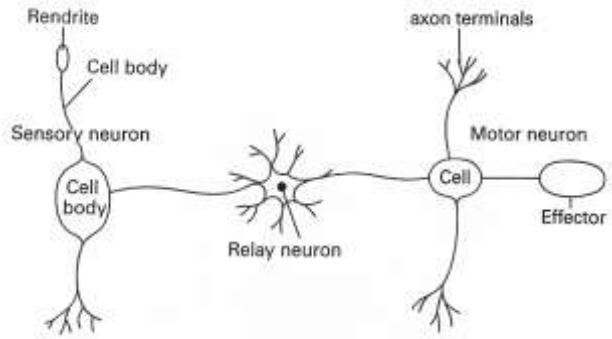
Both gills and lungs have a large surface area that allows efficient gas exchange between the organism and its environment.

They have a moist surface which enables oxygen and carbon dioxide to dissolve before diffusion can take place.

Both are highly vascularized with capillaries to transport oxygen and carbon dioxide to and from the respiratory surface.

They possess thin walls or membranes that reduce the diffusion distance for gases, allowing rapid and efficient exchange.

4. Draw well labelled diagrams to show the arrangement of neurons for transmitting impulse from receptor to the effector.



5. Differentiate spermatogenesis from oogenesis based on the following aspects: (a) Specific site of occurrence (b) Number of cells formed (c) Result of cytoplasmic division during meiotic I and meiotic II (d) Size of cell formed (e) Transformation of the cells formed

(a) Spermatogenesis occurs in the seminiferous tubules of the testes, while oogenesis takes place in the ovaries.

(b) Spermatogenesis results in four functional sperm cells from one germ cell, whereas oogenesis produces only one functional ovum and three non-functional polar bodies.

(c) In spermatogenesis, cytoplasmic division is equal in both meiotic I and II, producing cells of equal size. In oogenesis, the cytoplasmic division is unequal, with most cytoplasm retained in one large ovum.

(d) The sperm cells formed are small and motile, while the ovum is large and non-motile with a rich cytoplasm for nourishing the embryo.

(e) In spermatogenesis, spermatids undergo transformation into mature spermatozoa with a tail, head, and midpiece. In oogenesis, the secondary oocyte matures into a functional ovum capable of being fertilized.

6. With the help of a diagram, explain how a 6 carbon compound is converted to two molecules of a 3 carbon compound in respiration.

The process begins with glucose, a 6-carbon sugar, which enters the cytoplasm of the cell. This glucose molecule undergoes a series of enzyme-controlled reactions collectively known as glycolysis.

In the first step, the glucose molecule is phosphorylated using ATP to form glucose-6-phosphate. This molecule is then isomerized into fructose-6-phosphate, which is again phosphorylated to become fructose-1,6-bisphosphate.

The 6-carbon fructose-1,6-bisphosphate is then split into two 3-carbon molecules: dihydroxyacetone phosphate (DHAP) and glyceraldehyde-3-phosphate (G3P). The DHAP is quickly converted into another G3P, so at this point, there are two identical 3-carbon molecules.

Each glyceraldehyde-3-phosphate molecule undergoes further reactions involving the oxidation and formation of ATP and NADH. Eventually, each G3P is converted into one pyruvate molecule. Since there are two G3P molecules, the process yields two 3-carbon pyruvate molecules.

This conversion does not require oxygen and occurs in the cytoplasm. It results in a net gain of 2 ATP molecules and 2 NADH molecules for each glucose molecule broken down.

7. (a) Evaluate the rate of respiration based on each of the following criteria:

(i) Size of organisms

(ii) Age of organisms

(iii) Health condition of organisms

(iv) Body temperature

(i) Smaller organisms have a higher surface area to volume ratio, which allows faster exchange of gases and nutrients. As a result, they tend to have a higher rate of respiration to meet their energy needs.

(ii) Young organisms are actively growing and require more energy, thus they respire at a higher rate than older organisms whose growth and metabolic activity may have slowed down.

(iii) Healthy organisms have properly functioning cells and organelles such as mitochondria, which support efficient respiration. In contrast, illness or damage can impair respiration efficiency and lower the rate.

(iv) Respiration involves enzyme-controlled reactions, which are affected by temperature. An increase in body temperature within the optimal range speeds up the rate of respiration. However, extreme heat may denature enzymes, reducing the rate.

(b) Justify the fact that when the same amount of lipid and glucose is respired, lipid releases more energy than glucose.

Lipids contain more carbon-hydrogen bonds compared to glucose. These bonds store more energy, and when broken during respiration, they release a higher quantity of ATP per molecule than glucose.

Lipids are more reduced molecules, meaning they have more electrons available for the electron transport chain. This leads to increased production of NADH and FADH2, which results in more ATP generation during oxidative phosphorylation.

Also, lipids yield more ATP because the beta-oxidation of fatty acids produces more acetyl-CoA units, which enter the Krebs cycle and contribute to higher ATP yield than the glycolytic breakdown of one glucose molecule.

8. (a) Analyse four features which are found in the virus but not in bacterium cell.

Viruses have a protein coat called a capsid that encases their genetic material, while bacteria have a cell wall made of peptidoglycan.

Viruses contain either DNA or RNA as their genetic material, but never both, whereas bacteria have both DNA and RNA within their cells.

Viruses cannot reproduce independently; they require a host cell to replicate, while bacteria can reproduce on their own through binary fission.

Viruses lack cellular structures such as cytoplasm, ribosomes, and organelles that are found in bacteria, making them metabolically inactive outside a host.

(b) Viruses have merits and demerits in human life. Justify this statement by giving two merits and demerits.

One merit of viruses is their use in scientific research, particularly in genetics and molecular biology, where viral vectors are used in gene therapy and vaccine development.

Another merit is that some viruses help in controlling pest populations in agriculture, thus reducing the need for chemical pesticides.

One demerit is that viruses cause serious human diseases such as HIV/AIDS, influenza, and COVID-19, leading to illness and death.

Another demerit is that viral infections can disrupt social and economic systems due to healthcare costs and outbreak management challenges.

9. Osmosis and diffusion are ways for transporting materials in living organisms. Evaluate four benefits of each way to living organisms.

Osmosis plays a crucial role in water absorption by plant roots. Through osmosis, water moves from the soil, where its concentration is higher, into the root hair cells where its concentration is lower. This is essential for plant hydration and nutrient uptake, enabling plants to grow and carry out photosynthesis effectively.

Another benefit of osmosis is the maintenance of turgor pressure in plant cells. Turgor pressure is the force exerted by the water-filled vacuole against the cell wall. It keeps the plant cells firm and helps maintain the structural integrity of the plant. Without turgor pressure, plants wilt and become flaccid.

In animal systems, osmosis regulates water balance between cells and their surrounding fluids. For example, in red blood cells, osmosis ensures that water does not excessively enter or leave the cell, preventing it from bursting (lysis) or shrinking (crenation). This regulation is key to maintaining homeostasis.

Osmosis also facilitates water movement in the kidneys during the reabsorption of water in the nephron. As filtrate passes through different parts of the nephron, water is reabsorbed into the bloodstream by osmosis, allowing the body to conserve water and maintain a proper fluid balance.

Diffusion allows the movement of gases such as oxygen and carbon dioxide in and out of cells. In the lungs, oxygen diffuses from the alveoli into the blood capillaries, while carbon dioxide diffuses from the blood into the alveoli to be exhaled. This gas exchange is vital for cellular respiration and energy production.

Diffusion is essential for the absorption of nutrients in the small intestine. Glucose and amino acids diffuse from the lumen of the intestine into the blood capillaries, ensuring that the body receives the necessary substances for growth, repair, and energy.

It also plays a role in the excretion of metabolic wastes. Urea and other waste products formed in body cells diffuse into the bloodstream and are transported to the kidneys for excretion. This helps detoxify the body and maintain a stable internal environment.

Additionally, diffusion is involved in the transmission of nerve impulses. Neurotransmitters released at synapses diffuse across the synaptic cleft to the next neuron, allowing the continuation of the nerve signal. This enables communication within the nervous system and control of body activities.

10. In four points, justify the fact that animals cannot survive without plants.

Plants are the primary producers in almost all ecosystems, meaning they convert solar energy into chemical energy through photosynthesis. This energy is stored in the form of carbohydrates and passed on to herbivores and then to carnivores. Without plants, the energy flow in ecosystems would be disrupted, and animals would have no source of food.

Plants produce oxygen as a byproduct of photosynthesis. This oxygen is essential for the survival of most animals because it is required for aerobic respiration, the process through which animals obtain energy from food. Without oxygen, animals would be unable to produce enough energy to sustain life.

Plants play a critical role in maintaining the balance of atmospheric gases. They absorb carbon dioxide during photosynthesis, helping to regulate the levels of this greenhouse gas. Without plants, carbon dioxide would accumulate to dangerous levels, leading to global warming and making the environment uninhabitable for many animals.

Plants provide shelter and breeding grounds for many animal species. Trees, shrubs, and grasses offer habitats where animals can hide from predators, find food, and reproduce. The destruction of plant life leads to habitat loss and the eventual extinction of many animal species that depend on them.

11. With the aid of a diagram, describe the life cycle of a bryophyte.

The life cycle of a bryophyte, such as a moss, shows an alternation of generations between the haploid gametophyte and the diploid sporophyte. The dominant phase in bryophytes is the gametophyte, which is green and photosynthetic. It produces the reproductive organs: antheridia (male) and archegonia (female).

In the presence of water, motile sperm from the antheridia swim to the egg in the archegonium and fertilize it, forming a diploid zygote. The zygote remains attached to the gametophyte and develops into a sporophyte. The sporophyte consists of a foot, seta (stalk), and a capsule where spores are formed through meiosis.

When mature, the capsule releases haploid spores into the environment. These spores germinate to form new gametophytes, thus completing the cycle. The entire cycle depends heavily on water for fertilization and dispersal of sperm, which limits bryophytes to moist environments.