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: 2007**

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) Give two functions of each of the following cellular organelles:
   (i) Nucleus
   (ii) Endoplasmic reticulum
   (iii) Golgi apparatus
   (iv) Lysosomes

Answer:
(i) Nucleus
- Stores genetic material (DNA) and regulates gene expression.
- Controls cellular activities such as growth, metabolism, and reproduction.

(ii) Endoplasmic reticulum
- Rough ER synthesizes and transports proteins.
- Smooth ER synthesizes lipids and detoxifies harmful substances.

(iii) Golgi apparatus
- Modifies, sorts, and packages proteins and lipids for secretion or use within the cell.
- Produces lysosomes and vesicles.

(iv) Lysosomes
- Break down waste materials and cellular debris.
- Play a role in autophagy by digesting damaged organelles.

(b) What advantages does a eukaryotic cell gain by having internal membrane-bound organelles?

Answer:
- Compartmentalization allows separation of cellular processes, increasing efficiency.
- Provides specific environments for specialized reactions (e.g., acidic conditions in lysosomes).
- Facilitates storage and transport of molecules within vesicles.
- Enables greater regulation and coordination of cellular functions.

2. (a) Explain why organisms like Entamoeba, Euglena, Spirogyra, and Phytophthora are put in kingdom Protista despite their differences in many aspects.

Answer:
- These organisms are placed in Protista because they are unicellular or simple multicellular eukaryotes.
- They exhibit diverse modes of nutrition (autotrophic, heterotrophic, or mixotrophic).
- They do not fit into other kingdoms like Plantae, Animalia, or Fungi due to their unique traits (e.g., Euglena is photosynthetic but motile).

(b) Discuss briefly the ways Agaricus is adapted to its mode of life.

Answer:

- Agaricus (mushroom) has a mycelium that grows in the soil to absorb nutrients.
- Its fruiting body is adapted for spore dispersal, aiding reproduction.
- Produces enzymes that break down organic matter for nutrition.
- Thrives in moist environments conducive to fungal growth.

3. The diagram below shows chemical pathways involved in respiration and photosynthesis.

(a) Name the process that produces pyruvate from glucose.
Answer: Glycolysis

(b) Name the compounds labeled X and Y.
Answer:
X - ATP
Y - NADPH

(i) In which part of a chloroplast is glycerate-3-phosphate converted into ribulose bisphosphate?
Answer: Stroma

(ii) Describe the role of ribulose bisphosphate in photosynthesis.
Answer: Ribulose bisphosphate (RuBP) acts as a carbon dioxide acceptor in the Calvin cycle, enabling the fixation of carbon dioxide to form 3-phosphoglycerate.

4. Distinguish between the following:

(a) Action potential and generator potential
Answer: Action potential is a rapid electrical signal triggered when a threshold is reached, while generator potential is a graded response to a stimulus that may lead to an action potential if the threshold is exceeded.

(b) Conduction and transduction of nerve impulses
Answer: Conduction is the transmission of electrical signals along a neuron, while transduction is the conversion of a stimulus into an electrical signal by sensory receptors.

(c) Synapses and synapsis
Answer: Synapses are junctions between neurons for signal transmission, while synapsis is the pairing of homologous chromosomes during meiosis.

(d) Rods and cones in the human eye
Answer: Rods are photoreceptors sensitive to low light for black-and-white vision, while cones detect color and function in bright light conditions.

5.(a) State the components of homeostatic mechanisms.
The components of homeostatic mechanisms include:
i. Receptors – These detect changes in the internal or external environment (stimuli) and send signals to the control center.
ii. Control Center – Usually the brain or endocrine glands, which process the information from receptors and coordinate an appropriate response.
iii. Effectors – Organs or tissues that carry out the response to restore balance, such as muscles or glands.

(b) Explain briefly why the body temperature of a man standing beside a rock on a hot day remains relatively constant while that of a rock rises to about 50°C.

A man's body temperature remains relatively constant due to the body's homeostatic mechanisms, specifically thermoregulation. The human body regulates temperature through processes like sweating, vasodilation, and heat loss by radiation. When the external temperature rises, sweat glands produce sweat, which evaporates and cools the body. Blood vessels near the skin also widen (vasodilation) to release heat.

In contrast, a rock has no biological temperature regulation system. It absorbs and stores heat from the sun, leading to a rise in temperature. Since it does not sweat, radiate heat efficiently, or circulate fluids like blood, its temperature increases according to environmental conditions.

6. (a) Distinguish between 'passive' and 'active' transport of materials within the body of an organism.

Passive transport is the movement of molecules across a membrane without energy expenditure, following the concentration gradient (from high to low concentration). Examples include diffusion, osmosis, and facilitated diffusion.

Active transport requires energy (ATP) to move molecules against the concentration gradient (from low to high concentration). It is mediated by protein pumps and is used in processes like the uptake of minerals in plant roots and sodium-potassium ion exchange in nerve cells.

(b) Explain how water gets from the soil to the leaf vein.
Water is absorbed by root hairs from the soil through osmosis, as the soil solution has a higher water potential than the root cells. It then moves through the root cortex via the apoplastic pathway (cell walls) or the symplastic pathway (cytoplasm and plasmodesmata) until it reaches the endodermis.

At the endodermis, the Casparian strip forces water to enter the xylem, where it is transported upward by root pressure, capillary action, and transpiration pull. The transpiration pull is the primary force, created by water evaporating from leaf stomata, pulling more water up the plant via cohesion (water molecules sticking together) and adhesion (water sticking to xylem walls).

7. (a) Why are oxygen and water required in the germination of seeds?

Oxygen is needed for aerobic respiration, which provides the energy (ATP) required for cellular processes, including enzyme activation, cell division, and root and shoot growth.

Water is essential for breaking seed dormancy, softening the seed coat, activating enzymes, dissolving stored nutrients, and facilitating their transport to the growing embryo. It also enables metabolic reactions necessary for germination.

(b) State and describe two differences between endospermic and non-endospermic seeds.

i. Storage of nutrients:
Endospermic seeds retain the endosperm as a food storage tissue (e.g., maize).
Non-endospermic seeds absorb all the endosperm into the cotyledons before germination (e.g., beans).

ii. Cotyledon size:
Endospermic seeds have small cotyledons since nutrients are stored in the endosperm.
Non-endospermic seeds have large cotyledons because they store food there.

8. (a) Define the term 'growth' as applied to multicellular organisms.
Growth in multicellular organisms is the irreversible increase in size and mass due to cell division (mitosis) and cell enlargement. It leads to the development of tissues, organs, and the entire body structure over time.

(b) When measuring growth in a living organism, what are the advantages and disadvantages of taking fresh mass and dry mass measurements?

Fresh mass:
Advantages: It is easy to measure and provides immediate results.
Disadvantages: It fluctuates due to water content variations, leading to inconsistent results.

Dry mass:
Advantages: Provides an accurate measurement of organic material, excluding water content.
Disadvantages: It requires the organism to be dried, often leading to its death, making it impractical for continuous measurements.

9. (a) Define mutation.

A mutation is a permanent change in the DNA sequence of a gene or chromosome, which can result in altered protein production and genetic variation. Mutations can be beneficial, harmful, or neutral.

(b) Explain why harmful recessive mutations are likely to survive in many generations than dominant mutations.

Harmful recessive mutations persist in populations because they remain hidden in heterozygous carriers (Aa) and do not affect survival unless inherited from both parents (aa). Dominant harmful mutations (A), however, are expressed in heterozygotes (Aa and AA), causing negative effects that reduce survival and reproduction, leading to their elimination from the gene pool.

10. (a) What is meant by artificial selection?
Artificial selection is the process where humans selectively breed organisms with desirable traits to enhance characteristics like higher yield, disease resistance, or faster growth. It is widely used in agriculture and animal breeding.

(b) Give the differences between allopatric speciation and sympatric speciation

i. Geographical isolation:
Allopatric speciation occurs due to physical barriers (e.g., mountains, rivers) separating populations.
Sympatric speciation occurs without geographical barriers, often due to genetic mutations or ecological differences.

ii. Gene flow:
Allopatric speciation prevents gene flow between separated populations.
Sympatric speciation allows populations to coexist but evolve separately due to different selective pressures.
iii. Example:
Allopatric speciation: Darwin's finches on the Galápagos Islands.
Sympatric speciation: Polyploidy in plants, where chromosome duplication creates new species without physical separation.

11. (a) State the properties of enzymes.

i. Specificity – Each enzyme catalyzes only one type of reaction or acts on a specific substrate due to its unique active site.

ii. Catalytic nature – Enzymes speed up chemical reactions without being consumed or altered permanently.

iii. Reversibility – Some enzyme-catalyzed reactions can proceed in both directions, depending on the concentration of reactants and products.

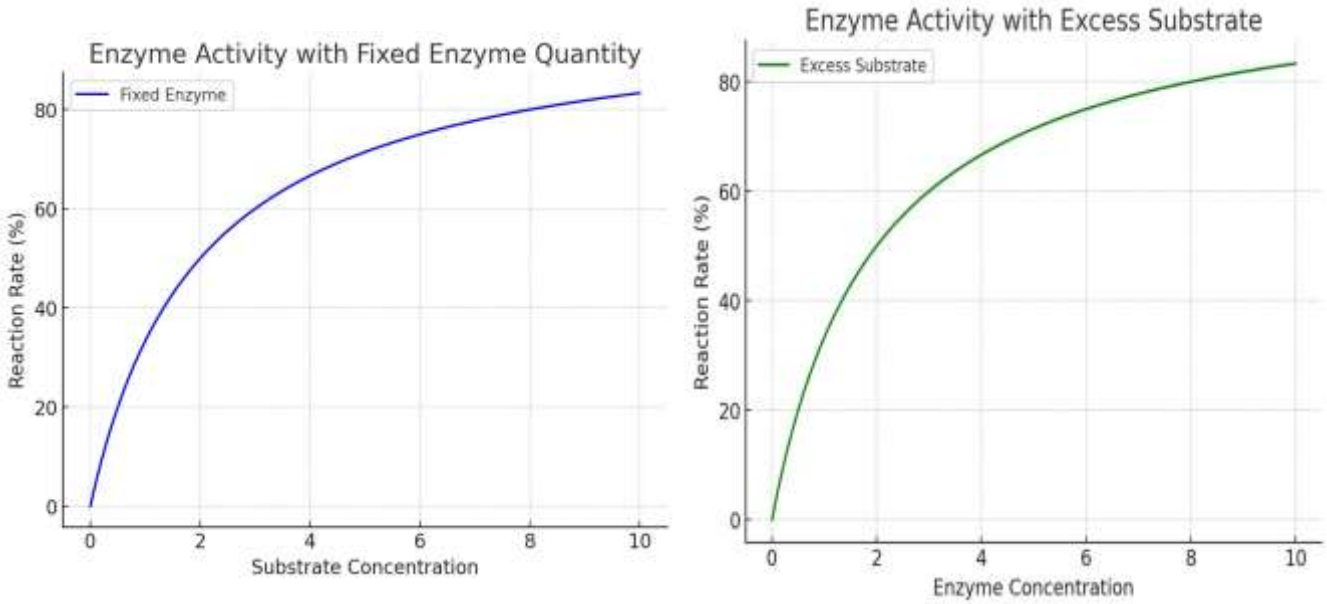
iv. Sensitivity to temperature – Enzymes work best at an optimum temperature, usually around 37°C in humans, but denature at high temperatures.

v. Sensitivity to pH – Enzymes function within a specific pH range, beyond which they become inactive or denatured.

vi. Inhibition – Enzyme activity can be reduced by inhibitors, which may be competitive (blocking the active site) or non-competitive (altering enzyme shape).

vii. Activation energy reduction – Enzymes lower the activation energy required for a reaction, making biochemical processes faster and more efficient.

(b) Sketch graphs to show the types of curves that would be obtained when investigating enzymic activity under constant conditions when:



The graphs above illustrate:

(i) Fixed enzyme quantity – The reaction rate increases as substrate concentration increases but eventually plateaus when all active sites are occupied.
(ii) Excess substrate – The reaction rate increases as enzyme concentration increases, provided there is an excess of substrate to bind to the enzyme molecules.

(c) Describe the roles of lipids in living organisms.

Lipids perform several vital functions in living organisms:

i. Energy storage – Lipids store energy in a more concentrated form than carbohydrates. They provide long-term energy reserves, especially in animals.

ii. Structural components – Lipids are essential components of cell membranes, where phospholipids form the bilayer that regulates the entry and exit of substances.

iii. Insulation – In mammals, lipids act as heat insulators, preventing excessive heat loss, particularly in cold environments.

iv. Protection – Lipids form protective layers around delicate organs (e.g., the kidneys and heart), cushioning them from mechanical damage.

v. Hormone production – Some lipids (such as cholesterol) serve as precursors for steroid hormones, including testosterone and estrogen.

vi. Waterproofing – Waxes, a type of lipid, prevent water loss in plants (cuticle) and in animals (fur and feathers).

vii. Buoyancy – Lipids contribute to buoyancy in aquatic animals, such as whales and seals, helping them float.

12. (a) Explain why human beings cannot see clearly during the night, while cats and night birds like owls can see clearly.

Answer:
Human eyes are adapted for daylight vision due to the dominance of cone cells in the retina, which function well under bright light but poorly in dim light. At night, vision relies on rod cells, which are more light-sensitive but cannot detect colors effectively.

In contrast, cats and owls have more rod cells and a specialized reflective layer called the tapetum lucidum, which enhances their ability to capture and amplify low light, allowing them to see in the dark. Additionally, their pupils can open much wider, allowing more light to enter.

(b) Give the importance of natural and synthetic phytohormones in crop production.

Answer:
Natural phytohormones play a key role in plant growth and development, while synthetic phytohormones are used in agriculture to improve productivity. Their importance includes:

i. Seed germination – Gibberellins stimulate the breaking of dormancy, promoting faster seed sprouting.

ii. Root and shoot development – Auxins encourage root formation, which is useful in vegetative propagation.

iii. Flowering and fruit development – Cytokinins and gibberellins help in controlling flowering and increasing fruit size.

iv. Ripening control – Ethylene gas regulates fruit ripening, allowing farmers to delay or hasten the process.
v. Weed control – Synthetic auxins are used as selective herbicides to kill weeds without harming crops.

vi. Tissue culture and cloning – Phytohormones like auxins and cytokinins aid in the micropropagation of plants.

13. Discuss the ways in which oxygen and carbon dioxide are transported in a mammalian body.

Answer:
In mammals, oxygen transport occurs primarily through hemoglobin in red blood cells. Oxygen enters the lungs, diffuses into the blood, and binds to hemoglobin to form oxyhemoglobin. In tissues, oxygen is released due to lower oxygen partial pressure and higher carbon dioxide concentration.

Carbon dioxide transport occurs in three main ways:

i. As bicarbonate ions (HCO_3^-) – About 70% of CO_2 is converted into carbonic acid (H_2CO_3), which dissociates into bicarbonate ions, transported in plasma.

ii. Bound to hemoglobin – About 20% of CO_2 binds with hemoglobin to form carbaminohemoglobin.

iii. Dissolved in plasma – About 10% of CO_2 is carried in dissolved form in blood plasma.

At the lungs, CO_2 is released from hemoglobin and bicarbonate ions, diffuses into alveoli, and is expelled through exhalation.

14. (a) A very large number of eggs is normally laid by animals with external fertilization, while many species with internal fertilization produce relatively few eggs. Explain.

Answer:
Animals with external fertilization (e.g., fish and amphibians) lay many eggs because fertilization occurs outside the body, exposing the eggs to environmental hazards such as predation, water currents, and unfavorable conditions. To ensure species survival, they compensate by producing a large number of eggs. In contrast, species with internal fertilization (e.g., mammals and birds) protect their fertilized eggs inside the female body, reducing mortality rates. Since fertilization and early development occur in a controlled environment, fewer eggs are needed to sustain population growth.

(b) State and describe the critical hormonal changes in human females that respectively trigger ovulation and cause degeneration of the corpus luteum.

i. Ovulation – Triggered by a surge in luteinizing hormone (LH) from the pituitary gland. LH stimulates the rupture of a mature follicle in the ovary, releasing an egg (ovulation), usually around day 14 of the menstrual cycle.
ii. Degeneration of the corpus luteum – If fertilization does not occur, progesterone levels drop, leading to the degeneration of the corpus luteum. This is caused by a decrease in LH secretion, which stops supporting

the corpus luteum. As a result, the corpus luteum shrinks, ceases progesterone production, and menstruation begins.

15. (a) In a population of human beings, there are more color-blind individuals as compared to hemophiliacs. Genes for the two characters are transmitted in the same way. Explain this difference in frequency.
Answer
Both color blindness and hemophilia are sex-linked recessive traits, meaning they are carried on the X chromosome. The difference in frequency is due to the genetic mutation rates and selective pressures.
- Mutation Rate. Color blindness is caused by mutations in genes responsible for color vision (e.g., opsin genes), and these mutations occur more frequently compared to mutations causing hemophilia.
- Selective Pressure. Hemophilia often leads to severe health complications and reduces survival chances if untreated, thus reducing its prevalence in the population. In contrast, color blindness has little to no impact on survival, so it persists in the population at a higher frequency.
- Carriers in Females. Female carriers for both conditions have a single copy of the mutated gene and are unaffected. However, since hemophilia has more severe consequences, it may lead to fewer carriers due to the health risks associated with the condition in affected males.

(b) A certain species of flies has the following genotypic attributes:
(i) Female flies have two X chromosomes (XX).
(ii) Male flies have one X and one Y chromosome (XY).
(iii) The Y chromosome does not carry any gene.
(iv) The eye color trait is sex-linked, and red eye color trait is dominant over white eye trait.

What would be the phenotypes and genotypes of the males and females in F_1 and F_2 when a white-eyed female is crossed with a white-eyed male?

The cross is between a white-eyed female (X^aX^a) and a white-eyed male (X^aY), where X^a represents the white-eye allele.
F_1 Generation.
- Parental genotypes: X^aX^a (female) × X^aY (male)
- Gametes:
  Female produces X^a, X^a.
  Male produces X^a, Y.

- Punnett square:

Female\Male	X^a	Y
X^a	X^aX^a	X^aY
X^a	X^aX^a	X^aY

- F_1 Phenotypes and Genotypes.

- Females: All white-eyed (X^aX^a).
- Males: All white-eyed (X^aY).

- F_2 Generation.
- Cross between F_1 individuals: White-eyed female (X^aX^a) × White-eyed male (X^aY).
- Gametes:
  Female produces X^a, X^a.
  Male produces X^a, Y.

- Punnett square:

Female\Male	X^a	Y
X^a	X^aX^a	X^aY
X^a	X^aX^a	X^aY

- F_2 Phenotypes and Genotypes.
  - Females: All white-eyed (X^aX^a).
  - Males: All white-eyed (X^aY).

Conclusion.
Both F_1 and F_2 generations consist entirely of white-eyed males and females, as the recessive white-eye allele is present in all individuals due to the parental genotypes.