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: 2003**

Instructions:

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

1. (a) Explain how the following are involved in the process of protein synthesis:

(i) RNA polymerase
RNA polymerase is an enzyme that synthesizes messenger RNA (mRNA) from the DNA template during transcription. It binds to the promoter region of DNA, unwinds the DNA strands, and adds ribonucleotides complementary to the DNA template strand, forming a single-stranded mRNA molecule.

(ii) Messenger RNA
Messenger RNA (mRNA) carries the genetic information transcribed from DNA to the ribosomes in the cytoplasm. It contains codons, sequences of three nucleotides, each specifying a particular amino acid. The ribosome reads these codons during translation to assemble proteins.

(iii) Transfer RNA
Transfer RNA (tRNA) is responsible for bringing amino acids to the ribosome during translation. Each tRNA molecule has an anticodon that is complementary to the mRNA codon and carries a specific amino acid corresponding to the codon.

(iv) UAA, UAG, and UGA codons
These codons are stop codons, signaling the termination of protein synthesis during translation. When the ribosome encounters one of these codons, it stops adding amino acids, and the completed polypeptide chain is released.

(b) Figures P and Q below represent two reproductive structures found in flowering plants:

(i) Identify the structures P and Q.
P represents an ovule.
Q represents a pollen grain.

(ii) Name the plant structures in which structures P and Q are formed.
P (ovule) is formed in the ovary of the flower.
Q (pollen grain) is formed in the anther of the flower.

(iii) Name the structures represented by letters A to F.
A: Micropyle
B: Embryo sac
C: Nucellus
D: Integuments
E: Exine
F: Intine

(iv) Name the biological process involved in the formation of structures P and Q.
The biological process involved in the formation of structures P and Q is meiosis followed by mitosis.

2. (a) Outline the life cycle of a named malaria-causing parasite using fully labeled diagrams only.

The malaria-causing parasite, *Plasmodium*, follows a life cycle involving two hosts: humans and mosquitoes.

a. In humans:
i. Sporozoites are injected into the bloodstream by an infected mosquito during a bite.
ii. Sporozoites invade liver cells, multiply asexually, and form merozoites.
iii. Merozoites are released into the bloodstream, infecting red blood cells, leading to cycles of asexual reproduction and red blood cell destruction.
iv. Some merozoites develop into sexual forms (gametocytes).

b. In mosquitoes:
i. Gametocytes are ingested by a mosquito during a blood meal.
ii. Gametes fuse in the mosquito's gut, forming a zygote that develops into an ookinete.
iii. The ookinete invades the mosquito's gut wall, forming an oocyst.
iv. Sporozoites are produced and migrate to the salivary glands, ready to infect another human host.

(b) In what ways are viruses important to man?
i. Viruses are used in genetic engineering as vectors to introduce genes into host cells.
ii. They are used in vaccine production to prevent diseases like polio and measles.
iii. Bacteriophages are used in biological control to combat bacterial infections.
iv. Some viruses, like bacteriophages, are tools for molecular biology research.

(c) Discuss the problems associated with the classification of viruses.
i. Viruses are non-living outside a host and living inside a host, challenging the criteria of life.
ii. They lack cellular structure, making them distinct from other organisms.
iii. Their genetic material can be RNA or DNA, leading to varied classification criteria.
iv. Viruses can infect all life forms, adding complexity to their taxonomic categorization.

3. (a) Describe the structure of the mammalian ear.

The mammalian ear consists of three main parts: the outer ear, middle ear, and inner ear.

i. Outer ear:
- The pinna: A cartilaginous structure that collects sound waves and directs them into the auditory canal.
- Auditory canal: A passage lined with hairs and ceruminous glands that produce earwax to trap debris and protect the ear.

ii. Middle ear:
- Tympanic membrane (eardrum): Vibrates in response to sound waves, transmitting vibrations to the ossicles.

- Ossicles: Three tiny bones (malleus, incus, and stapes) that amplify sound vibrations and transmit them to the oval window.
- Eustachian tube: Connects the middle ear to the pharynx, helping to equalize pressure on both sides of the eardrum.

iii. Inner ear:
- Cochlea: A spiral-shaped structure filled with fluid, containing hair cells that convert sound vibrations into electrical signals.
- Vestibule and semicircular canals: Involved in balance and detecting head movements.
- Auditory nerve: Transmits electrical signals from the cochlea to the brain for interpretation.

(b) Explain how the organ of Corti operates.

The organ of Corti, located within the cochlea, is the primary auditory receptor. It functions as follows:

i. Sound waves are transmitted from the ossicles to the oval window, causing vibrations in the cochlear fluid.
ii. These vibrations create waves in the basilar membrane, where the organ of Corti is located.
iii. Hair cells within the organ of Corti have stereocilia that bend when the basilar membrane moves.
iv. The bending of stereocilia opens ion channels, allowing potassium ions to enter the hair cells, generating an electrical signal.
v. The electrical signal is transmitted to the auditory nerve, which sends it to the brain for interpretation as sound.

4. (a) Describe the pathway of a carbon atom from the air into a photosynthetic cell of a leaf and its subsequent fixation (assume its incorporation into a carbohydrate) until it releases energy in an active muscle of a mammal.

i. Carbon dioxide from the atmosphere enters the leaf through stomata.
ii. It diffuses into the chloroplasts of mesophyll cells, where it is fixed into a three-carbon compound (3-PGA) during the Calvin cycle.
iii. Through a series of reactions, 3-PGA is converted into glucose, a six-carbon carbohydrate.
iv. The glucose is transported through the phloem to various parts of the plant.
v. When consumed by a mammal, glucose is broken down during glycolysis to form pyruvate in the cytoplasm.
vi. Pyruvate enters the mitochondria, where it undergoes the Krebs cycle, releasing carbon dioxide and high-energy electrons.
vii. The electrons pass through the electron transport chain, generating ATP, which powers muscle contraction.

5. (a) Explain the relationship between habitat and type of waste product.

i. Freshwater organisms like fish excrete ammonia because it is toxic and requires large amounts of water to dilute.
ii. Terrestrial animals like mammals excrete urea, which is less toxic and conserves water.
iii. Insects excrete uric acid, which is non-toxic and requires minimal water, an adaptation to arid environments.

(b) (i) Which of the above waste products is associated with the evolution of the cleidoic egg?**
Uric acid is associated with the cleidoic egg. It allows the embryo to safely store nitrogenous waste without toxic effects, as uric acid is insoluble and crystallizes within the egg.

(ii) Why is alcohol not recommended for diabetic victims?
i. Alcohol affects liver function, impairing glucose regulation and leading to hypoglycemia.
ii. It interferes with the action of insulin, causing erratic blood sugar levels.
iii. Alcohol adds empty calories, complicating weight management in diabetics.

6. Study the diagram of a nerve synapse below and then answer the questions which follow:**

(a) Identify structures A – F.

i. A: Axon terminal
ii. B: Synaptic vesicles
iii. C: Mitochondria
iv. D: Synaptic cleft
v. E: Neurotransmitter molecules
vi. F: Post-synaptic membrane

(b) Why are the structures labelled C present in larger numbers?

i. Mitochondria provide ATP, which is essential for energy-demanding processes such as the synthesis and release of neurotransmitters.
ii. They also support the reuptake mechanisms and ion transport across membranes, ensuring efficient synaptic transmission.

(c) Describe how impulse transmission across a synapse takes place.

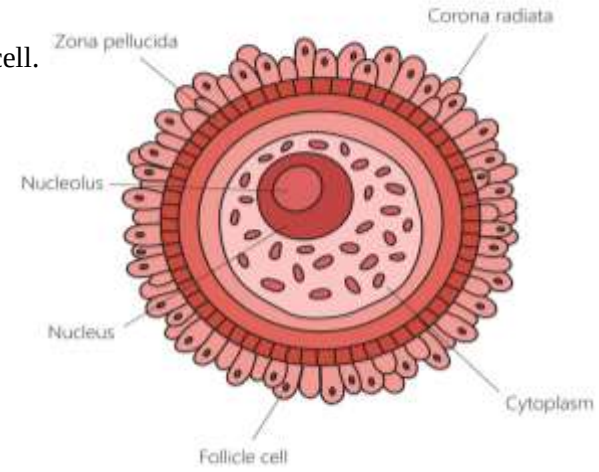
i. An electrical impulse reaches the axon terminal, triggering the opening of voltage-gated calcium ion channels.
ii. Calcium ions enter the synaptic terminal, causing synaptic vesicles to fuse with the pre-synaptic membrane.
iii. Neurotransmitters are released into the synaptic cleft by exocytosis.

iv. These neurotransmitters diffuse across the synaptic cleft and bind to specific receptors on the post-synaptic membrane.
v. The binding generates a post-synaptic potential, leading to the continuation or inhibition of the impulse.

(d) List three functions of a synapse.

i. Synapses facilitate communication between neurons or between neurons and effector cells.
ii. They ensure unidirectional transmission of impulses.
iii. Synapses allow integration and modulation of signals to enable complex responses.

7. (a) Draw a labelled diagram of a human egg cell.



A labelled diagram would include:
i. Plasma membrane
ii. Zona pellucida
iii. Cytoplasm
iv. Nucleus
v. Cortical granules
vi. Polar bodies nbkomputer.com

(b) Discuss the functions of the placenta.

i. Exchange of nutrients and gases: The placenta facilitates the transfer of oxygen and nutrients from the mother to the fetus and removes carbon dioxide and waste products from the fetal blood.
ii. Hormone production: It secretes hormones such as human chorionic gonadotropin (hCG), progesterone, and estrogen to maintain pregnancy.
iii. Immunological protection: The placenta acts as a barrier, protecting the fetus from certain infections and preventing rejection by the maternal immune system.
iv. Waste elimination: The placenta ensures the transfer of metabolic waste from the fetal blood to the maternal blood for excretion.

8. (a) What do you understand by evolution?

Evolution is the gradual change in the genetic composition of populations over successive generations, leading to the development of new species. It is driven by processes such as natural selection, mutation, genetic drift, and gene flow.

(b) Using relevant examples, explain how comparative anatomy supports the theory of organic evolution.

i. Homologous structures: These are anatomical features in different species that have a common evolutionary origin but may serve different functions. For example, the forelimbs of vertebrates such as humans, whales, and bats have similar bone structures, indicating common ancestry.
ii. Analogous structures: These are structures that serve similar functions but have evolved independently. For example, the wings of insects and birds are used for flight but have different evolutionary origins.

iii. Vestigial structures: These are remnants of structures that were functional in ancestral species. For example, the human appendix and pelvic bones in whales are evidence of evolutionary history.

9. (a) Define the following terms:

i. Community: A group of interacting populations of different species living in the same area at the same time.
ii. Ecosystem: A community of living organisms interacting with each other and their physical environment.
iii. Food chain: A linear sequence of organisms through which energy and nutrients flow, starting from producers to primary consumers and ending with tertiary consumers.

(b) Evaluate the use of studying food webs, rather than food chains, in ecology.

i. Food webs provide a more accurate representation of energy flow as they illustrate the complex feeding relationships in an ecosystem.
ii. They help identify keystone species and their impact on ecosystem stability.
iii. Food webs demonstrate the interdependence among species, highlighting the effects of disturbances on the entire ecosystem.

(c) Consider the trophic levels of a pyramid of numbers and illustrate how energy is lost while passing through the levels.
i. Energy is lost as heat during metabolic processes at each trophic level.
ii. Only about 10% of the energy from one trophic level is transferred to the next, while the rest is lost.
iii. This energy loss explains why there are fewer organisms at higher trophic levels, resulting in a pyramid shape.