THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

DIPLOMA IN SECONDARY EDUCATION EXAMINATION

733/1 **BIOLOGY 1**

Time: 3 Hours **ANSWERS** **Year: 2010**

Instructions

1. This paper consists of section A, B and C.
2. Answer all questions in section A and two questions from section B and C.

1. What do you understand by the term "genetic diseases"? Mention four genetic diseases.

Genetic diseases are disorders caused by abnormalities in an individual's DNA, which can be inherited from parents or occur due to spontaneous mutations. These conditions affect the structure or function of proteins, leading to a wide range of health issues, such as metabolic dysfunction or developmental delays.

One example is Cystic Fibrosis, a genetic disease caused by mutations in the CFTR gene, leading to thick mucus buildup in the lungs and digestive system.

Another is Sickle Cell Anemia, resulting from a mutation in the hemoglobin gene, causing red blood cells to become crescent-shaped and impair oxygen delivery.

Down Syndrome is also a genetic disease, caused by an extra copy of chromosome 21, leading to intellectual disability and distinct physical features.

Lastly, Hemophilia, a disorder due to mutations in clotting factor genes, prevents proper blood coagulation, increasing bleeding risks.

2. Consider the metabolic pathway shown below:

A ----> B ----> C ----> D ----> E ---> F

A represents the substrate, B, C, D, E, and F are products, e_1 to e_5 are enzymes. How might an excess of E regulate the metabolic pathway?

An excess of E, a product in the metabolic pathway, can regulate the process through feedback inhibition. In this mechanism, E binds to the allosteric site of the first enzyme (e_1), altering its shape and reducing its activity, which slows the conversion of A to B.

This regulation prevents the overproduction of downstream products, maintaining cellular balance and conserving energy, as the pathway shuts down when E accumulates beyond the cell's needs.

The process is reversible, allowing the pathway to resume if E levels decrease, ensuring dynamic control over metabolism, such as in glucose breakdown.

This homeostatic mechanism protects the cell from toxicity or resource waste, exemplifying how end products like E can act as regulators in metabolic cascades.

3. What is the difference between tropisms and reflex actions?

Tropisms are directional growth responses of plants to environmental stimuli, such as phototropism, where a plant bends toward light due to auxin distribution, aiding survival by optimizing photosynthesis.

Reflex actions, on the other hand, are rapid, involuntary responses in animals to stimuli, like the knee-jerk reflex triggered by a tap, mediated by the nervous system to protect the body from harm.

Tropisms are slow, hormone-driven processes occurring over hours or days, whereas reflex actions are immediate, neural responses happening in milliseconds, highlighting their distinct biological roles.

4. Distinguish between passive immunity and active immunity.

Passive immunity involves the transfer of pre-formed antibodies from an external source, such as a mother to her baby via breast milk, providing immediate but temporary protection against diseases like measles.

Active immunity, conversely, develops when an individual's immune system produces antibodies after exposure to an antigen, such as through vaccination against polio, offering long-term protection through memory cells.

Passive immunity does not involve the recipient's immune response, making it short-lived, while active immunity requires an immune reaction, ensuring lasting defense after the initial response.

5. Give a summary of reactions which take place during aerobic respiration in yeast cells.

Aerobic respiration in yeast cells begins with glycolysis, where glucose is broken down in the cytoplasm into two molecules of pyruvate, producing 2 ATP and 2 NADH.

The pyruvate is then transported into the mitochondria, where it is converted to acetyl-CoA, entering the Krebs cycle, generating additional NADH and $FADH_2$, which yield energy carriers.

In the electron transport chain, oxygen acts as the final electron acceptor, facilitating the production of approximately 34 ATP through oxidative phosphorylation, completing the process.

This pathway maximizes energy yield, producing about 36–38 ATP per glucose molecule, sustaining yeast growth under oxygen-rich conditions.

6. What do you understand by the following terms used in ecosystem studies?

(a) Abiotic factor

(b) Biotic factor

(c) Food chain

(d) Food web

(a) Abiotic factor:

An abiotic factor is a non-living component of an ecosystem, such as temperature, sunlight, or water, that influences the survival and distribution of organisms, like how sunlight drives plant growth.

(b) Biotic factor:

A biotic factor is a living component, such as plants, animals, or microorganisms, that affects ecosystem dynamics, like predators controlling prey populations.

(c) Food chain:

A food chain is a linear sequence showing the flow of energy from one organism to another, such as grass to rabbit to fox, illustrating a single feeding pathway in an ecosystem.

(d) Food web:

A food web is a complex network of interconnected food chains, such as a web including grass, rabbits, foxes, and hawks, reflecting multiple feeding relationships and energy transfers.

7. Show how ATP in a cell is related to a battery.

ATP (adenosine triphosphate) in a cell is like a battery because it stores and releases energy for cellular activities, similar to how a battery powers electronic devices.

Just as a battery discharges energy when its chemical potential is used, ATP releases energy when its phosphate bonds are broken, providing power for processes like muscle contraction.

Both are rechargeable; a battery can be recharged with electricity, while ATP is regenerated through cellular respiration, replenishing energy stores with glucose.

The limited capacity of a battery parallels ATP's finite energy supply, requiring constant recharging to sustain cellular functions.

8. Explain the following terms as applied in reproduction:

(a) Gametogenesis

(b) Spermatogenesis

(c) Oogenesis

(d) Gonads

(e) Differentiation

(f) Mutation from modification

(a) Gametogenesis:

Gametogenesis is the process of forming gametes (sperm and eggs) through meiosis, ensuring genetic diversity, such as in humans where it produces haploid cells from diploid precursors.

(b) Spermatogenesis:

Spermatogenesis is the specific production of sperm in the testes, involving mitosis and meiosis, resulting in four functional spermatozoa per spermatogonium.

(c) Oogenesis:

Oogenesis is the formation of ova in the ovaries, where one ovum and polar bodies are produced per oogonium through unequal meiosis, supporting reproduction.

(d) Gonads:

Gonads are the reproductive organs, such as testes and ovaries, that produce gametes and sex hormones, essential for sexual development and reproduction.

(e) Differentiation:

Differentiation is the process where cells become specialized, such as stem cells developing into nerve cells, shaping tissue and organ functions during development.

(f) Mutation from modification:

Mutation from modification refers to a change in DNA sequence due to environmental factors or errors, like UV radiation causing thymine dimers, potentially altering gene function.

9. (a) State the difference between alcoholic fermentation and basal metabolic rate.

(b) List the major products of glycolysis.

(a) State the difference between alcoholic fermentation and basal metabolic rate:

Alcoholic fermentation is an anaerobic process in yeast that converts pyruvate to ethanol and CO_2, producing energy without oxygen, whereas basal metabolic rate (BMR) is the minimum energy expended by an organism at rest to maintain vital functions, including respiration and circulation, regardless of activity level.

(b) List the major products of glycolysis:

The major products of glycolysis are two molecules of pyruvate, two ATP (net gain), and two NADH, generated from the breakdown of one glucose molecule in the cytoplasm.

10. State the difference between phenotype and genotype.

Phenotype refers to the observable physical or biochemical traits of an organism, such as eye color or height, resulting from the interaction of genotype and environment.

Genotype is the genetic makeup of an organism, represented by the specific alleles (e.g., BB or Bb for brown eyes), which determine the potential traits passed from parents.

11. Discuss the criteria to use when selecting a quality textbook for teaching Biology.

One criterion is content accuracy, ensuring the textbook provides correct information on topics like cell division, supported by current scientific evidence.

Another is clarity of language, using simple terms to explain complex concepts like photosynthesis, making it accessible to students.

The inclusion of visuals, such as diagrams of the human heart, enhances understanding and retention of biological processes.

Relevance to the curriculum ensures the textbook covers required topics, such as genetics, aligning with educational standards.

Durability of the material, with sturdy binding and pages, ensures the book withstands repeated classroom use.

Finally, the presence of activities, like experiments on osmosis, encourages practical learning and engagement.

12. Teacher's manual is the document that shows logical sequence of steps to follow to accomplish a certain lesson or experiment. Elaborate on the main components of this manual and mention the purpose it serves.

One main component is the lesson objectives, outlining what students should learn, such as understanding respiration, guiding the teaching process.

Another component is the content outline, detailing topics like cell structure in a logical order, ensuring comprehensive coverage.

The manual includes teaching methods, suggesting activities like group discussions for ecology, enhancing engagement.

It contains assessment strategies, providing quizzes on genetics to evaluate student progress.

Resource lists, such as materials for dissections, are included to prepare teachers adequately.

The purpose it serves is to provide a structured guide, ensuring consistent and effective delivery of biology lessons, saving time and improving teaching quality.

13. Differentiate a teacher's manual from a teacher's guide.

A teacher's manual is a detailed document with step-by-step instructions and specific lesson plans, such as a procedure for a mitosis lab, offering a rigid framework for teaching.

A teacher's guide is a broader resource with general suggestions and strategies, like recommending videos for photosynthesis, allowing flexibility in implementation.

The manual includes answers and assessments, such as a key for a respiration test, while the guide focuses on pedagogical tips without specific solutions.

The manual is more prescriptive, dictating the sequence for ecology lessons, whereas the guide is advisory, leaving room for teacher adaptation.

14. Write an essay on the features of a Biology subject log book.

A Biology subject log book serves as a record of a student's practical work, featuring dated entries for experiments, such as dissections, ensuring a chronological account of learning.

It includes detailed observations, like sketches of onion cells under a microscope, providing visual evidence of findings.

The log book contains hypotheses and results, such as predictions and outcomes of a photosynthesis experiment, fostering scientific inquiry.

It features teacher comments and grades, offering feedback on a respiration lab, guiding student improvement.

Safety notes and procedures, like handling chemicals in titration, are included to promote lab safety awareness.

Finally, it acts as a reference for revision, helping students review topics like genetics before exams, enhancing retention.

15. A Biology teacher for form three students, discuss briefly the procedures for planning, organizing and executing a biology field trip in Mikumi National Park for ecological studies.

Planning involves selecting the date and obtaining permission from school authorities, ensuring the trip to Mikumi National Park aligns with the ecology curriculum.

Organizing includes preparing a checklist of equipment, such as binoculars and notebooks, and assigning roles to students, like record-keepers, for efficient data collection on wildlife.

Executing the trip requires briefing students on safety and objectives, guiding them to observe and document species interactions, such as predator-prey dynamics, during the visit.

Supervision during the trip ensures students follow protocols, collecting samples like plant leaves safely for analysis.

Finally, post-trip evaluation involves discussing findings, such as ecosystem balance, and compiling a report to reinforce ecological concepts.

16. Outline how you would apply dicotyledonous flower during biology practical of reproduction in plants using dicotyledonous flower.

I would start by selecting a fresh dicotyledonous flower, such as a hibiscus, and provide each student with one for the practical.

Next, I would demonstrate dissecting the flower, guiding students to remove the sepals, petals, stamens, and pistil, identifying each part's role in reproduction.

I would instruct students to observe the anther for pollen grains and the stigma for receptive surfaces, explaining their function in pollination.

Using a microscope, I would have them examine a cross-section of the ovary to identify ovules, linking this to seed formation.

Finally, I would encourage sketching and labeling the flower parts, reinforcing understanding of the reproductive process.

17. State how you will prepare for your students the following solutions:

(a) 0.05 M iodine solution

(b) 70% alcohol

(a) 0.05 M iodine solution:

To prepare 0.05 M iodine solution, first determine the molar mass of iodine (I_2) as 253.8 g/mol. For 1 liter of 0.05 M solution, calculate the mass needed: $0.05 \times 253.8 = 12.69$ grams. Dissolve 12.69 grams of iodine crystals in a small amount of potassium iodide solution (to enhance solubility) in a 1-liter volumetric flask. Add distilled water to the mark, mix thoroughly, and store in a dark bottle to prevent degradation.

(b) 70% alcohol:

To prepare 70% alcohol, measure 700 mL of absolute ethanol (95% or higher) using a measuring cylinder. Add 300 mL of distilled water to make a total volume of 1000 mL (1 liter). Mix the solution well to ensure uniformity, and label it clearly for safety and use in disinfection or preservation.

18. A form one student wanted her teacher to explain to her the nature of fire. She also wanted to know the types of fire fighting equipment which may be found in Biology laboratories. What would the teacher's response be?

The teacher would explain that fire is a rapid chemical reaction involving fuel, oxygen, and heat, producing light and heat, often initiated by a spark or flame in a lab setting.

The teacher would note that fires in biology labs are typically Class B (flammable liquids) or Class C (electrical), requiring specific extinguishing methods.

Types of fire fighting equipment include fire extinguishers, such as CO_2 or dry powder types, effective for electrical or liquid fires.

Fire blankets would be mentioned, used to smother small fires on a person or bench by cutting off oxygen.

Safety showers would be highlighted, providing water to extinguish fire on clothing or skin.

The teacher would emphasize the importance of training students to use this equipment safely during lab emergencies.