**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: 2017.**

**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) What structure does Figure 1 represent?

The structure represented by Figure 1 is the plasma membrane, showing the fluid mosaic model.

(ii) Identify the parts labeled A, B, C, and D.

- A: Phospholipid bilayer
- B: Integral protein
- C: Peripheral protein
- D: Cholesterol

(iii) State four functions of the structure labeled B.

The integral protein performs various roles, including:
- Acting as channels or transporters to facilitate the movement of molecules across the membrane.
- Serving as receptors for cell signaling by binding to specific molecules like hormones.
- Functioning as enzymes to catalyze reactions on the membrane surface.
- Providing structural support by anchoring the cytoskeleton to the membrane.

(b) Describe three functions of microtubules.
Microtubules are essential components of the cytoskeleton and perform the following functions:
- They provide structural support and maintain the cell's shape.
- They are involved in intracellular transport, facilitating the movement of organelles and vesicles within the cell.
- They play a critical role in cell division by forming the mitotic spindle, which separates chromosomes during mitosis and meiosis.

2. (a) Analyze the differences between cyanobacteria and yeast cells based on the following criteria:

(i) Cell division
Cyanobacteria divide by binary fission, a simple process without a nucleus. Yeast cells divide by budding, a process involving a nucleus and eukaryotic organelles.

(ii) Respiration
Cyanobacteria perform anaerobic or aerobic respiration but lack mitochondria. Yeast cells perform aerobic respiration in mitochondria and can also ferment under anaerobic conditions.

(iii) Photosynthesis
Cyanobacteria are photosynthetic, using chlorophyll and thylakoid membranes. Yeast cells are non-photosynthetic and rely on external sources of organic compounds for energy.

(iv) Protein synthesis
Cyanobacteria have 70S ribosomes and synthesize proteins in the cytoplasm. Yeast cells have 80S ribosomes and synthesize proteins in the cytoplasm and rough endoplasmic reticulum.

(b) Enumerate five similarities between mitochondria and chloroplasts.

- Both mitochondria and chloroplasts have a double membrane.
- They possess their own DNA, allowing them to produce some of their proteins.
- Both organelles generate energy for the cell: mitochondria produce ATP through respiration, while chloroplasts produce glucose through photosynthesis.
- They contain ribosomes for protein synthesis.
- Both have highly folded inner membranes (cristae in mitochondria and thylakoid membranes in chloroplasts) to increase surface area for their respective processes.

3. (a) (i) Briefly explain how to test for protein in a given solution using the Biuret test.

To perform the Biuret test, add a few drops of sodium hydroxide solution to the protein sample to make it alkaline. Then add a few drops of copper sulfate solution. If proteins are present, the solution will turn purple. If no protein is present, the solution remains blue.

(ii) What is the basis of protein test?
The Biuret test is based on the presence of peptide bonds in proteins. These bonds react with copper ions in an alkaline solution, producing a violet or purple color.

(b) Explain how each of the following factors causes protein denaturation:
(i) Heat
Heat causes protein denaturation by disrupting the hydrogen bonds and non-covalent interactions, leading to the unfolding of the protein structure.

(ii) Acid
Acids alter the pH, disrupting ionic bonds and hydrogen bonding within the protein, causing it to lose its shape and function.

(iii) Alkalis
Alkalis disrupt hydrogen bonds and ionic interactions by altering the pH, leading to changes in the protein's tertiary structure.

(iv) Mechanical force
Mechanical force, such as stirring or shaking, disrupts the weak bonds stabilizing the protein structure, causing denaturation.
(v) Chemical agents
Chemical agents like urea or detergents disrupt hydrophobic interactions and hydrogen bonds, leading to the unfolding of proteins.

4. (a) (i) Identify each of the parts labeled T, U, V, W, X, and Z.

- T: Axon terminal
- U: Synaptic vesicles
- V: Neurotransmitters
- W: Calcium ion channels
- X: Synaptic cleft
- Z: Postsynaptic membrane

(ii) What is the state of the region shown by letter Y?

The region labeled Y represents the presynaptic membrane. It is in an active state, releasing neurotransmitters into the synaptic cleft in response to the influx of calcium ions.

(iii) State the role played by structures labeled U and W respectively.

- U (Synaptic vesicles): Store neurotransmitters and release them into the synaptic cleft when triggered by an action potential.
- W (Calcium ion channels): Facilitate the entry of calcium ions into the presynaptic neuron, which is essential for triggering the release of neurotransmitters from the synaptic vesicles.

(b) Why do some impulses arriving at the presynaptic membrane fail to produce an action potential in the postsynaptic neuron whereas several impulses arriving in succession can do so?

Some impulses fail to produce an action potential in the postsynaptic neuron because they do not release enough neurotransmitters to reach the threshold potential required to generate an action potential. However, when multiple impulses arrive in succession, they summate, either temporally or spatially, increasing the concentration of neurotransmitters in the synaptic cleft. This cumulative effect allows the postsynaptic neuron to reach the threshold potential and initiate an action potential.

5. (a) Briefly explain the roles of the following in photosynthesis:

(i) NADP
NADP (Nicotinamide adenine dinucleotide phosphate) acts as an electron carrier during photosynthesis. It accepts electrons during the light-dependent reactions, forming NADPH, which provides reducing power for the Calvin cycle in the light-independent reactions.

(ii) Ribulose diphosphate
Ribulose diphosphate (RuBP) is a five-carbon sugar molecule that acts as a substrate in the Calvin cycle. It combines with carbon dioxide during the process of carbon fixation, catalyzed by the enzyme RuBisCO, to form two molecules of 3-phosphoglycerate.

(iii) Photosystems I and II (PSI and PSII)
Photosystem II absorbs light energy to split water molecules into oxygen, protons, and electrons (photolysis). Photosystem I absorbs light energy to excite electrons, which are then transferred to NADP to form NADPH. These photosystems work together to generate ATP and NADPH during the light-dependent reactions.

(b) Giving reason, explain the effect of lowering oxygen concentrations on:

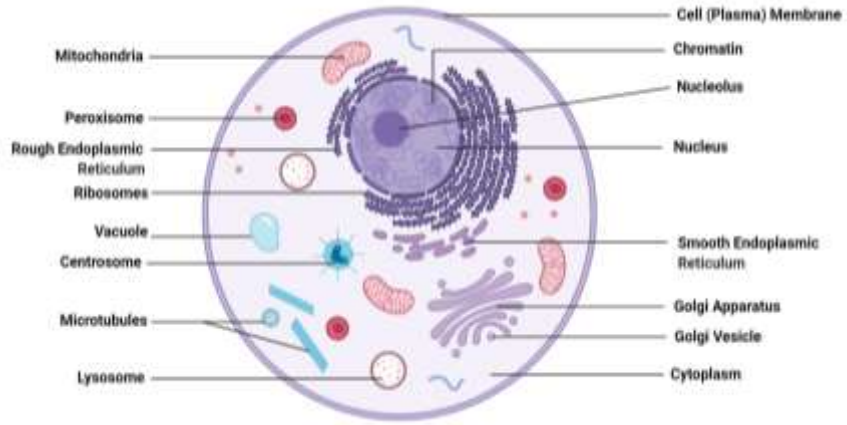
(i) C3 photosynthesis
Lowering oxygen concentrations increases the efficiency of C3 photosynthesis because it reduces photorespiration. Photorespiration occurs when RuBisCO binds to oxygen instead of carbon dioxide, leading to a wasteful process. Reduced oxygen levels minimize this competition, enhancing carbon fixation.

(ii) C4 photosynthesis
C4 photosynthesis is less affected by lowering oxygen concentrations because the pathway has a mechanism to concentrate carbon dioxide at the site of the Calvin cycle, reducing the interaction of RuBisCO with oxygen.
(c) Why the rate of photosynthesis decreases at high temperatures?

High temperatures can denature the enzymes involved in photosynthesis, such as RuBisCO, reducing their efficiency. Additionally, high temperatures increase the rate of water loss through transpiration, causing stomata to close and limiting carbon dioxide availability for photosynthesis.

6. (a) Draw the structure of an animal cell as seen under an electron microscope.

munnumf16user.z21.web.core.windows.net



An animal cell, as observed under an electron microscope, reveals a complex and organized structure composed of various organelles, each performing specific functions essential for the cell's survival and proper operation.

This electron micrograph illustrates the following key components of an animal cell:
Nucleus is the control center of the cell, containing genetic material (DNA) and responsible for regulating gene expression and cell division.

Nucleolus is located within the nucleus and is the site of ribosomal RNA (rRNA) synthesis and ribosome assembly.

Mitochondria are known as the "powerhouses" of the cell, generating adenosine triphosphate (ATP) through cellular respiration, providing energy for cellular activities.

Endoplasmic reticulum (ER) consists of two types. The rough ER is studded with ribosomes and is involved in the synthesis and modification of proteins destined for secretion or membrane insertion. The smooth ER lacks ribosomes and is involved in lipid synthesis, detoxification processes, and calcium ion storage.

Golgi apparatus is a series of flattened membranous sacs responsible for modifying, sorting, and packaging proteins and lipids for delivery to targeted destinations.

Lysosomes are membrane-bound vesicles containing hydrolytic enzymes that digest macromolecules, old cell parts, and foreign invaders.

Centrioles are cylindrical structures involved in organizing microtubules during cell division and forming the basis of cilia and flagella.

Ribosomes are molecular machines responsible for protein synthesis, found either floating freely in the cytoplasm or attached to the rough ER.

Plasma membrane is a phospholipid bilayer that encloses the cell, regulating the movement of substances into and out of the cell and facilitating communication with the external environment.

Cytoplasm is the gel-like substance filling the cell, in which organelles are suspended and various cellular processes occur.

These structures work together to maintain the cell's integrity, perform metabolic processes, and respond to environmental stimuli, ensuring the proper functioning of the animal cell.

(b) (i) Name a double membrane organelle found in plant cells only.
Chloroplast.

(ii) How is the organelle adapted to its role?

The chloroplast is adapted to its role in photosynthesis in several ways. It has a double membrane that regulates the entry and exit of substances. The inner membrane encloses the stroma, which contains enzymes for the Calvin cycle. The thylakoids are arranged in stacks called grana, providing a large surface area for light absorption by chlorophyll and for the electron transport chain. Additionally, the chloroplast contains its own DNA and ribosomes, allowing it to produce proteins required for photosynthesis.

7. (a) What is meant by natural system of classification?

The natural system of classification is a method of grouping organisms based on their evolutionary relationships, structural similarities, and genetic information. It considers homologous characteristics, which are inherited from a common ancestor, to classify organisms into hierarchical taxa such as kingdom, phylum, class, order, family, genus, and species.

(b) Why is it difficult to achieve a complete natural system of classification?

Achieving a complete natural system of classification is difficult because of the vast diversity of organisms, many of which are yet to be discovered or fully understood. Additionally, evolutionary relationships are not always clear due to limited fossil evidence or convergent evolution, where unrelated organisms develop similar traits. Genetic variations and horizontal gene transfer in microorganisms also complicate classification efforts.

8. Elaborate the main adjustments that occur to the heart rate and circulatory system just before, during, and after a 100m race.

Before the race, the heart rate increases due to anticipatory activation of the sympathetic nervous system, which prepares the body for action by increasing cardiac output and blood flow to muscles. Adrenaline is released, causing vasodilation in skeletal muscles and vasoconstriction in less active regions.

During the race, the heart rate reaches its peak to supply oxygen and nutrients to the active muscles. Blood flow is directed to the muscles, and the stroke volume increases. The respiratory rate also increases to match the oxygen demand.

After the race, the heart rate gradually decreases as the parasympathetic nervous system restores normal function. Blood vessels dilate, allowing the removal of metabolic waste products like lactic acid, and oxygen is supplied to repay the oxygen debt.

9. (a) (i) Briefly explain the concept of capacitation as it is related to reproduction.

Capacitation is a physiological process that sperm undergo in the female reproductive tract to acquire the ability to fertilize an egg. During capacitation, changes occur in the sperm membrane, enhancing its motility and preparing it for the acrosomal reaction. This process is essential for successful fertilization in mammals.

(ii) Outline two protective roles of the mammalian placenta to the fetus.

The placenta acts as a barrier, protecting the fetus from harmful substances such as toxins and pathogens in the maternal blood. It also prevents the mother's immune system from attacking the fetus by suppressing maternal immune responses against the fetal tissues.

(b) The chromosome number in a radicle of a certain species of a flowering plant is 16. Giving reason, calculate the number of chromosomes in each of the following cells:
(i) Pollen tube nucleus: 16 (haploid).
(ii) Antipodal cell: 16 (haploid).
(iii) Endosperm: 24 (triploid, resulting from one sperm nucleus and two polar nuclei).
(iv) Pollen mother cell: 32 (diploid, precursor of haploid gametes).
(v) Integument cell: 32 (diploid, as it forms part of the seed coat).

10. Identify the vascular tissues in plants and explain how they are adapted to their roles.

The two main vascular tissues in plants are xylem and phloem.

Xylem is adapted to transport water and dissolved minerals from the roots to other parts of the plant. It consists of dead cells (vessels and tracheids) that form hollow tubes, providing a continuous pathway for water movement. The walls are lignified, offering mechanical support and resistance to collapse under tension.

Phloem transports organic nutrients, such as sucrose, from the leaves to other parts of the plant. It is composed of living sieve tube elements connected by sieve plates, which allow the flow of sap. Companion cells support the sieve tubes by providing energy for active transport. The structure of phloem ensures efficient translocation of nutrients to meet the metabolic demands of the plant.