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: 1997**

Instructions:

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

1. (a) The diagram below represents hematotic metaphase plate of a hypothetical cell as seen from polar view start the diagram carefully then answer the questions which follow.

i. State the number of pairs of homologous chromosomes and the value of 2n.
The number of pairs of homologous chromosomes is 3, and the value of 2n is 6.

ii. Show diagrammatically the appearance of the metaphase plate of meiosis I as viewed from the side.
[For this part, draw a diagram showing homologous chromosome pairs aligned along the metaphase plate, with spindle fibers attached to their centromeres, preparing for separation during meiosis I.]

(b) Name the organelles in animal cells in which the processes mentioned below occur:
i. Transcription: Nucleus
ii. Synthesis of adenosine triphosphate: Mitochondria
iii. Synthesis of polypeptides: Ribosomes
iv. Formation of primary lysosomes: Golgi apparatus

2. (a) i. In what ways are fungi similar to and different from plants?
Similarities:
- Both have cell walls (though fungal cell walls are made of chitin and plant cell walls are made of cellulose).
- Both are immobile and grow in soil or other substrates.
Differences:
- Fungi are heterotrophic, while plants are autotrophic.
- Fungi reproduce through spores, while plants reproduce through seeds or spores.

ii. Giving specific examples, mention two ways in which fungi are of medical importance.
- Antibiotics: Penicillium produces penicillin, an antibiotic used to treat bacterial infections.
- Pathogens: Candida albicans causes fungal infections like thrush in humans.

(b) Briefly explain why the exoskeleton in insects is both an advantage and a disadvantage.
Advantages:
i. Provides structural support and protection against predators and physical damage.
ii. Prevents water loss, aiding in survival in dry environments.
Disadvantages:
i. Limits growth, requiring insects to molt periodically.
ii. Adds weight, which can restrict movement and energy efficiency.

3. (a) i. What do you understand by the phrase "biological control"?
Biological control refers to the use of natural predators, parasites, or pathogens to regulate populations of harmful pests, reducing the need for chemical pesticides.

ii. State the advantages and disadvantages of biological control.
Advantages:
- Environmentally friendly and sustainable.

- Reduces reliance on harmful chemical pesticides.
- Cost-effective once established.

Disadvantages:
- May be slow to act compared to chemical methods.
- Risk of non-target species being affected.
- Introduced species might become invasive.

(b) The free-living planarians and the parasitic tapeworms belong to the same phylum. Identify the features which are well developed in the former but show partial or total degeneracy in the latter.

i. Planarians have a well-developed digestive system, while tapeworms lack one and absorb nutrients through their body surface.

ii. Planarians have a nervous system and sense organs, whereas tapeworms exhibit reduced sensory structures.

iii. Planarians can move freely, while tapeworms are adapted for attachment in hosts, lacking locomotory structures.

4. (a) i. What are lipids?

Lipids are organic compounds composed of carbon, hydrogen, and oxygen. They are hydrophobic and include fats, oils, and steroids.

ii. Describe the roles of lipids in organisms.
- Energy storage: Lipids provide long-term energy storage.
- Insulation: Lipids help maintain body temperature by providing insulation.
- Protection: They cushion and protect vital organs.
- Structural components: Lipids are key components of cell membranes.

(b) State the properties of water which account for its ability to play various life-promoting functions in organisms.

i. High specific heat capacity: Stabilizes temperature in organisms and the environment.

ii. Solvent properties: Dissolves a wide range of substances, enabling biochemical reactions.

iii. Cohesion and adhesion: Facilitates water transport in plants and blood flow in animals.

iv. High heat of vaporization: Aids in cooling through sweating or transpiration.

5. (a) Describe the fate of pyruvic acid under anaerobic conditions.

i. In animals, pyruvic acid is converted to lactic acid during anaerobic respiration, producing a small amount of ATP.

ii. In plants and some microorganisms, pyruvic acid is converted to ethanol and carbon dioxide through fermentation, also yielding a small amount of ATP.

(b) How is the small intestine in humans adapted for its role of absorption?

i. Large surface area: The presence of villi and microvilli increases the surface area for absorption.

ii. Rich blood supply: Capillaries in the villi enhance nutrient transport.

iii. Thin epithelium: Reduces the distance for diffusion of nutrients.
iv. Specialized transport mechanisms: Active and passive transport allow absorption of various nutrients.

6. (a) i. Explain the relationship between the type of excretory waste and habitat.
The type of nitrogenous waste produced by an organism is closely related to its habitat due to the availability of water for excretion.
- Ammonia is excreted by aquatic organisms such as Osteichthyes (bony fish) because it is highly toxic and requires large amounts of water for dilution and excretion.
- Urea is excreted by terrestrial organisms like mammals because it is less toxic and can be concentrated, conserving water.
- Uric acid is excreted by insects and some reptiles because it is non-toxic and can be excreted as a paste or solid, minimizing water loss, which is critical in arid environments.

ii. Which of the above nitrogenous excretory wastes is associated with the evolution of the cleidoic eggs?
Uric acid is associated with the evolution of cleidoic eggs. Cleidoic eggs are enclosed and conserve water, requiring excretion of uric acid to prevent the buildup of toxic waste within the egg.

(b) Why is it not advisable for a victim of diabetes mellitus to drink alcohol?
i. Alcohol disrupts glucose metabolism, causing fluctuations in blood sugar levels, which can lead to hypoglycemia or hyperglycemia in diabetics.
ii. Alcohol impairs liver function, reducing its ability to regulate blood sugar effectively.
iii. Excessive alcohol can interfere with diabetes medications, reducing their efficacy or causing adverse reactions.

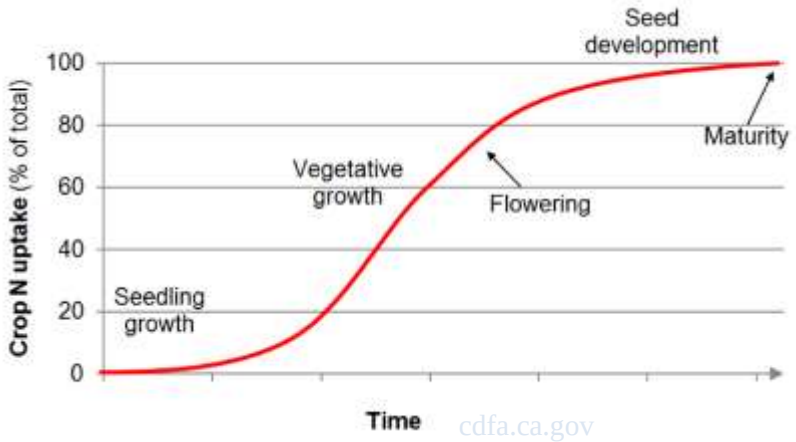
7. (a) Draw a sketch graph to show a growth curve of an annual plant starting with seed germination and ending with production.
The growth curve of an annual plant, from seed germination to seed production, typically follows a sigmoid (S-shaped) pattern. This curve can be divided into distinct phases:

i. Lag Phase
Following seed germination, the plant undergoes a period of slow growth as it establishes its root system and begins initial leaf development.

ii. Log (Exponential) Phase
The plant experiences rapid growth, characterized by swift cell division and elongation, leading to significant increases in size and biomass.

iii. Maturation (Stationary) Phase
Growth rate decreases as the plant reaches maturity. Energy is redirected from vegetative growth to reproductive processes, culminating in flowering and seed production.

This sigmoid growth pattern is common among annual plants, which complete their entire life cycle—from germination to seed production—within a single growing season.



(b) Account for the shape of the growth curve.
i. Lag phase: During this initial phase, growth is slow as the seed germinates and the plant establishes itself.
ii. Exponential phase: Growth accelerates as the plant actively photosynthesizes and develops stems, leaves, and roots.
iii. Plateau phase: Growth slows as the plant matures and energy is directed toward reproduction, such as flowering and seed production.

8. (a) i. Explain what has happened to pawpaw pieces in A and B setups.
- In setup A (distilled water), the pawpaw piece absorbed water through osmosis, becoming turgid and increasing in size.
- In setup B (25% sucrose solution), the pawpaw piece lost water through osmosis to the hypertonic solution, becoming flaccid and shrinking.

ii. What biological concepts are demonstrated by the experiment?
- Osmosis: Movement of water across a semi-permeable membrane from a region of low solute concentration to high solute concentration.
- Turgidity and plasmolysis: Turgidity occurs when cells swell due to water uptake, and plasmolysis occurs when cells lose water and shrink.

iii. How are the concepts you have mentioned in (ii) above useful to plant life?
- Osmosis facilitates water absorption by root hairs from the soil.
- Turgidity provides structural support to plant cells, maintaining the plant's upright position.
- Plasmolysis helps plants conserve water during drought conditions by closing stomata.

(b) State the factors which influence the rate of transpiration.
i. Temperature: Higher temperatures increase the rate of evaporation and transpiration.
ii. Humidity: High humidity reduces transpiration by decreasing the water vapor gradient.
iii. Wind: Increased wind removes water vapor near the leaf surface, enhancing transpiration.
iv. Light intensity: Higher light intensity increases stomatal opening, promoting transpiration.
v. Soil water availability: Adequate soil moisture supports continuous water uptake and transpiration.

9. (a) i. Name any two types of plant growth regulating substances and state one function of each.
- Auxins: Promote cell elongation and are involved in phototropism and geotropism.
- Gibberellins: Stimulate stem elongation, seed germination, and flowering.

(b) Outline the events which take place during the transmission of a nerve impulse across the synapse.
i. An action potential arrives at the presynaptic terminal, causing calcium ion channels to open and calcium ions to enter.
ii. This triggers the release of neurotransmitters from synaptic vesicles into the synaptic cleft via exocytosis.
iii. The neurotransmitters diffuse across the synaptic cleft and bind to specific receptors on the postsynaptic membrane.
iv. This binding causes ion channels in the postsynaptic membrane to open, leading to depolarization if the threshold is reached, and generating an action potential.
v. The neurotransmitters are either broken down by enzymes or reabsorbed into the presynaptic terminal for reuse.

10. (a) i. In a certain population of mice, yellow coat is dominant to gray coat. Whenever yellow mice were interbred, the resulting offspring were yellow and gray in the ratio of 2:1. Give an illustrated explanation of this observation.
The 2:1 ratio indicates that the yellow coat trait is lethal when homozygous.
- Genotype of yellow mice: Yy (heterozygous).
- Cross between two yellow mice (Yy x Yy):
  - YY (homozygous yellow) is lethal, leading to death.
  - Yy (heterozygous yellow) survives and appears yellow.
  - yy (homozygous gray) appears gray.

This results in a phenotypic ratio of 2 yellow: 1 gray in the surviving offspring.

(b) Give two examples of human traits which are inherited in a criss-cross fashion.
- Hemophilia: Passed from a carrier mother to her son.
- Color blindness: Inherited from a carrier mother by her son.

11. (a) i. Define the term population from a geneticist's point of view.
A population is a group of interbreeding individuals of the same species sharing a common gene pool.

ii. Define the term population from an ecologist's point of view.
A population is a group of organisms of the same species living in a specific area and interacting with one another.

(b) Explain two factors which affect population growth.
i. Birth rate: A higher birth rate increases population size, while a lower birth rate reduces it.
ii. Mortality rate: A high mortality rate decreases population size, while a low mortality rate allows population growth.

12. (a) Explain these experimental results in terms of natural selection.
Initially, the use of DDT reduced the pest population significantly, as most pests were susceptible to the pesticide. Over time, pests with genetic resistance to DDT survived and reproduced, leading to an increase in the resistant population. This demonstrates natural selection, where resistant pests were selected for in the population.

(b) What are the limitations of Darwin's theory of natural selection?
i. Lack of understanding of genetic mechanisms: Darwin's theory did not explain how traits were inherited or how variations arose.
ii. Limited explanation for sudden changes: The theory could not account for rapid evolutionary changes seen in the fossil record.
iii. Overemphasis on survival: The role of genetic drift and neutral mutations was not considered.
iv. Incomplete knowledge of developmental biology: Darwin's theory did not address how embryonic development influenced evolution.