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: 2019**

Instructions:

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

1. Using examples, explain five advantages and disadvantages of Kingdom Fungi to human beings.

Advantages:
i. Decomposition: Fungi play a crucial role in breaking down organic matter and recycling nutrients. For example, saprophytic fungi decompose dead plant and animal matter.
ii. Food production: Certain fungi are used in food preparation, such as yeast in bread making and fermentation in beer and wine production.
iii. Medicine: Fungi produce antibiotics like penicillin, which are essential for treating bacterial infections.
iv. Industrial use: Some fungi are used in the production of enzymes, organic acids, and vitamins. For instance, Aspergillus species are used in citric acid production.
v. Symbiotic relationships: Mycorrhizal fungi enhance nutrient uptake in plants, benefiting agriculture and forestry.

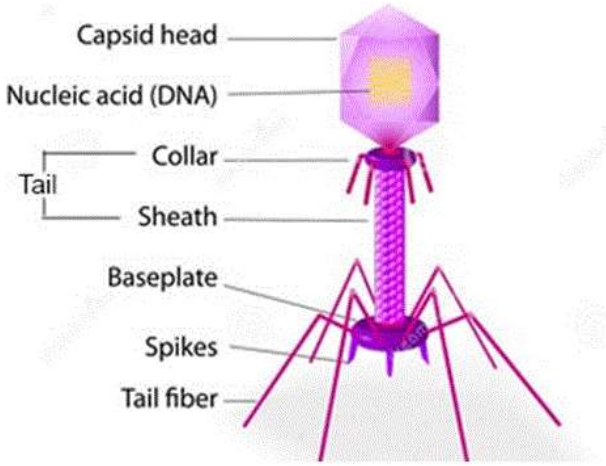
Disadvantages:
i. Pathogenicity: Some fungi cause diseases in humans, such as athlete's foot and candidiasis.
ii. Crop damage: Parasitic fungi like rusts and smuts cause significant agricultural losses.
iii. Food spoilage: Fungi like molds spoil stored food, leading to wastage.
iv. Allergies: Fungal spores can trigger respiratory allergies in sensitive individuals.
v. Mycotoxins: Certain fungi produce toxic substances like aflatoxins, which contaminate food and cause health issues.

2. (a) Draw a diagram of a bacteriophage and label six parts.
A bacteriophage, often referred to as a phage, is a virus that infects bacteria. Its structure is composed of several distinct parts, each playing a crucial role in its ability to infect and replicate within bacterial cells. Here's a labeled diagram illustrating the typical structure of a bacteriophage:

Key Components

- Capsid Head: This is the protein shell that encases the phage's genetic material, which can be either DNA or RNA.
- Genetic Material (DNA or RNA): Located within the capsid, this nucleic acid contains the instructions necessary for the phage to replicate inside a host bacterium.
- Collar: A structure that connects the head to the tail, providing stability and support.
- Sheath: A contractile tube that surrounds the tail core; it contracts during infection to inject the phage's genetic material into the host cell.
- Tail Fibers: These are long, thin structures that help the phage recognize and attach to specific receptor sites on the surface of a bacterial cell.

- Base Plate: The terminal structure of the tail to which tail fibers are attached; it plays a critical role during the attachment and penetration stages of infection.



Each of these components works in concert to ensure the bacteriophage can successfully infect a host bacterium, replicate its genetic material, and produce new phage particles. If you require a detailed hand-drawn or computer-generated labeled diagram, I can provide further assistance.

(b) Viruses pose problems in identification as they possess characteristics of both living and non-living things. Justify this statement by stating four living and three non-living characteristics of viruses.

Living characteristics:
i. Reproduction: Viruses replicate only within host cells, similar to living organisms.
ii. Mutability: Viruses mutate, allowing them to adapt to their environments.
iii. Genetic material: They contain DNA or RNA, which are essential for genetic information.
iv. Infectivity: They can infect and interact with living cells.

Non-living characteristics:
i. Lack of metabolism: Viruses do not have metabolic activities outside host cells.
ii. Acellular structure: They lack cellular components like a nucleus and cytoplasm.
iii. Crystallization: Viruses can crystallize, a property of non-living matter.

3. (a) With the help of a diagram, describe the formation and removal of urea in mammalian liver.

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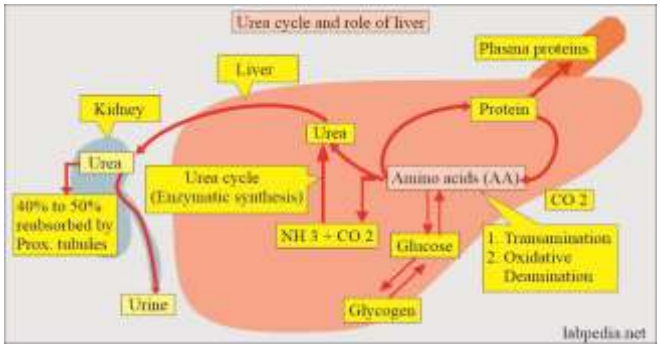

The process involves:
i. Deamination: Amino acids are broken down, releasing ammonia.
ii. Conversion: Ammonia is converted to urea via the urea cycle in the liver.
iii. Excretion: Urea is transported in the blood to the kidneys, where it is filtered and excreted as urine.

The urea cycle, also known as the ornithine cycle, is a vital metabolic pathway in mammals that converts toxic ammonia into urea for safe excretion. This process primarily occurs in the liver and involves a series of enzymatic reactions that detoxify ammonia produced during amino acid metabolism.

Formation of Urea:

- Ammonia production: When proteins are broken down, amino acids undergo deamination, releasing ammonia (NH_3), a toxic byproduct.

- Carbamoyl phosphate formation: In the mitochondria of liver cells, ammonia combines with carbon dioxide (CO_2) to form carbamoyl phosphate. This reaction is catalyzed by the enzyme carbamoyl phosphate synthetase I and requires two molecules of ATP.

- Citrulline synthesis: Carbamoyl phosphate reacts with ornithine to produce citrulline, facilitated by the enzyme ornithine transcarbamylase. Citrulline is then transported from the mitochondria to the cytoplasm.

- Argininosuccinate formation: In the cytoplasm, citrulline combines with aspartate to form argininosuccinate, a reaction driven by argininosuccinate synthetase and the hydrolysis of one ATP molecule.

- Arginine and fumarate production: Argininosuccinate is cleaved by argininosuccinate lyase to yield arginine and fumarate.

- Urea generation: Finally, arginine is hydrolyzed by the enzyme arginase to produce urea and regenerate ornithine. Ornithine is transported back into the mitochondria to perpetuate the cycle.
- Removal of Urea:

The urea produced in the liver is released into the bloodstream and transported to the kidneys. In the kidneys, urea is filtered out of the blood and excreted from the body through urine. This excretion process effectively removes excess nitrogen and prevents the accumulation of toxic ammonia in the body.

(b) Identify the major excretory products in vertebrates.
i. Ammonia: Excreted by aquatic organisms like fish.
ii. Urea: Excreted by mammals.
iii. Uric acid: Excreted by birds and reptiles.

(ii) For each excretory product identified, state their nature and give one example of an organism which excretes it.

i. Ammonia: Highly toxic and requires large amounts of water for excretion; example: fish.
ii. Urea: Less toxic, water-soluble; example: humans.
iii. Uric acid: Non-toxic, excreted as a paste to conserve water; example: birds.

4. (a) Describe the growth curve pattern of a pea plant.

Growth stages:
i. Lag phase: Slow initial growth as the plant adapts.
ii. Exponential phase: Rapid growth due to optimal conditions.
iii. Plateau phase: Growth slows as resources become limiting.
iv. Decline phase (if applicable): Growth stops or decreases due to unfavorable conditions.

(b) Outline five causes of seed dormancy.
i. Hard seed coat: Prevents water absorption and gas exchange.
ii. Immature embryo: Requires further development before germination.
iii. Presence of inhibitors: Hormones like abscisic acid prevent growth.
iv. Lack of light: Some seeds require light to germinate.
v. Temperature: Dormancy persists if conditions are too cold or too hot.

5. (a) Explain two roles of deoxyribonucleic acid (DNA).
i. Genetic information storage: DNA contains instructions for the development and functioning of all living organisms.
ii. Protein synthesis: DNA provides templates for mRNA, which is translated into proteins.

(ii) Describe the chemical composition of DNA.
DNA is composed of:
i. Phosphate group.
ii. Deoxyribose sugar.
iii. Four nitrogenous bases: adenine, thymine, cytosine, and guanine.

(b) Describe four properties of genetic materials.
i. Replicability: DNA can replicate to ensure genetic continuity.
ii. Variability: Mutations in DNA lead to genetic diversity.
iii. Stability: DNA is stable enough to store genetic information across generations.
iv. Universal code: The genetic code is shared among almost all living organisms.

6. In cats, the genes controlling the coat color are carried on the X chromosomes and are codominant. A black-coat female mated with a ginger-coat male produced offspring consisting of black male and tortoiseshell female kittens. What is the expected F_2 phenotypic ratio? Explain the results.

Genetic explanation:
- The gene for black coat (B) and ginger coat (b) are codominant and located on the X chromosome.
- Female cats (XX) can be black (BB), ginger (bb), or tortoiseshell (Bb).
- Male cats (XY) can be black (B) or ginger (b) as they inherit only one X chromosome.

Cross:
F_1 (Black female: Bb) x (Ginger male: bY).
F_2 phenotypic ratio:
1 black female: 1 ginger female: 2 tortoiseshell females: 1 black male: 1 ginger male.

7. (a) Briefly explain how each of the following human activities affects the flow of energy in the ecosystem.

i. Poaching: Reduces populations of key species, disrupting food chains and energy flow.
ii. Deforestation: Reduces primary producers, decreasing energy available for higher trophic levels.

(b) Describe seven biotic factors which affect population distribution.
i. Competition: Limits resource availability among species.
ii. Predation: Influences prey populations.
iii. Parasitism: Weakens host species, affecting survival.
iv. Mutualism: Enhances survival of interdependent species.
v. Disease: Reduces population sizes.
vi. Food availability: Determines population density.
vii. Reproductive success: Influences growth rates.

8. (a) Enumerate six essential features of natural selection as put forward by Charles Darwin.
i. Variation: Differences exist among individuals.
ii. Overproduction: More offspring are produced than can survive.
iii. Competition: Individuals compete for limited resources.
iv. Survival of the fittest: Individuals with advantageous traits survive.
v. Reproduction: Survivors pass their traits to offspring.
vi. Adaptation: Over time, populations become better suited to their environment.

(b) Describe how geographical, reproductive, and genetic isolations bring about speciation.
i. Geographical isolation: Physical barriers like mountains prevent gene flow between populations.
ii. Reproductive isolation: Differences in mating behavior or timing prevent interbreeding.
iii. Genetic isolation: Mutations and genetic drift in isolated populations lead to divergence and speciation.