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: 2018**

Instructions:

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

1. (a) Give six reasons to justify that human beings belong to phylum Chordata.

i. Presence of a notochord: Human embryos possess a notochord, a flexible rod-like structure that is characteristic of all chordates.
ii. Dorsal hollow nerve cord: Humans have a dorsal hollow nerve cord that develops into the brain and spinal cord.
iii. Pharyngeal slits: In the embryonic stage, humans exhibit pharyngeal slits, which are a feature of chordates.
iv. Post-anal tail: Human embryos have a post-anal tail, which is a distinguishing feature of chordates, though it regresses during development.
v. Endoskeleton: Humans have a vertebral column and an internal skeleton, which support the body and are characteristic of chordates.
vi. Bilateral symmetry: The human body exhibits bilateral symmetry, a defining feature of the chordates.

(b) Using examples, explain seven advantages of the Kingdom Animalia to human beings.

i. Source of food: Animals provide protein-rich food such as meat, milk, and eggs, which are essential for human nutrition.
ii. Transportation: Animals like horses, camels, and oxen are used for transportation and carrying goods in various regions.
iii. Companionship: Domestic animals such as dogs and cats provide companionship and emotional support to humans.
iv. Raw materials: Animals supply raw materials like wool, leather, and silk, which are used in clothing and industry.
v. Pollination: Insects such as bees help in pollinating crops, ensuring food production.
vi. Research: Animals are used in scientific research to study disease mechanisms and develop medical treatments.
vii. Waste decomposition: Animals like earthworms and dung beetles help in decomposing organic matter, enriching the soil.

2. (a) (i) Draw the structure of Escherichia coli and label five parts.

Escherichia coli (E. coli) is a rod-shaped, gram-negative bacterium commonly found in the intestines of warm-blooded organisms. Its structure comprises several key components, each playing a vital role in its function and survival.

Key Structural Components of E. coli:

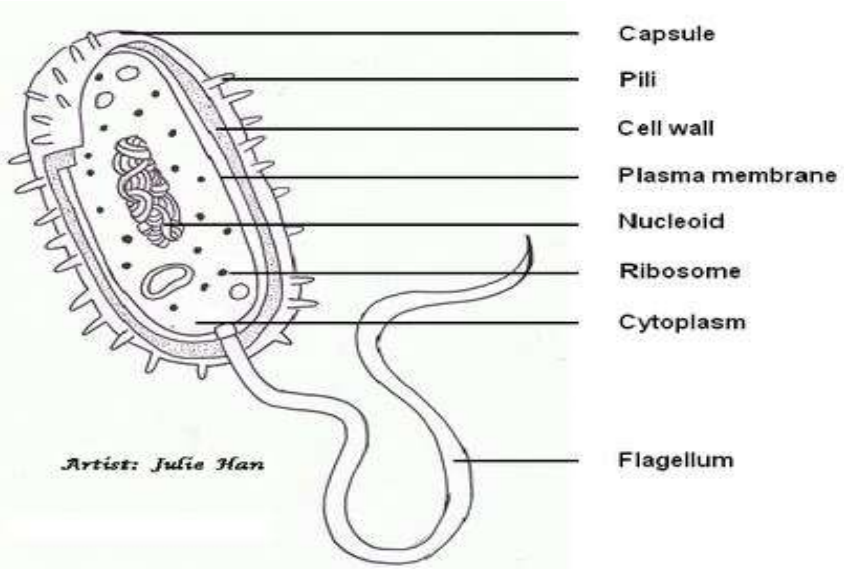
- Cell Wall: Composed of a thin peptidoglycan layer, the cell wall provides structural support and maintains the bacterium's shape. In gram-negative bacteria like E. coli, an outer membrane surrounds this peptidoglycan layer, contributing to the cell's defense mechanisms.

- Plasma Membrane: Located beneath the cell wall, the plasma membrane regulates the movement of substances into and out of the cell, playing a crucial role in nutrient uptake and waste elimination.

- Cytoplasm: This gel-like substance fills the interior of the cell, housing various cellular components, including ribosomes and the nucleoid region.

- Nucleoid Region: Unlike eukaryotic cells, E. coli lacks a true nucleus. Its genetic material, typically a single circular chromosome made of DNA, is located in the nucleoid region.

- Flagella: Many E. coli cells possess flagella—long, whip-like structures that protrude from the cell body. These structures facilitate movement, allowing the bacterium to navigate its environment.



(ii) State the role played by each part labeled in 2 (a) (i).

i. Flagellum: Provides motility, enabling the bacterium to move in response to stimuli.
ii. Cell wall: Protects the cell and provides structural support.
iii. Plasma membrane: Regulates the transport of substances into and out of the cell.
iv. Cytoplasm: Contains enzymes and nutrients necessary for cellular metabolism.
v. DNA (nucleoid): Carries genetic information essential for replication and protein synthesis.

(b) Explain how the reproduction of bacteria takes place.

Bacteria reproduce primarily by binary fission, a form of asexual reproduction. The process involves:
i. DNA replication: The bacterial DNA is duplicated.
ii. Cell elongation: The cell grows in size, and the two DNA molecules move to opposite poles.
iii. Septum formation: A dividing wall forms between the two DNA molecules.
iv. Separation: The cell splits into two identical daughter cells, each with a copy of the DNA.

3. (a) (i) Identify three major nitrogenous excretory wastes in animals.

i. Ammonia
ii. Urea
iii. Uric acid

(ii) Identify which animals excrete each identified type of nitrogenous wastes in (a) (i) and give three reasons for your answer. Tabulate your answer as shown in the table.

Nitrogenous waste	Animals excreting it	Reasons
Ammonia	Fish	Highly toxic, requires large amounts of water to dilute and excrete.
Urea	Mammals	Less toxic, soluble in water, requires moderate water for excretion.
Uric acid	Birds and reptiles	Non-toxic, excreted as a paste to conserve water.

(b) Enumerate five responses which occur in the body when the body temperature is higher than normal.

i. Sweating: Evaporation of sweat cools the body.
ii. Vasodilation: Blood vessels near the skin widen to release heat.
iii. Reduced metabolic rate: Decreases heat production in the body.
iv. Behavioral changes: Seeking shade or reducing physical activity to prevent overheating.
v. Increased respiration: Enhanced breathing rate helps expel heat through evaporation.

4.Describe events which take place in animal cell during the first four mitotic stages.

i. Prophase: Chromosomes condense, spindle fibers form, and the nuclear envelope disintegrates.
ii. Metaphase: Chromosomes align at the metaphase plate.
iii. Anaphase: Sister chromatids separate and move to opposite poles.
iv. Telophase: Chromosomes decondense, nuclear envelopes reform, and the cell begins to divide.

5. (a) Evaluate three merits of genetic engineering in human beings.

i. Treatment of genetic disorders: Gene therapy can be used to replace defective genes with healthy ones.
ii. Improved agriculture: Genetically modified crops enhance yield and resistance to pests and diseases, ensuring food security.
iii. Production of biopharmaceuticals: Genetic engineering enables the production of insulin, vaccines, and other medicines.

(b) If a pure strain of mice with brown-colored fur are allowed to breed with a pure strain of mice with grey-colored fur, they produce offspring having brown-colored fur. If the F_1 mice are allowed to interbreed, they produce an F_2 generation with fur color in the proportion of three brown-colored to one grey. Carry out genetic crosses to illustrate these results.

Let B represent the dominant allele for brown fur and b represent the recessive allele for grey fur.

P generation: BB (brown) x bb (grey)
F_1 generation: Bb (all brown fur)

F_2 generation (F_1 x F_1):

	B (mother)	b (mother)
B (father)	BB	Bb
b (father)	Bb	bb

Phenotypic ratio: 3 brown : 1 grey
Genotypic ratio: 1 BB : 2 Bb : 1 bb

5. Study Figure 1 and answer the questions which follow.

(a)
(i) Name the structure represented by Figure 1.
The structure is a DNA molecule.

(ii) Identify the structures represented by letters R, S, T, U, V, W, X, and Y.
- R: Phosphate group
- S: Deoxyribose sugar
- T: Adenine
- U: Thymine
- V: Guanine
- W: Cytosine
- X: Hydrogen bonds
- Y: Phosphodiester bonds

(iii) What is the name given to both structure T and U?
They are nitrogenous bases classified as purines.

(iv) What is the name given to both structure V and W?
They are nitrogenous bases classified as pyrimidines.

(v) Name the bonds which help in the formation of structure shown in Figure 1.
- Hydrogen bonds between complementary nitrogenous bases.
- Phosphodiester bonds between the sugar and phosphate groups along the backbone.

(b) Enumerate five differences between deoxyribonucleic acid and ribonucleic acid.

i. DNA contains deoxyribose sugar, while RNA contains ribose sugar.
ii. DNA has thymine as a nitrogenous base, while RNA has uracil instead of thymine.
iii. DNA is double-stranded, while RNA is single-stranded.
iv. DNA is more stable and stores genetic information, while RNA is less stable and functions in protein synthesis.
v. DNA is confined to the nucleus (in eukaryotic cells), while RNA is found in both the nucleus and cytoplasm.

7. Clearly describe nine procedures used to estimate population for each of the following methods:

(a) Quadrant method.
i. Select a representative area within the ecosystem.
ii. Place a square or rectangular quadrant randomly within the area.
iii. Identify and count all individuals of the target species within the quadrant.
iv. Record the data for each quadrant.
v. Repeat the process at multiple randomly selected sites within the area.
vi. Calculate the mean population density by averaging the counts from all quadrants.
vii. Determine the total area of the ecosystem.
viii. Estimate the total population by multiplying the mean density by the total area.
ix. Analyze and compare the results with population estimates from different seasons or years.

(b) Capture-recapture method.
i. Capture a random sample of the target species.
ii. Mark all captured individuals using a harmless technique (e.g., tagging or dyeing).
iii. Release the marked individuals back into the population.
iv. Allow time for the marked individuals to mix with the unmarked population.
v. Recapture a second sample from the population.
vi. Count the number of marked and unmarked individuals in the second sample.
vii. Use the Lincoln Index formula:
Population size = (Number of marked individuals × Total number of second capture) ÷ Number of marked recaptures.
viii. Ensure the marking method does not harm the species or alter their behavior.
ix. Repeat the process for accuracy and consistency.

8. (a) Explain Lamarck's theory of evolution.
Lamarck's theory of evolution, known as the theory of inheritance of acquired characteristics, suggests that organisms evolve through the use and disuse of body parts. He proposed that:
i. Organisms adapt to their environment by developing traits that are beneficial.
ii. These traits are acquired during an individual's lifetime (e.g., a giraffe's neck growing longer to reach higher leaves).

iii. Acquired traits are then passed on to the offspring, leading to evolutionary changes over generations.

(b) Why almost all modern biologists reject Lamarck's theory of evolution?

i. Lack of evidence: Acquired traits do not alter an organism's genetic material and cannot be inherited.
ii. DNA-based inheritance: Modern genetics has proven that traits are passed through DNA, not through acquired characteristics.
iii. Observations in evolution: Many traits evolve due to natural selection, not the direct use or disuse of organs.
iv. Experiments: Experiments, such as cutting the tails of mice, showed no inheritance of acquired traits.
v. Modern synthesis: Evolutionary theory now incorporates Darwin's natural selection, genetics, and mutation, leaving no support for Lamarck's ideas.