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: 2020**

Instructions:

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

Prepared by: Maria Marco for TETEA

1. (a) Euglena has both plant and animal characteristics. Explain its three plant and animal characteristics.

Plant characteristics:
i. Chloroplasts: Euglena contains chloroplasts with chlorophyll, which enable it to carry out photosynthesis. This allows it to produce its own food in the presence of sunlight, a key feature of plants.
ii. Autotrophic nutrition: In the presence of light, Euglena synthesizes its food through photosynthesis, just like plants. This ability allows it to survive independently in favorable light conditions.
iii. Presence of a pellicle: Although not as rigid as a plant cell wall, the pellicle provides structural support and some protection, aiding Euglena in maintaining its shape and adapting to its aquatic environment.

Animal characteristics:
i. Motility: Euglena uses its flagellum to move actively, a trait commonly associated with animals. This movement enables it to locate light for photosynthesis or organic matter for heterotrophic feeding.
ii. Heterotrophic nutrition: In the absence of light, Euglena can ingest and feed on organic substances, exhibiting a heterotrophic mode of nutrition similar to animals.
iii. Absence of a cell wall: Unlike plants, Euglena lacks a rigid cell wall, allowing it to move and change shape more flexibly, a feature that supports its active lifestyle.

(b) In seven points, describe the structural adaptations of Euglena to its mode of life.

i. Flagellum: Euglena possesses a long whip-like structure, the flagellum, which propels it through water. This allows it to actively seek light for photosynthesis or organic material for heterotrophic feeding.

ii. Chloroplasts: These organelles contain chlorophyll, enabling Euglena to capture sunlight and produce energy through photosynthesis, ensuring its survival in light-abundant environments.

iii. Eyespot (stigma): The eyespot detects the intensity and direction of light, guiding Euglena toward light sources for efficient photosynthesis, a behavior known as phototaxis.

iv. Pellicle: The pellicle provides flexibility and structural support, allowing Euglena to move and adapt its shape to different environmental conditions, including squeezing through narrow spaces.

v. Contractile vacuole: This organelle regulates water balance by expelling excess water from the cell, preventing it from bursting in hypotonic environments where water enters the cell by osmosis.

vi. Plasma membrane: The selectively permeable plasma membrane allows the exchange of gases, nutrients, and waste, supporting both autotrophic and heterotrophic modes of nutrition.

vii. Paramylon granules: These store carbohydrates in the form of paramylon, ensuring Euglena has an energy reserve for survival during unfavorable conditions like prolonged darkness.

2. Describe any six processes which are impaired when the mammalian liver is severely damaged.

i. Detoxification: The liver's ability to neutralize and remove toxins such as alcohol and drugs is compromised. This leads to the accumulation of harmful substances in the bloodstream, which can cause systemic toxicity.

ii. Protein synthesis: The liver produces essential plasma proteins like albumin and clotting factors. Damage to the liver results in hypoalbuminemia (causing edema) and clotting disorders, increasing the risk of bleeding.

iii. Bile production: The production of bile, which aids in the digestion and absorption of fats, is reduced. This leads to fat malabsorption and deficiencies in fat-soluble vitamins (A, D, E, and K).

iv. Glycogen storage and glucose regulation: The liver stores glycogen and converts it back to glucose when needed. Liver damage impairs this function, causing unstable blood sugar levels, including hypoglycemia or hyperglycemia.

v. Lipid metabolism: The liver processes and regulates cholesterol and other fats. Damage can lead to fatty liver disease, hyperlipidemia, and other lipid metabolism disorders.

vi. Ammonia detoxification: The liver converts toxic ammonia into urea for excretion. Severe liver damage leads to a buildup of ammonia in the blood, causing hepatic encephalopathy, which affects brain function.

3. describe three main events which take place in each of the following stages of the cell cycle:

(a) Interphase:
i. G1 phase: The cell grows in size, synthesizes proteins, and produces organelles required for DNA replication and cellular functions.
ii. S phase: The DNA is replicated, resulting in the duplication of chromosomes to ensure that each daughter cell will have a complete set of genetic material.
iii. G2 phase: The cell prepares for division by synthesizing proteins necessary for mitosis and ensuring all DNA is correctly replicated.

(b) Prophase:
i. Chromosomes condense into visible structures, each consisting of two sister chromatids joined at a centromere.
ii. The nuclear envelope begins to break down, and the nucleolus disappears, signaling the onset of mitosis.
iii. Spindle fibers form from the centrioles and attach to the chromosomes' centromeres, preparing for their alignment.
(c) Metaphase:
i. Chromosomes align at the metaphase plate (cell equator) due to the pull of spindle fibers.

ii. Each chromosome is attached to spindle fibers from opposite poles, ensuring proper segregation during the next phase.
iii. The cell ensures that all chromosomes are correctly aligned and attached to the spindle apparatus to prevent errors in division.

4. (a) In four points, explain the usefulness of genetic engineering in different fields.

i. Medicine: Genetic engineering is used to produce therapeutic proteins like insulin and vaccines, as well as for gene therapy to treat genetic disorders such as cystic fibrosis.

ii. Agriculture: It enables the creation of genetically modified crops with improved yields, pest resistance, drought tolerance, and enhanced nutritional content.

iii. Industry: Genetically engineered microorganisms are used in industrial processes, such as producing biofuels, enzymes, and biodegradable plastics.

iv. Environmental management: Genetic engineering is applied in bioremediation to create microorganisms capable of breaking down pollutants, such as oil spills or heavy metals.

(b) When white and black-colored fur mice were mated, all of the F1 had black-colored fur. Carry out genetic crosses to show the formation of F1 and F2.

Let B represent the dominant allele for black fur and b represent the recessive allele for white fur.

P generation:
White (bb) x Black (BB)
Gametes: b from white, B from black

F1 generation:
All offspring: Bb (heterozygous), black fur

F2 generation (F1 self-cross):
Bb x Bb

	B (mother)	b (mother)
B (father)	BB (black)	Bb (black)
b (father)	Bb (black)	bb (white)

Phenotypic ratio: 3 black : 1 white
Genotypic ratio: 1 BB : 2 Bb : 1 bb

5. Describe how vestigial organs, chemical constituents, and physiological processes support evolution among groups of organisms.

i. Vestigial organs: Vestigial organs are remnants of structures that were functional in ancestral species but have lost their original function over time. Examples include the human appendix, which may have been used for digesting cellulose in herbivorous ancestors, and the pelvic bones in whales, which are remnants of hind limbs from terrestrial ancestors. These organs provide evidence of evolutionary changes and common ancestry.

ii. Chemical constituents: The similarities in DNA sequences, proteins, and other molecules among different species indicate evolutionary relationships. For instance, humans and chimpanzees share over 98% of their DNA, demonstrating a close evolutionary link. Similarly, the universal genetic code used by all living organisms supports the idea of a common ancestor.

iii. Physiological processes: Shared physiological processes, such as cellular respiration and reproduction, suggest that diverse organisms have evolved from common ancestors. For example, the process of glycolysis, which is essential for energy production, occurs in nearly all living organisms, indicating its evolutionary significance.

6. (a) Briefly describe how a quadrant is used to estimate population size.

A quadrant is a square or rectangular frame of known dimensions used to estimate the population size of organisms in a defined area. It is commonly used for studying plants or sessile organisms. The process includes:

i. Random placement of the quadrant in the study area to ensure an unbiased sample.
ii. Counting the number of individuals of the target species within the quadrant.
iii. Repeating the process in multiple locations to gather enough data.
iv. Calculating the average population per quadrant and scaling it up to the total study area based on its size.

(b) Describe how a quadrant can be used to estimate population size with respect to species density, species frequency, and species cover.

i. Species density: This is calculated as the total number of individuals of a species per unit area. By counting the individuals within each quadrant and dividing by the total area sampled, the density of the species is determined.

ii. Species frequency: This is the proportion of quadrants in which a particular species is present. It is calculated by dividing the number of quadrants where the species is found by the total number of quadrants sampled, expressed as a percentage.

iii. Species cover: This refers to the percentage of ground covered by a species within the quadrant. It is estimated visually or by dividing the area occupied by the species by the total area of the quadrant. Species cover provides information about the dominance and abundance of a species in an ecosystem.

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