**THE UNINTED REPUBLIC OF TANZANIA**

**MINISTRY OF EDUCATION AND CULTURE**

**ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION**

**133/1** **BIOLOGY 1**

**Time: 2:30 Hours** **ANSWERS** **Year: 2011.**

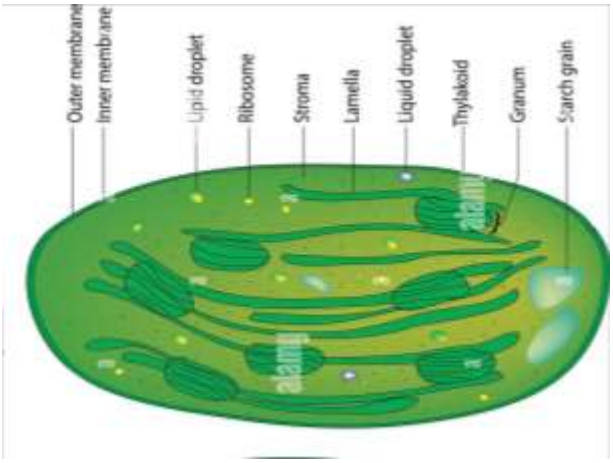
**Instructios:**

1. this paper consists of eleven questions
2. answer all questions in section A, and three questions in section B.
3. the marks allocation is indicated at the beginning of each section.

1. (a) Why is it advantageous for cells to be small in size?

The small size of cells is advantageous because it increases their surface area-to-volume ratio. This allows efficient exchange of materials such as oxygen, nutrients, and waste products between the cell and its environment. A high surface area relative to volume ensures faster diffusion, better communication between cells, and effective intracellular transport.

(b) Draw a large and neat diagram of a chloroplast and label the parts involved in the process it undertakes.




- Diagram description. The chloroplast should include parts such as the outer membrane, inner membrane, stroma, thylakoids, grana, and lamellae. These parts are involved in photosynthesis, with thylakoids hosting the light-dependent reactions and the stroma hosting the Calvin cycle.

2. (a) State one characteristic of the class to which the wheat plant belongs in reference to each of the following:

i. Leaf morphology. Leaves are narrow and parallel-veined.
ii. Stem anatomy. The stem is hollow and cylindrical, containing vascular bundles scattered throughout.
iii. Seed morphology. The seeds are monocotyledonous with a single cotyledon.
iv. Flowers. Flowers are typically small and lack sepals or petals, adapted for wind pollination.
v. Root morphology. Roots are fibrous, spreading out extensively near the surface.

(b) Study the diagrams of the five flowering plants in Figure 1.

Using the key provided, identify plants A, B, C, D, and E by their common names:

i. Plant A. Deadnettle
ii. Plant B. Primrose
iii. Plant C. Wild daffodil
iv. Plant D. Lesser celandine
v. Plant E. Bluebell

3. Describe the structure of the columnar epithelium of the digestive system of man, showing how it is related to its digestive roles.

Columnar epithelium in the digestive tract consists of tall, column-shaped cells with microvilli on their apical surfaces. These microvilli increase the surface area for absorption of nutrients. Goblet cells are interspersed, secreting mucus to lubricate and protect the digestive lining from mechanical damage and pathogens.

4. (a) Show the fate of a pyruvate under anaerobic conditions in:

i. Plants and microorganisms. Pyruvate is converted into ethanol and carbon dioxide through alcoholic fermentation.
ii. Animals and muscle cells. Pyruvate is reduced to lactic acid through lactic acid fermentation to regenerate NAD+ for glycolysis.

(b) Briefly explain three ways in which carbon dioxide is transported in a vertebrate body.

i. Dissolved in plasma. A small amount of carbon dioxide dissolves directly in blood plasma.
ii. As bicarbonate ions. The majority of carbon dioxide reacts with water to form carbonic acid, which dissociates into bicarbonate ions for transport.
iii. Bound to hemoglobin. Carbon dioxide binds to hemoglobin to form carbaminohemoglobin.

5. (a) In what ways are the chemical compositions of blood and glomerular filtrate similar and yet different?

Blood and glomerular filtrate both contain water, glucose, amino acids, and ions. However, blood contains large molecules like proteins and blood cells, which are absent in the filtrate due to the size-selective filtration barrier.

(b) List all the blood vessels and organs, in sequence, through which urea must pass to reach the kidney from the liver.

i. Hepatic vein
ii. Inferior vena cava
iii. Heart
iv. Aorta
v. Renal artery

6. (a) Name the structures/cells labelled A, B, C, D, E, F, and G in Figure 2.

i. A: Mesophyll cell
ii. B: Companion cell
iii. C: Sieve tube element
iv. D: Phloem loading site

v. E: Xylem vessel
vi. F: Root cell
vii. G: Soil particle

(b) What name is given to this hypothesis?

The hypothesis is known as the "Mass Flow Hypothesis."

(c) What technical terms are given to the regions labelled C and F?

i. C: Source
ii. F: Sink

(d) Explain briefly how the hydrostatic pressure gradient is developed.

The hydrostatic pressure gradient is developed due to active loading of sugars into the sieve tube elements at the source. This causes water to enter by osmosis, creating high pressure. At the sink, sugars are actively or passively unloaded, reducing the osmotic pressure and causing water to leave, creating a low-pressure region.

7. (a)

(i) Arrange the events in a correct sequence.
1. Vesicle fuses to membrane.
2. Transmitter molecule releases into the synaptic cleft.
3. Transmitter molecule attaches to receptor site.
4. Movement of ions through post-synaptic membrane.
5. Depolarization of post-synaptic membrane.
(ii) Name the ions labeled A and B.
- A: Sodium ions ($Na^+$)
- B: Calcium ions ($Ca^{2+}$)

(iii) Name the process by which transmitter molecules move across the synaptic cleft.
- The process is diffusion
(iv) Name one transmitter molecule released by synaptic vesicles.
- Acetylcholine

(b) (i) Explain why one impulse arriving at the pre-synaptic membrane fails to produce an action potential in the post-synaptic neuron, while several impulses arriving in succession can do so.
A single impulse may not release enough neurotransmitter to reach the threshold required to depolarize the post-synaptic membrane and generate an action potential. However, successive impulses can cause summation, increasing the neurotransmitter concentration at the synaptic cleft and enabling the threshold to be reached.

(ii) What name is given to the process described in (b)(i) above?
- Temporal summation

8. (a) Explain using appropriate genetical symbols, the possible blood groups of children whose parents are both heterozygous, the father being blood group A and the mother blood group B.

Let IA and IB represent the alleles for blood groups A and B, and i represent the allele for blood group O.
- Father's genotype: IAi
- Mother's genotype: IBi

The possible genotypes of their children from the cross are:
- IAIB (Blood group AB)
- IAi (Blood group A)
- IBi (Blood group B)
- ii (Blood group O)

Hence, the children can have blood groups A, B, AB, or O.

(b) If the parents have non-identical twins, what is the probability that both of the twins will be blood group A?

The probability of one child being blood group A is 1/4. For two non-identical twins, the probability is: $1/4 \times 1/4 = 1/16$.

9. (a) Briefly explain the shortcoming of Lamarck's Theory of Organic Evolution.

Lamarck's theory suggested that traits acquired during an organism's lifetime could be inherited by its offspring. This is incorrect as modern genetics has shown that traits are passed on through genes, which are not influenced by acquired characteristics.

(b) Briefly explain why Darwin came to the conclusion that there is natural selection operating in nature.

Darwin observed that individuals within a population vary in their traits and that some of these traits confer a survival or reproductive advantage. He also noted that more offspring are produced than can survive, leading to competition for resources. Over time, advantageous traits become more common in the population, demonstrating natural selection.

10. (a) Figure 4 represents the process of sperm production in mammalian testis.
(i) Explain why cell A and B are genetically identical.
Cell A and B are genetically identical because they are produced by mitosis, which creates two daughter cells with the same genetic material as the parent cell.

(ii) How does cell division give rise to cells C and D, which are genetically different from the mother cell?
Cells C and D are produced through meiosis, which involves recombination and independent assortment of chromosomes, resulting in genetic variation.

(b). briefly describe two events occurring during cell division that lead to genetic variation in offspring.

i. Crossing over. During prophase I of meiosis, homologous chromosomes exchange genetic material, leading to new combinations of alleles.
ii. Independent assortment. During metaphase I, homologous chromosome pairs align randomly, ensuring different combinations of parental chromosomes in the gametes.

11. Identify the features and adaptations of the cardiac muscle to the role it performs.

Cardiac muscle has unique adaptations that make it suitable for its role in the heart:

i. Intercalated discs: These specialized structures allow synchronized contraction of the cardiac muscle cells by facilitating the rapid transmission of electrical impulses.

ii. Striations: The alternating dark and light bands in cardiac muscle aid in contraction and relaxation, similar to skeletal muscles.

iii. Branching fibers: These fibers are interconnected to ensure that the contraction spreads uniformly throughout the heart.

iv. Myogenic activity: The cardiac muscle can initiate its own contractions without external stimulation, making it highly efficient for continuous pumping.

v. Rich blood supply: Cardiac muscles have a dense network of capillaries to supply oxygen and nutrients and remove waste products.

vi. Mitochondrial abundance: The cardiac muscle has a high number of mitochondria to provide the energy required for sustained contractions.

12. (a) How is sex genetically determined in birds and humans?

In humans, sex is determined by the XY system:

- Males have one X and one Y chromosome (XY), and females have two X chromosomes (XX). The sperm determines the offspring's sex since it carries either an X or a Y chromosome.

In birds, sex is determined by the ZW system:

- Males have two Z chromosomes (ZZ), and females have one Z and one W chromosome (ZW). The ovum determines the sex of the offspring since it carries either a Z or a W chromosome.

(b) A woman has four sons, one of whom is a hemophiliac. Suggest the genotype of the woman and her husband.

Hemophilia is a recessive X-linked trait. For a son to be hemophiliac, he must inherit the affected X chromosome from his mother.

- Mother's genotype: XhX (carrier)
- Father's genotype: XY (normal)

(c) Show whether it is possible for the couple in (b) above to have a hemophiliac daughter.

For a daughter to be hemophiliac, she must inherit the affected X chromosome from both parents. The father, being normal (XY), does not pass on the affected X chromosome, making it impossible for them to have a hemophiliac daughter.

13. Outline the main adjustments that occur to the heart rate and circulatory system just before, during, and after a 100m race.

i. Before the race: The heart rate increases due to anticipatory adrenaline release, preparing the body for action.

ii. During the race: The heart pumps blood faster to deliver oxygen and nutrients to the muscles. Blood flow is redirected from non-essential organs to skeletal muscles. Stroke volume and cardiac output increase significantly.

iii. After the race: The heart rate gradually decreases as the body transitions back to resting state. Oxygen debt is repaid, and blood flow normalizes. Cooling mechanisms, such as sweating and vasodilation, are also activated.

14. (a) From the graph state the day:

i. Ovulation is most likely to happen.
- Day 14

ii. In which fertilization is most likely to occur, assuming that sperms are present.
- Day 14-16

iii. The corpus luteum starts to break down.
- Day 24

iv. Menstruation begins.
- Day 28

(b) State four protective and two endocrine roles of the placenta.

Protective roles:
i. Acts as a barrier against certain infections.
ii. Prevents maternal immune cells from attacking the fetus.
iii. Provides cushioning to protect the fetus from physical shocks.
iv. Filters harmful substances from reaching the fetus.

Endocrine roles:
i. Secretes progesterone to maintain the uterine lining.
ii. Produces human chorionic gonadotropin (hCG) to sustain the corpus luteum.

15. (a) Using oat coleoptiles, describe experiments that can be carried out to show that phototropic responses in plants are due to the presence of a chemical found in the root tip, which passes down into the growth region.

Darwin and Boysen-Jensen conducted classic experiments demonstrating the role of auxin in phototropism. These involved:

- Tip removal: Removing the coleoptile tip eliminated the phototropic response, showing the tip's importance.
- Gelatin barrier: Placing a gelatin block between the tip and the coleoptile allowed the response, indicating a chemical diffused through.
- Mica barrier: Blocking the signal with mica prevented the response, confirming the chemical's movement.

(b) Mention the name of the chemical in (a) above.
- Auxin