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# BIOLOGY MARKING SCHEME S01

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**DR G MBASHI EDUCATION  
WORKED EXAMPLE 1  
BIOLOGY 2 - MARKING SCHEME**

1. a. i. **Division of kingdom Plantae**

- Division Bryophyta (01 mark)
- Division Filicinophyta (01 mark)
- Division Coniferophyta (01 mark)
- Division Angiospermtophyta (01 mark)

ii. **Floral formula** is a way of representing the structure of flower by using specific letters, symbols and numbers. (02 marks)

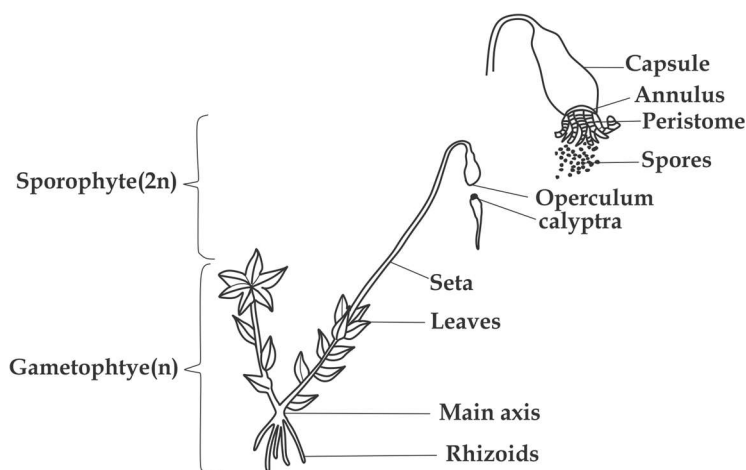
**Floral diagram** is a diagrammatically representation of the cross section of flower by using respective symbols. (02 marks)

iii. **Symbols used in floral formula**

Symbol	Meaning
$\Phi$	Actinomorphic
%	Zygomorphic
♀ / ♂	Female/ Male flower
K	Calyx/sepals
C	Corolla/petals
A	Androecium
G	Gynoecium

*Any 5@ 01 mark - 05 marks*

b. i. **Diagram of moss plant showing sporophyte and gametophyte**



*05 marks*

- ii. Most members of division Bryophyta do not grow taller because they lack vascular tissue to transport water, mineral salts and food from one part to another. (02 marks)

2. a. **Mechanism of urea formation**

Urea is the main nitrogenous waste in mammals and marine organism such as shark and dog fish. Urea is formed in the liver through the ornithine cycle which involves the following stages: (02 marks)

- i. **Formation of carbomyl phosphate:**  
*Ammonium* from deamination and *carbondioxide* from respiration in solution forms (ammonium and bicarbonate respectively) react to form carbomyl phosphate under the presence of carbomyl phosphate synthetase enzyme. (2 marks)
- ii. **Synthesis citrulline**  
Carbomyl phosphate reacts with ornithine to form citrulline under the presence of citrulline synthetase enzyme. Citrulline can easily pass through the mitochondrial membrane, thus it diffuses from the mitochondrion into cytoplasm of the liver cells. (02 marks)
- iii. **Synthesis of argininosuccinate**  
In the cytoplasm; Citrulline combine with amine group of aspartate by condensation reaction to form argininosuccinate under the presence of argininosuccinate synthetase enzyme. (02 marks)
- i. **Cleavage of argininosuccinate**  
Argininosuccinate is hydrolysed by an enzyme argininoisuccinase to form arginine. (02 marks)
- v. **Cleavage of arginine**  
Arginine is broken down into urea and ornithine by arginase. Urea is transported to the kidney for excretion and ornithine restart the cycle. (02 marks)

b. **Roles of mammalian Kidneys**

- i. It excretes metabolic waste products from the body such as urea.
- ii. It controls water balance (osmoregulation) in the body.
- iii. It regulates blood pressure in the body.
- iv. It regulates osmotic pressure (mineral ions) in the body.
- v. It controls red blood cells production in the body.
- vi. It controls vitamin D production in the body.

*Any 4 points@ 02 marks - 08 marks*

3. a. i. Allometric growth (01 mark)

- ii. Allometric growth is the pattern of growth in which the organs of the body grow at different mean rate from the rest of the body. (02 marks)
- iii. Example of organism that exhibit Allometric growth is mammal such as human. (02 mark)
- iv. Thymus gland grow rapids in early stages to produce white blood cells to fight infections because at that time immunity is still weak and risk of disease is very high. (02 marks)

**b. Features associated with secondary growth in dicot plants**

**i. Wood**

**Wood** is the accumulation of secondary xylem vessels in the stem. The central region of the wood is called the **heart wood** which appears dark in colour due to the deposition of toxic wastes such as tannis, resins and oils. Its only main function is to provide support to the stem. The outer region of the wood is called **sap wood**. It is the active part of the wood, transporting water and dissolved mineral salts from the roots to the leaves. (05 marks)

**ii. Annual rings**

**Annual rings** are the concentric rings in the wood produced each year due to the change in annual seasons. The rings are formed because of the wood grow differently in the spring than they do in the summer. In spring, little xylem vessels are formed due to the availability of water for growth and the wood appears dark. In summer, large xylem vessels are formed due to deficiency of water and the wood appears light. Alternating, large and small cells form light and dark bands that look like rings called **annual rings**. They are responsible for estimating the age of the plant. Each ring represents one year's growth. (05 marks)

**iii. Cork and lenticels**

It is an outer bark produced by the cork cambium due to rupture of epidermis. They impregnated with waterproofing (suberin) to provide protection in the woody stem and also containing small opening called lenticels for maximum gaseous exchange. (05 marks)

- 4. a. Organic evolution is the gradual development of complex form of life from the pre-existing simple form of life in a course of time. (02 marks)
- b. i. **Gene flow** is the migration of the population from one place to another may which result into continual interchange of alleles between organisms. Random introduction of new alleles into the

recipient population and their removal from donor population leads to increase in genetic variation that can lead to organic evolution at a given period of time. (04 marks)

- ii. **Mutation** is the sudden change in genetic constitution of organism. Mutation can lead to introduction of new gene in a population that confers better adaptation of organism bearing it. The mutant gene can then be passed from one generation to another and multiply generation to generation; hence evolution. (04 marks)
- iii. **Natural selection** is the process by which the nature itself select the organisms that are well adapted to survive. Thus favoured or selected organisms will now reproduce comfortably and pass their traits to the next generation as the result new species is evolved by natural selection. (04 marks)
- iv. **Genetic drift** is the variation of gene frequencies within the population which occurs by chance rather than by natural selection in small/ isolated population. Genetic variation lead to extinction of population result into population becoming better adopted to the environment and more widely different from parental from parental population hence evolution. (04 marks)

c. **Weaknesses of special creation theory**

- i. It cannot be subjected to scientific proof. (1 mark)
- ii. It is against the law of biogenesis; as it stresses out, life arose from nothing but the word of GOD. (01 mark)

- 5. a. i. **Detritus food chain** is the type of food chain whereby the first trophic level is occupied by detritus (decomposing material) and the second trophic level is occupied by detritivorous. (01½ marks)
- ii. **Trophic level** is the position occupied by an organism in a food chain or food web; for example producers – first trophic level. (01½ marks)
- b. i. **Interspecific competition** is the type of competition which occurs between organisms of different species. Example is competition of lions and leopards for antelopes. (02 marks)
- ii. **Intraspecific competition** is the type of competition which occurs between organisms of the same species, example is competition of male lions for mates. (02 marks)
- c. **Living organisms depend on each other in the following ways:**
  - i. **Competition** – This involves struggle between organisms for the limited environmental resources such as light, food, water, mate

and space. The competition may be intraspecific when it occurs between organisms of the same species for the same limited resources. One example of intraspecific is when several cocks compete for the same hen for mating. Competition can also occur between organisms of different species competing for the same limited resources. Herbivores animals such as buffalo, antelope and zebra compete for limited fodders. This type of competition involving two or more different species is called interspecific competition. (03 marks)

- ii. **Predation** – This is a feeding relationship in which the predator eats another animal of a different species. The eaten animal is called a prey. In an ecosystem with a *predator – prey* relationship, the two populations regulate each other and result in cyclic changes in the population size. (03 marks)

- iii. **Symbiosis** – This is the interrelationship between two or more organisms of different species living together in which one organism (symbiont) or both may benefit from the relationship. There are three common types of symbiotic relationship, namely; mutualism, commensalism and parasitism. Mutualism refers to a symbiotic association of two organisms of different species living together in which each member benefits from the living association. Mutualism is exemplified by a relationship between fungi and green algae, which is called lichen. In this association, the fungi penetrate its hyphae deep to the algae body tissue to provide water and dissolved minerals to the algae. The algae, in turn photosynthesize food and pass some of it to the fungi body which is heterotroph. Commensalism also refers to a symbiotic relationship in which one species benefits the association, whereas, the other species is neither harmed nor does it benefit from the association. For example the barnacles live on the whale and are transported to various parts of the ocean for feeding. In this relationship, the whales are neither affected nor benefited. Parasitism is another type of symbiotic relationship in which one organism called a parasite benefits and the other organism called a host is harmed. Examples include *plasmodium* species (malaria parasites) and worms such as tape worms. (03 marks)

6. a. i. Potatoes blight disease. (01 mark)  
ii. Organism – Phytophthora infestant. (01 mark)  
Kingdom – Protocista  
Phylum – Oomycota (02 marks)

iii. **Adaptations of Phytophthora infestant**

- Formation of cyst during unfavourable conditions ensures its survival.
- Ability to reproduce asexually and sexually which ensures its survival chances.
- It has haustoria with a large surface area for penetration into the plant cells and absorption of nutrients from them.
- The haustoria secrete enzymes which help to penetrate into its host cells.
- It has spores which withstand the adverse condition, such that, under favourable conditions, they germinate to adult Phytophthora infestant.

*5 points @ 02 marks – 10 marks*

b. The lowest taxon in which fish and whale are grouped together is **Phylum chordata** because they both have the following features:

- i. They have a notochord at some stages of their development.
- ii. They have visceral cleft which are slits perforating the body wall in the pharynx.
- iii. They have endoskeleton made up of bones and cartilage.
- iv. They have post anal tail at some stages of their development.
- v. They have a *dorsal hollow nerve cord* found above the notochord and below the epidermis.
- vi. They have ventrally positioned heart, which is a pumping organ, as it pumps blood.
- vii. They are *triploblast, coelomate* animals with *bilaterally symmetrical* body.

*Any 6 points @ 01 mark – 06 marks*

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1. a. i. A - Gametophyte  
B - Antheridia  
C - Sperm (n)  
D - Egg (n)  
E - Zygote  
F - Sporophyte (2n)  
G - Spore (n)  
H - Protonema  
I - Meiosis

*9 points @ 01 mark - 09 marks*

- ii. Water is needed to moss plants for their reproduction since male gamete should swim to meet female gamete during fertilization. (01 mark)
- Also moss plants do not have vascular system for conduction of water inside their bodies, thus cells in moss body need to have easy access to water from their environment. (01 mark)
- iii. Funaria hygrometrica (01 mark)

**b. Advantages of kingdom fungi**

- i. Some members of kingdom fungi such as *Agaricus species* are source of food to human being.
- ii. Some members of kingdom fungi are used in the production of medicines such as penicillin from *penicillium species*.
- iii. Some members of fungi such as yeast are used in fermentation to produce alcohol.
- iv. Some members of kingdom fungi such as *saprophytic species* are used in biological control as they obtain their food by destroying other organisms like amoeba and nematodes.
- v. Some members of fungi such as *Gibberella fujikuroi* are used as a source of phytohomes.
- vi. Some members of fungi such as *Neurospora* are used in biological research.

*Any 4 points @ 01 mark - 04 marks*

**Disadvantages of Kingdom fungi**

- i. Some members of kingdom fungi are poisonous and so can cause death when eaten such as *Amanita species* of mushroom.
- ii. Some members of kingdom fungi causes diseases such as vagina thrush is caused by *candida species*.



- iii. Some members of kingdom fungi such as saprophytic species deteriorates organic materials such as leather, natural fabrics.
- iv. Some members of kingdom fungi destroys crops such as maize by fungi like *puccinia* which causes rotting of the plant.
- v. Some members of kingdom fungi such as *penicillium* which are used in pharmaceutical cause various types of allergic reactions to some people.

*Any 4 points @ 01 mark – 04 marks*

2. a. During summer water is lost through evaporation by sweating. Blood of an individual becomes more concentrated, the Osmoreceptor in the hypothalamus detect the rise in osmotic pressure of the blood and set up nerve impulse to the posterior pituitary gland to release ADH. The ADH hormone travels in the blood to the kidney where it increases the permeability of the distal convoluted tubule and collecting duct to water, hence much water is reabsorbed back to the blood stream and little water allow passing out as urine and finally more concentrated urine will be produced. (06 marks)

- b. Camels conserve water during urine formation by excreting less toxic and insoluble nitrogenous waste called urea in which its excretion required less amount of water, thus much water is conserved in the body of camels. (04 marks)

- c. **Kidney stones:** This is urinary disorder caused by the concentrated minerals such as uric acid, calcium oxalate or other organic matter in the kidney which result into small particles called stones. 01 mark

*Symptoms*

- Stones give rise to severe colic pain starting in the back and down to the front of testes in males or vulva in females. ( 01 mark)
- Stones may give rise to blood in the urine. (01 mark)
- The patient may have nausea, vomiting and fever. (01 mark)

*Treatment and prevention*

Best way to prevent most of kidney stones is to drink enough fluids every day and if the stone is persistence surgery is indicated.

(01 mark)

**Urinary tract infection (UTI):** This is urinary disorder caused by the inflammation of urethra and bladder due to invasion of bacterial infection. (01 mark)

*Symptoms*

- Painful in urination (01 mark)

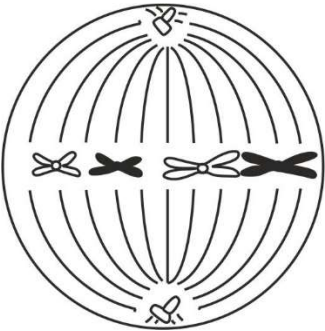
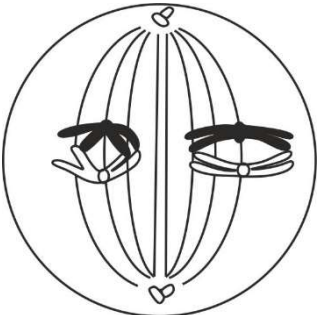
- Lower abdominal pain radiate to the back. (01 mark)
- Frequent in urination (01 mark)

*Treatment and prevention*

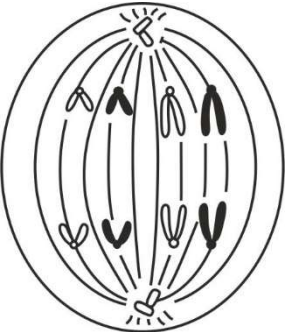
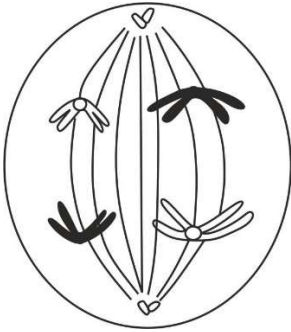
Use antibiotics and drinking plenty of fluids every day. (01 mark)

3. To differentiate between the following stages in meiosis and mitosis:

a. i. **Metaphase** (04 marks)

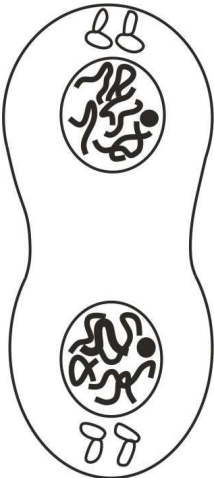
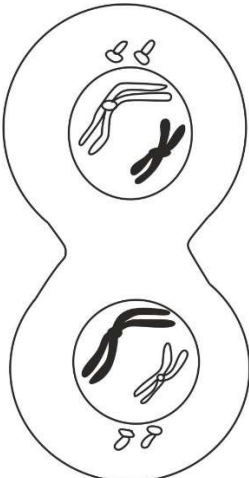
Mitosis	Meiosis
In <i>mitosis</i> chromosomes arrange along the equatorial but form a single row.	In <i>meiosis</i> chromosomes arrange along the equatorial but form a double row.
	

i. **Anaphase** (04 marks)

Mitosis	Meiosis
In mitosis chromosome divide along the centromere and move to the opposite poles.	In meiosis chromosome as whole move to the opposite pole.
	

## iii. Telophase

(04 marks)

Mitosis	Meiosis
Chromatids reach the opposite poles and two daughter cells are obtained	Chromosomes reach the opposite poles and four daughter cells are obtained.
	

## b. Two types of seed dormancy and causes of each type:

**Primary seed dormancy** is a type of seed dormancy in which seed will not germinate immediately after dispersal even if the factors for germination are present. (02 marks)

**Factors causes' primary seed dormancy:**

- Hardness of seed testa to resist rupture.
- Immaturity of seed embryo.
- Presence of growth inhibitors such as abscissic acid.
- Impermeable seed testa to water and oxygen.

4 points @ 0½ mark – total 02 marks

**Secondary seed dormancy** is the type of seed dormancy in which seed will not germinate due to lack of the external conditions that are necessary for germination. (02 marks)

**Factors causes' secondary seed dormancy:**

- Lack of optimum temperature.
- Lack of appropriate light.
- Lack of oxygen
- Lack of water

Any 4 points @ 0½ mark – Total 02 marks

4. a. i. There are more haemophilic males than haemophilic females in the population because women must have two X – chromosomes in order to develop a disease while in men the disease manifest when a single X – chromosome is affected. (02 marks)

ii. Let

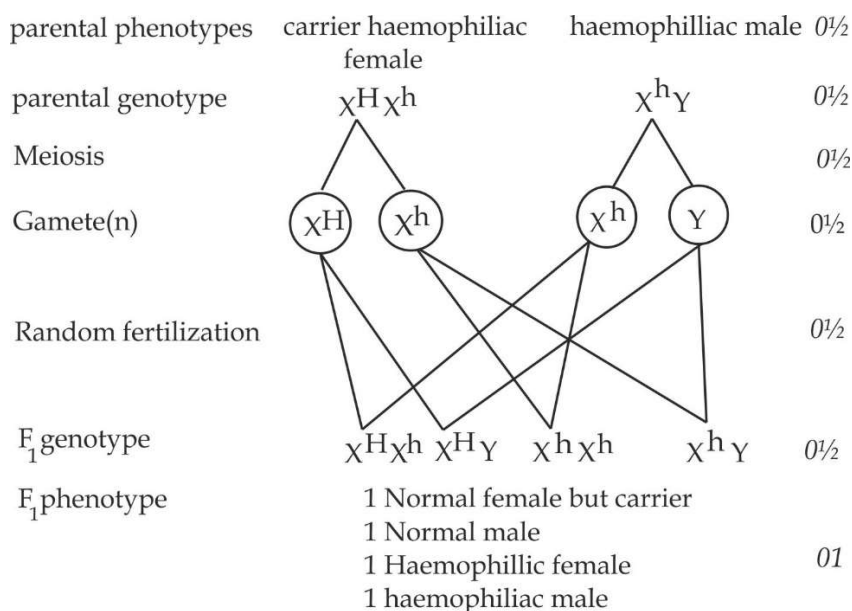
H – Normal allele for haemophilia

h – Represent allele for haemophilia

XX – represent female individual

XY – represent male individual

(01 mark)



**Total 06 marks**

- b. i. Mendel's first law of inheritance states that " the characteristics of an organism are controlled by *internal factors/ allele* that occurs in pairs, from which only one of these factors can be present in a single gamete. (02 marks)

ii. **Meiotic explanation of Mendel's first Law:**

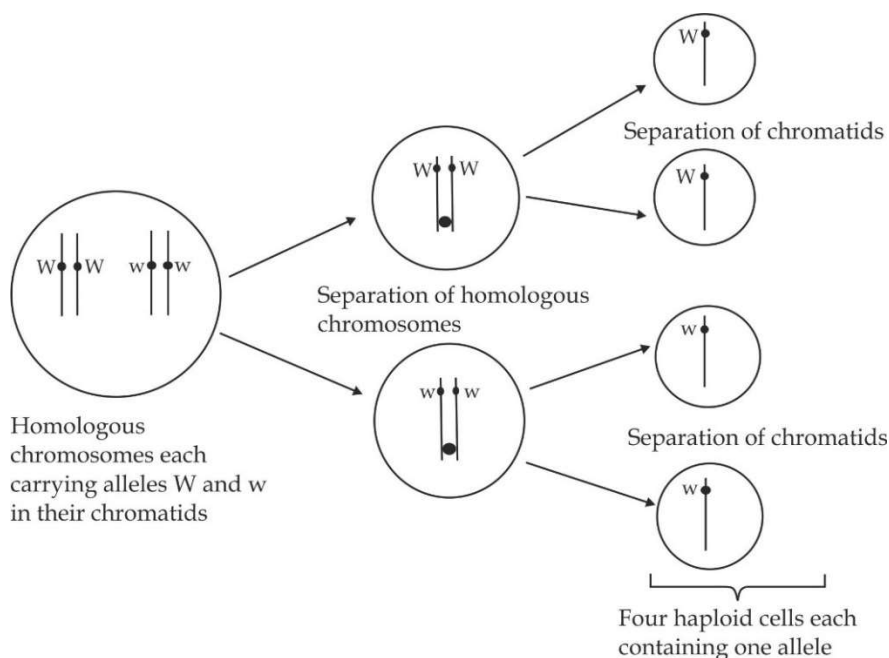
Although Mendel knew nothing about meiosis process, his first law can be explained by behaviour and movement of chromosomes during meiosis. (01 mark)

During meiosis I, at anaphase I, homologous chromosome pairs separate from one another, as a result, each haploid gamete

receives half of the number of chromosomes present in parental cell. (01 mark)

The allele also occur in pairs, each allele being located on one of two homologous chromosomes. (01 mark)

Thus when the chromosomes separate they take their allele with them and therefore each gamete receive only one pair of the allele in a pair in similar way as it receives only one chromosome. (01 mark)



*Diagram - 02 marks*

iii. **The characteristics of genetic code:**

**The genetic code is triplet:** Three nitrogenous bases specifying one amino acid. The codons are formed using the bases which are available in the mRNA. The four nucleotide bases (A, G, C and U) in the mRNA are used to produce three base codons ( $4^3 = 64$  three base groups). Therefore, there are 64 codons, which code for the 20 amino acids and since each codon codes for only one amino acid, this means that, one amino acid can be coded by more than one codon.

**The genetic code is degenerate in nature:** All amino acids except methionine (AUG) and tryptophan (UGG) are coded by more than one codon. For example, threonine is coded by four codons

ACU, ACC, ACA and ACG. In this case, there are more codons than there are amino acids.

**The genetic code is punctuated:** Genetic code is punctuated, that means, it has the start and stop signals. The codon AUG (methionine) acts as a start signal for the initiation of polypeptide chain and the codons UAG, UAA and UGA are stop signal, which determine the end of polypeptide chain synthesis.

**The genetic code is universal:** Genetic code is universal, that means, the same codon for the same amino acid in all living organisms and viruses, however, a few exceptions are found in mitochondria. For example, UGA is one of the termination codons, which code for tryptophan in yeast mitochondria.

**The genetic code is non-overlapping:** The genetic code is sequentially read in groups of three without overlapping except in some viruses. For example, mRNA with base sequence AUGUCUCCA can be read as AUG/ UCU/ CCA and not AUG/ GUC/ CUC/CCA.

*Any 4 points@ 01 mark – total 04 marks*

5. a. i. **The main ideas of Lamarck's theory of organic evolution:**  
**Change in environment change;** the change in the environment may lead to the change in the pattern of behaviour of an organism to cope with environment. (02 marks)  
**The use and disuse of organ;** if the body organ is constantly used, it will become strong and better developed, and if the organ is not used, it will become weak and disappear. (02 marks)  
**The inheritance of acquired character;** the acquired character during the life time can be passed from one generation to another. (02 marks)
- ii. **Almost all biologist reject Lamarck's theory due to:**
- The use and disuse of the body part cannot determine its existence or degeneracy.
  - The theory did not distinguish between inheritable and non-inheritable characteristics.
  - The acquired character cannot be transmitted from one generation to another since it is not part of heredity.
  - The theory did not explain the role of genetic in variation.
- 4 points @ 01 mark – total 04 marks*

- b. i. **Selection** is a process through which best adapted individuals in a population survive, reproduce and pass their genes on to the next generation and less adapted individuals are eliminated in a population. (01 mark)

ii. **Taxonomy as evidence of organic evolution:**

**Taxonomy** is a branch of classification which is based on comparing the similarities and differences between organisms across the groups called taxa. **Taxonomy** suggests that; the similarities in structures and characteristics from different organisms show the evolutionary relationship from common ancestral origin. The difference may be explained as due to adaptation of organisms in changing environmental condition within each taxa over period of time. This evidence is also described as the **linear classification**. (03 marks)

**Palaeontology as evidence of organic evolution:**

**Palaeontology** is the study of the remains of past life called fossils; when plants and animals die, their remains are either decomposed by bacteria or preserved as fossils. There are two (2) main reasons which support the fossil studies as the evidence of organic evolution among living organisms of the given species. **Firstly**; the fossil record suggests that; the complex and advanced forms of plants and animals evolved from simple and primitive forms of life. For example, research on fossils has shown that the earliest fossils were monera, followed by protocista and then fungi. The oldest fossils of animals are those of fishes followed by amphibians and latest are mammals. **Secondly**; The fossil record suggests that, The structure of organisms do not remain fixed but rather change from simple to more complex forms. The fossils of the single organisms are formed in the deeper layer of the sedimentary rocks are simple and those of the more complex are found in the upper layer. This indicates evolutionary relationship among organisms. (03 marks)

**Biogeography as evidence of organic evolution:**

**Biogeography** is the study of the distribution of the animals and Plants in different parts of the world. The presence of different plants and animals in the areas that were once adjacent in the past indicates that; organisms were originated from the common ancestral, however the geological isolation cause the organisms to adapt different by the pressure of natural selection in order to cope with new environmental conditions. This pattern of adaptation is called **adaptive radiation**, which is an example of

divergent evolution. Example of adaptive radiation which support the biogeography as evidence of organic evolution include - **Darwin finches** and **continental drift**. (03 marks)

6. a. **Examples of economic activities that can alter ecosystem:**

**Afforestation:**

Refers to the planting of trees to make new forests (forests that were never there), Afforestation which is practised by human favours energy flow since it increases the number of producers.

**Deforestation**

Refers to the burning or cutting down of trees, deforestation which is practised by human decreases the energy flow since it decreases the number of producers in the ecosystem.

**Use of pesticides in agriculture**

These remove primary consumers in the ecosystem, thereby decreasing the flow of energy in the ecosystem.

**Poaching**

It is the act of man killing animals especially in national parks, mostly primary consumers such as zebra, elephants, and giraffes. Poaching which is practised by humans decrease the flow of energy, since it decreases the number of consumers.

**Dynamite fishing**

Refers to use of explosive in fishing, this generates fumes of different types which are harmful to the life of living organisms, Dynamite which is practised by humans decrease the energy flow since it decreases the number of producers as well as consumers in water.

*5 points @ 02 marks - total 10 marks*

b. **Capture – recapturing method**

This refers to the method used to count the total number of individuals by capturing them in the same way without causing any damage and replace to the same area so that can resume a normal role in a population. It is usually used to estimate the population size of small mobile animals such as insects. (03 marks)

c. **Procedures for capture recapturing methods:**

- i. Capture a first sample of individuals from a population.
- ii. Count a first sample of individuals and record as  $n_1$ .



- iii. Marked all captured animals (Given them each an identified).
- iv. Release them back into the original population.
- v. Provide enough time for released animals to remix with the whole population.
- vi. Capture a second sample of individuals from the same population.
- vii. Count a second sample of individuals and record as **n<sub>2</sub>**.
- viii. Count the number of marked recaptured individuals in a second sample and record as **n<sub>3</sub>**.
- ix. Use the following formula to calculate the number of population size called *Lincoln index*:

$$N = \frac{n_1 \times n_2}{n_3}$$

N = Estimated population size

n<sub>1</sub> = Captured sample 1

n<sub>2</sub> = Captured sample 2

n<sub>3</sub> = recapture sample 2

*Any 7 points @ 01 mark - total 07 marks*

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WORKED EXAMPLE 3  
BIOLOGY 2 - MARKING SCHEME

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1. a. **Problems resulted with transfer of plant from aquatic to terrestrial:**
- i. **Desiccation** – plant is unable to obtain and conserving sufficient water essential for plant life.
  - ii. **Reproduction** – male gamete sex cells fail to swim toward the female gamete during fertilization.
  - iii. **Support** - plant body lack turgor pressure which offers support created by osmotic movement of water.
  - iv. **Nutrition** – Plant lacks water as essential raw materials for the photosynthesis.
  - v. **Environmental variables** – terrestrial environment is much subjected to change in important factors such as temperature, pH, light intensity and mineral ions.
  - vi. **Gaseous exchange** – Plant fail to obtain sufficient respiratory gases, since lenticels are not much used.

*6 points @ 02 marks – total 12 marks*

b. **Adaptations of Agaricus compestris to its mode of life:**

- i. They have pileus or cap made up of closely packed hyphae to confer protection to the basidiospores.
- ii. They have stem or stipe to give support to the cap or mushroom as whole.
- iii. They have ability of secreting enzymes needed for extra cellular digestion.
- iv. They have hyphae for anchoring and absorption of digested food.
- v. They produce large numbers of resistant basidiospores which are easily dispersed and ensure survival chances.
- vi. They store carbohydrates in the form of glycogen for use during shortage of food supply

*Any 4 points @ 02 marks – total 08 marks*

2. a. **Homeostatic system** is the self-regulatory mechanism which normal keeps all body parameters constant regardless the fluctuation of the environment. *(02 marks)*
- i. **Input or set point**  
Is the desired point which essentially triggers the control system to start operating in homeostatic mechanism. It is also referred to as stimulus such factors include temperature. *(02 marks)*

ii. **Detector or receptor**

It is the component that are capable of detecting the stimuli such as thermoreceptors in the hypothalamus that detect change in body temperature. (02 marks)

iii. **Regulator or controller**

It is the component that are capable of receiving stimulus and initiating appropriate corrective measures. Example of regulator is pituitary gland. (02 marks)

iv. **Effector**

It is the organ or gland that carry out corrective measures from the control centre. Examples of effectors are the sweat glands, blood vessels and muscles. (02 marks)

iv. **Output**

Is the response produced relevant to stimulation. Example when there is a need of thyroxine of the body. (02 marks)

**b. The structure and role of the first part of the uniferous tubules:**

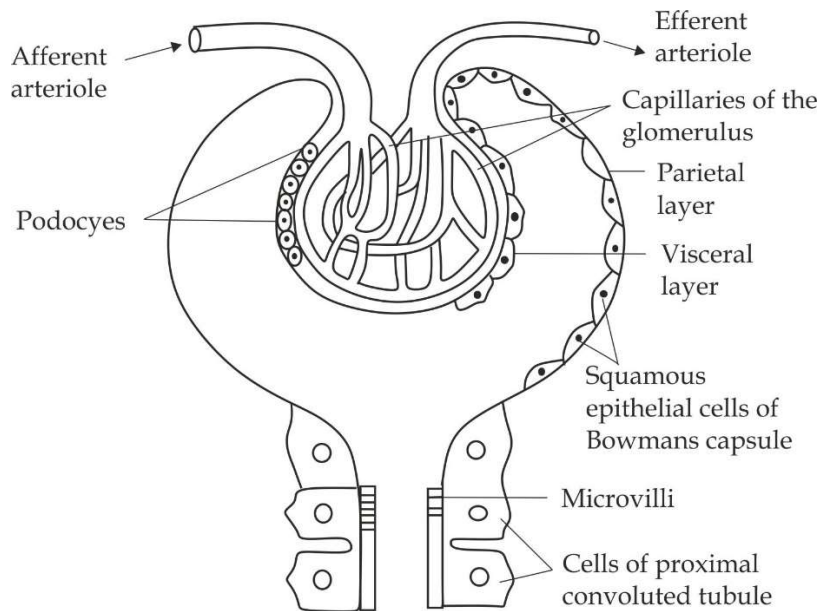
The first part of the uniferous tubules (nephrons) is called renal corpuscle or Malpighian body which consists of the glomerulus and the Bowman's capsule. (01 mark)

**Glomerulus** is a mass or network of blood cappilaries. The blood supply to the glomerulus is from the afferent arteriole of the renal artery and blood leaves the glomerulus via the narrower efferent arteriole. The capillary walls are composed of a single layer of endothelial cells with opening between them of diameter of 50 – 100 nm. These cells are pressed up against a basement membrane (basal lamina) which completely envelops each capillary and forms the only continuous structure separating the blood in the capillary from the lumen of Bowman's capsule. (02 marks)

**Bowman's capsule** is a double wall cap shaped structure that enclose the glomerulus. The inner layer of Bowman's capsule is composed of cells called **podocytes (foot processes)** which support the basement membrane and capillary beneath it and gaps of 25nm between the foot processes, called slit – spores, facilitate the process of filtration. The outer cells of Bowman's capsule are unspecialised squamous epithelial cells. (02 marks)

Roles of Malpighian body:

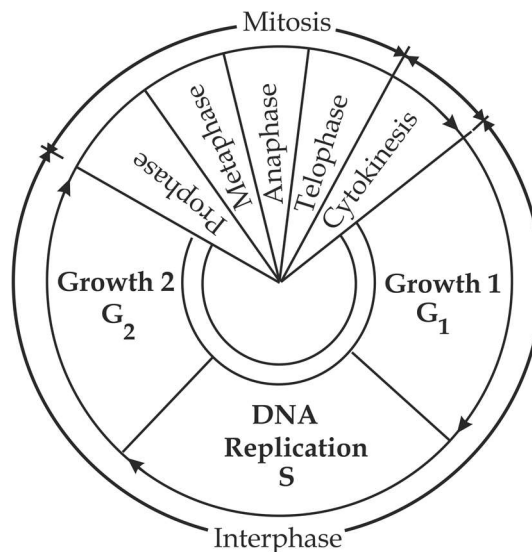
- i. It is the site for ultrafiltration which involves the removal from the blood all substances with a molecular mass less than 68 000 and the formation of a fluid called glomerular filtrate. (01 mark)
- ii. It controls the blood pressure by releasing renin enzymes in response to low blood volume. (01 mark)



The first part of the uniferous tubule (renal corpuscle)

*Correct diagram - total 03 marks*

3. a. **Cell cycle** is a pattern of events which a cell undergoes during cell division. It involves three main stages; which are interphase, mitosis and cytokinesis. (01 mark)



The diagram of a cell cycle

*Correct diagram - 03 marks*

**Interphase** is the period of intense chemical activity of the cell which has the following events: (01 mark)

- i. First growth phase ( $G_1$ ) in which cell grows, metabolic rate is high and organelles are synthesized. (01 mark)
- ii. Synthesis phase (S) in which DNA replication occurs and the chromosomes become two chromatids. (01 mark)
- iii. Second growth phase ( $G_2$ ) in which the energy stores increases and centrioles replicates. (01 mark)

**Mitosis** is the type of nuclear division in which two (2) daughter cells are formed carrying the same number of chromosomes as that of the Parental cell. It involves the following stages of events: (01 mark)

- i. **Prophase** in which chromosomes become shorten, thick and visible as pair of chromatids joined at the centromere. (01 marks)
- ii. **Metaphase** in which chromosomes arranged at the equator and spindle fibres attach them at the centromeres. (01 mark)
- iii. **Anaphase** in which spindle fibres shorten and separate sister chromatids to the opposite poles. (01 mark)
- iv. **Telophase** in which chromatids reach at the opposite poles and nuclear membrane and nucleolus reappear. (01 mark)

**Cytokinesis** is the stage of the cell cycle which involves the splitting of the cytoplasm to form two separate daughter cells. (01 mark)

The cytokinesis in animal cells involve the constriction of the plasma Membrane from the peripheral to the centre while cytokinesis in the plant cells involve the addition of cell plates called dictyosomes from the centre to the peripheral. (01 mark)

**b. The significances of Allometric growth in higher animals:**

- i. It leads to differentiate young animal from an adult animal for example reproductive organ grow very little in early stages and rapidly with the onset of sexual maturity at puberty. (01 mark)
- ii. It creates enough and relevant body immunity in early life. For example lymph tissues grow rapidly in early life. (01 mark)

**The significances of seed dormancy in seed dependent plants**

- i. It enables the seeds to survive during unfavourable condition until the period of germination.
- ii. It simplifies the storage of seeds; because it allows seeds to have time to disperse.

- iii. It simplifies the dispersal of seeds; because it allow seeds to be stored in the embryo without germinating for a long period of time until they are required to be sown.
- iv. It minimizes metabolism which enables the seeds to accumulate the food until the period of germination.
- v. It prevents premature germination of seeds.

*Any 3 points @ 01 mark – total 03 marks*

4. a. i. **The characteristics of hereditary materials**

- **Constancy**

The amount of hereditary materials remain constant within each somatic cell of a healthy individual to ensure genetic stability.

- **Linearity**

The hereditary materials are linear structurally, so that the genetic information can be carried out in linear array.

- **Metabolic stability**

The hereditary materials are metabolically stable and chemical inert so as to store the genetic information.

- **Self-replication**

In the presence of appropriate enzymes, the hereditary materials are capable of undergoing self-replication.

- **Mutation**

In the presence of mutagens, the hereditary materials are capable of undergoing mutation. The tendency is very important for evolution

*Any 5 points @01 mark – 05 marks*

- ii. If the sample of DNA contained 33% of guanine then it contains 33% of cytosine too because they pair up so out of 100% guanine and cytosine is 66% of nucleotide so that means adenine pairs with thymine to make 34%, so a percentage of adenine is 17%.

*(05 marks)*

- b. A plant with a dominant trait may be homozygous for example if the gene for black colour B is dominant over white colour b then now considering two black individuals their phenotype is the same in which both are black were as their genotype may homozygous dominant (BB) or heterozygous dominant (Bb).

*(05 marks)*

- c. Variation caused by environment do not affect the gene hence they are not passed from one generation to another where as those caused by mutation usually affect the genes hence they are passed from one generation to another; that is they are inherited. *(05 marks)*

5. a. i. **Mutation**

**Mutation** is a sudden and permanent change in the genetic constitution of an organism .If a mutation is beneficial and involve the reproductive cells (gametes), it can make the organism bearing it (mutant) to survive best in a given environment and pass on the mutation to the next generation, finally new species is evolved. For example, the existence of antibiotic resistant bacteria in hospital environment, the antibiotics are toxic drugs that kill bacteria over a period of time. If at the end of that period of time not all bacteria are killed. The survival bacteria undergo mutation and become resistance to antibiotics whereby these bacteria pass the mutation to the next generation as the result the new species is evolved. *(02½ marks)*.

ii. **Natural selection**

It is the mechanism by which the nature (environment) itself select the organisms that are well adapted to survive. Thus favoured or selected organisms will now reproduce comfortably and pass their traits to the next generation as the result new species is evolved by natural selection. *(02½ marks)*

iii. **Geographical isolation**

This type of speciation occurs as a result of two populations becoming geographically isolated by the physical barrier such as river, mountain and flooding. Geographical isolation is the most common way in which new species are formed. The geographical barrier creates spatial separation that prevents mating and gene flow between members of two separated population. The prolonged separation may result into adaptation to new environment by natural selection which change the gene pools of each group, in this way new species may arise; Example frogs are geographical isolated from one another by the area of deforestation in amazon basin.

*(02½ marks)*

**b. Types of fossils that support organic evolution****i. Entire organism**

In this type of fossils, the entire body of organism is preserved. The preserved materials can be ice, tar, amber or oil seeps. Example of this include woolly mammoth found in Siberia.

**ii. Hard skeletal materials**

These fossils are formed when hard skeletal parts such as teeth, bones skull and shells are trapped by sedimentary sands and clay which in turn form sedimentary rocks.

**iii. Petrified fossils**

This kind of fossil is formed when minerals such as silica, pyrites and calcium gradually replace the organic material in a body of buried organism and eventually fill the space left as the organism decays. Example, silica replace the echinoderm.

**iv. Moulds or casts**

Organisms buried in sediments slowly decompose and dissolve away leaving a cavity or mould that contains an exact imprint of the organisms shape and size. i.e., cast of footprint.

**v. Imprints**

These are fossils in the form of footprints, trails, tracks and tunnels of different organisms, for example the footprints of dinosaurs.

**vi. Compressed or carbonized plant fossils**

These are fossils which are formed when the oils in the plant cells are leached out and the remaining matter is reduced to carbon film. The plants are normally fossilized through carbonization such as a coal.

**vii. Coprolites**

These are formed pellets that are prevented from decomposing and later get compressed in sedimentary rocks. They often contain some evidences of the food eaten. The example for this is Cenozoic mammalian faecal remains.

*Any 5 points @ 02½ marks - total 12½ marks*

6. a. **Zonation** is the spatial distribution of species according to variation of biological and physical environmental factors. (02 marks)



**b. The following are factors triggers zonation of living organisms****i. Competition**

Competition among individuals seems to be the major biotic factor determining the population growth and distribution. The competition may be directly for resources such as sunlight, food or minerals or it may be for space, net sites or mates. If competition occurs between organisms for the limited resources such as food, usually the weaker species may not survive or reproduce or leave the areas, hence affect population growth and distribution.

**ii. Predation**

The presence of organisms that prey on or parasites a particular species may play a crucial role in the regulation of population size. If predation occurs between organisms, usually prey will not survive or leave the areas, hence affect population growth and distribution, many parasites do not kill their host, whereas predators do.

**iii. Diseases and pest**

Diseases and pest slow down the growth and reproductive rate of an organisms within a population hence limiting their population growth and distribution. Diseases are more a problem in large populations because disease can spread easily from one individual to another, especially epidemic outbreak such as covid 19 and ebola.

**iv. Availability of water**

The availability and quantity of water is essential for survival of living organisms. The availability of water will favour high reproduction and immigration of other organisms from place where such resources are scarce. This will lead to rapid population growth or increase in population size; on the other hand, their shortage slow reproduction, increase mortality and emigration hence limiting the population growth or reducing population size.

**v. Availability of food**

Adequate of nutrients favour high reproduction (natality) and immigration of other organisms from places where such resources are scarce. This will lead to population growth or

increase in population size. In contrast, insufficiency amount of food leads to competition, emigration, slow reproduction and high mortality of organisms hence limiting the population growth or reducing population size.

vi. **Sunlight**

Sunlight quality, quantity and duration affect much of the plant population because they depend on light for photosynthesis, when sunlight is sufficient plants will reproduce, thrive hence leading to population growth. In contrast, when *sunlight* is poor and inadequate plants compete and others dies hence limiting population growth or reducing population size.

vii. **Weather**

Weather conditions such as temperature, wind rain, humidity affect much the population growth of populations at a given habitat. Every species is able to survive within a range of each of these factors. This is called the species tolerance range; near the upper or lower limit of the tolerance range, individuals experience stress. This will reduce their health and rate of growth and reproduction and even cause emigration hence limiting population growth. The largest and healthiest population of a species will occur when conditions are within the optimal range.

viii. **Natural disasters**

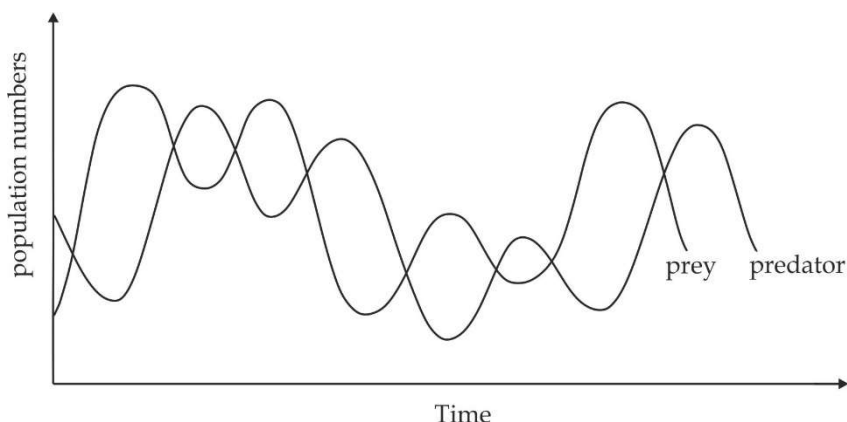
Natural disasters such as earthquakes, volcanic eruption, drought, hurricanes, tsunamis and volcanic eruption cause drastic changes in the environment leading to the destruction of the resources and even may cause deaths of members of a population hence limiting growth of population.

ix. **Availability of shelter**

Shelter may be for protection against predation or physical factors such as excessive heat. Availability of living space and shelter favours high natality and immigration consequently leading to increase in population size, however, shortage of living space and shelter leads to competition, emigration and high mortality of living organisms hence limiting the population growth or reducing the population size.

*Any 5 points @ 02 marks - total 10 marks*

## c. The predator prey relationship curve:



**Correct diagram - 02 marks**

**Interpretation of the curve:**

In ecosystem with a predator – prey relationship, the two populations regulate each other and result into cyclic changes in the population size. The reasoning underlying is straight forward. **(02 marks)**

As a prey population increases in number it provides more food for the predators and so, after an interval of time, the predator population increases too. The predators increase to the point where they are eating the prey species faster than it can reproduce, so the population of prey decreases. **(02 marks)**

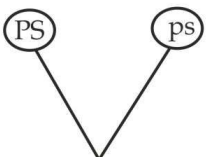
In turn, this limits the food supply of the predators and so their number will fall as well, allowing the prey to increase again and the cyclic changes continues as shown in Figure above. **(02 marks)**

**DR G MBASHI EDUCATION**  
**WORKED EXAMPLE 4**  
**BIOLOGY 2 - MARKING SCHEME**

1. a. Purple colour and short stem are dominant characters. (0½ mark)  
**Reason:** From the cross all F<sub>1</sub> phenotypes were purple colour and short stem, this means purple and short masked the expression of red colour and long stem respectively in F<sub>1</sub> generation. (0½mark)

**b. Formation of F<sub>1</sub>**

Let; P – represent purple flower (dominant) (0½ mark)  
 p – represent red flower (recessive) (0½ mark)  
 S – represent short stem (dominant) (0½ mark)  
 s – represent long stem (recessive) (0½ mark)

Parental phenotype	Purple short	x	Red long	01 mark
Genotype	PPSS	X	ppss	01 mark
Gametes	PS		ps	01 mark
Fertilization				01 mark
F <sub>1</sub> genotypes	All PpSs			01 mark
F <sub>1</sub> phenotypes	All purple flowered and short stemmed plants			01 mark

**Formation of F<sub>2</sub> (F<sub>1</sub> x F<sub>1</sub>)**

F <sub>1</sub> phenotype	Purple short	x	Purple short	01 mark
Genotype	PpSs	X	PpSs	01 mark
Gametes	PS Ps pS ps		PS pS pS ps	01 mark

**Fertilization by punnet square: F<sub>2</sub> genotypes**

Gametes	PS	Ps	pS	ps
PS	PPSS	PPSs	PpSS	PpSs
Ps	PPSs	PPss	PpSs	Ppss
pS	PpSS	PpSs	ppSS	ppSs
ps	PpSs	Ppss	ppSs	ppss

(06 marks)

<b>F<sub>2</sub> phenotypes:</b> Purple - short - 9	<i>0½ mark</i>
Purple - long - 3	<i>0½ mark</i>
Red - short - 3	<i>0½ mark</i>
Red - long - 1	<i>0½ mark</i>

2. a. If blood becomes acidic, the collecting duct removes hydrogen ions by active transport and add them to the urine. Hydrogen carbonate ions are returned to the blood by the kidney tubules to neutralize excess hydrogen ions in the blood. *(02 marks)*

If the blood pH becomes too acidic, the kidney secrete ammonium ions (NH<sub>4</sub><sup>+</sup>) to reduce hydrogen ions in the blood by forming the ammonium salts. If the pH of blood rises, the reverse process takes place. *(02 marks)*

- b. **Acute renal failure** is a suddenly damage of the kidneys.

Causes of the acute renal failure:

- Decreased blood supply to the kidneys, possibly as a result of loss of blood through an accident, heart failure.
- Severe bacterial infection to the kidneys or severe nephritis.
- Physical damage due to accident or toxic chemicals.
- Obstruction of the ureters, bladder or urethra by kidney stones.

*4 points @01 mark - total 04 marks*

Symptoms of acute renal failure

- Little or no urine produced.
- Generalized body swelling or oedema.
- Accumulation of nitrogenous wastes in the blood.
- Salt imbalance.

*4 points @ 01 mark - total 04 marks*

**Chronic renal failure** is a progressively and permanent damage of the kidneys.

Causes of the chronic renal failure:

- Bacterial infections of the pelvis and surrounding tissues.
- Damage of the kidneys due to high blood pressure.
- Damage of the kidneys due to sugar diabetes.
- Reduced blood supply to kidneys due to atherosclerosis.

*4 points @01 mark - total 04 marks*

Symptoms of chronic renal failure:

- Reduced quantity of urine.
- Production of diluted urine.
- Salt and pH imbalance.
- Severe high blood pressure.

*4 points @01 mark - total 04 marks*

3. a. **Effects of light to the activities of living organisms**
- i. **Photosynthesis** – In green plants light provides energy for the manufacturing of food.
  - ii. **Transpiration** – evaporation of water and opening of stomatal is caused by light.
  - iii. **Vision** – in most animals, light stimulates photoreceptors for seeing of objects.
  - iv. **Synthesis of vitamins** – light stimulates the manufacturing of vitamin D on the skin.
  - v. **Movement** - light enables organisms to move from one area to another or to extend their organs like photonasty.
  - vi. **Photoperiodism** – light is important to synching behaviours among organisms in different seasons like reproduction.

*Any 5 points @01 mark – total 05 marks*

- b. **Advantages of stratified random sampling**
- i. It ensures that each group is represented in the sample.
  - ii. It is a flexible method and can be used to many areas and populations.
  - iii. Correlations and comparison can be made between sub groups.
  - iv. It can be used with random or systematic sampling and other methods of population study

*Any 3 points @02 marks – total 06 marks*

**Disadvantages of stratified random sampling**

- i. It is tiresome and time consuming.
- ii. It requires large samples than other methods.
- iii. It requires more skills and technique than other methods.
- iv. Some individual's in sub groups have no chance of being selected in samples.

*Any 2 points @ 02 marks – total 04 marks*

4. a. **Adaptation of organisms** is the process by which organisms adjust to changes in the environmental for better survival. *(02 marks)*

- b. i. **According to Darwin theory of organic evolution**  
The theory of natural selection would suggest that both forms of variations of elephants with short trunks and long trunks co – existed in the environment. *(01 mark)*  
Gradually environmental conditions changed, food became scarce and all grasses converted into desert and leaving behind few tall trees. *(01 mark)*

For survival elephants had to feed on the leaves of tall trees (Struggle for existence). *(01 mark)*

Only elephants with long trunks could obtain food from tall tree branches using the trunk. Elephants with short trunks experienced starvation, some died and others could not pass their genes to the next generations so they disappeared but elephants with long trunks were advantaged to breed and pass on their genes to the next generations until today. *(01 mark)*

For this case nature favoured elephants with good adaptive long trunks and selected against elephants with poor adaptive short trunks. *(1 mark)*

ii. **According to Lamarckism theory of organic evolution**

The principal of use and disuse would suggest that originally all elephants in the environment had short trunks and could obtain food from the grasses. *(01 mark)*

Gradually environmental conditions changed, food became scarce and all grasses converted into desert and leaving behind few tall trees. *(01 mark)*

For survival, the elephants started stretching their short trunks to reach and obtain food from tall trees constantly. *(01 marks)*

Due to continuously stretching, the elephants developed long trunks and passes this adaptive variation from one generation to the next until today. *(01 mark)*

The elephants which could not stretch their trunks to obtain food on tall trees disappeared and could not pass their genes to next generations due to starvation. *(01 mark)*

c. i. **Incompleteness of fossil record**

- Only hard part of organisms can form fossils.
- Most dead organisms decay or may be eaten by other organisms before they form fossils.
- Only a small fraction of fossils has been discovered.
- Fossils are also destroyed by the natural factors like floods, earthquakes and weathering.
- Most organisms die in poor conditions and cannot form fossils.

*5 points @01 mark – 05 marks*

ii. **Prevalence of sickle cell anaemia**

Individuals with the allele for sickle cell in heterozygous state have a great advantage of not suffering from malaria, because

in the sub – Saharan regions there is high infection of malaria parasites due to large population of mosquitoes in these regions. Plasmodium parasites fail to breed sufficiently in blood of individuals with sickle cell anaemia. Therefore the allele for sickle cell is good adaptive variation and passed from generation to generation. (03 marks)

5. a. i. DNA replication – **synthesis** (01½ marks)  
Mitochondria replication – **growth phase II** (01½ marks)  
ii. Anaphase (01½ marks)  
iii. Cytokinesis (01½ marks)
- b. All daughter cells have the same number and type of chromosomes like the parental cell. Therefore all cells in mitosis have the same in genetic composition so they have similar characteristics. (04 marks)
- c. **Primary growth** is type of growth which leads to the formation of the primary plant body. Primary growth involves additions of primary phloem and primary xylem, and results in an increase in the length of the shoot or root. (01 mark)

### Mechanism of primary growth

The mechanism of the primary growth is divided into four phases – *cell division, cell differentiation, cell elongation and formation of permanent tissues.* (01 mark)

### Cell division

This is the first phase of primary growth whereby the Meristematic cells undergo repeated mitotic division to produce many daughter cells. (02 marks)

### Cell elongation

Daughter cells have many small vacuoles which fuse together to form large vacuoles as shown in Figure 4. 20. The result of this vacuolar fusion is the development of turgor pressure in the cell. This pressure forces the cell to elongate, because its cell wall is still thin and extensible. As the process of vacuole fusion continues, the plant organs continue to expand and elongate. (02 marks)

### Cell differentiation

The elongated daughter cells undergo cell maturation to form specialized tissues, namely; procambium, ground meristem and



protoderm. The first tissues to start differentiate is **procambium** which form the primary xylem, primary phloem and cambium. **Ground meristem** differentiate into ground tissues such as cortex, pericycle, pith and medulla collectively known as parenchyma. In the course of development, **protoderm** differentiate into outer protective layer of the plant called epidermis. (02 marks)

#### Formation of permanent tissues

Finally the cell wall become secondarily thickened by the deposition of  $\text{Ca}^{2+}$  and  $\text{mg}^{2+}$  which lignifies the cell walls into permanent tissues. The whole process of development of the primary plant body requires energy, which is supplied by the mitochondria. (02 marks)

#### 6. a. Reproduction processes of kingdom monera

Among the bacteria there are two forms of reproduction; which are asexual reproduction by binary fission and sexual reproduction by conjugation. (02 marks)

**Binary fission** - It involves the replication of DNA and organelles which may lead to increase in size of bacterium. The bacterium then splits equally to form two identical daughter cells. Each daughter cell develops into mature bacterium. (04 marks)

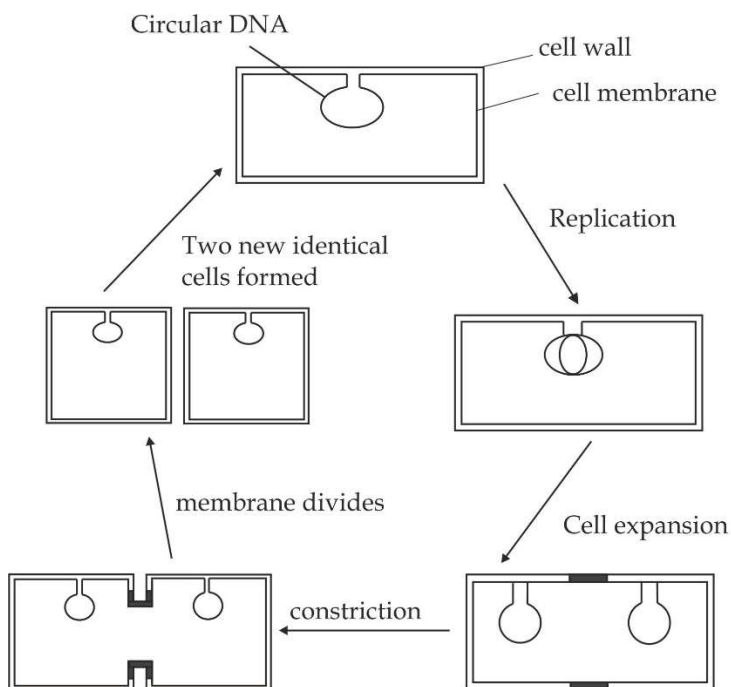


Diagram of binary fission

(03 marks)

**Conjugation** – this involves transfer of genetic material from one bacterial cell to another. The donor cell is called male while the recipient cell is called female. Plasmid in the male cell controls the release of DNA through a pilus into another bacterial female cell.

(04 marks)

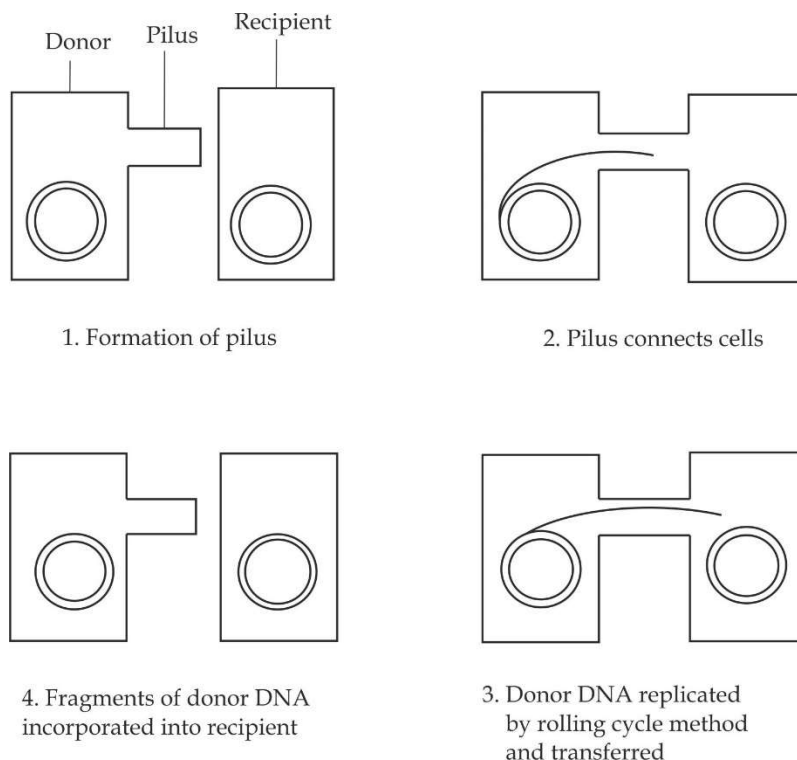


Diagram of conjugation in bacteria (02 marks)

b. **Similarities of life cycle of moss and fern**

- i. Both formation of spores occur in capsule.
- ii. Both formation of spores is by meiosis.
- iii. Both involve asexual and sexual reproduction.
- iv. Both fertilization takes place in water.

*Any 3 points @ 01 mark – total 03 marks*

**Differences between life cycle of moss and fern**

Gametophyte is dominant	Sporophyte is dominant
Depends more in water	Depends less in water
Male gamete have flagella	Male gamete have cilia
Sporophyte is dependent	Sporophyte is independent

*Any 2 points @ 01 – total 02 marks*

**WORKED EXAMPLE 5**  
**BIOLOGY 2 - MARKING SCHEME**

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1. a. i. The organism in question is mushroom. (01 mark)
- ii. **Other four detrimental effects of kingdom fungi:**
- Some species of fungi such as candida albican causes illness to humans.
  - Some species of fungi such as moulds cause decay to food.
  - Some species of fungi such as penicillium causes allergic reaction to human.
  - Some species of fungi such as saprophytic fungi deteriorate organic materials, for example leather, natural fabrics and damp timber.

*4 points @ 01½ marks - total 06 marks*

- b. **Behavioural mechanism of viruses that make it hard to cure:**
- i. Viruses are proteins, thus they are essentially mimic a living system inside host body. As the result, the body immune system gets activated quite late and hence can't prevent viral infection.
  - ii. Viruses tend to modify our body immune system by producing inhibitory proteins which interact and stop the immune system.
  - iii. Viruses are highly mutant, as the result there is no drug that can effective target the viruses.
  - iv. Viruses tend to insert their genomes into the human genomes, thus it is impossible to eradicate these viruses.

*4 points @ 01 mark - total 04 marks*

- c. The class of locust is a class insecta (01 mark)
- The features of class insecta are:
- i. Their bodies are divided into three main regions, namely the head, thorax and abdomen.
  - ii. They have three pairs of walking legs on the thorax.
  - iii. They have a pair of compound eyes.
  - iv. They have one or two pairs of wings on the thorax.
  - v. They have tracheal system for maximum gaseous exchange.
  - vi. They undergo metamorphosis during their development.
  - vii. Their bodies are covered by exoskeleton.

*Any 6 points @ 0½ mark - total 03 marks*

Insects are successful on their life due to the following reasons

- i. Insects have exoskeleton which prevents excess water loss.
- ii. Insects have jointed appendages for locomotion and feeding.

- iii. Insects have wings for flight away from predators.
- iv. Insects have antennae to detect external stimuli.
- v. Insects have small in size to hide from predators and feed a little food.
- vi. Insects have short lifecycle make them to adapt very fast to the environment.
- vii. Insects have metamorphosis which allow one organism to use different habitats.

*Any 5 points @01 mark - total 05 marks*

2. a. The control mechanism is called osmoregulation. *(0½ marks)*  
Hypothalamus is responsible for controlling osmotic pressure of the Blood by producing *antidiuretic hormone (ADH)* which passes to the short distance to the posterior pituitary gland. *(0½ mark)*  
When the osmotic pressure of the blood is increased, osmoreceptors in the hypothalamus detect a fall in blood solute potential which set up a nerve impulse to stimulate the posterior pituitary gland which release ADH. *(02 mark)*  
ADH travels into the blood stream to the kidney whereby it increases the permeability of the distal convoluted tubule and collecting duct to water. Water then is reabsorbed and taken into the blood whereby blood becomes diluted and return into normal osmotic potential. *(02 marks)*  
When the osmotic pressure of the blood is decreased, the cells of the osmoreceptors in the hypothalamus do not detect the osmotic change in pressure. *(02 marks)*  
ADH releases is inhibited; the distal convoluted tubule and collecting duct becomes impermeable to water, less water is reabsorbed into the blood whereby blood then becomes more concentrated and return to normal osmotic pressure, urine becomes more diluted. *(02 marks)*
- b. **Endotherms** are animals that use internal heat to maintain a stable internal body temperature, often one different from environment. Such animals include mammals and birds. *(01 mark)*

Behavioural mechanism of controlling body temperature during hot are:

- i. Aestivation – is a state of animal dormancy in burrow, it takes place during hot season. Aestivation is usual characterized by inactivity and a lowered in metabolic rate that is entered in response to high temperature and arid condition.

- ii. Taking bath or spraying water on themselves during hot to cool the body temperature.
- iii. Drink cool water frequently to cool the body temperature.
- iv. Stay in shades to avoid overheating.
- v. Wearing light clothes to enhance heat loss.

*Any 2 points @01 mark – total 02 marks*

Physiological mechanism controlling body temperature during hot are:

- i. Vasodilatation – this is relaxing of blood vessels near the skin to enhance heat loss.
- ii. Sweating – this is the loss of water from the body as water vapour through the skin pores during hot in which heat is lost as latent heat of vaporization.
- iii. Relaxing of hair erector muscles causes fur to lie flat which trap little air to insulate heat loss, as the result more heat is lost.
- iv. Panting – this is the evaporation of water from the body during hot by hanging the tongue outside as done by dogs.

*Any 3 points @ 03 mark – total 02 marks*

Behavioural mechanism that controlling body temperature during cold:

- i. Hibernation – is a state of animal dormancy in burrow, takes that place during cold season.
- ii. Wearing heavy clothes like coats to avoid heat loss.
- iii. Warm the body with oven or open fires.
- iv. Exercising to generate body heat.

*Any 2 points @ 01 mark – total 02 marks*

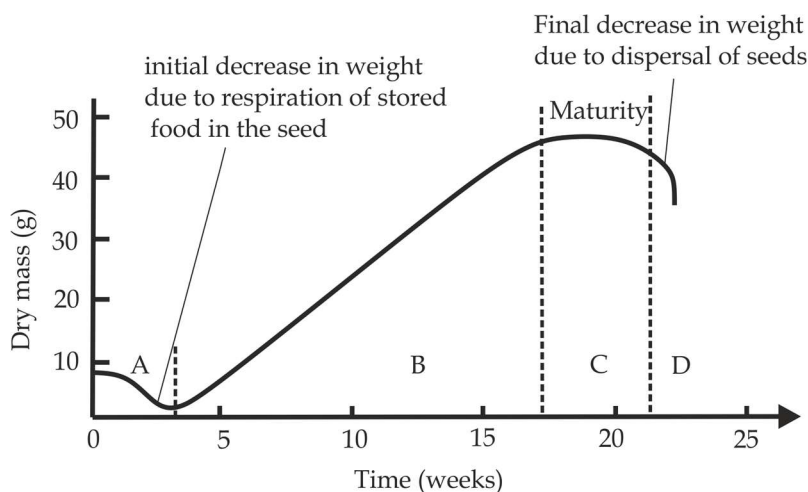
Physiological mechanism controlling body temperature during cold are:

- i. Vasoconstriction– this is contracting of blood vessels away from the skin to prevent heat loss by conduction.
- ii. Shivering – is the automatic and involuntary contraction of the skeletal muscle to generate heat in the body during cold.
- iii. Contraction of hair erector muscles that cause hair to stand up which trap more air that insulate heat loss from the body.
- iv. Counter current heat exchanger – this is circulatory adaptations that allow more heat to be transferred from the blood vessels containing warmer blood to those containing cooler blood.

*Any 3 points @ 01 mark – total 03 marks*

3. a. **Annual plant growth curve**

It is a growth curve in annual plant in which dry mass is plotted against time, as a result an S - shaped curve commonly known as the sigmoid curve is obtained as shown in figure below. (02 mark)



(03 marks)

**Interpretation of sigmoid annual growth curve**

At A: The dry mass of seed decreases at germination because the food stored in cotyledons and endosperm is oxidized to produce energy during respiration that is needed by a developing embryo.

At B: The dry mass of seedling increases after germination, as the first foliage leaves are formed, the photosynthesis takes place which accumulate the food in the plant.

At C: The dry mass of plant remains constant since the rate of anabolism (photosynthesis) and catabolism (respiration) are almost the same for a certain period.

At D: The dry mass of the plant declines or senescence during which catabolism exceeds anabolism. At this point, the decreases in dry mass contributes into the dispersal of seeds and fruits.

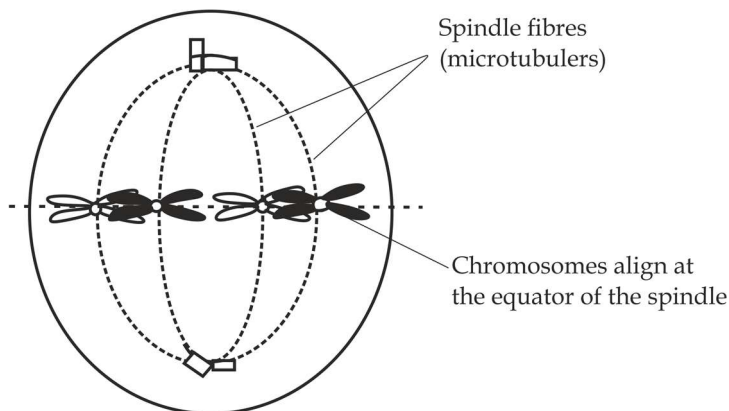
**4 points @ 02 marks – 08 marks**

b. **Metaphase** is a second stage of mitosis which is characterized by the following events as shown in diagram below.

i. The nucleolus and nuclear membrane disappear completely.

- ii. The chromosomes align at the equator of the spindle fibres.
- iii. The spindle fibres attach chromosomes at the centromere.

**3 points @ 02 marks – total 06 marks**



**(Diagram - 03 marks)**

4. a. The two types of genetic materials are RNA and DNA. **(01 mark)**

**b. Differences between RNA and DNA**

DNA	RNA
It is a single helix polynucleotide	It is a double helix.
It is found in the nucleus	It is found in the cytoplasm
Pentose sugar is deoxyribose	Pentose sugar is ribose
It contains thymine as pyrimidine	It contains uracil as pyrimidine
It can undergoes <i>self-replication</i>	It can't undergo <i>self-replication</i>
It has larger molecular weight	It has lower molecular weight
It is more stable	It is less stable

**Any 4 points@0½ mark – total 02 marks**

**c. The mechanism of DNA replication**

The mechanism of DNA replication is divided into three (3) phases; namely; unwinding of the DNA, replication of the parental strands and sealing the gaps.

**Unwinding of double stranded DNA molecule**

- i. DNA replication starts with the unwinding or unzipping of the two intertwined antiparallel strands of DNA by the **helicase**

**enzyme.** This enzymes untwists the helices at locations known as replication origin by breaking down the weak hydrogen bonds between the complementary strands base pairs of DNA molecule resulting into the formation of Y – shaped structure called a **replication fork**. (01 mark)

- ii. Each of the separated strands acts as a template to which sets of the nucleotides would attach by base pairing for making the new strands of DNA. (01 mark)
- iii. A single strand binding protein (SSB) stabilises each of the unwound parental DNA strands. This prevents the winding up or zipping up of the two strands before the replication of new strands is complete. (01 mark)

### Replication of the parental strands

As a result of their different orientations or anti – parallelism, the one of the strands is oriented in the 3' to 5' direction towards the replication fork. The 3' to 5' is the **leading strand** whereas the other strand oriented in the 5' to 3' direction away from the replication fork is called the **lagging strand**. The enzyme DNA polymerase III can work only in a 5' end to 3' end direction. (01 mark)

#### i. Replication of the leading strand

- A short piece of RNA known as a primer that is produced by an RNA polymerase enzyme called Primase, comes along and bind to the end of the leading strand. This is necessary because the enzyme DNA polymerase III cannot initiate the synthesis of new DNA strands without a primer. The primer acts as a starting point for a new strand synthesis. (01 mark)
- The enzyme DNA polymerase III then binds to the leading strand and moves along it while adding free nucleotides by complementary base pairing. (01 mark)
- Adding of nucleotide is done to the new strand of DNA in the 5' - 3' direction without interruption manner along the entire length of the leading strand, hence, it is called a continuous replication. (01 mark)

#### ii. Replication of the lagging strand

- On the lagging strand, DNA synthesis is interrupted because the DNA polymerase must as well move in the 5' - 3' direction. (01 mark)



- The relatively short lengths of replicated DNA are formed by this process, known as *Okazaki fragment* of the lagging, hence, it is called a discontinuous replication.

(01 mark)

### Sealing the gaps

- Once all the bases are matched up, an enzyme called RNA polymerase I, strips away the primers and fill the gaps which occupied by the primers by complimentary nucleotides.
- The DNA polymerase III and I proofread the newly synthesized strand to make sure there are no mistakes in the new DNA sequence. (01 mark)
- At the end of the DNA replication process, the enzyme called DNA ligase joins or stretches the sugar - phosphate backbones of the Okazaki fragments to create a continuous strand of DNA. It also seals up the sequence of DNA into two continuous double strands by catalysing the construction of hydrogen bonds between the bases pairs of DNA strands. Each of the constructed DNA molecule has one old strand and one new strand. This sort of DNA replication is called a semi - conservative replication. (01 mark)