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: 1999.**

Instructios:

1. this paper consists of eleven questions
2. answer all questions in section A, and three questions in section B.
3. the marks allocation is indicated at the beginning of each section.

1. (a) Giving reasons, name the type of cell division shown in the photographs.

The type of cell division shown in the photographs is mitosis. This is evident because the images display distinct stages of the division process (prophase, metaphase, anaphase, and telophase) with the chromosomes clearly visible and no homologous chromosome pairing or crossing over, which are characteristic of meiosis.

(b) (i) Identify the stages of cell division shown in the four photographs, A, B, C, and D.

A - Metaphase
B - Anaphase
C - Telophase
D - Cytokinesis

(ii) Describe the events taking place at each of the four stages, A, B, C, and D.

A (Metaphase): Chromosomes align at the cell's equatorial plane, and spindle fibers attach to the centromeres of each chromosome.
B (Anaphase): The spindle fibers shorten, pulling the sister chromatids apart toward opposite poles of the cell.
C (Telophase): Chromatids reach the poles, nuclear membranes reform around each set of chromatids, and the chromosomes begin to uncoil into chromatin.
D (Cytokinesis): The cytoplasm divides, forming two genetically identical daughter cells.

(c) Explain the importance of the type of cell division mentioned in 1(a) above.

Mitosis is essential for growth, repair, and maintenance in multicellular organisms. It ensures that new cells are genetically identical to the parent cell, maintaining genetic stability. Mitosis also plays a role in asexual reproduction in some organisms.
(d) Basing only on 3 pairs of chromosomes, draw large and well-labeled diagrams to represent stages B and D.

- For stage B (Anaphase): Three pairs of chromosomes splitting into individual chromatids moving toward opposite poles.
- For stage D (Cytokinesis): Two newly formed cells with identical chromatin enclosed by nuclear membranes, separated by a cleavage furrow.

2. Describe the location of parenchyma tissue in plants and show how the structure of this tissue is related to its functions.

Parenchyma tissue is located in various parts of a plant, including the cortex and pith of stems, roots, mesophyll of leaves, and as storage tissue in fruits and seeds.

The structure of parenchyma tissue is related to its functions as follows:
(i) Thin cell walls allow easy transport of water and nutrients.
(ii) Large vacuoles enable storage of food, water, and waste products.
(iii) Presence of chloroplasts in some parenchyma cells (chlorenchyma) allows photosynthesis.
(iv) Air spaces in some cells (aerenchyma) facilitate gas exchange in aquatic plants.

3. (a) Explain why we classify organisms.

Classification of organisms is essential because:
(i) It helps in organizing the vast diversity of living organisms into groups for easier study and understanding.
(ii) It aids in identifying organisms and understanding their relationships, such as evolutionary connections.
(iii) It facilitates the prediction of characteristics based on related groups.
(iv) It provides a universal system of naming organisms, which helps in scientific communication globally.

(b) Discuss Artificial and Natural systems of classification. Clearly point out the advantages and disadvantages of each system.

Artificial system of classification:
This system groups organisms based on one or a few observable characteristics, such as size, shape, or habitat, without considering evolutionary relationships.

Advantages:
(i) Easy to use and understand.
(ii) Useful for quick identification of organisms.

Disadvantages:
(i) Does not consider genetic or evolutionary relationships.
(ii) Organisms with similar external features but different evolutionary backgrounds may be grouped together.

Natural system of classification:
This system groups organisms based on their natural relationships, including genetic, morphological, and evolutionary connections.

Advantages:
(i) Reflects evolutionary relationships among organisms.
(ii) Provides a scientific basis for classification.

Disadvantages:
(i) Requires detailed and time-consuming research.
(ii) May misclassify organisms if evolutionary data is incomplete.

4. (a) In the early classification schemes, fungi were grouped together with plants.

(i) What features possessed by fungi lead to this classification?
Fungi were grouped with plants because they are immobile, have a cell wall, and reproduce through spores, similar to plants.

(ii) What considerations have been taken in separating fungi and plants into different kingdoms?
Fungi lack chlorophyll and cannot photosynthesize, relying on organic material for nutrition. Additionally, their cell walls contain chitin, unlike plant cell walls made of cellulose.

(b) Discuss the ways in which fungi are harmful to human beings.

(i) Fungi cause diseases such as athlete's foot, ringworm, and candidiasis.
(ii) Some fungi produce toxins, such as aflatoxins, which contaminate food.
(iii) They can spoil food and other organic materials, leading to economic losses.
(iv) Fungal infections in crops reduce agricultural productivity.

5. (a) Compare photosynthetic phosphorylation and oxidative phosphorylation.

Photosynthetic phosphorylation occurs in chloroplasts during photosynthesis and involves the generation of ATP using light energy to drive the electron transport chain.

Oxidative phosphorylation occurs in mitochondria during cellular respiration and involves the production of ATP through the oxidation of glucose-derived molecules, with oxygen acting as the final electron acceptor.

(b) Describe how energy in the form of ATP is formed during cyclic photophosphorylation.

In cyclic photophosphorylation, electrons from chlorophyll in photosystem I are excited by light energy. These electrons pass through a series of carriers in the electron transport chain and return to photosystem I. The movement of electrons creates a proton gradient across the thylakoid membrane, driving ATP synthesis through ATP synthase.

6. (a) Discuss the physiological processes which account for the opening of stomata during the day and closing at night.

During the day, light stimulates the active transport of potassium ions into guard cells, lowering their water potential. Water moves into the guard cells by osmosis, causing them to swell and open the stomata. At night, potassium ions diffuse out of the guard cells, increasing their water potential. Water moves out by osmosis, causing the guard cells to become flaccid and close the stomata.

(b) Explain any six features or methods used by xerophytes in minimizing water loss.

(i) Thick cuticle: Reduces water loss through the epidermis.
(ii) Sunken stomata: Traps moist air, reducing transpiration.
(iii) Reduced leaf size or spines: Minimizes the surface area for water loss.
(iv) Deep roots: Access water from deep soil layers.
(v) Stomata open at night (CAM plants): Reduces water loss during the hotter daytime.
(vi) Storage of water in tissues: Acts as a reservoir during drought.

7. (a) What do you understand by Autonomic Nervous System?

The autonomic nervous system controls involuntary actions in the body, such as heartbeat, digestion, and glandular secretions. It consists of the sympathetic and parasympathetic divisions, which regulate body functions to maintain homeostasis.

(b) Differentiate between the sympathetic and parasympathetic systems. Explain their antagonistic effects giving five examples.

The sympathetic system prepares the body for "fight or flight" responses, increasing heart rate, dilating pupils, and reducing digestion. The parasympathetic system promotes "rest and digest" activities, decreasing heart rate, constricting pupils, and enhancing digestion.

Examples of antagonistic effects:
(i) Heart rate: Sympathetic increases, parasympathetic decreases.
(ii) Pupil dilation: Sympathetic dilates, parasympathetic constricts.
(iii) Digestion: Sympathetic inhibits, parasympathetic stimulates.
(iv) Saliva production: Sympathetic reduces, parasympathetic increases.
(v) Bronchial muscles: Sympathetic relaxes, parasympathetic contracts.

8. Albinism in human beings is caused by a recessive gene which is transmitted in Mendelian fashion. A couple which is phenotypically normal for skin pigmentation has four children. The first three have normal skin and the fourth is an albino.
(a) What is the genotype of the parents?
(b) What is the probability that the fifth child will be an albino?
(c) One of the first three children marries a normal-skinned woman. What predictions can you make regarding the skin of their first child?
(d) The albino child marries a normal-skinned widow who had an albino child in her first marriage. What is the probability of this couple producing a normal-skinned child?
(a) What is the genotype of the parents?

In this case, the parents are phenotypically normal for skin pigmentation but have an albino child. Albinism is caused by a recessive gene, meaning that for a child to be albino, they must inherit two recessive alleles

(aa), one from each parent. Therefore, the parents must each carry one normal dominant allele (A) and one recessive allele (a). Their genotype is Aa for both parents.

(b) What is the probability that the fifth child will be an albino?

To calculate the probability, we use a Punnett square to represent the genetic cross between two heterozygous parents (Aa x Aa):

	A (Parent 1)	**a (Parent 1)**
A (Parent 2)	AA	Aa
a (Parent 2)	Aa	aa

From the Punnett square:
- AA: 1/4 or 25% (homozygous dominant, normal skin)
- Aa: 2/4 or 50% (heterozygous, carrier but normal skin)
- aa: 1/4 or 25% (homozygous recessive, albino)

The probability that the fifth child will be an albino is 25% or 1 in 4.

(c) One of the first three children marries a normal-skinned woman. What predictions can you make regarding the skin of their first child?

If one of the first three children marries a normal-skinned woman, there are two possibilities:
1. The normal-skinned woman is homozygous dominant (AA).
2. The normal-skinned woman is heterozygous (Aa).

For case 1 (AA x Aa):
- All children will have normal skin, but 50% will be carriers (Aa).

For case 2 (Aa x Aa):
- Using a Punnett square, the probabilities are:
  - 25% normal (AA)
  - 50% normal carriers (Aa)
  - 25% albino (aa)

Thus, if the woman is homozygous dominant (AA), none of the children will be albino. However, if she is a carrier (Aa), there is a 25% chance that the child will be albino.

(d) The albino child marries a normal-skinned widow who had an albino child in her first marriage. What is the probability of this couple producing a normal-skinned child?

The albino child's genotype is aa. Since the widow had an albino child in her first marriage, she must be a carrier of the albinism gene (Aa). The cross is aa (albino) x Aa (carrier).

Using a Punnett square:

	A (Widow)	**a (Widow)**
a (Albino)	Aa (carrier)	aa (albino)

From the Punnett square:
- Aa: 50% (normal-skinned but carrier)
- aa: 50% (albino)

The probability of producing a normal-skinned child is 50%. However, this child will always be a carrier of the albinism gene.

9. Discuss Darwin's contributions to the theory of evolution and show how this theory has been updated.

Darwin's contributions:
(i) Theory of natural selection: Darwin proposed that organisms better adapted to their environment survive and reproduce, passing on favorable traits to the next generation.
(ii) Descent with modification: He suggested that all species share a common ancestor and evolve over time through gradual changes.
(iii) Struggle for existence: Organisms compete for limited resources, and only the fittest survive.

Updates to Darwin's theory:
(i) Mendelian genetics: The discovery of genes and inheritance mechanisms provided a genetic basis for variation, which Darwin could not explain.
(ii) Modern synthesis: Integrates Darwin's ideas with population genetics, showing how evolution occurs at the genetic level.
(iii) Molecular biology: Advances in DNA sequencing confirm common ancestry and provide evidence for evolutionary relationships.
(iv) Epigenetics: Demonstrates that environmental factors can influence gene expression and be inherited, adding complexity to the evolutionary process.
(v) Fossil evidence: New fossil discoveries continue to fill gaps in the evolutionary record, supporting Darwin's concept of gradual change over time.