THE UNINTED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION AND CULTURE

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

133/2 **BIOLOGY 2**

Time: 2:30 Hours **ANSWERS** **Year: 2000**

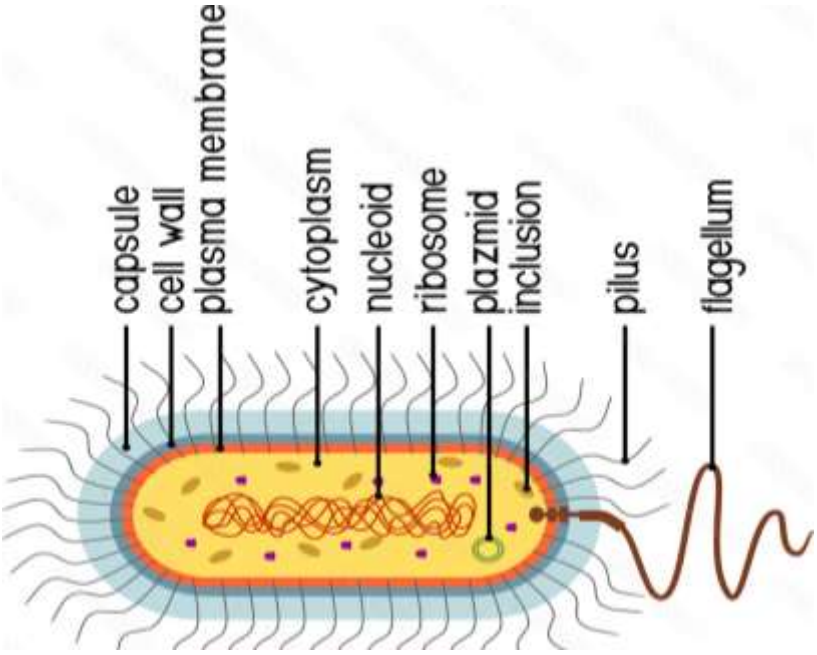
Instructions:

1. this paper consists of six questions
2. answer five questions
3. Each question carries twenty marks.

1(a) Outline the main ideas of the cell theory.

The cell theory is a fundamental principle in biology, and its main ideas are:
i. All living organisms are composed of one or more cells. This principle highlights that cells are the basic units of structure in all living things, whether unicellular or multicellular.
ii. The cell is the basic unit of life. All the physiological and biological functions of living organisms occur within cells.
iii. All cells arise from pre-existing cells. This emphasizes the process of cell division, such as mitosis and meiosis, which enables organisms to grow and reproduce.
iv. Cells contain hereditary information (DNA) that is passed on during cell division. This ensures the continuity of life.
v. Energy flow occurs within cells. All metabolic and energy-related activities, like respiration, occur within the cells.

(b) With the help of a well-labelled diagram of a rod-shaped bacterium, describe the structure of a prokaryotic cell.
A prokaryotic cell, exemplified by a rod-shaped bacterium, possesses a simple yet efficient structure that enables it to thrive in diverse environments. Below is a well-labeled diagram illustrating the key components of a typical rod-shaped prokaryotic cell:



Key Structures of a Prokaryotic Cell:

i. Capsule
The capsule is an outer protective layer found in some bacteria, composed of polysaccharides. It aids in moisture retention, protection against phagocytosis, and helps the cell adhere to surfaces.
ii. Cell Wall
The cell wall is a rigid structure made primarily of peptidoglycan that provides shape and protection to the cell. It prevents the cell from bursting in hypotonic environments.
iii. Plasma Membrane
The plasma membrane is a phospholipid bilayer that regulates the movement of substances into and out of the cell, maintaining the internal environment.
iv. Cytoplasm
The cytoplasm is a gel-like substance filling the cell interior, where cellular processes occur. It contains water, enzymes, nutrients, wastes, and gases.
v. Nucleoid
The nucleoid is a region within the cytoplasm where the cell's circular, double-stranded DNA is located. Unlike eukaryotes, prokaryotes lack a membrane-bound nucleus.
vi. Ribosomes (70S)
Ribosomes are molecular machines responsible for protein synthesis. Prokaryotic ribosomes are smaller than those in eukaryotes.
vii. Plasmids
Plasmids are small, circular DNA molecules separate from the chromosomal DNA. They often carry genes that provide advantages, such as antibiotic resistance.
viii. Flagella
Flagella are long, whip-like appendages that facilitate movement, allowing the bacterium to navigate its environment.
ix. Pili (Fimbriae)
Pili are hair-like structures on the cell surface that assist in attachment to surfaces and in the exchange of genetic material during conjugation.
2(a) What are proteins?

Proteins are complex macromolecules made up of amino acids linked by peptide bonds. They are essential biomolecules that play a variety of roles in the structure, function, and regulation of cells and tissues.

(b) Discuss the importance of proteins in the structure and metabolism of organisms.
i. Structural support – Proteins like collagen and keratin provide structural integrity to cells and tissues.
ii. Enzymes - Many proteins act as enzymes that catalyze biochemical reactions, such as amylase and DNA polymerase.
iii. Transport - Proteins like hemoglobin transport molecules (e.g., oxygen) within the body.
iv. Defense – Antibodies are proteins that protect the body from pathogens.
v. Communication – Hormonal proteins like insulin regulate processes such as glucose metabolism.
vi. Movement – Muscle contraction is facilitated by proteins like actin and myosin.
vii. Storage – Some proteins store nutrients, such as ferritin storing iron.

3. (a) One of the current systems of classification which have been recommended for scientific purposes recognizes five kingdoms. Name the five kingdoms and describe the distinctive characteristics of each kingdom.
Answer:
The five kingdoms are:
i. Monera: This includes prokaryotic organisms like bacteria. They lack a nucleus and membrane-bound organelles. Their DNA is circular and found in the nucleoid region.
ii. Protista: These are mostly unicellular eukaryotic organisms, such as algae and protozoa. They have a defined nucleus and organelles, and can be autotrophic or heterotrophic.
iii. Fungi: Includes eukaryotic organisms like molds, yeasts, and mushrooms. They are saprophytic or parasitic, with cell walls made of chitin.
iv. Plantae: Consists of multicellular, autotrophic organisms with chlorophyll. They have cell walls made of cellulose and perform photosynthesis.
v. Animalia: Multicellular, heterotrophic organisms that lack cell walls. They are motile and rely on other organisms for food.

(b) Outline the distinguishing features of the phyla to which the following organisms belong: plasmodium, wheat, and hookworm.

i. Plasmodium: Belongs to the phylum Apicomplexa. It is unicellular, parasitic, and has complex life cycles with spore-like stages.
ii. Wheat: Belongs to the phylum Angiospermae (division Magnoliophyta). It is a flowering plant with seeds enclosed in fruits.
iii. Hookworm: Belongs to the phylum Nematoda. It is a parasitic worm with a cylindrical, unsegmented body and a complete digestive tract.

4. With the aid of a well-labelled diagram, describe the structure of a mature maize plant.

A mature maize plant includes:
i. Roots: Fibrous root system for anchorage and absorption of nutrients.
ii.Stem: Hollow and segmented for support and transport of water and nutrients.
iii. Leaves: Long and narrow with parallel venation for photosynthesis.
iv. Flowers: Male flowers in tassels at the top, and female flowers in cobs.
v. Fruits (grains): Seeds enclosed within the cob, protected by husks.

5. Discuss the biological importance of water to plants.

Water plays a crucial role in the life of plants, serving various biological functions:

i. Photosynthesis: Water is a raw material in photosynthesis, where it splits to release oxygen and provide hydrogen for glucose formation.

ii. Transport: Water acts as a solvent, facilitating the transport of minerals and nutrients from the soil to different plant parts through xylem vessels.
iii. Turgidity. Water provides turgor pressure, which helps maintain cell shape and structural support for plants.
iv. Temperature regulation: Through processes like transpiration, water helps plants regulate temperature by cooling leaves.
v. Growth. Water provides the medium for enzymatic activities essential for cell division and elongation.
vi. Seed germination: Water activates enzymes during seed germination, aiding the conversion of stored food into energy for growth.

6(a) Describe the uptake and movement of mineral ions across roots.

The uptake and movement of mineral ions across roots involve:
i. Absorption by root hairs: Root hairs increase surface area for ion absorption from the soil. Active transport allows the uptake of ions against the concentration gradient.
ii. Movement through the cortex. Mineral ions move via apoplast (cell walls) or symplast (cytoplasm) pathways to reach the endodermis.
iii. Selective transport at the endodermis. The Casparian strip ensures that ions enter the symplast pathway, where selective transport proteins regulate entry into the stele.
iv. Loading into xylem. Ions are actively transported into xylem vessels, where they are carried to the shoot by the transpiration stream.

(b) Describe the circulatory systems found in non-vertebrates and vertebrates.

i. Non-vertebrates: They have an open circulatory system where hemolymph is not confined to vessels and directly bathes organs (e.g., insects). Some, like annelids, have closed systems with blood confined to vessels.
ii. Vertebrates: They possess a closed circulatory system with blood vessels. The heart pumps blood, maintaining high pressure for efficient nutrient and oxygen transport. Examples include single circulation in fish and double circulation in mammals.

7(a) . Describe and account for the pattern of the curve observed.

The bacterial growth curve typically follows:
i. Lag phase. No increase in population as bacteria adapt to the environment.
ii. Log phase. Exponential growth due to abundant nutrients and favorable conditions.
iii. Stationary phase: Growth slows as resources deplete and waste accumulates.
iv. Decline phase. Death rate exceeds reproduction due to resource exhaustion.

(b) What would you expect to observe in case the experiment was allowed to continue for 40 hours?

If the experiment continued for 40 hours, the following would be observed:

i. Stationary phase extension: Due to nutrient depletion and waste accumulation, the growth rate would plateau further, keeping the population size constant.
ii. Decline phase initiation: Cells would begin to die faster than they reproduce as resources become critically low, and toxins build up in the culture.

(c) Discuss the factors which would contribute to the expected observations in (c) above.
i. Nutrient depletion: Limited supply of essential nutrients like carbon and nitrogen would restrict growth.
ii. Waste accumulation: Byproducts of metabolism, such as acids, could create a toxic environment.
iii. Oxygen availability: Decreased oxygen levels might limit aerobic respiration in bacteria.
iv. Space limitation: Overcrowding could inhibit bacterial cell division.
v. Energy exhaustion: Depleted energy reserves within the cells would affect their survival and reproduction.

8. (a) Describe the disorders given below and show clearly their modes of inheritance.

(i) Haemophilia
Haemophilia is a genetic disorder characterized by the inability of blood to clot properly due to the absence or low levels of clotting factors. This condition results in excessive bleeding from minor injuries.
Mode of inheritance: Haemophilia is a sex-linked recessive disorder, primarily affecting males. The defective gene is located on the X chromosome. Females can be carriers if they inherit one defective X chromosome and one normal X chromosome, while males with a defective X chromosome manifest the disease since they only have one X chromosome.

(ii) Albinism
Albinism is a genetic condition marked by a lack of melanin pigment in the skin, hair, and eyes. This leads to pale skin, white or light-colored hair, and light-colored eyes, with increased sensitivity to sunlight.
Mode of inheritance: Albinism follows an autosomal recessive inheritance pattern. For a person to have albinism, they must inherit two copies of the defective gene, one from each parent. If they inherit only one defective gene, they will be carriers without showing symptoms.

(b) Outline the observations and deductions made by Charles Darwin and Wallace which led to their hypothesis or theory of evolution.
Darwin and Wallace independently developed the theory of evolution by natural selection. Their observations and deductions include:
i. Overproduction: Organisms produce more offspring than can survive.
ii. Variation: Individuals within a species show variation in traits.
iii. Struggle for existence: Due to limited resources, not all offspring survive.
iv. Survival of the fittest: Individuals with advantageous traits are more likely to survive and reproduce.
v. Inheritance: Favorable traits are passed on to offspring, leading to adaptation and evolution over generations.

9. (a) Meaning of conservation
Conservation is the sustainable use and management of natural resources such as wildlife, water, and forests to prevent their depletion or destruction. It aims to maintain the balance of ecosystems and ensure that resources are available for current and future generations.

(b) Importance of conserving the following natural resources: wildlife, water, and forests.
i. Wildlife
- Maintains ecological balance: Wildlife plays critical roles in ecosystems, such as pollination, seed dispersal, and maintaining food chains.
- Source of biodiversity: Protecting wildlife preserves genetic diversity essential for adaptation and survival.
- Economic benefits: Tourism and research depend heavily on wildlife.

ii. Water
- Essential for life: Water is vital for all living organisms to survive and perform metabolic functions.
- Agricultural importance: Water is crucial for irrigation and food production.
- Industrial use: Water is required in industries for cooling, cleaning, and as a raw material.

iii. Forests
- Carbon sequestration: Forests absorb carbon dioxide, mitigating climate change.
- Habitat: Forests are home to countless species of plants and animals.
- Source of resources: Forests provide timber, medicine, and non-timber products.
- Prevents soil erosion: Tree roots stabilize the soil, preventing erosion and maintaining fertility.