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O' Level Biology Seminar

Proposed answers to questions

At Makerere University

On Sunday 24th September, 2023

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TOPIC 1: Diversity of living things

QUESTION ONE

(a) Insects have three main body divisions

Insects have three pairs of legs

They have one pair of antenna

(b) Name the other types of arthropods apart from insects (03 marks)

Crustaceans

Arachnids.

Myriapods

- (c) Insects are the most abundant animals on this planet. Suggest reasons for this observation.
- ✓ Evolution of special organs for flight, the wings which enable them to diverse and colonize new areas
 - ✓ They have exoskeletons made of chitin which has protects them from drying up in the terrestrial environments
 - ✓ The small size has enabled them to occupy every place on the planet.
 - ✓ They excrete a toxic waste product as uric acid which has enabled them to conserve water
 - ✓ They have tracheal systems which have enabled them to carry efficient gaseous exchange.
 - ✓ Disposition of legs enables them to maintain swift locomotion.
 - ✓ They have high reproduction rates that ensure that a large number of offspring is produced.
 - ✓ Some have compound eyes that provide wide field of view while in their habitats
 - ✓ The various kinds of mouth parts in different insects adapted to different modes of feeding reduce completion for food
 - ✓ They carry out internal fertilization that increases chances of fertilizations which ensures efficient reproduction

QUESTION TWO

(a) (i) Identity; P- Legume

Q- Berry

R- Seed

- (ii) P is legume because it has two sutures (lines of weakness) on its pericarp
Q is berry because it has many seeds and the whole of it fleshy
R is a seed because it has only one scar

(b) Both R and a bean seed have only one scar

Both R and a bean seed have a seed coat

Both R and a bean seed have an endosperm

(c) P is dispersed by self-dispersal. The pericarp splits open along the sutures to release the seeds. This is made possible due to the tension that is built during the process of dying of the fruit

Q is dispersed by animals. It possess edible parts which are succulent / juicy and the only part of the fruit that is eaten by animals and the rest containing the seeds is thrown away which seeds can form new plants upon germination

(d)

- ✓ Marginal placentation; the ovules are situated at or near the margin of the ovary e.g in beans and peas
- ✓ Axile placentation; Ovules centrally located in the ovary with ovary divided into many chambers e.g. in Orange and tomato
- ✓ Parietal placentation; Placenta is found on the inner wall of the fruit and the ovules are attached on the inner wall e.g. in pawpaw
- ✓ Free central Ovules located on the projection from the base of a one chambered fruit e.g. in green paper
- ✓ Basal placentation; Ovule found on a placenta that arises from the base of the ovary, fruit usually single seeded e.g. mango

QUESTION THREE

- (a) (i) Z is the simplest
 (ii) V, W, Y and Z are invertebrates
 (iii) V is an obligatory parasite
 (iv) U and x are chordates
- (b) -Heterotrophic nutrition
 -Both lay eggs

- (c) Differences between W and Y

W	Y
Lack wings	Has wings
5 pairs of legs	Three pairs of legs
Two pairs of antennae	One pair of antennae

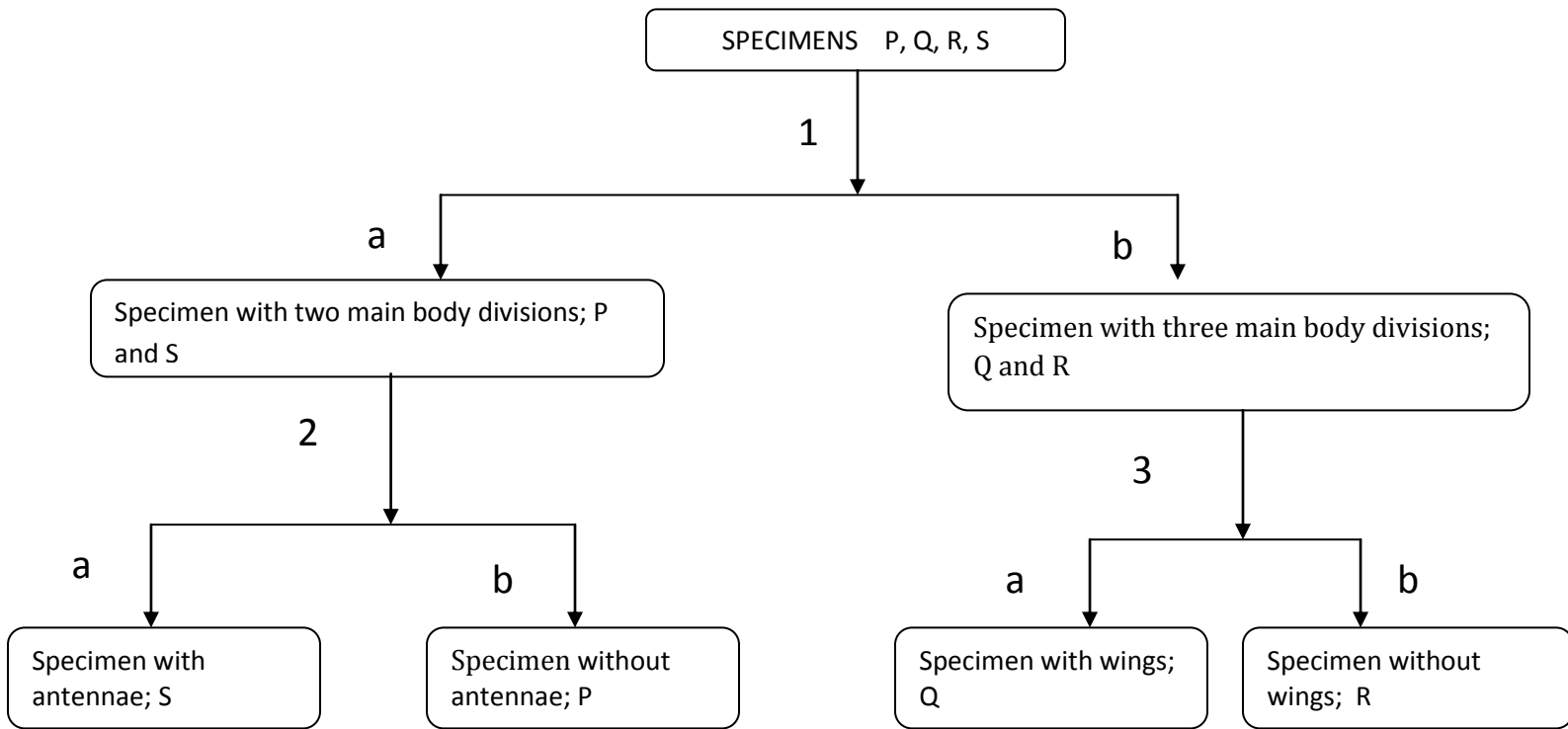
QUESTION FOUR

- (a)

SPECIMENS	NUMBER OF LEGS	NUMBER OF BODY DIVISIONS	NUMBER OF ANTENNAE	NUMBER OF WINGS
P	4 pairs	2	No antennae	No wings
Q	3 pairs	3	1 pair	1 pair
R	3 pairs	3	1 pair	No wings
S	5 pairs	2	2 pairs	No wings

- (b)

A FLOW CHART



(c)

- 1 Specimen with two main body divisions.....P and S, Go to 2
- 1 Specimen with three main divisions.....Q and R, go to 3
- 2 Specimen with antennae_____S
- 2 Specimen without antennae_____P
- 3 Specimen with wings_____Q
- 3 Specimen without wings_____R

TOPIC 2: Soil

QUESTION FIVE

(a)

- (i) Weathering is the gradual process by which soil is formed from parent rocks
- (ii) Nitrification refers to the conversion of ammonium salts via nitrites to nitrates by soil living microorganisms

(iii) Leaching is the washing down of soluble minerals from topsoil layers to bottom layers where they cannot be accessed by plants.

(iv) Soil conservation refers to the prevention of topmost layers of soil from erosion and prevention of reduced soil fertility as a means of keeping the soil fertile.

(b) (i). During weathering, the parent rock is broken down into small soil particles.

Once a parent rock has been broken down, the particles are eroded into a new place and these compile to form a layer of soil.

(ii).

(c) An experiment to determine the pH of a soil sample using universal indicator

QUESTION 6

(a)

Sample A: Sand soil, because it has the highest percentage of air.

Sample B: Clay soil, it has the least percentage of air

Sample C: Loam soil , it has a moderate percentage of air

(b)

(i)

Volume of air in the mixture = volume of air in soil sample A + volume of air in soil sample B + volume of air in soil sample C

Volume of air in the mixture = 20 + 16 + 13

Percentage volume of air in the mixture = 49

(ii)

- ✓ It provides oxygen for respiration of soil organisms and plant roots.
- ✓ Oxygen is also needed for the decay that produces humus.
- ✓ It also provides nitrogen for fixation by the nitrogen-fixing bacteria in the soil.
- ✓ The nitrogen absorbed is needed in the formation of nitrates and proteins.
- ✓ Carbon dioxide present in the air helps in increasing soil acidity which favours proper growth of some plants.
- ✓ Carbon dioxide present in the air dissolves in water to form carbonic acid for weathering.

(d)

- ✓ Experiment to determine the percentage of air in the soil

Apparatus

Measuring cylinders (2)

- ✓ Dry soil sample
- ✓ Water
- ✓ Glass rod

Procedure

A known volume of dry soil is measured using a measuring cylinder

A known volume of water is measured into another measuring cylinder.

The water in the measuring cylinder is mixed with the soil and the mixture is stirred.

The mixture is allowed to stand until no more bubbles appear.

The final volume of the mixture is read and recorded.

The percentage of air in the soil sample is calculated from;

$$\text{Percentage of air} = \frac{\text{volume of air}}{\text{volume of soil}} \times 100\%$$

(e)

This is because the roots of such plants when introduced in excess water conditions cannot absorb required oxygen. It causes the death and decay of plant due to the excess in flow of water into cells.

QUESTION 7

(a)

Earth worms are common in moist soils rich in humus. They tunnel into the soil by force, thus improving the soil aeration and drainage, nutrient availability and improves soil structure and hence soil fertility.

(b)

Clay soil reduces soil fertility when added to soil. This is because clay soil reduces water infiltration and air penetration into the soil.

(c)

- ✓ Deforestation; this involves cutting down of trees leaving the soil exposed to wind and water making it easy for top layers of soil to be washed away
- ✓ Overgrazing which leads to reduction in soil cover which increases the rate of soil erosion
- ✓ Industrial activities that involve dumping of soil pollutants causes degradation of soil

- ✓ Intensive cultivation which causes over exploitation of soil nutrients that later makes the soil infertile
- ✓ Forest fires made by humans as a way of acquiring land for settlement or agriculture degrades the soil
- ✓ Construction work also causes soil degradation

QUESTION 8

- (a) Nitrogen fixation; this is the process that involves converting of non-reactive atmospheric nitrogen into its more active forms of ammonium compounds, nitrites and nitrates.

Nitrification is the process by which bacteria in the soil use oxygen to change compounds of nitrogen in dead organisms' material into nitrates through nitrites which can then be absorbed by plants.

Denitrification is the process by which nitrates are converted back into atmospheric nitrogen through nitrites and ammonium compounds.

Putrefication is the anaerobic decomposition of dead organic matter to release free ammonium compounds

- (b)

Nitrifying bacteria
 Denitrifying bacteria
 Putrefying bacteria
 Nitrogen fixing bacteria
 b

- (c) Water logged soils are nitrate deficient because water soluble nitrates are leached down the soil and some of the nitrates are lost by denitrification as oxides of nitrogen. Water logged soils are oxygen deficient making it difficult to the aerobic bacteria to carry out oxidation of nitrogen containing compounds into nitrates.

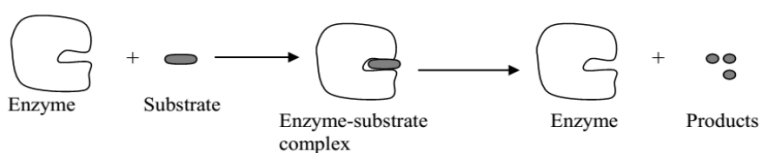
- (d) Denitrification makes the nitrates unavailable in the soil since during the process, nitrates are converted into atmospheric nitrogen hence making infertile for proper plant growth. Denitrification therefore leads to poor plant growth.

TOPIC 3: Nutrition in plants and animals

QUESTION 7

- (a)
- (b)
- (i) Optimum temperature is
 - (ii) The rate of enzyme activity is low because some of the enzymes are inactive and therefore cannot bind with substrates to form the corresponding products.
 - (iii) Above 45°C the rate of enzyme activity decreases rapidly because enzymes are denatured and their active sites can no longer bind with substrate to form the corresponding products.
- (c)
- ✓ Substrate concentration
 - ✓ Enzyme concentration
 - ✓ pH of the medium
 - ✓ Enzyme inhibitors
 - ✓ Enzyme activators
- (d)
- (i) Substrate: Starch
 - (ii) Product: Maltose
- (e)

The lock and key hypothesis suggests that the enzyme has a specific region known as the active site where the substrate with a complementally shape to the shape of the active site of the enzyme fits like a key fits in a lock. In this hypothesis the key is analogous to the substrate and the lock to the enzyme. When the substrate combines with the enzyme, an enzyme- substrate complex is formed. This breaks down to release the products and the enzyme, which can pick other substrates.



QUESTION 8

- (a)
- ✓ Salivary amylase; this catalyses the hydrolysis of cooked starch breaking it down to disaccharide called Maltose.
 - ✓ Pepsin catalyses the hydrolysis of proteins into polypeptides.
 - ✓ Renin coagulates soluble milk proteins caseinogen to an insoluble milk protein, casein which is then acted upon by pepsin breaking it down to polypeptide.
 - ✓ Trypsin catalyses the hydrolysis of proteins into peptides

- ✓ Pancreatic amylase catalyses the hydrolysis of un cooked starch breaking it down to disaccharide called Maltose
- ✓ Pancreatic lipase catalyses the hydrolysis of fats into fatty acids and glycerol
- ✓ Sucrose catalyses the hydrolysis of sucrose into glucose and fructose
- ✓ Lactase catalyses the hydrolysis of lactose into glucose and galactose
- ✓ Maltase catalyses the hydrolysis of maltose into glucose molecules
- ✓ Peptidase catalyses the hydrolysis of polypeptides and peptides into amino acids

(b)

Bile which contains bile salts which are important in the emulsification of lipids for their easy digestion.

Pancreatic juice that contains sodium hydrogen carbonate which provides an alkaline pH medium for proper functioning of enzymes

(c)

- ✓ It is highly coiled/folded and consequently long thus providing a large surface area for absorption of food.
- ✓ It has a thin layer of cells to reduce the diffusion distance over which soluble food passes through
- ✓ It is highly supplied with blood capillaries and lacteals which transport away absorbed food thus maintaining a diffusion gradient.
- ✓ It has numerous villi which increase the surface area for absorption of the digested soluble food.
- ✓ The villi also have numerous micro villi which *further* increase the surface area for absorption of soluble food products.

QUESTION 9

(a)

Photosynthesis is the process by which plants manufacture their own food called starch using carbon dioxide and water in presence of sunlight energy.

(b)

- (i) Sunlight energy is used to split water molecules to provide hydrogen ions that reduce carbon dioxide into a carbohydrate
- (ii) Chlorophyll is used to trap sunlight energy to be used during the process of photosynthesis

(c)

(i)

- ✓ Plants have long slender roots to increase the surface area for absorption of water from the soils
- ✓ Plant roots have root hairs to increase the surface area for absorption of water from the soil
- ✓ Plants have thin layers of cells in their roots to allow faster absorption of water from the soil

(ii)

- ✓ Plants have stomata on their leaves which allow uptake of carbon dioxide by the plants
- ✓ Plants have large air spaces between their spongy mesophyll cells to allow uptake storage of carbon dioxide
- ✓ Plants have numerous leaves to increase the surface area for carbon dioxide uptake
- ✓ They have guard cell bordering their stomata to regulate the entry of carbon dioxide into the plant.

(iii)

- ✓ Plant leaves have photosynthetic pigments like chlorophyll which traps light radiations.
- ✓ Plant leaves have numerous chloroplasts in the palisade mesophyll layer to increase the surface area for trapping sunlight
- ✓ Plants have numerous leaves to increase the surface area for trapping sunlight energy
- ✓ Some plants have leaves with broad leaf laminae to increase the surface area for trapping sunlight energy

(d)

A carbohydrate, starch

TOPIC 4: Transport in plants and animals

QUESTION 10

(a)

- a: Pulmonary artery
- b: Pulmonary vein
- c: Renal artery
- d: Hepatic vein
- e: Hepatic artery
- f: Hepatic portal vein
- g: Renal vein

(b)

(i)

Blood vessel a	Blood vessel b
Has little carbon dioxide	Has more carbon dioxide
Has more oxygen	Has little oxygen

(ii)

Blood vessel c	Blood vessel g
Has less carbon dioxide	Has more carbon dioxide
Has more urea	Has less urea

Has more oxygen	Has less oxygen
Has more water	Has less water

(iii)

Blood vessel d	Blood vessel f
Has little glucose	Has more glucose
Has more urea	Has less urea
Has more carbon dioxide	Has less carbon dioxide
Has less oxygen	Has more carbon dioxide

(c)

Blood vessel x (vena cava)	Blood vessel y (aorta)
Has a wide lumen	Has a narrow lumen
Has thin walls with smooth muscles	Has thick walls with smooth muscles
Has few elastic fibres	Has more elastic fibres
Has no valves along its length	Has valves along its length

(d)

Blood flows in to the heart from the rest of the body via the vena cava to the right atrium which pumps it to the right ventricle via the tricuspid valve.

The right ventricle pumps blood to the pulmonary artery to the lungs and blood flows back to the left atrium via the pulmonary vein which pumps it to the left ventricle via the bicuspid valve and then finally pumped to the rest of the body via the aorta.

QUESTION 11

(a)

(i)

Similarities;

- ✓ Both rates of transpiration in windy and still air are low when a few stomata open,
- ✓ Both rates of transpiration in windy and still air are high when more stomata open.

Differences;

Rates of transpiration in windy air	Rates of transpiration in still air
Initially, transpiration occurs	Initially, no transpiration occurs
Rates of transpiration is higher through out	Rates of transpiration is low through out
Rates of transpiration increases rapidly	Rates of transpiration increases gradually

(ii)

- ✓ When a few stomata are open the rates of transpiration are low in both conditions because there is a reduced evaporation of water vapor from the mesophyll cells of the leaves
- ✓ When a more stomata are open the rates of transpiration are high in both conditions because there is an increased evaporation of water vapor from the mesophyll cells of the leaves
- ✓ Initially, transpiration occurs in windy air because the movement of air across the surface of leaves causes evaporation of water from mesophyll cells while Initially, no transpiration occurs in still air because there is no evaporation of water from the mesophyll cells
- ✓ Rates of transpiration is higher throughout in windy conditions than in still air as more stomata open because the movement of air across the surface of leaves where more stomata open causes more evaporation of water from the air spaces of mesophyll cells of the leaves compared to how much water that evaporate in still air when more stomata open

(b) The rate of transpiration increases as the stomata opens because opening of the stomata exposes the airspaces of the mesophyll layers of the leaves causing them to lose water by evaporation.

(c)

- ✓ Temperature; The rate of transpiration increases with increase in temperature because high temperatures provide latent heat of vaporization which increases the evaporation of the water leading to more water to be lost.
- ✓ Light intensity
Rate of transpiration is high during the presence of light and low in the dark. This is because high light intensity results in high rate of photosynthesis which increases the sugar concentration in the guard cells which lead to wide opening of the stomata leading to more evaporation from the plant
- ✓ Relative humidity; As humidity increases, the rate of transpiration decreases. This is because the environment becomes saturated with the water vapour. The water then can be absorbed from the plant decrease which reduces the rate of transpiration.

(d)

- ✓ Transpiration results in the absorption of water and its movement up the plant to aid processes like photosynthesis.
- ✓ Transpiration contributes to maintenance of continuous stream of water throughout the plant.

- ✓ Transported water as a result of transpiration keeps the plant cells turgid and cools the plant.
- ✓ Transpiration results in the movement of mineral salts up the plants to where they are needed.

QUESTION 12

(a)

Osmosis is the movement of water molecules from a region of their high concentration to a region of their low concentration across a semi permeable membrane while diffusion is the movement of solute molecules from a region of their high concentration to a region of their low concentration.

(b)

An experiment to demonstrate osmosis in a potato tissue

Materials

- ✓ Cock borer
- ✓ Three beakers
- ✓ Water
- ✓ Irish potato
- ✓ Razor blade
- ✓ Sugar crystal

Procedure:

A certain volume of water is poured into three beakers and the beakers labeled A, B and C

Sugar crystals are mixed water in one beaker A to make 5% solution

Sugar crystals are mixed water in another beaker B to make 50% solution

The third beaker C is left with pure water

Using a cock borer, three potato cylinder of the same initial length are obtained.

The potato cylinders are then dipped each in a different beaker and the setup is left for 30 minutes.

After 30 minutes, the potato cylinders are removed from the solutions in the beakers and their lengths re-measured.

Observation:

The potato cylinder dipped in beaker A remains unchanged in terms of length

The potato cylinder dipped in beaker B decreases in length

The potato cylinder dipped in beaker C increases in size

Conclusion:

Osmosis occurs in plant tissues

Explanation:

The cylinder in water in beaker C increased in length because water molecules moved into it from the surrounding water by osmosis

There was no change in length for the cylinder in 5% sucrose solution in beaker A because the solution had the same concentration as the cell sap of a potato cylinder

hence no net osmosis.

There was a decrease in length for the cylinder in 50% sucrose solution in beaker B because water molecules moved out of the cylinder

(c)

- ✓ Palisade mesophyll layer contains numerous chloroplasts especially the palisade thus it is the best position to receive sunlight.
- ✓ Palisade mesophyll layer has cells with elongated shapes to minimize the number of cross wall which would minimize light penetration by absorbing some of it.
- ✓ The spongy mesophyll layer has large air spaces thus allowing many gases to easily diffuse into all the photosynthesizing cells.
- ✓ They have vascular tissues including the xylem and phloem where by xylem transports water and mineral salts up to the stem while the phloem transports food (starch) up to the stem.
- ✓ The network contains the phloem and the xylem where by the phloem conducts food made by the leaf and the xylem conducts dissolved mineral salts up to the stem.
- ✓ Presence of stoma that controls passage of gases and water vapour between air and the leaf
- ✓ They have cuticles which prevent desiccation (water loss) by the photosynthesizing tissues.
- ✓ Numerous chloroplasts that ensure that enough sunlight is trapped by the chlorophyll

TOPIC 5: Gaseous exchange and Respiration

QUESTION 13

(a)

(b)

- (i) Individual B is a trained athlete because his breathing rate increases gradually
- (ii) Individual A is a non trained athlete because his breathing rate increases rapidly

(c)

- (i) From 0 to 4 minutes, the rate of breathing increases; this is because, during an exercise a lot of carbon dioxide is generated by the actively respiring tissues decreasing the amount of oxygen in the tissues. As a

result, the breathing rate increases so as to take in more oxygen into the tissues as more carbon dioxide is taken out of the body.

- (ii) Between the fourth and the fifth minute, the rate of breathing remains constant because

(d)

The breathing rate of individual B after one minute at rest was higher than that of individual A because a lot of lactic acid is synthesized in the tissues of this individual which requires more oxygen to be broken down.

- (e) The expired air at rest has little carbon dioxide while that after the exercise has a lot of carbon dioxide

QUESTION 14

(a)

- ✓ They are moist to allow easy diffusion of gases.
- ✓ They are thin walled to reduce on the distance over which diffusion has to take place.
- ✓ They have a good network of blood capillaries for easy transportation of gases to the respiring tissues.
- ✓ They are well ventilated to maintain a high concentration gradient that favours diffusion of gases

(b)

- (i) The fish closes the operculum and opens the mouth. It then lowers the floor of the mouth cavity. This increases volume of the mouth cavity and lowers its pressure below that of the surrounding water. The mouth then opens to let in water into the mouth cavity. Water flows into the mouth cavity through the mouth. It then closes the mouth and rises the buccal cavity to decrease the volume and increase the pressure in the buccal cavity. Meanwhile the gullet is closed. This makes the water current to flow into the gill chamber.
- (ii) The internal intercostal muscles contract and the external ones relax. This makes the rib cage to move downwards and inwards and the diaphragm becomes dome-shaped. This reduces the volume of the thoracic cavity and increases its pressure beyond that of the atmosphere. This forces the lungs to contract and release Carbon dioxide through the bronchi, trachea and out through the nostrils.

(c)

- ✓ They utilize CO₂ produced by the plant cells for photosynthesis thus preventing accumulation.

- ✓ Plants produce oxygen as a bi-product of photosynthesis which is then used in respiration.
- ✓ Plants have numerous stomata and lenticels that favour fast gaseous exchange.
- ✓ They have large intercellular spaces that favour fast circulation of gases without blood.
- ✓ They have low demand for oxygen due to their low metabolic rate because they are less active since they are immobile.

QUESTION 15

(a)

Anaerobic respiration is the breakdown of food to release energy in absence of oxygen.

(b)

Aerobic respiration	Anaerobic respiration
A common mode of respiration in both plants and animals	Rare process limited to few plants and animals
Produces more Carbon dioxide	Produces less Carbon dioxide.
Occurs throughout life	Occurs temporary in very active muscles
Liberates large quantities of energy	Liberates less energy
Products are water, Carbon dioxide and energy	Products are Carbon dioxide, energy and alcohol or lactic acid.
Complete breakdown of food	Incomplete break down of food.
Oxygen is used	Oxygen is not used.

(c)

Oxygen in inspired air dissolves in the moisture of the alveolar epithelium and diffuses across this and capillary walls into the red blood cells of blood. Inside the red blood cell, oxygen combines with haemoglobin to form oxyhaemoglobin and carried in this form to the muscle cell.

TOPIC 6: Excretion, Homeostasis and Osmoregulation

QUESTION 16

(a)

Osmoregulation is the process of maintaining salt and water balance across membranes within the body of an organism while homeostasis is the maintenance of a constant internal environment of an organism.

(b)

(i) The increase in blood sugar level is detected by the pancreas; which secretes insulin from its beta cells in response; Insulin causes some glucose be taken up by the liver and converted to glycogen and stored there; some to be converted into fats which are stored in adipose tissue; and some to be broken down to release energy at higher rate which is stored in a form ATP; This reduces blood glucose in excess; Once the concentration of blood glucose is lowered to a normal level, the pancreas stops secreting insulin;

(ii)

The erector pill muscles of the hair contract to make the hairs stand upright to the skin; The hairs trap a layer of air, which insulates the skin; The metabolic activity of the liver increases to produce energy in form of heat; Blood vessels near the skin constrict in the process called vasoconstriction to reduce on the blood reaching the skin. This reduces heat loss through radiation; Shivering occur which results into production of heat energy; The rate of sweating reduces in order to reduce on the amount of heat lost through it.

(c)

The renal cortex produces a hormone called aldosterone hormone which regulates the amount of sodium ions in blood. When the blood sodium ion level is low, aldosterone is secreted which causes the active uptake sodium ions from the glomerular filtrate into capillaries, stimulation of sodium ions absorption in the gut and decreases the amount of sodium ions in sweat hence retaining sodium ions in blood.

(d)

- ✓ The skin has sweat pores for passage of sweat containing waste products of metabolism during excretion
- ✓ The skin has numerous hairs which are important during the process of temperature regulation
- ✓ The skin has subcutaneous fat layer which insulates the body against excessive heat gains and losses
- ✓ The skin has numerous blood vessels that under constriction or dilation during regulation of body temperature

- ✓ The skin has numerous sweat glands to increase the surface area for sweat production to be excreted.
- ✓ The skin has a cornified layer made up of dead cells, which are keratinized. to protect the inner parts of the body from mechanical injury and entry of bacteria and other germs.

QUESTION 18

- (a)
- (i) Between 5°C and 20°C the body temperature of animal A increases gradually. Between 20°C and 40°C the body temperature of animal A remains constant
 - (ii) Between 5°C and 40°C the body temperature of animal B increases gradually.
- (b)
- (i) The body temperature of animal A increases slightly and becomes constant with increasing temperature because the organism is an endotherm which regulates its body temperature.
 - (ii) The body temperature of animal B increases with increase in the environmental temperature because the organism is an ectotherm whose body temperature fluctuate with environmental temperature
- (c) Animal A consumes a lot of food per day. This is because it has a higher metabolic rate and it produces its own heat from metabolism of food nutrients so as to regulate its body temperature. Being with a high metabolic rate compared to animal B, it consumes a lot of food.
- (d)
- ✓ They are always active because their temperature is maintained at an optimum temperature for enzyme activity.
 - ✓ They can live in a wide range of environments i.e. both hot and cold.
 - ✓ Their metabolic rate is maintained at a high rate due to the ability to maintain a constant body temperature
- (e)
- ✓ They have a lot of hairs over their bodies to trap a layer of air
 - ✓ They have a thick fat layer to act as an insulator.

- ✓ Some are very big and thus have a small surface area to volume ratio to reduce the rate of heat loss.
- ✓ They have few sweat glands to reduce of the heat lost during sweating.
- ✓ They have fewer blood vessels on the skin surface to avoid heat loss through radiation.

QUESTION 19

(a)

The average volume of urine before running is higher than that after running.

The concentration of sodium ions in urine before running is higher than that after running.

(b)

After running, the volume of urine reduces and the concentration of sodium ions reduces because during running, the sweat glands become more active and more sweat is produced compared to the amount of urine produced. The sweat produced contains a lot of salts including the sodium ions hence their decrease in concentration in urine after running.

(c)

$$\begin{aligned}
 \% \text{ change} &= \frac{\text{concentration of sodium after running} - \text{concentration of sodium before running}}{\text{concentration of sodium before running}} \times 100\% = \\
 &= \frac{85.6 - 78.2}{85.6} \times 100\% \\
 &= 8.64\%
 \end{aligned}$$

(d)

The kidney tubules stop the reabsorption of the salts from the glomerular filtrate such that a lot of the salts are excreted out of the body through the formed urine.

QUESTION 19

QUESTION 20

(a)

Nastic response is the movement of part of the plant in response to a non-directional stimulus while a tropism is a growth movement of part of the plant towards or away in response to a unidirectional stimulus.

(b) Phototropism is the growth movement of part of the plant in response to unidirectional light.

(c)

An experiment to show the effect of unidirectional light on growth of the plant shoot
materials

2 Potted plants

2 opaque boxes

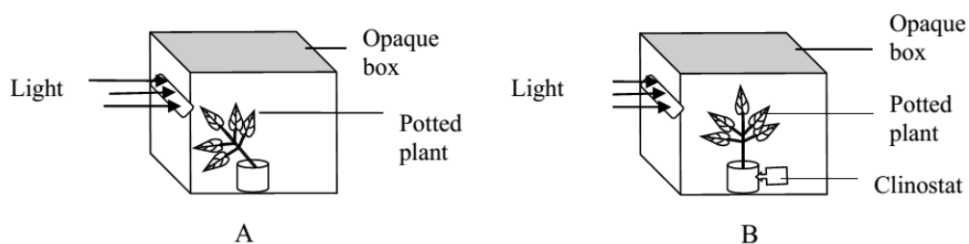
Klinostat

Razor blade

Procedure

- ✓ A small hole is cut on one side of each of the opaque boxes.
Two potted plants of equivalent sizes are placed one in box A and another in box B but fixed on a klinostat to serve as the control experiment.
- ✓ Both boxes are placed in light and the klinostat is started to rotate the plant in box B.
- ✓ The experiment for 7 days.

Illustration



Observation

- ✓ The shoot in A bent towards the direction of light while that in B continued to grow straight.

Conclusion

The shoot responds positively towards light.

(d)

- ✓ Phototropism enables plants leaves to trap maximum sunlight by enabling plant shoots to grow upright.

- ✓ Geotropism enables plants to become firmly anchored in the soil by the roots growing towards the ground.
- ✓ Hydrotropism enables plant roots to absorb or obtain water which is necessary for plant growth.
- ✓ Chemotropism enhances fertilization in plants since the pollen tubes grow towards the chemicals in the embryo sac.
- ✓ Phototropism enables climbing plants to gain support by twinning around the support.
- ✓ Tropisms allow plant parts to alter direction in response to changing conditions in the environment.

QUESTION 21

(a)

Voluntary action is one initiated consciously under the direct control of the brain while involuntary actions are the ones that occur without conscious thoughts of the brain.

(b)

Sound waves from the firing of the gun are collected and concentrated into the ear by the pinna; they are then directed to the tympanic membrane (ear drum) through the auditory canal; this causes the eardrum to vibrate; the vibrations of the eardrum are amplified and transmitted by three ossicles starting from the malleus, incurs and finally the stapes hands them over the oval window that leads to the inner ear. Vibrations in the oval window make the fluid in the inner ear and cochlea to vibrate. Receptors in the cochlea receive the information, change it into impulses and the impulses are taken to the brain via the auditory nerve for interpretation.

(c)

When Kajubi accidentally step on the thorn, the receptors in the pad of the foot receive the stimulus and convert it into nervous impulses that travel along the sensory neuron to the spinal cord and then cross the synapse; The impulse is then handed over to the relay neuron in the spinal cord (gray matter) and then cross another synapse; the relay neuron in turn hands over the impulse to the motor neuron; the motor neuron then carries the impulse from the spinal cord to the effector muscles of the leg. This causes the muscles to contract and the leg is removed from the thorn. At the same time, the original message is sent to the brain which then interprets it as pain or heat.

(d)

- ✓ Reflex actions enable animals to avoid danger.
- ✓ Reflex actions control activities in the body, which we do not have conscious control over

- ✓ Reflex actions form a basis of some animals' behavior.

QUESTION 22

(a)

(b)

- (i) Between 0 and 2 arbitrary units, the diameter of the pupil decreases gradually.
Between 2 and 6 arbitrary units, the diameter of the pupil decreases rapidly
Between 6 and 10 arbitrary units, the diameter of the pupil decreases gradually.
- (ii) The diameter of the pupil of the eye decreases with increase in the light intensity.

(c)

When the light intensity is high, Circular muscles of the iris contract, Radial muscles relax, Pupil becomes smaller and narrower, and less light enters into the eye.

When the light intensity is low, the radial muscles contract, Circular muscles relax, Pupil widens and more light is admitted into the eye

(d)

Short sightedness; it corrected by putting on diverging (concave) lenses.

Long sightedness; it can be corrected by wearing converging (convex) lenses

QUESTION 23

(a)

(i) Hormone X; Follicle stimulating hormone (FSH)

Hormone Y; Oestrogen hormone

(ii) Organ Z: Ovary

(b) Progesterone during pregnancy, maintains the uterine lining in preparation for implantation.

Progesterone hormone during the menstrual cycle inhibits production of FSH and LH if its level is high.

(c)

Hormone X causes the development of the graafian follicles in the ovaries. It stimulates the ovary to produce oestrogen.

(d)

The amount of follicle stimulating hormone decreases, the amount of oestrogen hormone increases and the amount of progesterone and the human chorionadotrophic hormone increases.

(e)

- ✓ It produces antidiuretic hormone (ADH), which controls the amount of water and salts reabsorbed into the blood stream by the kidneys.
- ✓ It produces thyroid-stimulating hormone (TSH), which stimulates the thyroid gland to secrete thyroxin.

QUESTION 24

(a)

- ✓ They have brightly colored petals to attract insects.
- ✓ They have a nice scent to attract insects.
- ✓ They produce nectar which is food source for the insects hence attract insects for pollination.
- ✓ Their stamens produce sticky pollen grains which adhere firmly to the bodies of visiting insects hence favoring insect pollination.
- ✓ They have stigma that are flat, lobbed and have sticky surface to which pollen grain can easily adhere from the visiting insects.
- ✓ They have landing plat forms and pollen guide which ensures that insects visit the flower hence favoring insect pollination.

(b)

Pollen grain lands on the stigma of a flower of the same species; On the stigma, pollen grain absorbs water, nutrients and then germinates to form a pollen tube which grows through the style under the control of the tube nucleus at the tip; Pollen grain has two nuclei i.e. generative nucleus and pollen tube nucleus; The generative nucleus divides mitotically to form two male nuclei which lie behind the pollen tube nucleus; The pollen tube enters the ovary and the tip of the pollen tube breaks. The pollen tube nucleus disappears; One of the male nucleus fuse with the egg nucleus to form a zygote which divides mitotically to form embryo; The other male nucleus fuses with two polar nuclei to form a triploid endosperm which develops into endosperm.

(c)

- ✓ Budding; this is a mode of asexual reproduction in which a plants develops an outgrowth (bud), which detaches its self from the parent plant and starts to grow as a self-reliant one.
- ✓ Spore formation; this is a mode of asexual reproduction, which involves production of spores. Spores have the ability to germinate into a new organism under favorable conditions into new plants

- ✓ Vegetative reproduction; this is a mode of reproduction in plants where part of the plant other than the seeds develops into a new individual plant.

QUESTION 25

(a)

Family planning refers to the determining of how many children a couple is have and when to have them.

(b)

- ✓ Use of condoms prevent semen from entering into the uterus of the female and hence prevents fertilization since sperm cells do not reach the egg.
- ✓ Use of a cervical cup or diaphragm fitted in the vagina and prevents sperms through the cervix.
- ✓ Use of spermicides that destroy sperms before they reach the uterus after being inserted into the vagina before sexual intercourse
- ✓ Use of a sponge fitted into the vagina to close the opening to the uterus such that sperm cells do not reach the uterus to fertilize the egg.
- ✓ Use of a cervical cup which is fitted over the cervix and blocks sperm from entering the uterus.

(c)

TOPIC 9: Genetics, cell division and Evolution

QUESTION 26

(a)

- (i) Mitosis is a type of cell division where a cell divides to give rise to two daughter cells each having the same number of chromosomes as the parent cell and each having exactly the same number of chromosomes as the parent cell while meiosis is a type of cell division where a cell divides into four haploid daughter cells each with half the number of chromosomes as the parent cell.

Mitosis occurs in all somatic cells and meiosis occurs in reproductive organs

(ii)

Prophase:

The chromosomes thicken and become visible; Each chromosome appears to consist of two chromatids lying parallel to each other; The

nucleolus disappears; The centrioles migrate to opposite poles and start forming spindle fibers; the nuclear membrane disintegrates and disappears towards the end of prophase.

Metaphase:

Chromosomes move to the center of the cell and arrange themselves at the spindle equator; Chromosomes attach to the spindle fibers at the centromeres; Sister chromatids face opposite poles of the spindle fibers

Anaphase:

Centromeres divide and the two chromatids of each chromosome move to opposite poles; Each chromatid now becomes a chromosome; Spindle fibers shorten as they pull the chromatids apart.

Telophase:

The chromosomes reach the poles; The cell divides by constriction of the cell membrane in animals or by forming a cell wall plate in plants; The nuclear membrane reappears; Spindle fibers disintegrate (break down); The nucleolus reappears; Chromosomes uncoil, become thread like and invisible.

(b)

(i)

Similarities:

- ✓ They both involve replication of chromosomes.
- ✓ They both involve similar stages e.g., prophase, metaphase, anaphase, telophase and interphase.
- ✓ In both chromosomes arrange themselves at the equator.
- ✓ In both a spindle is formed.
- ✓ Both begin with a diploid parent cell.

Differences

Mitosis	Meiosis
Occurs in somatic cells.	Occurs in reproductive cells.
Involves a single division of chromosomes and cytoplasm	Involves two divisions of chromosomes and cytoplasm.
Does not involve the process of synapsis	It involves synapsis
Crossing over does not occur	It involves crossing over between homologous chromatids.
Formation of bivalents does not occur.	There is formation of bivalents.
Two daughter cells are produced.	Four daughter cells are formed.
Diploid cells are formed.	Haploid cells are formed.
Daughter cells formed have the same number of chromosomes as the parent cell	Daughter cells formed have half the number of chromosomes compared to the parent cell
Does not involve formation of chiasmata.	It involves formation of chiasmata

(ii)

Meiosis leads to the formation of gametes that are used for the process of reproduction

QUESTION 27

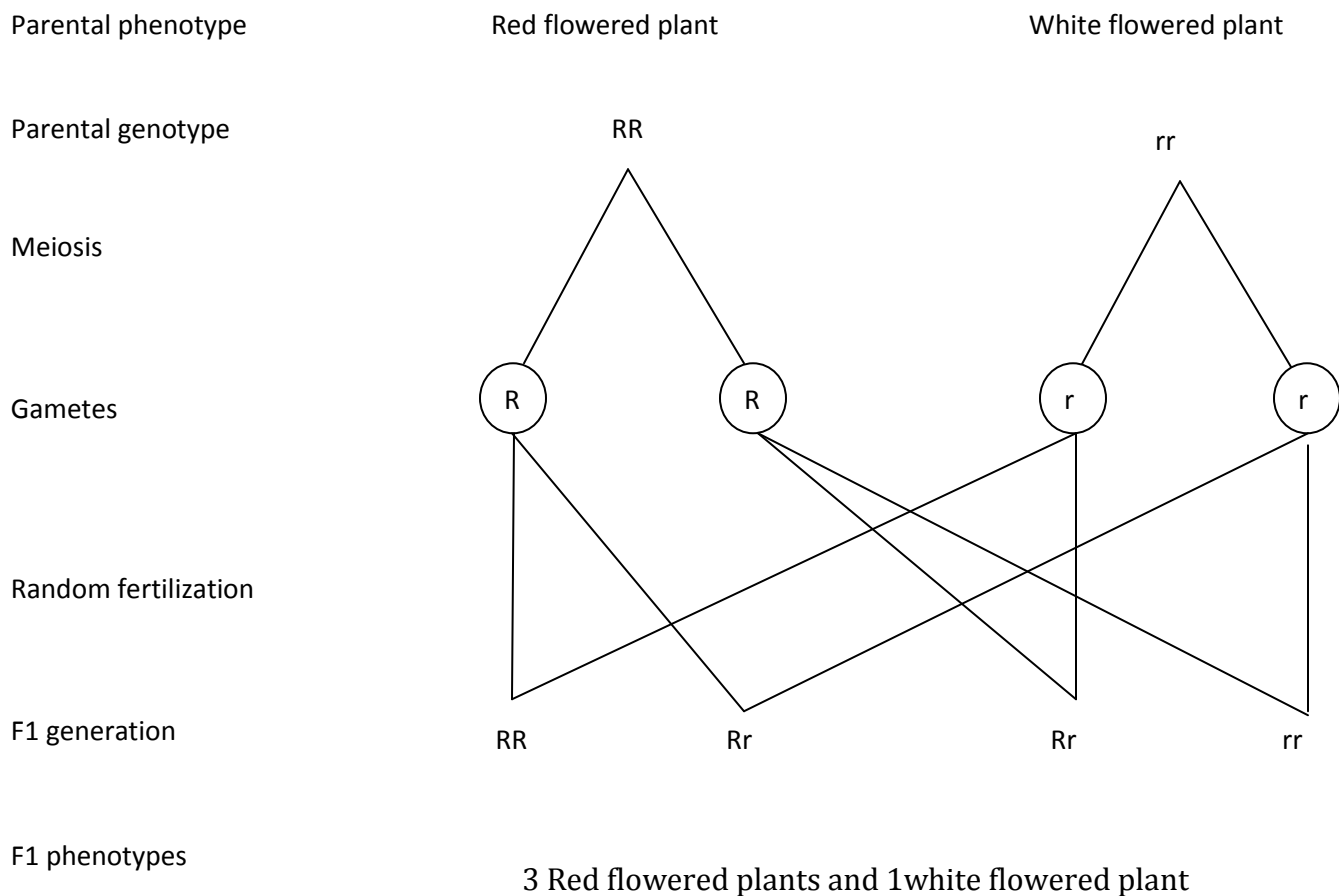
(a)

(i)

The plants in the F₁ generation were all red because the allele determining red flower color is dominant over the allele that determines white flower color and the allele that determines white flower color is recessive.

(ii)

Let the allele for white flower color be represented by r
Let the allele for red flower color be represented by R



(b)

(i)

Mutation is the sudden change in the structure and functioning of genes

(ii)

Radioactive substances
Heavy metals cause mutation
Diseases
Chemicals

(c)

(i)

Mutations are random occurrences which change the genetic constitution of organisms. They greatly increase genetic diversity, where advantageous mutations are favored by natural selection and disadvantageous ones are phased out leading to formation of a new species of organisms

(ii)

Mutations are used to cause variations in plants which results into formation of new crop and animal varieties with better characteristics since mutation is a source of variation.

QUESTION 28

(a)

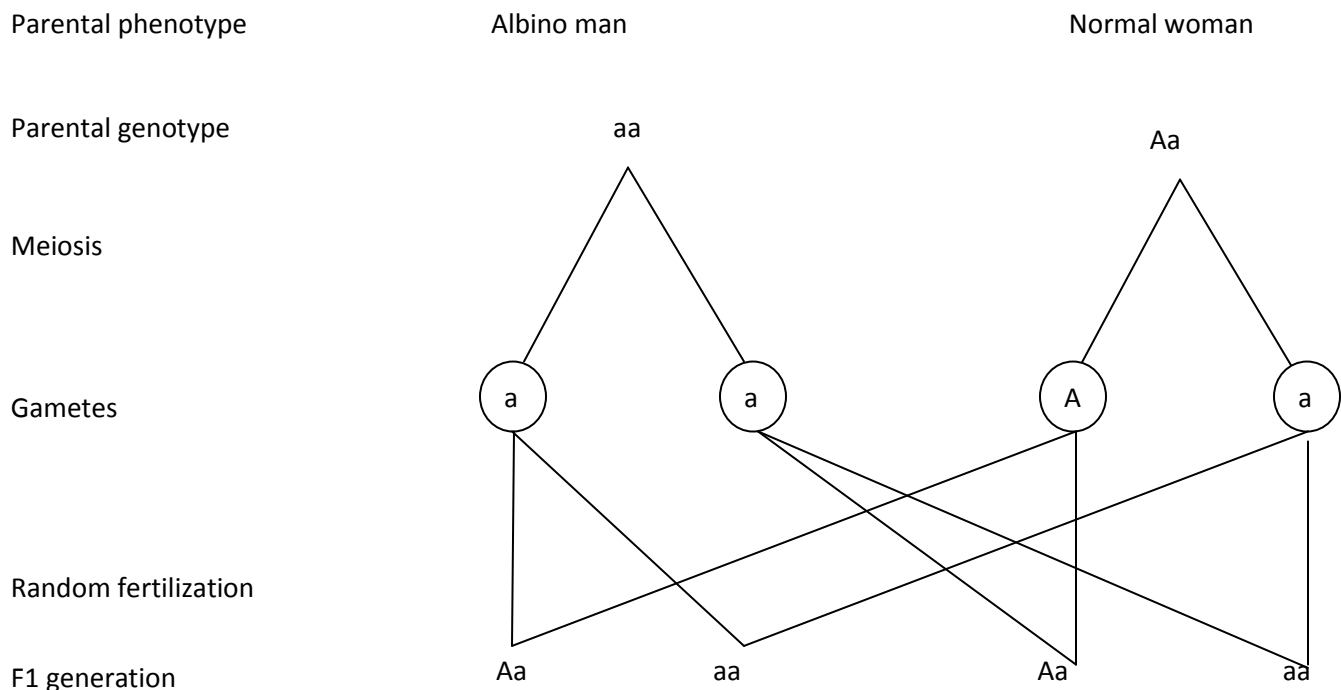
(i) Homologous structures are structures from the common ancestral origin that serve different functions

(ii)

When body structures of some organism are compare, they have similar structures but perform different functions, this implies that such organisms exhibit divergent evolution which is the type of evolution where by organisms with common ancestors have developed structures that perform different functions because of change in the environment they live in.

(b)

(i) Let the allele for normal skin pigment be represented by A
Let the allele for albinism be represented by a



Chances of their first child being an albino:

F1 phenotypes Two normal children, 2 albino children

Number of albinos = 2

Probability of producing an albino is $\frac{1}{2}$

(ii)

The mother and the two children are carriers

QUESTION 29

(a)

(i)

Color blindness is the inability of an individual to differentiate colours.

(ii)

A recessive gene is one that cannot express its effect when in a heterozygous state.

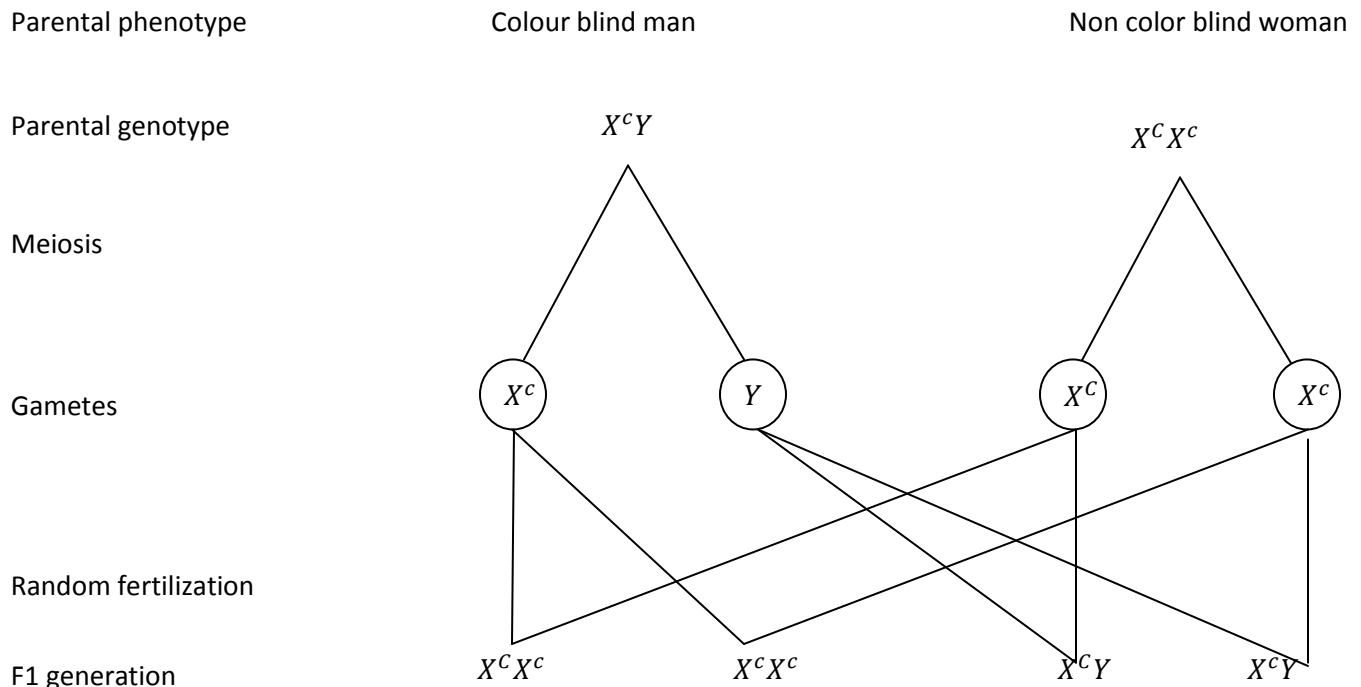
(iii)

A sex linked gene is one that are carried on the sex chromosomes

(b)

Let the allele for colour blindness be represented by c

Let the allele for normal colour vision be represented by C



F1 phenotypes; 1 girl with normal vision, 1 color blind girl, 1 boy with normal color vision, 1 color blind boy

(b)

Genetics is used in the synthesis of better crop and animal breeds in agriculture production.

Genetics is used in the diagnosis of genetic diseases

Genetics is used in vaccine development

TOPIC 10: locomotion and support

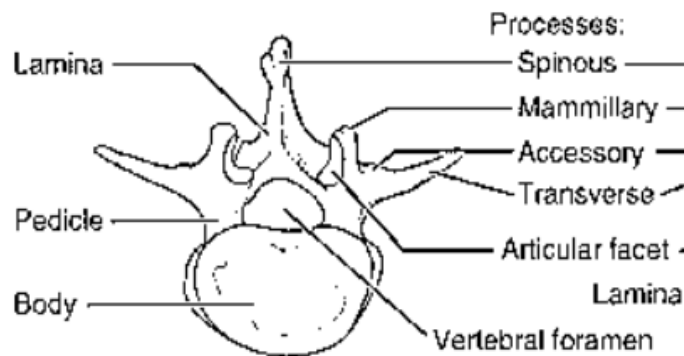
QUESTION 30

(a)

- ✓ Hydrostatic skeleton; this is a skeleton formed by fluid-filled compartment within the body. The organs in this compartment are supported by the aqueous fluid which also resists internal compression. The compartment is under hydrostatic pressure because of the fluid surrounded by circular and longitudinal muscles. Movement occurs when the contraction of the muscles compresses the fluid that makes up the hydrostatic skeleton. The hydrostatic skeleton is found in earthworms.
- ✓ Exoskeleton; this is an external skeleton that consists of a hard encasement on the surface of an organism. The exoskeleton is found in insects like houseflies, cockroaches and butterflies. The exoskeleton is made of a material called **chitin** in insects
- ✓ Endoskeleton; this consists of hard mineralized structures called bones inside the body of an organism. The endoskeleton is found in organisms like vertebrates including man, cows, reptiles

(b)

(i)



- ✓ Possession of large elongated transverse processes for attachment of abdominal muscles
 - ✓ Their spinous processes project downwards and forward thus allowing flexibility.
- (ii) Lactic acid is oxidized to carbon dioxide, water and more energy in the liver. The oxygen used in breaking down this lactic acid is attained by breathing deeply.

QUESTION 31

(a)

The biceps and triceps act against each other to bend and straighten the elbow and hence the arm.

To bend the arm, the biceps muscles contract and the triceps muscles relax causing a bending of the elbow.

To straighten the arm, the biceps muscles relax and the triceps muscles contract causing the straightening of the elbow.

(b)

(i) It possesses a large elongated transverse processes for attachment of abdominal muscles

Its spinous processes project downwards and forward thus allowing flexibility

(ii)

Similarities

- ✓ Both cartilage and bone are connective tissues
- ✓ Both are embedded in extracellular matrix
- ✓ Both provide support and are involved in movement
- ✓ Both contain collagen and elastic fibres

Differences

Bone	Cartilage
Matrix is firm, inelastic and rigid.	Matrix is firm, elastic and flexible
Blood vessels and nerves present.	Blood vessels and nerves absent
Have inorganic materials like Ca and P ions.	Lacks the inorganic molecules
Matrix is ostein	Matrix is chondrin.
Protects the body from mechanical damage	They shock absorbers
Bones are rigid	Flexible

QUESTION 32

(a)

Flight in birds involves upward and downward strokes and it is achieved by a pair of antagonism pectoralis muscles.

During the down stroke, the pectoralis major contracts as the pectoralis minor relaxes, the wing is pulled down and backward as it pushes against the air underneath thus causing the bird to gain height and move forward.

During the upstroke, the pectoralis minor contracts, as pectoralis major relaxes, the wing is raised and the cycle continues. These two sets of muscles work antagonistically.

(b)

- ✓ They have a keen eye sight to enable them judge distances correctly when landing
- ✓ They have a stream lined body to reduce air resistance and provide smooth movement in the air.
- ✓ They have the ability to fold legs backwards during flight to avoid friction between air and the legs.
- ✓ They have a translucent membrane that covers the eye during flight
- ✓ They have an efficient gaseous exchange system with air sacs that carries much oxygen needed for respiration and energy for flight
- ✓ They have the quill feathers that also provides large surface area for flight
- ✓ Their fore limbs are modified into wings to provide a large surface area for movement in air.
- They have large pectoral [flight] muscles which move the wings during flight
- ✓ They have skeletons made of light hollow bones which reduce the total weight of the bird.
- ✓ They have fused bones with a deep keel-like extension of the sternum which provides a large surface area for attachment of muscles.
- ✓ They have an efficient circulatory system necessary for transporting nutrients and respiratory gases.

(c)

- ✓ Skeletons provide a framework for the body where the internal body organs are held and prevented from crushing into each other.
- ✓ They protect the delicate body organs e.g. the skull protects the brain inner ear and parts of eye, the ribs protect the lungs and heart while the vertebral column protects the spinal cord.
- ✓ It enables locomotion by providing areas where muscles can be attached and joints for flexibility.
- ✓ The ribcage enables gaseous exchange by adjusting the volume and pressure of the thoracic cavity during ventilation.
- ✓ The skeletons are involved in transmission of sound in the ear i.e. the ear ossicles
- ✓ Skeletons manufacture blood cells in the bone marrow in skeleton
- ✓ Skeletons store calcium and phosphorus in the bones.

TOPIC 11: Growth and Development

QUESTION 33

- (a) This is the growth and development of an embryo of a seed into a seedling or a young plant under favorable conditions.
- (b) This type of germination where the elongation of the epicotyl is faster as compared to the elongation of the hypocotyle results into the cotyledons remaining below the ground and the radicle emerges e.g. maize. This is called hypogeal germination.
- (c)

An experiment to show that energy (heat) is released by germinating seeds during respiration.

Materials

- | | |
|---------------------|--------------------------------|
| ✓ Vacuum flask | ✓ Thermometer |
| ✓ Germinating seeds | ✓ Sodium hypochlorite solution |
| ✓ Cotton wool and | |

Procedure

The seeds are soaked in water for 24 hours.

One group of seeds is then killed by boiling them in water. Both sets of seeds are soaked in formalin for 15 minutes in order to kill any bacterial.

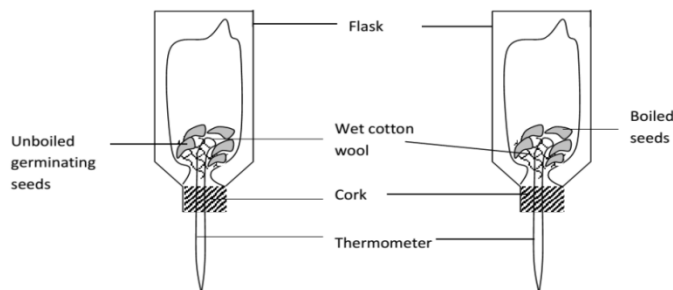
The moist germinating seeds are placed in one flask.

The boiled seeds are placed in another flask.

A thermometer is inserted into each of the flasks plugged with cotton wool.

The two flasks are fixed on a retort stand in an upside down position so that the seeds are near the thermometer bulb for three days as shown below.

Setup



Observation

After three days the temperature recorded in the flask containing germinating seeds is higher than that of the one containing boiled seeds. That of the boiled seeds remains constant.

Conclusion

Germinating seeds give out heat.

(d)

- ✓ Water; this activates the enzymes within the seed to hydrolyze the stored food, It makes the seed swell, soft and the testa to bursts and it is a medium in which all the chemical and enzymatic reactions proceed.
- ✓ Oxygen is necessary for the process of respiration, the oxidation of food to provide energy required for growth.
- ✓ Warmth which provides a suitable temperature that is important for the enzyme controlled reactions in the cotyledon of the germinating seed

QUESTION 34

(a) This is the developmental change from the eggs to the adult stage in the life cycle of an organism.

(b)

After mating, the female housefly lays eggs in batches. The eggs are laid on rotting matter such as meat or faeces, where it is warm and moist.

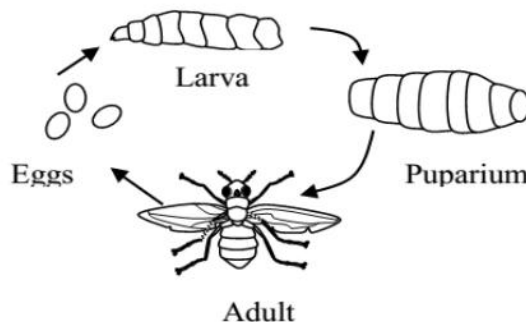
After about 24 hours, the eggs hatch into larvae.

After 5 days and shedding its cuticle twice, the larva then moves to a drier region of the meat or faeces and pupates.

The pupa is cigar shaped. The cuticle hardens, darkens and becomes brown to form the puparium or pupa case. This forms a protective covering as internal reorganization of tissues takes place inside.

After the puparium bursts open, the adult fly emerges.

The wings expand and harden and after a few hours, the fly flies away.



TOPIC 12: Ecology

QUESTION 35

(a)

- (i) Population size refers to the total number of organisms of the same species in a given area at a give time
- (ii) A community is an interacting group of various species of organisms in a given area at the same time.

(b)

Availability of food
 The quality water
 Space and shelter
 Competition for resources
 Predation
 Diseases

(c)

(i)

The population of fish in a pond can be estimated using the capture-mark recapture count method.

In this method fish in pond are captured and counted and their number recorded N_1 . They are then marked and released back into the pond.

The fish traps are then laid after a given period of time. The fish are captured are counted and the number of fish in the second capture are recorded N_2 .

The fish that were marked and recaptured again are also counted N_3 .

The estimated population size is then calculated from;

$$\frac{\text{number of fish in first capture} \times \text{number of fish in second capture}}{\text{number of fish recaptured}} = \frac{N_1 \times N_2}{N_3}$$

(ii)

Sampling is random

Relative large samples of fish are used

Using permanent marking material

The marking material used should not affect the distribution of fish

QUESTION 36

(a)

This is the addition of substances to the environment to levels that harm or destroy living components of the environment

(b)

Suspended solids like plastics reduce entry of oxygen into water bodies making the water polluted.

Industrial wastes dumped into water bodies that increase nitrate and phosphate content cause eutrophication

Artificial fertilizers washed into water bodies increase nitrate and phosphate content cause eutrophication

Detergents added into water bodies also increase nitrates and phosphates into the water bodies causing water pollution

Oils dumped in water from oil mining sectors also increase water pollution

(c)

By picking up litter from the water bodies and throwing it away into garbage cans for recycling

By putting strict laws on disposal of industrial wastes into water bodies

Avoid the disposal of oils in water

Applying mulches around areas where fertilizers are applied to reduce erosion of fertilizers into water bodies

By putting strict laws on dumping of solid wastes into water bodies on individuals

(d)

By determining the amount of dissolved oxygen in water

By checking the pH of the water

By checking the turbidity of water

By checking on the number of organisms in a given water body

By checking on the hardness of water

By determining the temperature of water

QUESTION 37

(a)

(b)

(i) Organism B

(ii) Organism A

(c) Organism A is the predator because its number increases after the number of organism B, the prey increases and a decreases in the number of organism B causes a decrease in the number of organism A. Also, the number of prey is higher than that of the predator throughout.

(d)

(e) The number of organism B increases because of a low number of organism B which feeds on it. The number of organism B decreases because of an increase in the number of organism A which feeds on it.

The number of organism A increases because of an increase in the number of organism B on which it feeds. The number of organism A decreases because of a decrease in the number of organism B on which it feeds.

- (f) Shelter or space
Amount of wastes in the environment
Diseases

QUESTION 38

(a) A food chain because there is linear transfer of energy throughout.

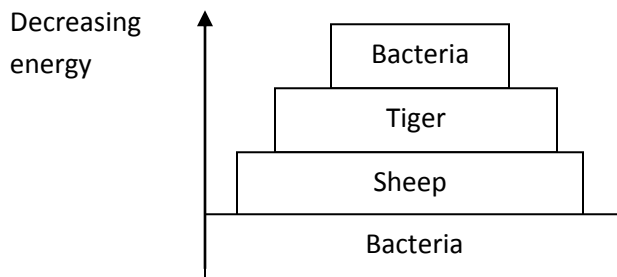
(b)

- (i) Grass
- (ii) Sheep
- (iii) Bacteria

(c)

When all sheep were killed, the number of tigers decreases and the number of grass plants increases.

(d)



(e) The amount of energy goes on decreasing from the lower trophic level to a higher trophic level.

This is because;

Some energy is used up during respiration.

Some energy is lost from herbivores in form of indigestible plant material.

Some organisms die before they are eaten.

Some of the chemical energy is converted into other forms such as sound, light energy, heat energy, which easily escapes from the organisms

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