THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATION COUNCIL OF TANZANIA

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

133/2 **BIOLOGY 2**

(For Both Private and School Candidates)

Duration: 3 Hour. **ANSWERS** **Year: 2025**

Instructions

1. This paper consists of **Six (6)** questions**.**
2. Answer **five (5)** questions.
3. Write your **Examination Number** on every page of your answer booklet(s).

1. Describe five merits and three demerits of bacteria in human life.

Bacteria play a significant role in human digestion. Certain species in the gut help break down food substances, synthesize vitamins like vitamin K and B12, and promote absorption of nutrients.

Bacteria are widely used in biotechnology and industry. In the production of cheese, yogurt, and vinegar, beneficial bacteria are employed to ferment milk and other substances into usable products.

In agriculture, bacteria such as Rhizobium fix nitrogen in the soil, converting atmospheric nitrogen into nitrates that plants can absorb. This enhances soil fertility and boosts crop productivity.

Bacteria are essential in waste management. In sewage treatment plants, they decompose organic waste material into harmless products, purifying water and preventing environmental pollution.

In medicine, bacteria are used in genetic engineering to produce drugs such as insulin and antibiotics. Genetically modified bacteria can be used to synthesize life-saving substances quickly and in large quantities.

However, some bacteria cause infectious diseases in humans such as tuberculosis, cholera, and typhoid. These illnesses can spread rapidly and be life-threatening if untreated.

Bacteria can spoil food by decomposing it and producing harmful toxins. This results in food wastage and health risks if contaminated food is consumed.

Certain bacteria produce toxins that pollute air and water. Their uncontrolled presence in industrial waste or sewage can lead to serious environmental problems and the spread of diseases.

2. A certain scientist went to Kalahari Desert with his dog for exploration. Despite the high temperature in the desert, they both survived. Elaborate four adaptive mechanisms that helped them to survive.

The scientist and his dog were likely protected from excessive water loss through sweating or evaporation by reducing activity during the hottest parts of the day. This behavioral adaptation helps conserve energy and prevents dehydration.

Both may have utilized physiological mechanisms such as efficient kidney function to concentrate urine and minimize water loss. This adaptation is essential for survival in arid environments where water is scarce.

The dog could regulate its body temperature by panting, which increases evaporation from the respiratory tract, allowing cooling without excessive water loss through sweat.

They may have relied on physical adaptations like light-colored clothing or fur to reflect sunlight and reduce heat absorption. This minimizes heat stress during daytime exposure to intense solar radiation.

3. (a) Describe the process of metamorphosis in housefly.

Metamorphosis in housefly is complete and involves four distinct stages: egg, larva, pupa, and adult. The female housefly lays eggs on decomposing organic matter. These eggs hatch into white, worm-like larvae known as maggots, which feed and grow rapidly.

After several molts, the larva develops into a pupa, during which it becomes encased in a hard protective shell. Inside the pupa, the organism undergoes significant transformation, reorganizing its body structure.

Eventually, the adult housefly emerges from the pupa. It now has wings, compound eyes, legs, and reproductive organs. The adult is capable of feeding, flying, and reproducing, continuing the life cycle.

(b) "Mitosis is a helpful process in multicellular and unicellular organisms." In five points, justify this statement.

Mitosis allows for growth in multicellular organisms by increasing the number of cells, which helps tissues and organs to expand and develop fully from a single fertilized egg.

It plays a key role in the repair of damaged tissues. Worn-out or injured cells are replaced through mitotic division, ensuring continuous function of the affected parts.

In unicellular organisms like amoeba, mitosis is a form of asexual reproduction. It enables the organism to multiply rapidly without the need for a mate, helping in population increase.

Mitosis maintains genetic stability by producing daughter cells that are genetically identical to the parent cell. This ensures that all body cells retain the same genetic makeup.

It supports the replacement of old cells with new ones. For instance, blood cells and skin cells are constantly renewed through mitotic divisions, which is essential for survival and health.

4. A cross carried out between purple flowered plant with short stem and red flowered long stem produced purple short stem plants in the first filial generation. Test crossing of the individuals in F_1 produced individuals with the ratio of 1:1:1:1. Use appropriate letter to carry out outcross to show the formation of the ratio.

Let P represent purple flower (dominant), p = red flower (recessive)
S = short stem (dominant), s = long stem (recessive)

F_1 genotype = PpSs (heterozygous for both traits)
Test cross is with a homozygous recessive (ppss)

PpSs × ppss → gametes from PpSs = PS, Ps, pS, ps
gametes from ppss = ps only

Offspring:
PS × ps = PpSs → purple short
Ps × ps = Ppss → purple long
pS × ps = ppSs → red short
ps × ps = ppss → red long

This gives a phenotypic ratio of 1:1:1:1 (purple short : purple long : red short : red long)

5. "There is no single type of ecological pyramid which is perfect on its own." Justify this statement by giving three advantages and limitations of each type of the ecological pyramid.

The pyramid of numbers gives a quick idea of the number of organisms at each trophic level, making it easy to study population sizes. However, it does not consider the size of organisms, so a single tree can support thousands of insects, distorting the pyramid shape.

The pyramid of biomass gives a better measure of energy transfer by considering the mass of organisms. Yet, it fails to account for seasonal variations and may give a temporary snapshot that doesn't reflect long-term energy flow.

The pyramid of energy is the most accurate as it shows the flow of energy from one trophic level to another and always maintains an upright shape. However, it is difficult to calculate the exact energy content, and data collection requires elaborate experiments and estimations.

These pyramids are useful in ecological studies but are not independently sufficient, hence none is perfect on its own.

6. Describe the formation of the following types of fossils and give an example for each:

(a) Coprolite forms when the excreta of ancient animals become buried and preserved through mineralization. Over time, the organic matter is replaced by minerals, forming fossilized feces. Example: dinosaur coprolite.

(b) Compressed and carbonized plant fossils form when plant material is buried under sediment, and pressure from overlying layers causes water and volatile substances to escape, leaving behind a thin film of carbon. Example: fossilized fern leaves.

(c) Imprints occur when an organism presses against soft sediment like mud or clay, leaving an impression of its shape. This sediment later hardens into rock, preserving the imprint. Example: leaf or feather imprints.

(d) Mould and casts form when an organism is buried and later decays, leaving a hollow cavity (mould). If minerals fill the mould, a cast is formed. Example: shell cast or trilobite cast.

(e) Entire organism fossils form when organisms are trapped in substances like amber, ice, or tar, which prevent decay. These preserve the whole body including soft tissues. Example: insect in amber or mammoth in ice.