PRESIDENT'S OFFICE
REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT
REGIONS JOINT FORM SIX MOCK EXAMINATION, 2024
BIOLOGY 2 MARKING SCHEME

1. i. Entamoeba exhibit a parasitic mode of life. Parasitic amoeba have the following adaptations to their mode of life.
   a) They can form cysts which resist digestive agents in the stomach.
   b) They lack contractile vacuoles, since they live in isotonic state with the host's gut fluid.
   c) They live where there is a plenty of food supply from their host.
   d) They are physiologically tolerant to low oxygen concentration, since they live in areas with low oxygen supply in the large intestine.
   e) They have rapid binary fission and production of a large number of cysts to ensure their existence and perpetuation in alternative hosts.
   f) They can feed on various foods, ranging from bacteria to blood cells, and digest them with their enzymes**.** ***04 points= 04 marks @ 01 mark***

   ii. As non-living organisms, viruses have the following characteristics;
   a) They do not replicate on their own and lack cellular structures hence unable to carry out any life processes when outside the host cell.
   b) They do not have any enzyme system such as respiratory enzyme, hence they lack energy releasing processes.
   c) While outside the host cell, viruses are inert, but retain their ability to replicate, if they invade a host cell. Viruses are therefore crystalline in the absence of a host cell. When they exist as individual particles outside the host cell, they are called virions.
   d) They are filterable; therefore, they can pass through a bacterial proof filter paper.
   e) They are resistant to very high temperatures due to lack of enzymes. Normally, at high temperatures, enzymes are denatured and thus render them useless.

   04 points= 04 marks @ 01 mark

   b) Euglena is an ancestor of plants and animals because, they possess both plant and animal characteristics.
   - Plant characteristics include; presence of chloroplasts containing chlorophyll, pyrenoids, and utilization of nitrites or ammonia as sources of nitrogen.
   - Animal characteristics include; possession of myonemes (muscle- like strands), and flagella for locomotion (euglenoid movement), utilization of amino acids, peptones or polypeptide as a source of nitrogen, presence of gullet with sphincter and reservoir for ingestion of food. ***06 points= 12 marks @ 02 marks***

2. a) The role of lateral meristem in secondary growth.

- The lateral meristems control the process of secondary growth in both roots and stems. These include the vascular and cork cambium in woody plants.
- Monocotyledonous plants such as grasses and herbaceous dicotyledonous plants which lack lateral meristems have no secondary growth.
- Lateral meristems are found parallel to the long axis of a root or shoot in the pericycle region at the junction between vascular tissue and cortex. They are positioned laterally as cylinders on the sides of the plant stem and root. They are responsible for the secondary growth of the plant which results into increased diameter or girth of the plant.

- The lateral meristems that produces secondary vascular tissues are of two types, namely: vascular cambium and cork cambium. The vascular cambium is found between xylem and phloem.
- The activity of the cells in the vascular cambium leads to the formation of secondary vascular tissues.
- The vascular cambium is anatomically made up of two types of cells, which are referred to as fusiform and ray initials. The ray initials differentiate to form parenchyma cells. The fusiform initials undergo mitosis to produce axial or longitudinal systems of the secondary phloem externally and secondary xylem internally.
- The second type of lateral meristem is a cork cambium.
- This later develops to give rise to phellem and phellodem which constitute a secondary cortex. Its main role is, therefore, to maintain a protective layer around the stem, which is actively increasing in diameter. ***Correct explanation= 05 marks***

b) The origin of lateral branches and lateral roots.

- There are two types of branching patterns in plants, namely: terminal and lateral branching.
- Terminal branching involves the separation of the apical meristems into two. Each of these two apical meristems continues to grow as a shoot branch. This mechanism is common in lower plants but rare in angiosperms.
- Lateral branching in angiosperms occurs mainly by the growth of axillary buds. When leaf primordial are initiated, a small group of cells in their axils remains small and non-vacuolated. These are referred to as detached meristems because they retain the meristematic characteristics but do not differentiate as the neighbouring cells do.
- However, they become spatially separated from the apical meristems. As the shoot grows and the detached meristems attain a distance from the apex, they are differentiated into shoot meristems that are also associated with several leaf primordial or buds. At this point, they do not grow further because of apical dormancy triggered by the shoot apical meristems.
- The growth of the axillary meristems is inhibited by auxin hormone produced by the apical meristems. In some plants, the inhibition is temporary until the main shoot has grown beyond the inhibitory range of the apex. In un-branched plants, the inhibition is permanent unless the apical meristems are removed. When apical inhibition ceases, the lateral bud begins to grow as a branch shoot.
- Lateral roots are defined as branches of the taproot. Lateral roots are formed as a result of the activity of cells in the main roots. They are endogenous in nature, meaning that their origin is from a deeper layer. The newly formed lateral roots usually occur near the root apex where there is active cell division. These roots are initiated from the pericycle at the point near xylem poles.
- In monocotyledonous plants, lateral root initiation can be opposite either protoxylem or phloem. In most plant species cell division occurs in endodermis in such a way that pericycle and endodermis contribute to the lateral root tissue.
- On contrary, adventitious roots are formed primarily on stem tissues but they have various sites of origin ranging from endogenous to exogenous from superficial tissues such as epidermis.
- However, in most monocotyledonous plants, adventitious roots arise from the cell division in pericycle of the stem and hence they originate from primary thickening meristems.

Correct explanation on lateral branches= 05 marks

Correct explanation on lateral branches= 05 marks
Total marks=10 marks

c) The role of **vascular cambium**, these regions are capable of undergoing rapid cell division, resulting in an increase in size of the roots and stem. Mitosis in the buds leads to development of buds in either flowers, branches, stems or leaves**.** ***(02.5 marks)***

The role of **cork cambium**. is to give rise to phellem and phellodem which constitute a secondary cortex. Its main role is, therefore, to maintain a protective layer around the stem, which is actively increasing in diameter. ***(02.5 marks)***

3 a) i) Dusting pea or bean seed with fungicide before packing is done in order to prevent borne diseases which the seed may get during storage, also to kill soil-borne pathogens by fungicide treatment this ensures production of healthly crops. ***(01 mark)***

ii) Sealing small seeds in an inner packet is done to ensure that moisture is not trapped within the container. ***(01 mark)***

iii) Printing a sow by date on the packet is done in order to check the length of the period during which seeds remain stored also determines their viability. Most seeds lose their viability in a period of one year following their dispersal while some seeds may remain viable for a number of years. The loss of viability results into total dormancy and hence, the death of the seed.
(01 mark)

b) Cold stratification is another method of breaking seed dormancy. It involves mimicking the exact natural conditions for seed germination. Cold stratification involves placing the seeds close together in moist sand so as to break seed dormancy. ***(03 marks)***

c) i) The storage center is an endosperm and cotyledon (s) which plays an important role in supporting embryonic growth by supplying nutrients, protecting the embryo growth and controlling embryo growth by acting as a mechanical barrier during seed development and germination. In the process of germination, the developing seedling utilizes energy which comes from the oxidation of food stored in the cotyledons and endosperm. ***(03 marks)***

ii) Growth center for germination is an embryo, germination occurs when the seed absorb water through the micropyle, the cells of an embryo start dividing and increasing in size, the seed coat breaks open and the root sprout and grows downwards. Then the shoot or plumule start growing upwards which later produces stem and leaves. ***(03 marks)***

d)

- Allows for long term preservation to ensure seed viability in the case of natural disasters.
- Helps to preserve the quality of seeds and protects them from potential contaminants.
- Seeds are stored for easy transportation; seed suppliers are not always able to market all the seeds they produce during the following planting seasons
- Seeds are stored for extended periods to improve the percentage and rapidity of germination by providing enough time for a natural release from dormancy

(04 points, 08 marks @ 02 marks)

4. a) i) The pea plant used by Mendel had the following characteristics:

(a) The species of *Pisum sativum* had several varieties with distinct characteristics

(b) The garden pea plant produced pure breeding (production of the same characteristics generation after generation) due to the fact that they normally undergo self-pollination since its reproductive structures are completely enclosed by the petals.
(c) The plants used (pea plant) were easy to cultivate.
(d) In case of artificial cross-breeding between Pisum sativum varieties, the produced hybrids were completely fertile. **(any 3; 01 mark@ = 03 marks)**

ii) Mendel succeeded in many of his experiments while others had failed. The secret behind his success was based on the following:
(a) He carried out several preliminary investigations to familiarise himself with experimental organisms.
(b) He carried out his experiments very carefully so that attention was focused on one variable at a time. This helped him to make clear observations.
(c) He was very careful when carrying out the techniques and this helped him to avoid the introduction of contaminating variables.
(d) He accurately recorded all experiments and the results obtained.
(e) He gave himself enough time to collect sufficient data that were statistically significant.
(01 mark@ = 05 marks)

b) This is a collaborative genes interaction that occurs when two genes influencing one characteristic interact to produce a new phenotype that could not be produced by either of the two genes alone. It is illustrated in the control of a comb form in chicken. **(01 Marks)**

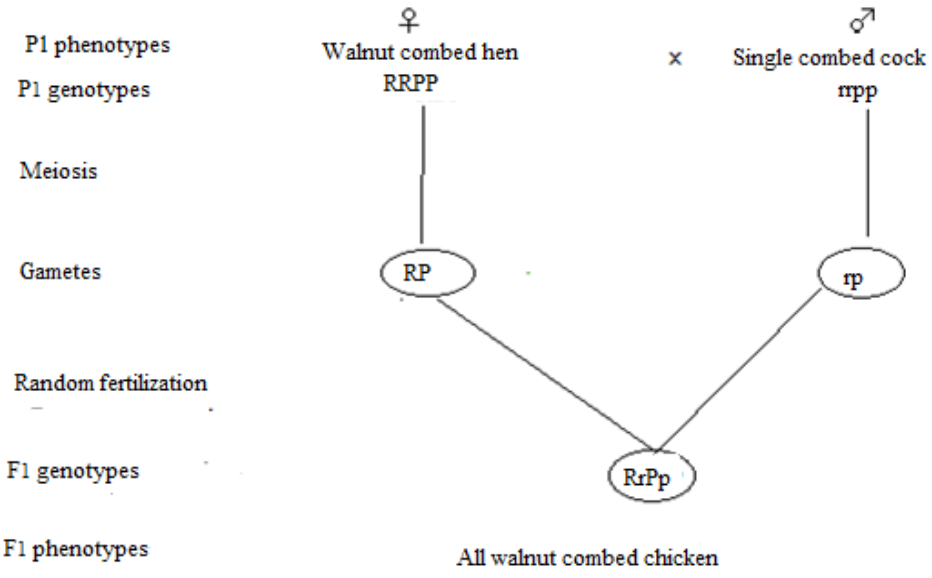
In this case, one gene **R** produces a rose comb whereas its recessive allele **r** produces a single comb. Another gene **P** produces a pea comb and its recessive allele **p** produces a single comb. When **P** and **R** interact, they collaborate to produce a walnut comb, which neither of the two genes could produce alone. **(02 Marks)**



Rose comb *Pea comb* *Walnut comb* *Single comb*

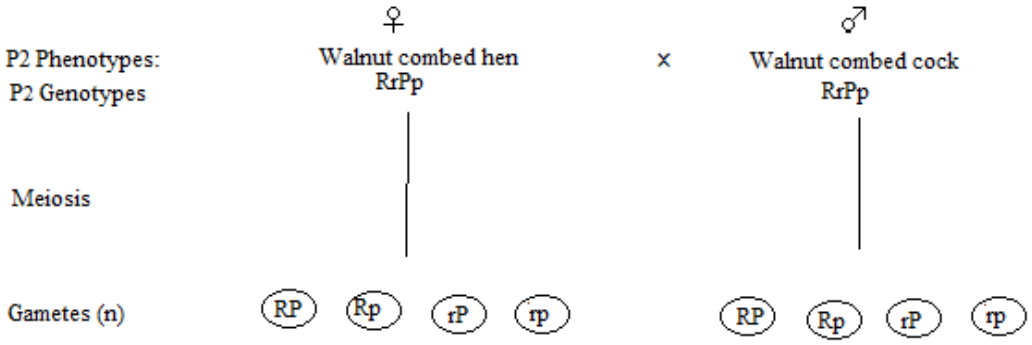
Let
RP – A collaborative gene for walnut comb gene and is dorminant over single comb.
rp - Single comb gene and is a recessive gene.
Then
Walnut combed hen – RRPP
Single combed cock – rrpp **(01 mark)**

A cross between a pure walnut combed hen and a single combed cock gives the following results in F_1 generation:



(02 marks)

If the F_1 progenies are selfed, the products in F_2 generation will appear as shown below:-



(02 marks)

Crossing these gametes in a punnet square; the following is obtained

		♂ Gametes			
		RP	Rp	rP	rp
♀ Gametes	RP	RRPP	RRPp	RrPP	RrPp
	Rp	RRPp	RRpp	RrPp	Rrpp
	rP	RrPP	RrPp	rrPP	rrPp
	rp	RrPp	Rrpp	rrPp	rrpp

(02 marks)

The phenotypic ratio of the F2 will be
9 Walnut combed chicken
3 Rose combed chicken
3 Pea combed chicken and
1 Single combed chicken **(02 marks)**

5. a) **Comparative biochemistry**, Evidence to support organic evolution has also been generated by comparing the chemical composition and physiological processes among groups of organisms. The occurrences of similar chemical molecules in a complete range of organisms.

(a) **Basic cellular components** are known to occur within groups of organisms in large numbers. For example, cytochrome C is identical in almost all aerobically respiring organisms, as it is for human and chimpanzee.

- The haemoglobin of humans, gorillas, and chimpanzees is almost the same and the chemistry of chlorophyll is the same in all chlorophyllous organisms.
- Furthermore, the chemistry of nucleic acids is the same and the genetic code is universal in all organisms.
- This similarity in cellular components suggests a common stem of organisms.
- Thus, since the similarities can be traced back to bacterial cells, then there is an evolutionary relationship between prokaryotes and eukaryote suggest the existence of biochemical homology.

(**b) Basic physiology** Various groups of organisms share similar physiological processes. For example, hormones in chordate have similar roles. Insulin hormone extracted from cattle and pigs is chemically and structurally similar to human insulin, therefore, it is used to treat diabetes. Another example involves the action of thyroxine hormone.

- If the thyroid gland is removed from a tadpole lava of a frog, the immature chordate will not metamorphose into an adult frog.
- However, if it is injected with thyroxine hormone extracted from human, cattle, goat and the like, metamorphosis is ensured and the lava grows into an adult animal. Another hormone of reference is prolactin. This stimulates synthesis and production of milk in mammals.
- However, the hormones, which are similar to prolactin, occur in various vertebrates where these hormones perform different functions.
- For example in bony fish, the hormone stimulates the secretion of skin mucus and increases urine production. In amphibians, it stimulates the secretion of egg jelly and increases skin permeability to water. Thus, similar physiology among chordates suggests a common ancestor

Palaeontology Studies of organisms that existed during the past life have generated substantial evidence to support organic evolution. Evidence that supports evolution has been generated by studying the fossil records of the previous organisms. This is done by specifically studying their structures and deduce their functions.

- Palaeontology is the study of the remains of past life called fossils. Palaeontology links biology with geology and is supported by archaeology which involves digging up of fossils down the rocks. When plants and animals die, their remains are either decomposed by bacteria or preserved as fossils.

- Fossils are therefore, defined as remains, traces, or imprints of life that have been preserved at sometime in the geological past. They prove that varieties of animals and plants existed in various geological ages of the earth. The process of fossils formation is known as fossilization. However, not all organisms that die become fossils. This is because most of them rapidly decompose after death.

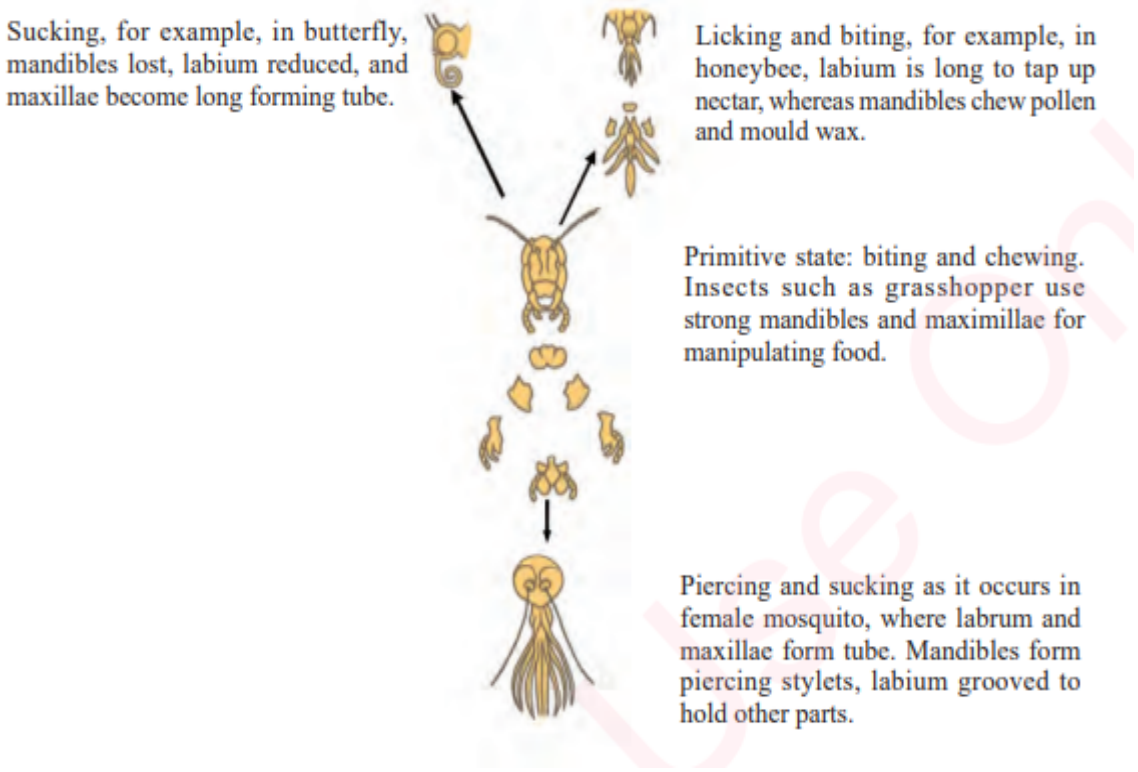
- The best place for fossilisation is the ocean because salt water checks the decay of organisms. In most cases, soft parts of the body are not preserved, hard parts such as bones, teeth, shells and woody parts of plants are preserved. Fossils are found mostly in

the sedimentary rocks, which are formed due to slow settling down of silt, mud or volcanic ash in rivers, lakes and sea.

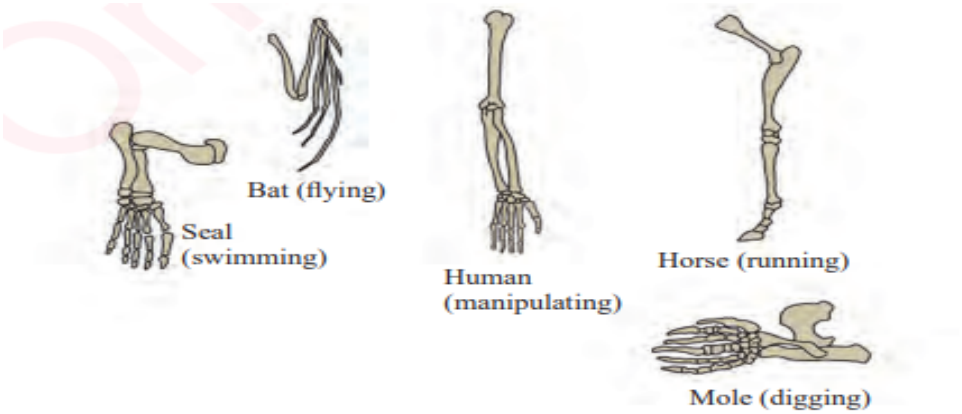
- The particles settle forming different layers. Each layer is called a stratum. The lowest stratum, which was deposited first, contains the fossils of the primitive forms of life, whereas the upper strata contain fossils of more complex and advanced plants and animals.

Comparative morphology and anatomy. Organic evolution is also evident in the similarities and differences in the basic structures of different organisms. Anatomy is the study of structure and form of organs in the body of living organisms. Comparative study of the anatomy of groups of animals and plants reveals a great similarity in certain structural features. This is explained based on the following aspects:

(a) Basic structures When the anatomy of various groups of organisms is compared, it can be found that certain basic structures are shared among the groups or within the groups of organisms. The basic structure of flowers, for example, is the same in all angiospermophytes. There is also a similarity across mouth parts of insects.



(b) Homologous structures and divergent evolution Homologous structures are body parts or organs of different species that share similar basic form or construction, but perform different roles as shown in Figure 5.8. Such structures are said to have the same origin. For example, limbs in all vertebrates are built on the same basic pattern called the pentadactyl pattern. However, due to the adaptive radiation, similar parts adapted to perform different roles. In this case, limbs have apparently evolved as different structures from the basic ones. Such organs can also be exemplified by flippers in whales for swimming, wings in birds for flying and fore limbs in monkeys for walking. Homologous structures suggest common ancestry, but they also suggest the existence of divergent evolution. The latter is defined as a relative phenomenon in which initial similar populations accumulate differences over evolutionary time and become increasingly distinct



(c) **Analogous structures and convergent evolution** Analogous structures are body parts or organs of different species, which have different construction and origin but perform similar roles. Examples of analogous structures include wings of insects and birds, eyes of vertebrate, squids and octopus, jointed legs of insects and those of vertebrates.

- Analogous structures only bear superficial similarities, and therefore, support convergent evolution. This may be explained in terms of the environment acting through the agency of natural selection, favoring these variations, which confer increased survival and reproductive potential on those organisms possessing them.
- Convergent evolution is thus a kind of evolution whereby organisms evolve structures that have similar functions but have unrelated evolutionary ancestry. In this process, unrelated or distantly related organisms evolve similar body forms, colourations, organs and adaptations.
- It describes the acquisition of the same biological trait in unrelated lineages Homologous structures and divergent evolution Homologous structures are body parts or organs of different species that share similar basic form or construction, but perform different roles. Such structures are said to have the same origin. For example, limbs in all vertebrates are built on the same basic pattern called the pentadactyl pattern. However, due to the adaptive radiation, similar parts adapted to perform different roles.
- These similarities in morphological and anatomical characteristics among organisms suggest a common ancestral origin. Their structural modification is due to environmental changes

(d) Vestigial structures These are homologous structures in some species with no apparent function. They are smaller and simpler in structure than the corresponding functional parts in the ancestral species.

- The existence of vestigial organs can be explained in terms of changes in the environment or modes of life of the species. Such organs were typically functional in the ancestral species but are now non-functional or have changed functions.
- Examples of vestigial organs include an appendix in humans, which is functional in the digestion of cellulose in herbivores. Others include halters (hind wings) of houseflies and leaves of some xerophytes such as Cactus plants. The existence of vestigial structures suggests a common ancestor from which they were inherited.

(e) Comparative embryology It is the comparison of embryo development across the species. This is the branch of embryology that compares and contrasts embryos of different species in vertebrates to show how animals are related. The greater the similarity of structure, the more closely related the species are and the more recent their common ancestor is.

- The development of an embryo from fertilisation until it becomes a foetus is called embryology. The development of embryos of vertebrates in the early stages is very similar.

They all possess the same features They have external brachial grooves (visceral clefts) in the pharyngeal region and a series of internal paired gill pouches. In fi shes, these pouches join to form gill slits for gaseous exchange. In other organisms, the perforation develops and become an eustachian tube and the auditory canal involved in hearing.

- In addition, both have segmental myotomes (muscle blocks) which are evident in the tail like structure retained in some vertebrates like rabbits. Furthermore, they develop a single circulatory system which includes a two chambered heart showing no separation of the right and left halves.
- This situation is only retained in fishes. These embryo similarities signify that vertebrates have a common ancestor ***(09 marks @03 marks)***

b) According to Lamarck, the environment creates the need that may lead to a changed pattern of behavior of an organism. This change can lead to either use or disuse of certain body parts or structures. The more the body part is used, the stronger and the more efficient it becomes and vice versa. That is, if the body part is less or not used, it gradually degenerates and disappears. The new traits acquired as a result of the constant use of the body parts become part of heredity and can be transmitted to the next generation. This concept of inheritance of acquired characters' states that, "Characteristics that individuals acquire during their lifetime as they adapt to their environment, become part of their genetic makeup and are thus handled down from one generation to another".

- For example, the environment plays an important role in producing a phenotypic change of human being as in case of body building exercises, which increase the size and strength of the body muscles. Despite these achievements, Lamarck's theory had various weaknesses. First, it is not true that the use or disuse of the body parts or structures can determine their existence or atrophy. Second, the acquired traits only affect the phenotype and therefore, are non- genetic. Since they have no influence on the genotype, they cannot be inherited from one generation to another.

(The Lamarck concept + human example = 06 marks)

c) Darwin proposed natural selection as a mechanism by which new species arise from the pre-existing species. The Darwin theory of natural selection is based on three observations and two deductions (conclusions) which are summarized as follows: -

Observation 1: Overproduction of the offspring or enormous fertility power

Darwin and Wallace observed that individuals within a population tend to reproduce more than the environment can support. On average, they reproduce more offspring than they are needed to replace them.

Observation 2: Constancy in the population size of each natural species Despite the high rate of reproduction among the members of the species, the number of individuals in each population tends to remain fairly constant.

Deduction 1: There is struggle for existence

Darwin and Wallace concluded that, over reproduction results in a severe competition among the newly produced organisms for the limited resources, such as food, shelter, space and mates. The competition can be either interspecific or intraspecific. The interspecific competition is a form of competition in which individuals of different species compete for the same resources while intraspecific is the one in which members of the same species compete for limited available resources. During the struggle, many organisms fail to either reproduce or die before reaching the reproductive age. This explains why the population size tends to remain approximately constant.

Observation 3: Variations exist within all populations as organisms struggle for existence, they try to become better adapted to their environment so that they successfully survive. For this reason, variations start to arise in the organisms.

Deduction 2: Natural selection or survival of the fittest In the course of struggle for existence, only those organism with favourable adaptive variations have a reproductive advantage and high survival chances. Those with unfavourable variations have limited chance in the struggle for existence, and therefore, they perish. Thus, Darwin concluded that, nature selects only those organisms which carry favourable traits. Organisms selected in this way are better adapted to their environment and can transmit their traits to their offspring. The key factor in determining survival is adaptation to the environment. Any physical, behavioural or physiological variations, giving one organism an advantage over another organism will act as a selective advantage in the struggle for existence. The advantaged organisms, therefore, survive the struggle whereas the disadvantaged ones perish away. Hebert Spencer called this concept "survival of the fittest".

The term "fit" means well adapted to the environment. As noted earlier, the favorable traits are inherited by the next generation, whereas unfavorable ones are selected out or "selected against" as their presence confer a "selective disadvantage" on that organism. In this way, natural selection leads to increased vigour within the species and ensures the survival of that species. This is because species gain adaptive features as they struggle to exist.

These adaptations are preserved and accumulated in the individuals of the species and ultimately lead to the origin of species.

As natural selection continues, the differences become more pronounced to mark off the successive generations as separate species. Thus, new species of organisms arise by natural selection over many generations during which the offspring become markedly distinct from their ancestors. Darwin's theory of natural selection can be used to explain the Lamarck's long necked giraffes. According to Darwin, both forms of giraffes existed, in other words, those with long and short necks as well as those with long and short limbs. When grasses were scarce on the land (selection pressure), giraffes had to eat the leaves of tall trees (struggle for existence).

Naturally, the giraffe with long necks and legs had a selective advantage over those with short necks and legs. They could get food more easily on higher branches of tall trees and had better chances of survival (survival of the fittest). Thus, the long-necked giraffe won in their struggle for existence, reproduced and became abundant. On the contrary, the short-necked giraffes failed in the struggle, starved and gradually became extinct.

Correct observation=03 marks@ 01 and correct deduction=02 marks@01 mark, total marks= 05 marks.

6. a) Energy flow in living organisms use energy in the form of radiant and fixed energy. The radiant energy is in the form of electromagnetic waves such as light. Fixed energy is the potential chemical energy, locked in various organic substances. Organisms that can utilize radiant energy and inorganic substances to produce organic molecules are called autotrophs.

On the contrary, organism that depend on energy-rich organic molecules synthesized by the autotrophs, are called heterotrophs. The primary source of energy in all ecosystems is the sun. Photosynthetic organisms (autotrophs) such as green plants are the only organisms capable of converting light energy into chemical energy during photosynthesis. This energy is then fixed in the bonds of synthesized organic matter from where it is made available to the consumers.

This energy is called Gross Primary Productivity (GPP), which is utilized for respiration and photorespiration. The energy which remains thereafter, is the Net Primary Productivity (NPP). This is stored in plant and made available to higher trophic level (herbivores and later carnivores) during feeding. However, not all energy and materials available in one trophic level are transferred to the next as food. Some energy is lost as heat in respiration, organic, and inorganic wastes during excretion and undigested materials.

These are consumed by detritivores. The primary consumers first feed on the primary producers and the energy flows from producers to the consumers. The energy then continues to fl ow through various consumer levels until it reaches the decomposers. This is a one-way and non-cyclic energy flow, as it never flows back to the sun which is the primary source of energy. The amount of solar energy intercepted by plants depends on how plants are organised and extent to which their vegetation covers. This energy in some places is estimated to be 1x10-6 kJ mol-1 per year. However, only 5 - 6 % is absorbed and (95 - 96%) is lost by plants and escape from plants via evaporation, reflection, and re-radiation. About 20 - 25% of stored energy is used by plants to produce organic molecules.

As the energy flows from one trophic level to the next, there is a decrease in its amount due to the fact that:

(a) Some of the energy is used to carry out physical and metabolic processes. These activities include movements, respiration and growth which may convert the stored energy into heat, and hence, lost into the atmosphere.

(b) Physiological processes such as digestion and assimilation are not 100% efficient. Thus, some of the energy remains interlocked in the molecules of the undigested food remains.

(c) Not all parts of the consumed organism are edible. For example, for the fruit plants, it is only a small portion of the energy, which is contained in the edible part of the fruit that will be passed to the consumers, in this case, frugivores. These are organisms, which feed on fruits.

The remaining amount of energy which is contained in the rest parts of the plant which are not edible will not flow to the frugivore. Similarly, if a carnivore eats a herbivore, the energy which is contained in parts such as horns, bones and hooves will remain fixed in these parts as they are mostly inedible. Thus, less energy is transformed at each feeding level, which explains why the number of feeding levels also called trophic levels is always limited to four or five. The organisms in the highest tropic level, such as, the decomposers, receive a very minimum amount of energy, which cannot make them support another feeding level.

(Correct explanation= 04 marks)

b) i. Interaction of components of ecosystem The abiotic component of the ecosystem determines the survival of a living organism through various interactions. In the natural ecosystem living organisms do not exist in isolation, but they interact with each other in various ways. One way in which the biotic components interact is through competition. This involves a 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 competition is when several cocks compete for the same hen for mating or plants such as maize grown very close to each other compete for light from the sun and nutrients from the soil. Competition can also occur between organisms of different species competing for the same limited resources. Herbivorous animals such as buffalo, zebra, and antelope compete for limited fodders.
- This type of competition involving two or more different species is called interspecific competition. The second way in which organisms interact is through predation. This is a

biological relationship in which the hunting animal or the predator eats another animal of a different species. The eaten animal is called a prey whereas the animal that eats the prey is called a predator. In an ecosystem with a predator-prey relationship, the two populations regulate each other and result in cyclic changes in the population size. As the predators increase in number, the population of prey decreases. The shrinkage of prey population results into a stiff competition among predators for the limited prey.

- This diminishes the population of predators as some of its individuals fail to obtain enough food for growth and reproduction. The decrease in a population of predators due to starvation and hence deaths allows the prey to reproduce and increase in number again. This increase leads to an increase in predators and the cyclic changes continues.

- The third way in which organisms interact is through grazing, which involves herbivores feeding on primary producers. The herbivores feed on vegetation such as grasses, shrubs, and trees. The larger the number of herbivores in an area, the greater the possibilities of decreased food supply which may result in starvation, death and ultimately decline in the population of herbivores. As the herbivores population declines grasses, shrubs, and trees increase and the food becomes available to herbivores.

- This enables them to reproduce and increase significantly in numbers again. The fluctuation in food occurs again and the cycle repeats. The fourth way in which biotic components interact is through symbiotic relationships. Symbiosis is the relationship 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.

  (i) Mutualism Refers to a symbiotic association of two organisms of different species living together in which each member benefits from the association. Mutualism is exemplified by a relationship between cellulose digesting bacteria that live in the alimentary canal of ruminants such as cattle. Usually, cellulose is a valuable food to ruminants but they cannot produce cellulose-digesting enzymes. When the bacteria feed on cellulose contained in the ruminant's diet, they help to convert it into a simple compound that the ruminants can digest, absorb and assimilate. The bacteria benefit cellulose, which is their major food and shelter. The ruminant on the other hand benefit from digested cellulose. The relationship between flowers and pollinators such as bees, butterflies, and birds is another example of the mutual association. The bees visit flowers in search of nectar, which is essentially used for food and for making honey. Birds and butterflies also feed on nectar. As these move inside the flower searching for nectar, pollen grains fall and stick on their bodies' fur, legs or feathers. These pollen grains are transferred from one flower to another as these insects and birds visit flowers of different plants in search for more food. This facilitates pollination in species with these flowers. Pollination is a very important process for an effective sexual reproduction in angiosperms. Fungi also have a mutual symbiotic association with green algae, which is called lichen. In this association, the fungi penetrate its hyphae deep to the algae body tissue. Algae, which is photoautotroph, photosynthesize food and pass some of it to the fungi body which is a heterotroph. The fungi, in turn provide algae with protection against desiccation. Lichens are commonly found growing on the rock surfaces and tree barks.

(ii) Commensalism This is the symbiotic relationship in which one species benefits the association, whereas, the other species is neither harmed nor does it benefit from the association. The species that benefits from the partnership is called commensal species and its counterpart is called a host.

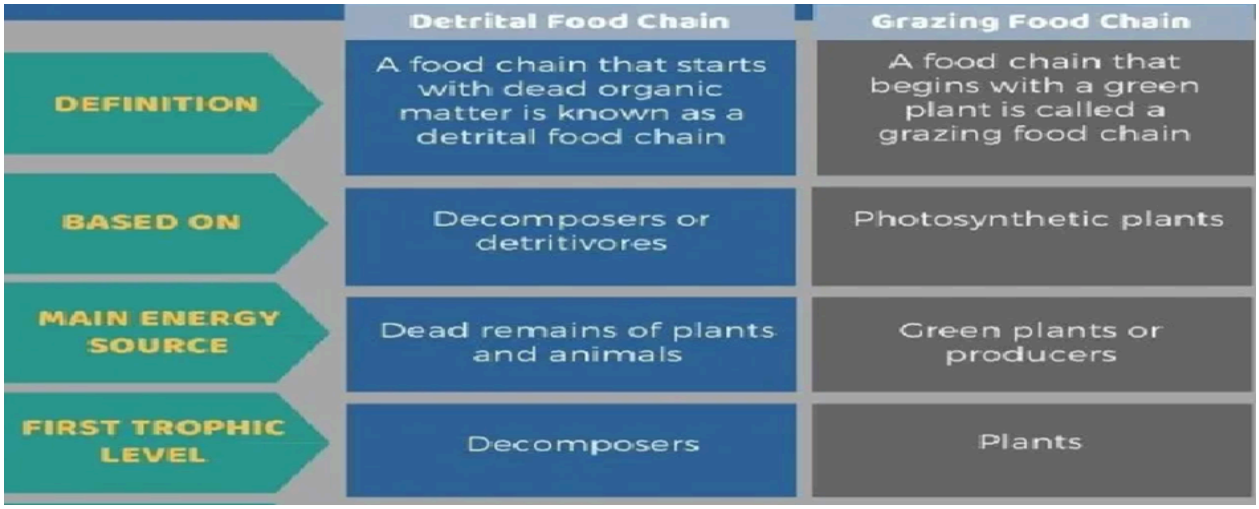
- For example, the barnacles live on the whale and are transported to various parts of the ocean for feeding. In this relationship, the whales are neither affected nor benefitted. Another example is seen in epiphytic orchids, mosses and ferns species. They grow on other plants where they get support and easy access to light. As they grow, they obtain water from the moist atmosphere, nutrients from debris and fissures on the barks of trees. In this association, the epiphytes obtain support, water, nutrients, and light as they grow on the host plant. The latter is not harmed and does not benefit from the relationship.

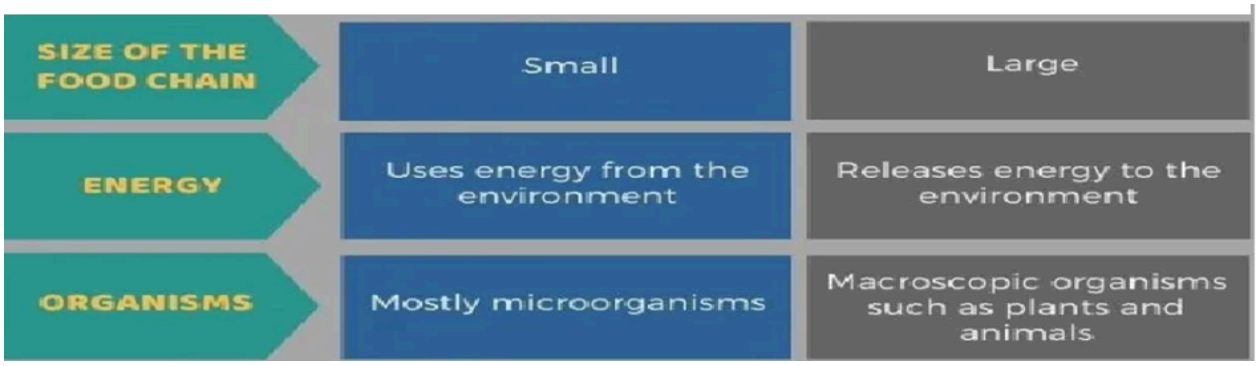
(iii) Parasitism It is another type of symbiotic relationship in which one organism called a parasite benefits and the other organism called a host is harmed. The parasite derives nutrients from its host and may also gain other benefits such as shelter in which it grows and reproduce. Some parasites live on the outer surface of the host and are called ectoparasites.

- These are exemplified by ticks and lice. In plants, ectoparasites include aphids, nematods, and larvae of butterflies. The endoparasites live inside their hosts' bodies where they obtain food and shelter. Endoparasites include Plasmodium (malaria parasites), worms such as ringworm and tapeworm. Some plant parasites such as *Cassytha filiformis* grow by strangling the plant externally but later they penetrate the host plant tissue using their haustoria to absorb water from xylem and nutrients from phloem Although the parasites solely rely on their hosts for food and shelter some parasites called facultative parasite do not spend their entire life inside the host. Fungi are an example of facultative parasites, which live on a living host body and when the host dies, the fungi can switch to saprophytic mode of nutrition and feed on the decaying host. The obligate parasites such as tapeworms on the contrary spend their entire life on host. In this case, death of the host may lead to death of the parasite**.**

(06 marks @ 02 marks)

ii. Food chain is the feeding relationship which can be observed in a linear sequence of organisms through the succession of organisms in a repeated process of eating and being eaten. The design of the food chain can vary in accordance with the ecosystems. Food chains are made up of the same basic trophic levels. The organisms that constitute the food chain are thus classified based on their feeding behavior. The classification of food chain depends on the type of organisms that constitute the first trophic level. On this basis two common types namely the grazing food chain and detritus food chain are recognized. The following are differences between grazing and detritus food chains:





(Any 4 differences, 04 marks@ 01 mark)

c) i. Ecological succession is a process involving several phases, which include:

i. Nudation:
- The process of succession begins with the formation of a bare area or nudation by several reasons, such as volcanic eruption, landslide, flooding, erosion, deposition, fire, disease, or other catastrophic agency.

ii. Migration
- The seeds, spores or other propagules of the species reach the bare area through the agency of air, water or animals. The process starting from the time a propagule leaves the parent plant to the time it arrives the bare area is called migration.

iii. Ecesis:
- Involves establishment and initial growth of vegetation. This is the successful establishment of migrated plant species into the new area. It includes germination of seeds or propagules, growth of seedlings and starting of reproduction by adult plants only a few immigrant propagules are capable of doing this under primitive hard conditions, and thus most of them disappear.

iv. Competition
- As vegetation becomes well established, grows, and spreads, various species begin to compete for space, light and nutrients action. During this phase, changes such as the buildup of humus affect the habitat, and one plant community replaces another.
- Competition results may result into stronger species replacing the weaker species

v. Reaction stage
   - The increase availability of food allows various kinds of animals to join the community and the resulting interactions further modify the environment and pave the way for fresh invasion by other species of plants and animals to move on the process of succession.

vi. Stabilization
   - Eventually a stage is reached when the final terminal community becomes more or less stabilized for a longer period of time and it can maintain itself in the equilibrium or steady state with the climate of that area. This is called **stable climax community**
   - Theoretically at least, this last stage is mature, self-maintaining, self-reproducing through development stages and relatively permanent. This terminal community is characterized be equilibrium between gross primary production and total respiration, between the energy captured from sunlight and energy released by decomposition, between the uptake of nutrients and the return of nutrients by litter fall.

(06 points, 03 marks@ 0.5 mark)

ii. Limitations of pyramids of number and biomass are overcame in the pyramid of energy due to the facts that:

- The pyramid of energy takes into consideration the rate of production, per unit area or volume unlike the pyramids of numbers and biomass which depend on standing states of organisms at a particular time.
- It allows comparison of different ecosystems, for example, aquatic and terrestrial ecosystem as well as comparison of relative importance of different populations within one ecosystem to be compared.
- The pyramid of energy is dynamic and therefore, it is likely to accommodate changes. For example, the input of solar energy can be added as an extra rectangle at the base of the pyramid. ***(03 marks; @01 mark)***