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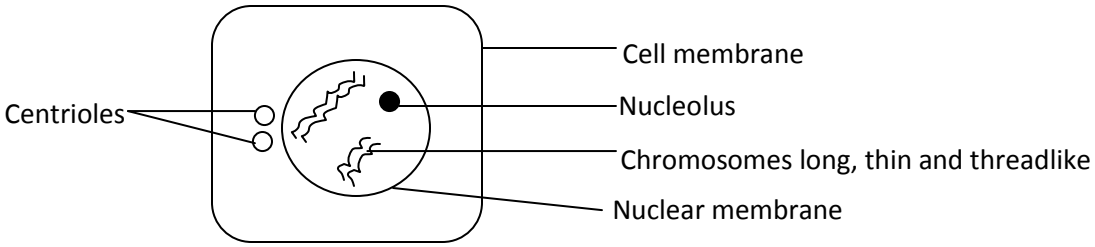
S.4 BIOLOGY SEMINAR ANSWER GUIDE 2015

1. (a) (i) Mitosis is the process of cell division whereby two identical daughter cells, each with the same number and kind of chromosomes as that of the parent cell are formed.
(ii) Mitosis occur in five stages namely; Interphase, metaphase, anaphase and telophase.

Interphase

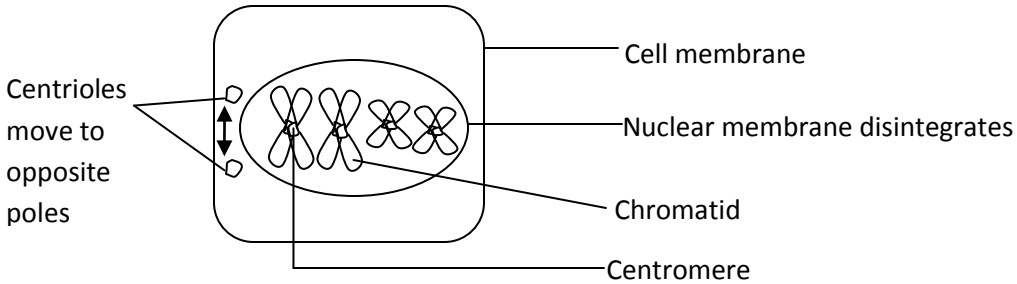
This is the first stage of mitosis. It also called the resting stage. During this stage, the cell grows to its normal size and carries out normal functions. In preparation for cell division the cell replicates it DNA, its organelles and there is also accumulation of energy in form of ATP. The chromosomes are thin, long and threadlike.



Prophase

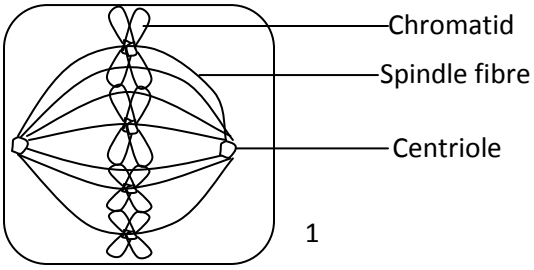
During this phase the parent cell undergoes the following changes.

- Chromosomes shorten and become clearly visible and will appear as a pair of replicated chromatids held together at a position called centromere.
- The nucleolus shrinks and eventually disappears.
- The centrioles move to opposite poles and starts to form spindle fibres
- The nuclear membrane dissolves.



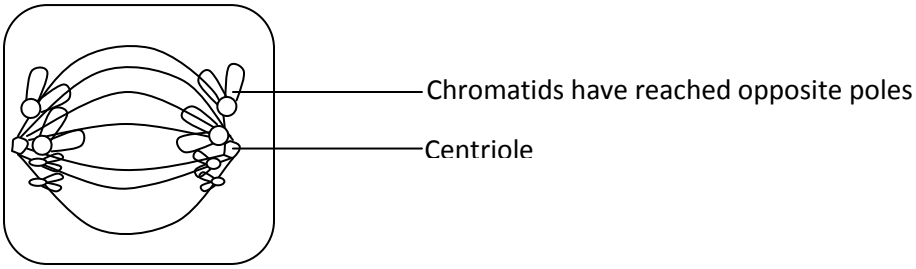
Metaphase

During this phase the chromosomes arrange themselves on the equator of the spindle. Note that the homologous chromosomes do not associate i.e chromosomes form a single row on the equator of the spindle.



Anaphase

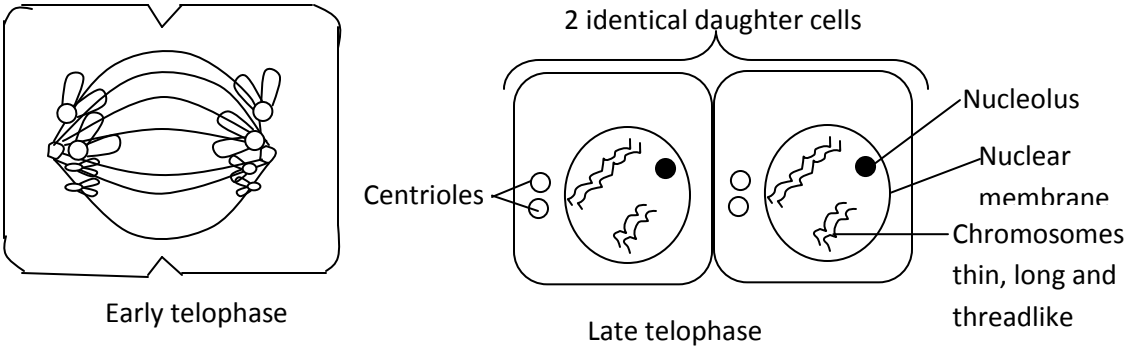
The chromosome split at the centromere region and sister chromatids move to opposite poles of the spindle with the centromere leading. Late anaphase is marked by chromatids reaching the opposite poles.



Telophase

This is the final stage of mitosis, and the following changes occur during this stage

- The cell membrane starts to constrict across the middle of the cell.
- The spindle apparatus disintegrates.
- The nuclear membrane and nucleolus reappear
- The chromatids regain their threadlike form.
- The stage ends by complete division of the parent cell into daughter cells, each having the same number of chromosome as the original parent cell.



(b) (i)Differences between mitosis and meiosis

Mitosis	**Meiosis**
Occurs in somatic cells	Occurs in gonads
Two daughter cells formed from a parent cell	Four daughter cells formed from a parent cell
Each daughter cell has same number of chromosomes as the parent cell.	Each daughter cell has half the number of chromosomes of the parent
Involves only one nuclear division	Involves two nuclear divisions
Bivalents are not formed	Bivalents are formed
Synapsis does not occur	Synapsis occurs
No chiasmata are formed	Chiasmata are formed
No crossing over takes place	Crossing over occurs
Chromosomes form a single row at the equator of the spindle	Chromosomes form a double row at the equator of the spindle

Does not lead to genetic variation	Leads to genetic variation
It's the basis of asexual reproduction	It's the basis of sexual reproduction
Does not lead to evolution	leads to evolution
Takes a shorter time	Takes longer time

(ii) Similarities between mitosis and meiosis

- Both follow similar stages i.e Interphase, prophase, metaphase, anaphase and telophase
- In both there is disappearance of the nucleolus and nuclear membrane
- Both require energy from ATP
- Both form daughter cells from a parent cell.
- Both involve division of the cytoplasm (cytokinesis) and nucleus (Karyokinesis)
- Both involve formation of spindle fibres.
- Both involve assembling of chromosomes on the spindle fibres.

2. (a) Tropism is growth movement of part of a plant in response to a unidirectional stimulus whereas nastic response is the movement of part of a plant in response to a non-directional stimulus.

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

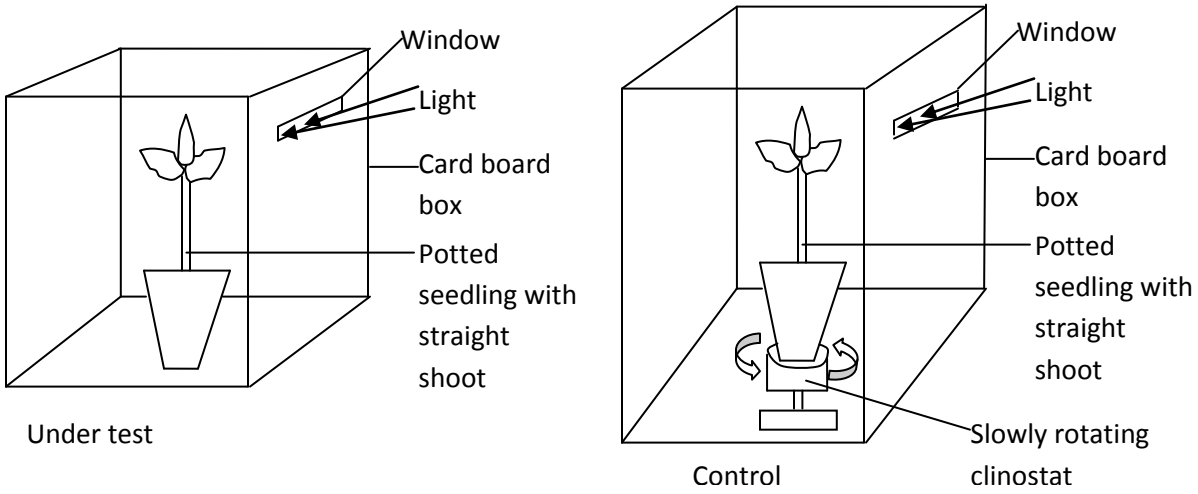
(c) **An experiment to demonstrate phototropism in plants**.

Materials

- Water
- Clinostat
- Two boxes with a window
- 2 potted seedlings with straight shoots.

Procedure

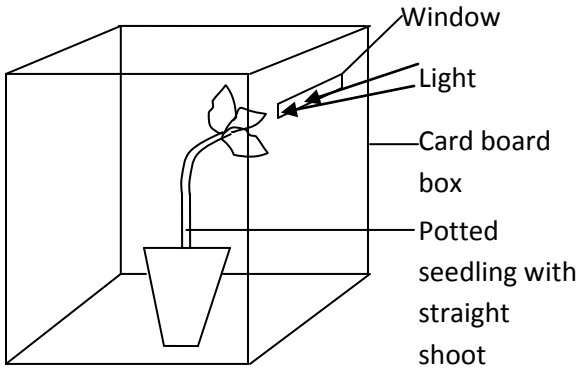
Two potted seedlings are watered. One is placed under a box with a window to allow illumination of shoot from one direction only. The other is placed in an identical situation but on a slowly rotating clinostat so that all sides of a shoot are exposed to light. The experiment is left stand for 5 days as shown below.



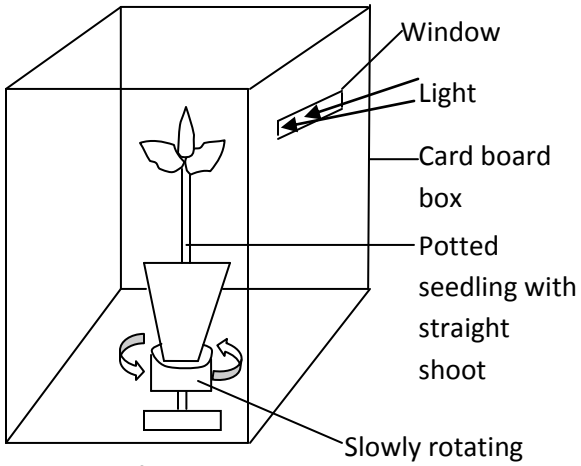
After few days the two seedlings were removed from the boxes and compared.

Observation

The shoot of seedling in box A which was illuminated on one side grew bending towards light while the seedling on the slowly rotating clinostat continued to grow straight as shown below.



Result for experiment under test



Result for Control

Conclusion

Shoots are positively phototropic i.e when a plant shoot is exposed to light from one direction it responds by growing towards it.

Explanation

When a plant shoot is illuminated with light on one side, light causes the auxins to move to away from the illuminated side to the dark side. The much auxins on the darker side causes more rapid cell elongation. Hence this side grows more rapidly than the other side causing its bending towards light.

(d) Importance of tropism

- It allows plant parts to alter direction in response to changing conditions in the environment.
- It enables plant leaves trap maximum amount of sunlight by enabling plant shoots grow upwards.
- It helps plants to become firmly anchored in the soil by roots growing towards the ground.

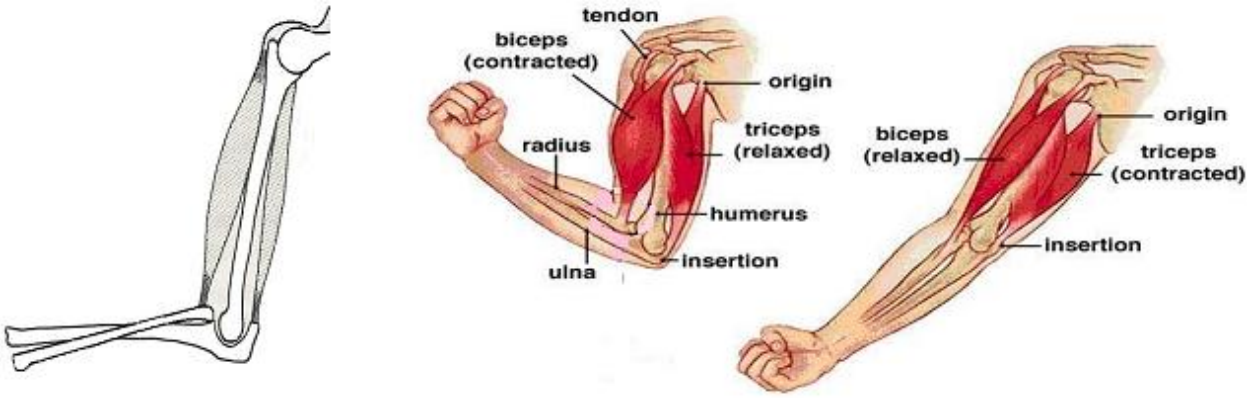
3. (a) Why a skeleton is necessary in a mammalian body
    - Helps in locomotion by providing surfaces for attachment of muscles.
    - It forms a rigid framework over which body organs are suspended and give shape
    - It protects certain delicate organs of the body e.g skull protects the brain, vertebral column protects the spinal cord, ribs protects the heart and lungs.
    - Helps in storage of calcium for usage by the body.
    - They are sites for manufacture of red blood cells and white blood cells i.e from bone marrow
    - Aid in breathing by use of rib cage and ribs.
    - Helps in transmission of sound by use of ear ossicles.
    - Facilitates chewing of food by use of teeth.

(b) **How a human arm can bend and straighten**

Muscles that cause movement of the arms are two, namely biceps (flexor) and triceps (extensor). These muscles work antagonistically such that when one muscle contracts, the other

muscle of the pair relax and vice versa. When the triceps relax, biceps contract and they pull on the radius thus raising [flexes] the fore arm as it bends at the elbow. However, when the biceps relax and the triceps contract, triceps pull on the ulna thus straightening [extends] the arm. triceps are thus called the extensor muscle because it extends the arm at the elbow.

Diagram illustrating bending and straightening of arms



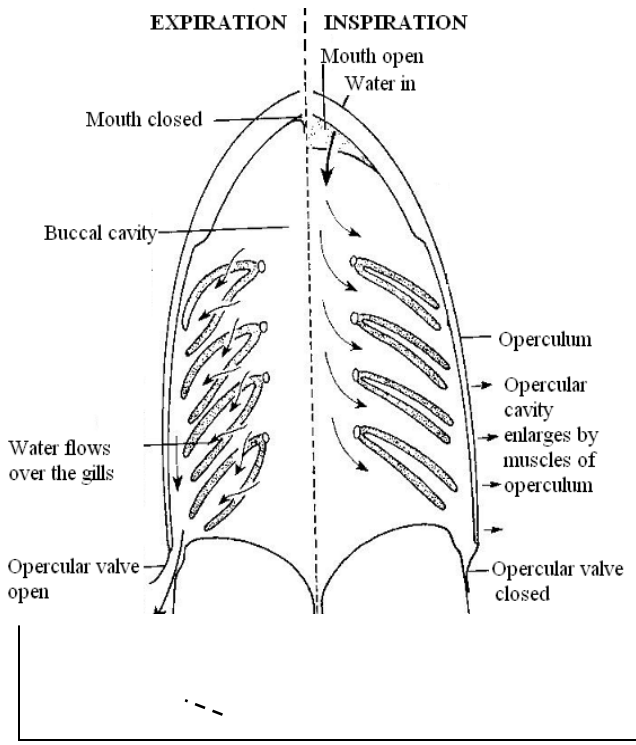
4. (a) Similarities between the respiratory surfaces of a fish and mammals
    - They are both moist to dissolve respiratory gases
    - They are both thin for easy diffusion of gases
    - They both have a large surface area for efficiency
    - They both have blood vessels to transport the absorbed gases
    - They are both many to ensure that a lot of air is transported
    - They are porous to allow diffusion of gases.

(b) Differences between the respiratory system of an insect and that of a frog

Insects	**Frog**
-One respiratory surface i.e tracheoles	-Three respiratory surfaces i.e skin, buccal cavity and lungs.
-Has spiracles	-Lacks spiracles
-Respiratory gases dissolve directly into body cells	-Respiratory gases dissolve into blood and transport to other parts of the body
-Contains no haemoglobin	-Contains haemoglobin

(c) At 4000 metres above sea level there increased breathing rate during exercise than at sea level because there is reduced oxygen partial pressure in air at high altitudes and so increasing breathing rate ensures that the respiring tissues get enough oxygen. On the other hand, there is reduced breathing rates at sea level as one does an exercise because there is high oxygen partial pressures which means enough oxygen reach the respiring tissue with even the slightest breathing rates.

(d) Ventilation and gaseous exchange in fish

	Mechanism of ventilation in bony fish
	• Contraction of the mouth muscles lowers the floor of the mouth, reducing its atmospheric pressure. Water (with dissolved oxygen) moves into the mouth and at the same time the operculum remain closed. • The mouth then opens and the operculum muscles relax; causing them to bulge open; this increases the volume but lowers the pressure in the gill region. • Water from the cavity moves into the gill region due to the reduced pressure; and bathes the gill filaments in opposite direction to the flow of the blood. Oxygen diffuses into the blood capillaries due to its high concentration in the gill region than the blood capillaries; it combines with hemoglobin and is transported as oxyhaemoglobin to the respiring tissues. • Carbon dioxide and toxic metabolic wastes, like ammonia which are at higher concentration in the blood than the gill filaments are excreted into the gills and exhaled through the water that moves out when the operculum opens.

5. (a) Differences between voluntary actions and reflex actions.

Voluntary actions	**Reflex actions**
-Does not occur spontaneously	-Occur spontaneously
-Does not occur very rapidly	-Occur very rapidly
-Many types of nerve cells are involved	-Only three types of nerve cells are involved
-They are mediated by pathways in cerebral cortex of the brain	-They are mediated by pathways in either brain or spinal cord
-Responses to stimuli are always varying according to conditions	-Responses to stimuli are the same

(b) The sequence of events that occur in the ear, until a sound of a bullet fired from a pistol is heard.

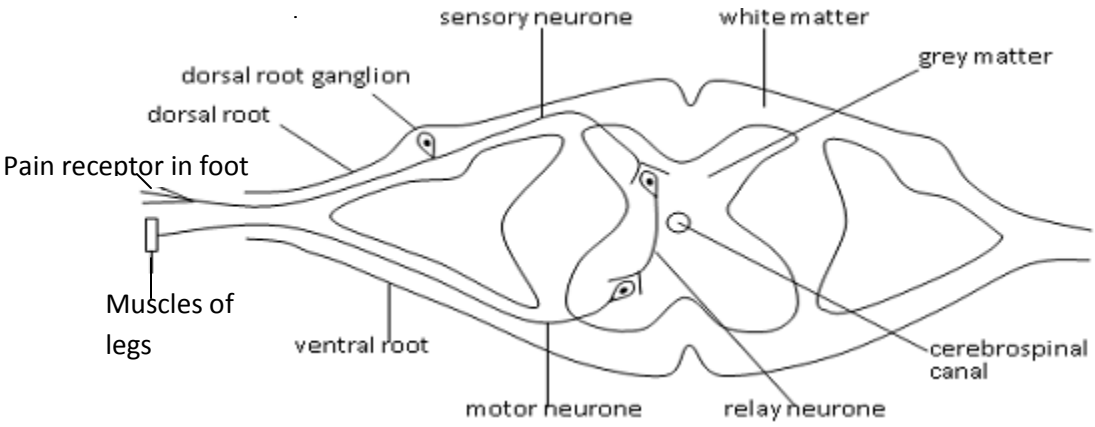
- Sound waves travel in air and they are collected into the ear by the pinna
- They then travel to the auditory canal and to the eardrum (tympanic membrane).
- Contact of sound waves with the eardrum causes it to vibrate.
- Vibration of the eardrum causes the vibration of the malleus, incus and stapes (ossicles).
- The stapes causes the vibration of the oval window and the vibration increases because the eardrum and ossicles are larger than the oval window
- Vibration of the oval window causes the fluid in the cochlea to vibrates
- The message of vibration activates the sensory cells and it is sent through the auditory nerve to the brain, which then interprets that the sound is of a bullet fired from a pistol.

6. (a) A reflex arc is a route or path taken by an impulse in bringing up a reflex action.

(b)(i) Description of quick withdrawal of a leg after being pricked by a thorn.

When Kajubi's leg was pricked, the pain receptors in the foot are stimulated. They generate impulses, which travel along the sensory neurones. They enter the spinal cord via the dorsal root. In the grey matter, the impulses pass to the relay neurons where interpretation takes place. The relay neurones generate impulses that pass to the motor neurones, which leave the spinal cord via the ventral root (see figure below). The motor neurones transmit the impulses to the quadriceps (thigh muscle), which contracts and withdraws the leg from the thorn.

Diagram of a reflex action involving a leg pricked



(ii). Advantages of reflex actions to animals.

- It provides an immediate protective response to organisms in time of danger.
- It provides a control of everyday actions over which we do not have conscious control.
- Reflex actions form the basis of some animals' behavior e.g. Amoebae.

7(a) Adaptations of birds for flight

- Possessing hollow bones to reduce body weight during flight.
- Possession of feather which are used during flight
- Possession of large muscles for moving the wings that causes flight.
- Having streamlined body to minimize air resistance during flight
- Having high visual ability to dodge obstacles and correctly judge distance for landing
- Having well developed brain for efficient coordination of flight muscles and feathers
- High metabolic rate provides the body with high operating body temperature during flight
- Efficient respiratory system with air sacs to provide necessary oxygen for respiration during flight.
- Have efficient circulatory system made of four-chambered heart with powerful muscles for quick transport of nutrients and oxygen to the flight muscles.
- Have forelimb modified into wings for providing large surface area for flight.
- Have extended (deep) keel for attachment of flight muscles
- Have very efficient digestive system for complete digestion to occur hence providing the necessary nutrients to muscles.

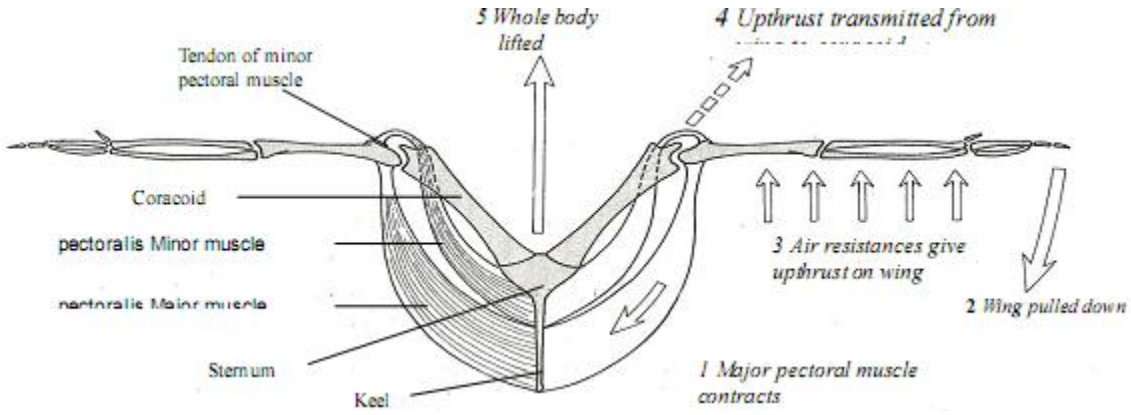
(b) -**Flapping flight**: Involves complex movements of the wings upward and downward against air.

-Gliding flight: Involves the bird spreading out its wings and tails and the body slowly moves forwards or downwards till it lands on tree branch or ground.

-Soaring flight: Is the upward movement of bird by the help of upward air currents to gain height.

(c) **How active flight is brought about in birds**

Flight is achieved by the movement of wings. The wings are moved by powerful direct flight muscles called pectoral muscles attached at the wing base and to the keel like extension of the sternum (breastbone) of the bird. There are two types of pectoral muscles: Pectoralis major and Pectoralis minor During the down stroke,the pectoralis major contracts as the pectoralis minor relax , 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.



8(a) Accommodation is the ability of the eye to focus both distant and near objects.

(b) The following changes occur in the eye to see nearby objects;

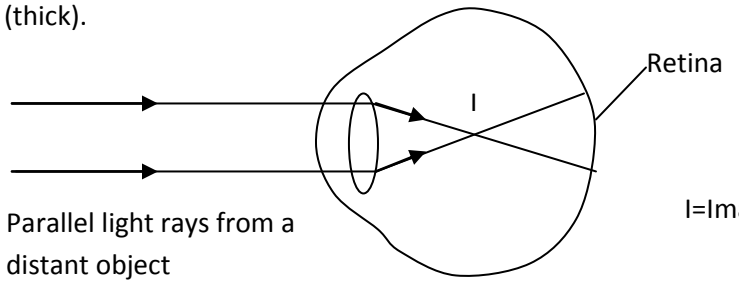
- Diverging light rays from an object reach the cornea where they are refracted
- Ciliary muscles in the ciliary body contract to a smaller circle.
- Suspensory ligaments relax hence slacken and tension is taken out.
- The lens becomes thicker or more convex
- So the refracted light rays at the cornea are focused onto the retina where an image of the object is formed.

Changes which occur in the eye to see distant objects include;

- Parallel light rays from an object reach the cornea where they are refracted
- Ciliary muscles in the ciliary body relax
- Suspensory ligaments contract hence developing tension.
- The lens become thinner or less convex
- So the refracted light rays at the cornea are focused onto the retina where an image is formed.

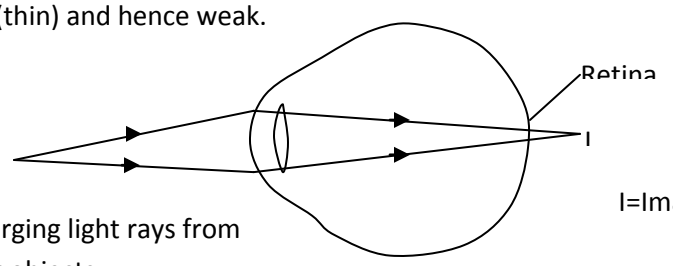
(c) (i) **Short sightedness (Myopia)**

This is the condition whereby light rays from a distant object form in front of the retina, hence one fails to see distant objects. Short sightedness is caused by either the eye ball being too long or the lens being to curved (thick).



Long sightedness (Hypermetropia)

This is the condition whereby light rays from a nearby object are formed behind the retina, hence one fails to see nearby objects. Long sightedness is caused by either the eye ball being too short or the lens being too flat (thin) and hence weak.

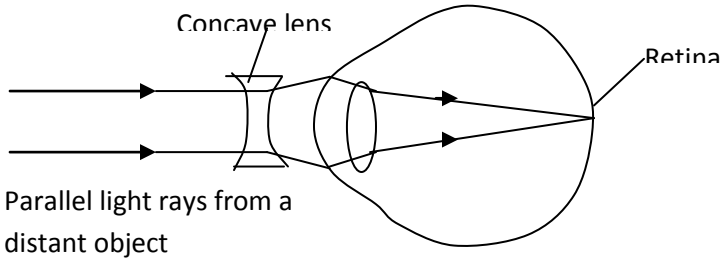


I=Image focused behind the retina

Diverging light rays from near objects

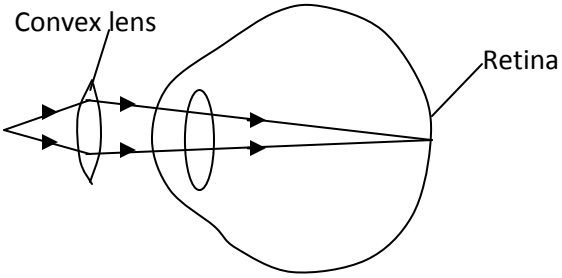
(ii) Correction methods

Short sightedness can be corrected by wearing diverging (concave) lenses, which make the parallel rays diverge, enabling the lens to focus them on the retina.



Parallel light rays from a distant object

Long sightedness can be corrected by wearing converging (convex) lenses, which converge the light rays before they reach the lens, which then converge them on the retina.



9. (a) Differences between asexual and sexual reproduction in spirogyra.

Asexual reproduction	**Sexual reproduction**
-Involves only one parent	-Two parents are usually involved
-Offsprings are identical to parents	-Offsprings are not identical to the parents
-Offsprings arise without fusion of gametes	-Offsprings arise as a result of fusion of gametes
-Many offsprings are produced at a time	-Few offsprings are produced at a time.
-It is a fast form of reproduction	-It is a slow form of reproduction
-It is based on mitosis only	-It is based on both meiosis and mitosis

Similarities between asexual and sexual reproduction include;

- Both produce new individuals or offsprings
- Both involve parent organism(s)
- Both involve mitosis.

(b) Advantages of asexual reproduction to such a plant

- No agents such as those for pollination are required
- Does not involve two sexes since no fertilization occurs.
- Increases the chances of survival since large numbers of offsprings are produced at a time.

(c) Description of asexual and sexual reproduction in mucor

Sexual reproduction is the type of reproduction in which new individuals a rise as a result of fusion of compatible male and female gametes from the parent organisms while asexual reproduction is a type of reproduction in which new individuals a rise from a single parental organism without fusion of gametes.
Mucor is a fungus that reproduces sexually by conjugation. Sexual reproduction occurs when conditions are unfavorable. During conjugation, tips of two hyphae belonging to different mycelia become swollen and grow towards each other till they touch. They are referred to as positive and negative hyphae. Nuclear division takes place in their swelling. Later the end walls disappears and the nuclei fuse in pair, a thick outer coat/cover forms around them to form a zygospore, this remains dormant for as long as conditions are unfavourable and when the favorable (warm, moist) conditions return, germination resumes to give rise to a hyphae at the tip of which is a sporangium that may contain asexual spores.

Asexual reproduction in mucor occurs by sporulation. This mode of reproduction occurs when conditions are favourable. During asexual reproduction, spores having thick resistant coat are produced. These spores are produced and contained in spore cases called sporangia. When released from the spore cases and on reaching a suitable substratum, spores germinate forming new individuals.

10 (a) Transpiration is the loss of water vapour from plants to the atmosphere.

(b) Environmental factors that affect the rate of transpiration include;

- Light intensity
- Temperature
- Humidity
- Wind velocity
- Amount of soil water

(c) An experiment to show that a plant transpires

Materials required

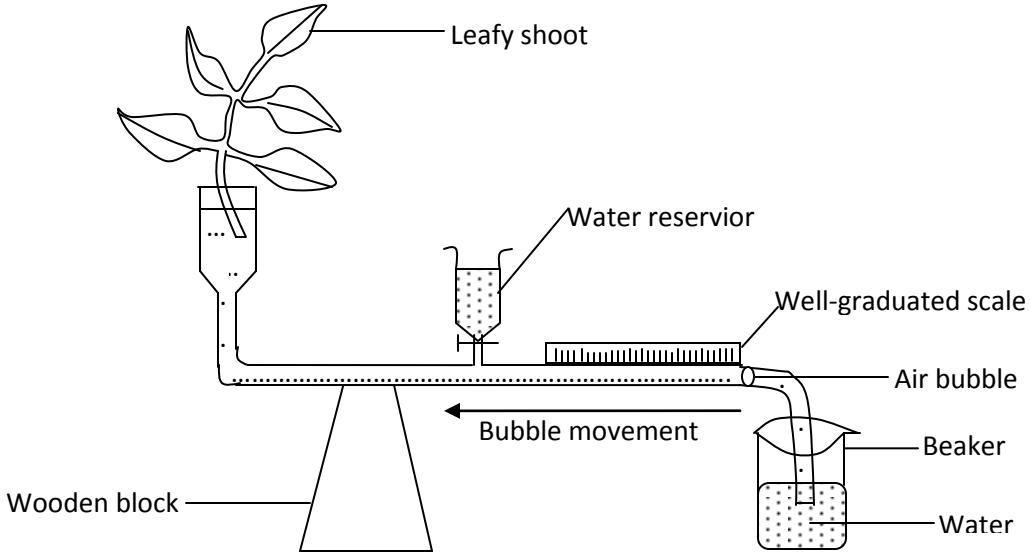
- Very leafy short-stemmed plant
- Potometer
- Sharp knife
- Beaker
- Wooden blocks
- Graduated scale
- Rubber stopper
- Timer (stop clock)

Method/procedure

-A shoot of a leaf plant is cut at its base under water to prevent air bubbles from entering and blocking the xylem vessels.

-The stem of cut shoot is pushed through rubber stopper as far as possible until it is immersed in water.

-Arrange the set up as shown below



-The bubble is introduced at the end of the capillary tube by slightly raising it up from water in the beaker and then back. The air bubble is set at starting point on a calibrated scale. The set up is placed in a well illuminated place and the distance moved by the air bubble is noted every minute.

Observation:

The air bubble continued moving from the starting point along the length of the graduated scale.

Conclusion:

The movement of air bubble is as a result of water lost from the leafy shoot by transpiration.

(d**) Adaptations of desert plants to conserve water**

-Some have a thick waxy cuticle which is impermeable to water e.g cuctus
-Some have leaves modified into spines or thorns to reduce the surface area for water loss.
-Most xerophytes have leaves with narrow lamina to reduce the surface area for water loss.
-Some shed off their leaves to cut down the rate of transpiration.
-Some roll their leaves to trap still and moist air which reduces water loss.
-Some have hairy lamina with hairs in the stomatal positions to reduce stomatal transpiration.
-Some have shinny cuticle which reflects some heat thus reducing the evaporation rate.
-Some have fewer numbers of stomatal pores thus reducing the outlets for water loss
-Some have sunken stomata which lower the rate of transpiration
-Some have succulent tissues in which water is stored by the plant to replace water lost by transpiration.
-Some plants open their stomata at night and close them during day i.e reverse stomatal opening.

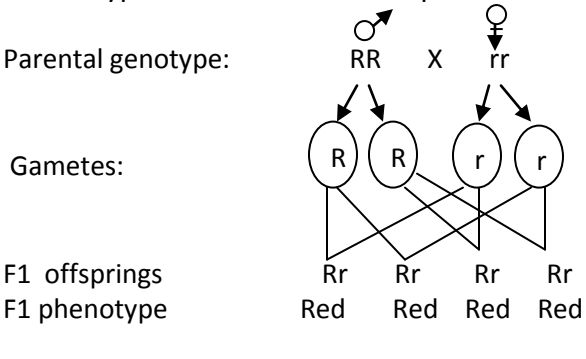
11. (a) Meiosis is the process where by four daughter cells are formed, each with half the number of chromosomes as the parent cell.

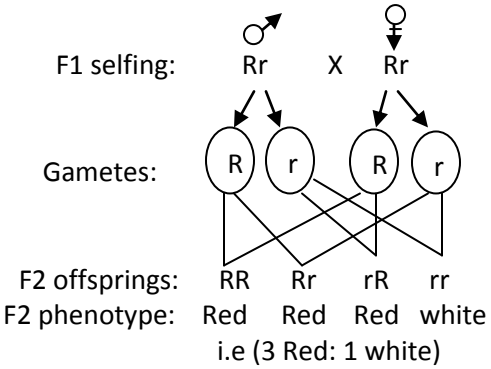
(b) The relevance of meiosis in reproduction

- Because meiosis occurs in reproductive cells, it is important for gamete formation
- Meiosis, by leading to formation of haploid gametes helps in formation of diploid organisms via fertilization in every generation
- During crossing over, there is gene mixing which can lead to genetic variation
- Genetic variation among organisms due to crossing over can lead to evolution
- By forming gametes, meiosis serves as a basis for sexual reproduction

(c) (i)The absence of white flowers in the F1 generation is because the gene for white flower colour is recessive and hence remain suppressed by the gene for red colour.

(i) Let R represent the allele for red flowers
Let r represent the allele for white flowers
Genotype of a red flowered plant =RR
Genotype of a white flowered plant =rr





12. (a) Parasitism is an association between two organisms of different species in which one of them (parasite) obtain food at the expense of another (host).

(b) The life cycle of *Plasmodium falciprum*

When a female anopheles mosquito bites an infected person, it picks up malarial organisms (**gametocytes**). The gametocytes differentiate into male and female gametocytes within the alimentary canal of the mosquito. The haploid gametocytes divide by mitosis to form **gametes**. The gametes fuse to form a zygote (**ookinete**) in the hind part of the alimentary canal of the mosquito. The zygote develops a coating forming **oocysts** within the body cavity of the mosquito. The oocysts rupture (break up) to form spores (**sporozoites**) which get localized in the salivary glands of the mosquito. This mosquito now becomes infective. When this infective mosquito bites another person, the sporozoites are transferred into the body and then migrate within blood to the liver cells where they multiply in number causing them to rupture. Some of the sporozoites multiply and attack the red blood cells maturing into malarial organisms called **trophozoites**. The trophozoites undergo growth to form **merozoites.** The merozoites undergo cell division by meiosis to form **gametocytes** which can be picked up by mosquitoes and the lifecycle is repeated.

(c) **Adaptations of parasites to their mode of life**

- Loss of some organs e.g eyes so as to live in low light areas.
- Possession of resistant cuticle on the body surface to withstand immune reactions of the host.
- Possession of attachment devices to enable them cling onto their hosts e.g. claws in ticks, suckers, and hooks on tapeworms.
- Ability to suspend development by forming cysts and spores e.g *Entamoeba histolytica* forms cysts which withstand adverse conditions.
- Ability to live in adverse conditions such as low oxygen tension, P.H fluctuations, low light intensity.
- Possessing dorso-ventrally flattened bodies which increases the surface area for absorbing digested food.
- Possession of sucking and piercing devices e.g. styles and proboscis in mosquitoes.
- Ability to suppress immune responses of the host.
- They normally have a high reproductive rate and their reproductive lifecycles are short. This increases the chances of survival.
- They inhabit suitable strategic areas of the host so that they obtain food easily and also be able to find their way to a new host e.g HIV that causes AIDS in blood and vaginal/ penile fluids.
- In some cases, parasites may use another organism to transmit their offspring to the host. The organisms are called **vectors.** E.g. the vector for plasmodium is a mosquito.
- Ability to use more that one host. E.g pork tapeworm has two hosts namely pig and man.

13. Methods for studying the distribution of rodents in a habitat

Capture mark and recapture method

This method is used to estimate the population size of organisms such as rodents, insects, birds and fish in water. It is done as explained below:

i. Collect a number of animals from the habitat, using a suitable trap.
ii. Count the captured animals and mark them using permanent ink.
iii. Release the marked animals into the same habitat they came from and leave them for a day or two to mix freely into the rest of the population.
iv. Make a second collection of similar animals from the habitat and note the number of marked individuals in this second sample.

$$\text{Total population} = \frac{\text{No. of individuals in first catch} \times \text{No. of individuals in second catch}}{\text{No. of marked individuals in second catch}}$$

Assumptions made when using this method

i. All the animals captured first do not die or migrate before the second catch
ii. Marked animals mix freely with the marked ones before the second collection is done
iii. All the animals of a particular type have equal chances of being captured
iv. The animals are restricted to one geographical location
v. Sufficient time must elapse between capture and recapture
vi. There is even distribution of animals within the area of study.

14. (a)(i) A mutation is any sudden change in the structure or amount of DNA of an organism i.e. a permanent change in the genetic material.

(ii) Causes of mutation

- Ionizing radiation e.g x-rays, γ (gamma) rays and ultra violet rays. These radiations carry enormous amounts of energy which cause changes in DNA
- High fluctuations in temperature.
- Mutagenic chemicals like nitrous acid, mustard gas, colchicine.
- Certain particles like particles like β- particles.

(b) (i) Mutation leads to changes in structures and forms of organisms which eventually lead into formation of new species and if it affected the gametes producing cells then the same traits can be passed on from generation to generation.

(ii) - If the gene for sickle cell anaemia become deleted by mutation
- If the gene for haemophilia become deleted.
- When the gene for albinism is deleted abruptly.

(iii) By crossing two unrelated species to produce hybrids which are usually triploid or tetraploid, a condition known as polyploidy. These hybrids are normally;

- high yielding so as to meet the needs of the growing population.
- resistant to pest and diseases
- Short stemmed and therefore can not be swept down by storm
- Has high nutrient level
- Reproduces at a very fast rate i.e high reproductive potential

15. (a) Pollution refers to the introduction of substances or energy to the environment at such levels that cause harm to life.

(b) **Causes of air pollution**

- Volcanic eruptions which emit gases like SO_2
- Weathering of rocks. This adds particles of rock to the air.
- Warm air suddenly condensing to form smog (mixture of smoke & fog) polluting of the environment.
- Deforestation causing destruction of forests which would otherwise remove carbon dioxide form the environment.
- Mining minerals especially heavy metals like lead, cadmium. Some of these metals are poisonous to man and his animals.
- Uncontrolled bush burning that cause high temperatures and smokes.
- Wars that produce a lot of sound and energy e.g atomic and nuclear bombs used in wars.
- Use of polychlorinated biphenyls and chloroflourocarbons (CFCs) as pesticides which cause damage to the ozone layer.
- Quarrying and road construction.
- Combustion of fossil fuels by automobiles and other machines that emit. CO_2, CO, SO_2, e.t.c to the atmosphere. These cause the green house effect.
- Industrial emissions.
- Burning of garbage in incinerators

(c) **How to control pollution**

1. Massive education of people about the dangers of pollution.
2. Legislation of laws and policies governing proper management of the environment.
3. Carrying out environment impact assessment before an activity is carried out by man.
4. Carrying out proper methods of waste disposal so as not to contaminate the environment.
5. Recycling some wastes so as not to contaminate the environment.
6. Peaceful conflict resolution to avoid wars, such as those occurring in the Middle East.
7. Controlling population size of man through family planning so as not to encroach on forests and other natural resources.

16. (a) Physical digestion is the breaking down of larger food particles into smaller particles by the grinding action of the teeth while chemical digestion is the breaking down of food into soluble end products by the action of enzymes on food.
(b) Description of starch and protein digestion after eating a meal rich in them;

In the mouth food is chewed using the teeth and mixed with saliva by the tongue. Chewing increases the surface area for enzyme activity. Saliva contains the enzyme salivary amylase/ptylin, which breaks down starch to maltose. It also contains mucus for lubricating the food passage.

Peristaltic movements in the oesophagus/gullet move the food to the stomach. Cardiac sphincter, at the upper end of the stomach controls the amount of food entering the stomach.

Presence of food in the stomach stimulates the walls of the stomach to produce gastric juice. In the stomach the food is churned and mixed with gastric juice, which also contains hydrochloric acid and the enzyme pepsin.

Hydrochloric acid provides the acidic P.H for the activity of enzyme pepsin, which breaks down proteins to peptides. The food then continues to the duodenum through the pyloric sphincter, which controls the rate of food movement from the stomach into the duodenum.

Pancreatic juice and bile are released when the food reaches the duodenum. Bile has no effect on starch and proteins but pancreatic juice contains pancreatic amylase, trypsin and pancreatic lipase. Pancreatic amylase breaks down starch to maltose and trypsin breaks down proteins to short polypeptide chains.

The food continues to the ileum, where succus intericus/intestinal juice is released. Succus intericus contains peptidase enzymes, which break down peptides to amino acids. It also contains maltase enzymes, which break down maltose to glucose.

(c)Adaptations of the ileum for its functions of absorption:

- It is long and heavily coiled thus providing a large absorbing surface area.
- The inner surface is folded thus increasing surface area for absorption.
- It has thin layer of epithelial cells which enables the digested food to quickly pass through it into blood.
- It has numerous finger-like projections called villi which increase the surface area for absorption.
- It contains a dense network of blood capillaries into which products of digestion are absorbed.

17. (a) Diffusion is the movement of molecules or ions from a region of their high concentration to a region of their low concentration whereas Osmosis is the movement of water molecules from a region of their high concentration to a region of their low concentration via a semi-permeable membrane.

(b) Experiment to demonstrate osmosis in potato tubers:

Aim: To show that osmosis occurs in living cells.

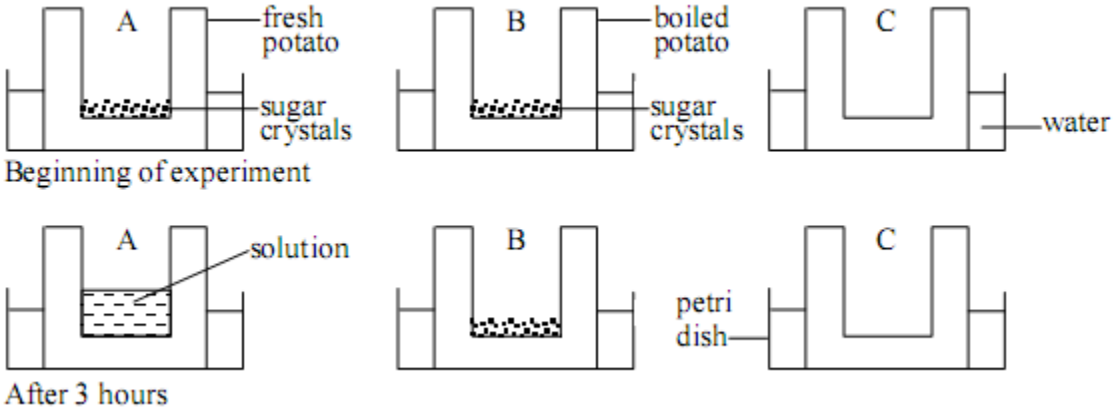
Requirements:

Potato tubers, water, sugar, knife, troughs, heat source

Procedure:

Three cubes A, B and C with a side of 5-10 cm are cut from Irish potatoes. A cavity is scraped in each cube. Cube B is immersed in boiling water for 3 minutes in order to kill the cells. Each cube is placed in a petri dish containing water. Sugar crystals are placed at the bottom of cubes A and B while cube C is left empty. The cubes are left for 3 hours.

Observations: A solution accumulates and rises in the cavity of cube A. In cubes B and C, no solution is seen in the cavity indicating that osmosis has not occurred.



Explanation: In cube A the sugar crystals dissolved in cell sap to form a sugar solution, which absorbed water from the adjacent cells by osmosis. The cells (in contact with water) take up the water molecules, which flow by osmosis across the tissue. Although sugar is present in cube B, dead cells cannot allow osmosis to occur. Although water molecules pass into the cells of cube C, none emerge into the cavity. B and C are controls to indicate that the results in A are due to the presence of sugar crystals in the cavity and to the action of living cells.

Conclusion: Osmosis occurs in living cells.

(c) Adaptations of root hair to its functions

- They are slender and flexible to penetrate between soil particles and absorb water from the soil.
- They lack cuticle which would prevent water from entering root hair cells since cuticles are impermeable
- They are thin which increases the surface area for absorption of water
- They are numerous to provide a large surface area over which absorption of water can take place
- Their sap vacuole has high concentration of salts which creates a high osmotic pressure for water to enter root hair cells.
- They have cells with fully permeable cell wall that allows entry of water.
-

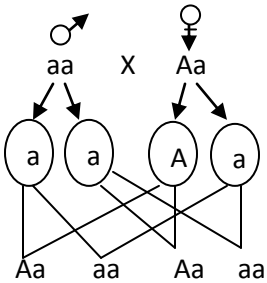
18. (a) (i)Homologous structures are basically similar structures of different organisms modified to serve different functions.

(ii) When different body structures are compared, it is observed that some organisms possess basically similar structures which are serving different functions. It is assumed that the homologous structures were possessed by the ancestors from which modern organisms arose but each ancestor underwent **adaptive radiation** which made the structure to be modified differently and serve different functions. An example of a homologous structure is the pentadactyl limb.

(b) (i) Let a represent the allele for albinism
Let A represent the allele for normal skin color
Genotype of the man = aa
Genotype of the woman =Aa

Parental genotype: ♂ aa X ♀ Aa

Gametes: a a A a



F1 offsprings Aa aa Aa aa Two carriers(Aa), two albino(aa)

(ii) There is 50% chance that their first child will be an albino because 2/4 of the offsprings have aa
i.e $\frac{2}{4}$ x 100% = 50%

(c) (i)Carriers are individuals who carry the allele that causes the defect but are not manifested in their phenotypes
(ii) Aa individuals are carriers.

19. (a) (i) Excretion is the removal of unwanted waste products of metabolism from the body.
(ii) Kidney-Urea, excess water, excess salts
Skin-Water, salts and traces of urea
Liver-Bile pigments
Lungs-Carbon dioxide and water vapour

(b) Urine formation in humans is as a result of ultra filtration and selective absorption. Impure blood from the renal artery, composed of water, salts, urea, glucose, plasma proteins, fat globules and blood cells enters the afferent tubules of the nephrons.

The afferent tubule is wider than the efferent tubule and the glomerulus is densely coiled. Hence, more materials enter compared to those that leave through the efferent tubule. This creates pressure in the glomerulus, which results into ultra filtration. The small and soluble particles penetrate through the pores of the glomerulus to form glomerular filtrate, which moves to the Bowman's capsule. The components of glomerular filtrate include water, salts, urea and glucose.

Glomerular filtrate continues to the proximal convulated tubule where all the glucose, some water and some salts are reabsorbed into the blood stream. Urea is not reabsorbed at all.

The process of reabsorption of water and salts continues down the loop of henle and distal convulated tubule, depending on the requirements of the body.

The excess water, excess salts and urea continue to the collecting duct as a mixture known as urine. This continues to the ureter and it is stored temporarily in the urinary bladder.

(c) Reasons why plants do not have complex organs of excretion include:
- Their excretory products are not very toxic
- Some excretory products are useful to the plants in other processes for example Carbon dioxide a by-product of respiration is used as a raw material in photosynthesis and oxygen a by-product of photosynthesis is used in respiration.
- The metabolic rate in plants is low hence plants produce waste products very slowly.

- Some waste products for example abscisins are sent to the leaves, which then fall off when mature.
- Some plants store waste products within their dead permanent tissues such as barks of stem.

20. (a) Germination is the growth and development of an embryo of a seed into a young plant or seedling under favorable conditions.
(b) Epigeal germination is where by the cotyledon are carried above the ground due to rapid elongation of the hypocotyl upwards whereas hypogeal germination is where by the cotyledons of the seed remain below the ground due to rapid elongation of epicotyl.

Diagram illustrating epigeal germination

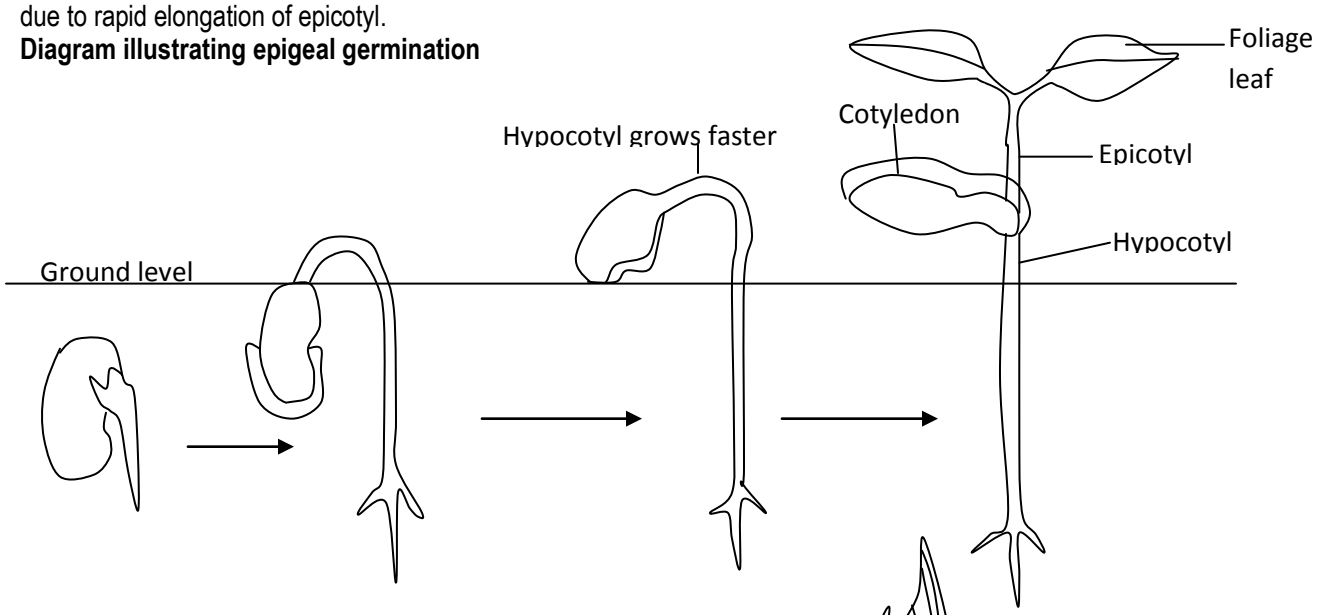
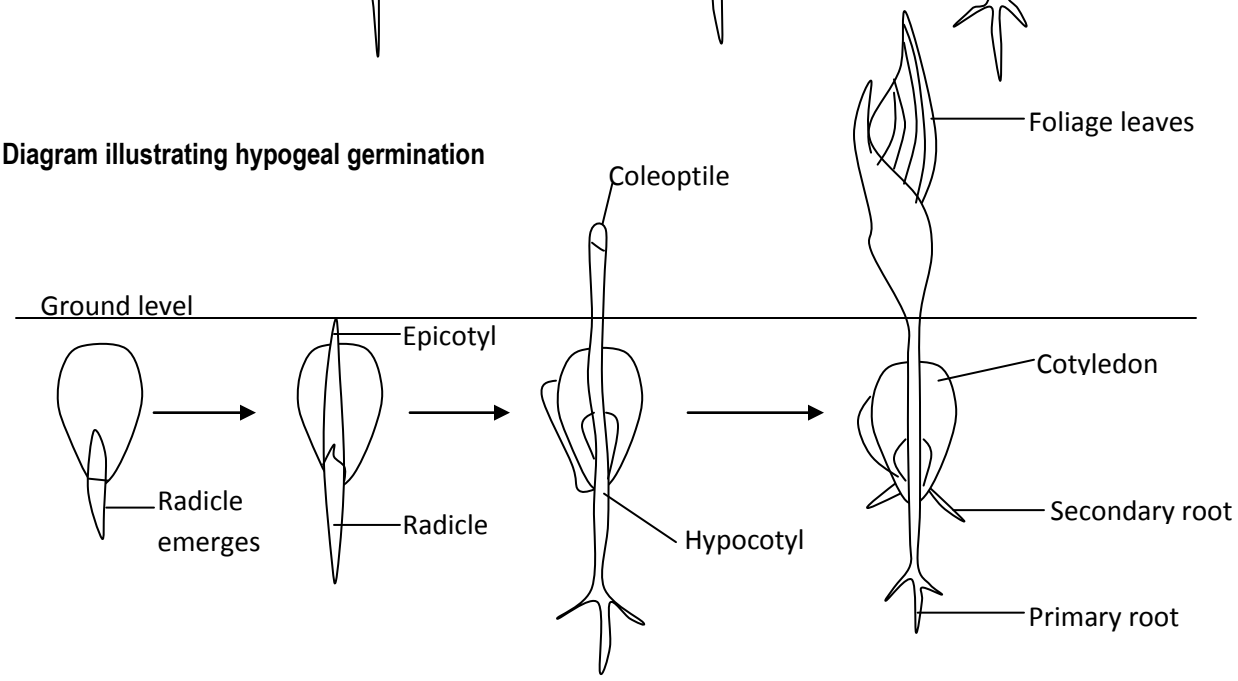


Diagram illustrating hypogeal germination



(c) An experiment to show that heat is liberated by germinating seeds.

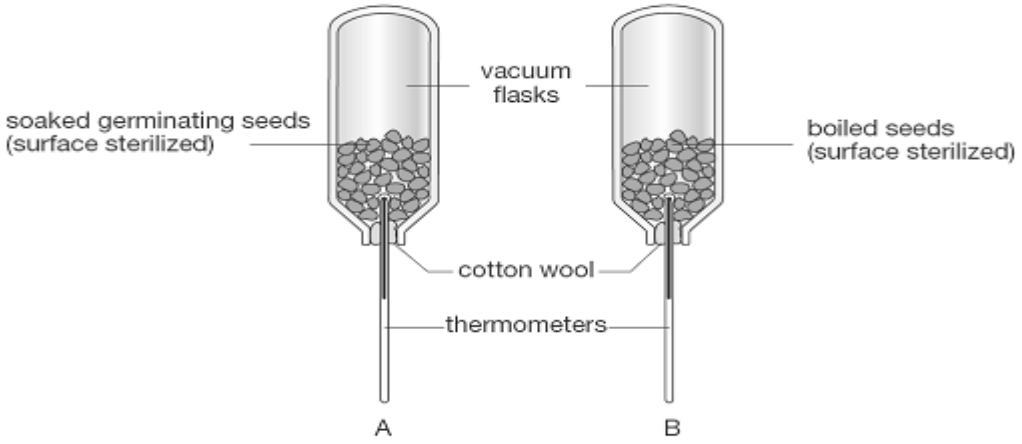
Materials required

-2 small thermos or vacuum flasks
-2 Thermometers
-Cotton wool
-2 Groups of 50 seeds
-1% sodium hypochorite solution
-Timer

Procedure

- The peas are soaked in water for 24 hours

- One group of peas is killed by boiling them in water
- Both sets are rinsed in 1% sodium hypochlorite for 5 minutes in order to kill the fungal spores on the seeds.
- The seeds then rinsed in cool boiled water.
- The Living seeds are placed in one flask labeled A and the boiled seeds are placed in the flask labeled B.
- Thermometers are inserted through the mouth of each flask into the middle of the seeds.
- Cotton wool is plugged into the mouth of the flask
- The apparatus is set up as shown below



Results

Temperature in flask A increases. Temperature in flask B remains unchanged.

Analysis and conclusion

Germinating seeds carry out respiration and produce heat. This leads to an increase in temperature in the vacuum flask. Boiled seeds cannot carry out respiration to produce heat. Therefore the temperature remains unchanged. Thus heat is produced by germinating seed.

21. (a)Family planning is the decision made by a couple on the number of children they feel they should have and at what interval.

(b) Methods of birth control

These are methods used to control unwanted pregnancies. They include;

1. Proper condom use- this method prevents sperms from reaching ovum.
2. Use of contraceptive pills: Pills prevent ovulation and development of graafian follicles.
3. Use of intra uterine devices e.g. coils, loops, which prevent implantation.
4. Vasectomy - this involves cutting and tying of sperm ducts so that sperms never leave the testes
5. Tubal ligation -here oviducts are cut and tied off.
6. Use of spermicides e.g. foaming tablets are placed in the vagina so as to kill the sperms
7. Use of cervical caps-this involves placing the rubber cap at the vaginal end to cover cervix. It prevents sperms from reaching uterus.
8. Rhythm method- this involves not having sexual intercourse during fertile period.
9. Coitus interruptus or withdrawal- this involves the removal of penis before ejaculation. However, this method is very unreliable.
10. Abstinence: This is a natural method of contraception which involves avoiding sexual intercourse. It is 100/safe.

(c) Changes that occur in the female reproductive system from the time of fertilization to birth are;

After fertilization, the zygote undergoes mitotic cell division to form a ball of cells, which later form an embryo. The embryo embeds itself into the wall of the uterus. This process is called implantation.
Villi begin developing between the embryo and the uterine wall and these later develop into the placenta. The thickening of the uterine wall is caused by the increasing level of progesterone hormone.
Through the placenta, food and oxygen are supplied to the embryo from the mother and wastes are removed from the embryo to the mother's body.
As the embryo develops, two embryonic membranes develop:
The amnion, which contains amniotic fluid in which the embryo lies and the chorion. The two membranes are mainly for protection.
The umbilical cord then forms and this has arteries for supplying blood to the embryo and veins, which transports blood away from the embryo to the placenta.
At birth, the membranes break. Oxytocin hormone is released and this causes the contraction of the uterine wall so as to expel the foetus. The placenta and the embryonic membranes are passed out as an afterbirth.

22. (a) Conservation refers to skillful and careful management. It involves sustainable use of natural resources.

(b) The dangers of destroying forests in Uganda.

1. Extinction of some species in our environment.
2. Reduction of biodiversity/losing the variety of living things.
3. Changes in the abiotic factors such as increased temperature due to deforestation.
4. Decrease in agricultural productivity due to loss of soil fertility.
5. Increased competition which can cause conflicts especially in man thereby causing wars.
6. Loss of habitats for some organisms.
7. Soil erosion due to deforestation.

(c) Ways of conserving forests in Uganda

1. Restricting human activities which threaten forests e.g cutting down trees.
2. Practicing family planning to reduce the increasing human pressure to destroy forests due to the ever increasing energy demands as a result of over population.
3. Recycling some materials so that fewer trees are exploited.
4. Planting artificial or man-made forests to supplement energy resources
5. Promoting re-afforestation of endangered or threaten species so as to save them from extinction.
6. Educating people to become aware of dangers of exploiting forests in terms of losing beautiful, fascinating and essential wildlife.
7. Introducing new species of animals and plants of increased production or improved strains.
8. Setting up conventions that ban the exploitation of some forests e.g. Convention on International Trade in Endangered Species (CITES) asked governments to pass laws to pass laws to protect threatened species.

23. (a) (i) Endotherms are organisms capable of maintaining a stable body temperature independent of the environmental temperature, by generating heat metabolically when environmental temperature is low while ectotherms are animals whose body temperature is regulated by behaviour or by the surroundings.

(ii) Why is it important for mammals to maintain a constant body temperature?

- Most body enzymes act efficiently within a narrow temperature range of 35 – 38^{0}C. Excessive temperature exceeding 45^{0}C denatures enzymes and other proteins and below that range inactivates enzymes, both of which are fatal.
- Excessively high or too low temperature disorganizes the structure and functioning of cell surface membranes, and consequently affects entry and exit of substances resulting into death of the organism.

(b)(i) Ways in which endotherms regulate their body temperature

Response to hot conditions	Response to cold conditions
a) **Physical and physiological means**: i) Vasodilation occurs i.e. superficial capillaries dilate to increase blood flow so that much heat can be lost by conduction and radiation. ii) Sweat production by sweat glands increases to enable	a) **Physical and physiological means**: i) Vasoconstriction occurs i.e. superficial capillaries narrow to reduce blood flow so that heat loss by conduction and radiation can be minimised. ii) Sweat production by sweat glands reduces/stops to reduce

evaporation of heat from the skin surface. iii) Panting occurs in birds, dogs to increase heat evaporation from the lungs, pharynx and other moist surfaces for body cooling. iv) Erector pili muscles relax to lower hairs/fur, so that no insulating layer of air is trapped near the skin surface, enabling much heat loss v) Metabolic rate reduces to minimise on the body heat generation. b) **Behavioural means (in man):** i) Taking cold drinks. ii) Putting on light clothing. iii) Moving to shady places. iv) Taking a bath. v) Being active mainly at night (nocturnability)	evaporation of heat from the skin surface. iii) Erector pili muscles contract to cause hairs/fur to 'stand on end' to trap an insulating layer of air near the skin to reduce heat loss by convection. iv) Metabolic rate increases to generate extra heat in the body. This occurs particularly in muscle and liver cells. Special brown fat may also be metabolized. v) Shivering, which the involuntary contractions of the skeletal muscles occurs so as to generate heat metabolically. b) **Behavioural means (in man):** i) Taking hot drinks. ii) Putting on thick clothing. iii) Moving near. iv) Turning on heat in houses.

(ii) Ways in which ectotherms regulate their body temperature

This is mainly achieved through modification of behaviour of the organism, which may include:

- Basking in the sun, at varying angles relative to the sun's rays so as to gain heat e.g. lizards and crocodiles.
- Hiding in burrows, holes or crevices in rocks away from sunlight reduces temperature e.g. lizards.
- Panting and exposing the moist tissues of the mouth, by licking the body surface or by swallowing in water an animal can increase evaporation and so heat loss from the body.
- Thermal gaping, opening the mouth to enable evaporation of moisture from the buccal cavity to cool blood e.g. alligators.
- Thermal dancing when it is hot i.e. lifting of opposite pairs of feet alternately so that they can cool in air e.g. shovel-snout lizards.
- Salivation over the neck and legs in tortoises to increase loss of heat as a result of water evaporating from such surfaces.

24. (a) Seed dormancy is a condition whereby viable seeds fail to germinate under certain conditions.

(b) **Causes of seed dormancy**

-Presence of hard impermeable seed coat
-Dryness and compactness of soil
-Lack sufficient oygen
-Immature embryo of seed
-Presence of germination inhibitors
-Extremes of temperature

(c) **Ways of breaking down seed dormancy**

-By scarification i.e action of bacteria in soil
-Action of fire to burn the hard seed coat
-By pre-chilling i.e exposing seeds to cold period bef
-By providing suitable conditions of oxygen, tempera
-By soaking seeds in water to remove the hard outer s
- Harvesting mature seeds
-Providing growth promoters
-By passing seeds through animal guts.
-Filing the seed coat to make it thin or soft
-Churning seed coat in concentrated sulphuric acid

25. (a) Homeostasis is mechanism of keeping the internal environment of the body of an organism constant regardless of the conditions in the external environment.

(b) Homeostatic control of sugar in the mammalian body

A rise in blood glucose level above the norm (known as **hyperglycaemia**) stimulates beta cells of the islets of langerhans in the pancreas to secrete the hormone **insulin** into blood. Insulin causes decrease in glucose concentration in the blood through;

i) Increased cellular respiration in muscle and liver cells to form carbondioxide and water
ii) Increased glycogenesis (glycogen formation from glucose) in muscle and liver cells
iii) Increased conversion of glucose to fat and protein in adipose tissue
iv) Increased uptake of glucose in muscle cells.

A decrease in blood glucose level below the norm (known as **hypoglycaemia**) inhibits insulin secretion but stimulates alpha cells of the islets of langerhans in the pancreas to secrete the hormone **glucagon** into blood. Glucagon causes increase in glucose concentration in the blood through:

i) Increased **glycogenolysis** (hydrolysis of glycogen to glucose).
ii) Increased formation of glucose from amino acids and glycerol. The formation of glucose from non-carbohydrate sources is called **gluconeogenesis.**
iii) Decreased metabolic rate

(c) Why is the liver considered to be the most functionally diverse organ of the body
The liver is the most functionally diverse organ because it executes several functions in the body than any other organ, some of these functions are;
-Regulation of blood sugar level of the body
-Deamination of excess amino groups
-Synthesis of fibrinogen which important in blood clotting
-Storage of vitamins and mineral salts
-Detoxification i.e converting harmful substances like ammonia to harmless substances
-Regulation of body temperature
-Excretion of bile pigments
-Storage of blood.

26. Describe the menstrual cycle, with reference to the alternation of menstruation and ovulation.
This refers to a series of changes that occur within the uterus of a female after the onset of puberty. It takes/lasts about 28 days in human being and the first menstrual cycle of a girl is called menarche.
The menstrual cycle is controlled by four hormones of which two are secreted from the anterior lobe of pituitary gland and the other two from ovaries. The pituitary gland secretes follicle stimulation hormone (FSH) and luteinising hormone (LH) and the ovary secretes progesterone and Oestrogen. The four hormones are secreted in the following sequence. The menstrual cycle is controlled by hormones released from the pituitary gland and the ovary. Shortly after menstruation, the hypothalamus releases a hormone called gonadotrophin releasing hormone. This hormone stimulates the anterior part of the pituitary gland to release follicle stimulating hormone (FSH). FSH causes the development of the follicles that contain ovum and also stimulate the ovaries to secrete Oestrogen. Oestrogen causes healing and repairs the uterine wall that was damaged by the previous menstruation, promotes further development of the ovum, Inhibits further secretion of FSH, and stimulates the release of luteinising hormone (LH) by the anterior lobe of the pituitary gland. LH brings about the release of the ovum from the ovary into the oviduct funnel a process called ovulation and causes the mature ovum (Graafian follicle) to change into a corpus luteum.Corpus luteum secrets progesterone, which cause further healing and strengthens uterine wall in preparation for implantation.Progesterone also inhibits the further release of LH from the pituitary gland which in turn inhibits the release of LH resulting in the degeneration (breakdown) of the corpus luteum-if pregnancy does not occur. With the degeneration of the corpus luteum, the production of progesterone is stopped. This leads to the breakdown of the uterine wall resulting in menstruation and the cycle is repeated. In man, the menstrual cycle takes about 28 days.

27 (a) Immunity is the body's ability and capacity to resist a disease.
(b)(i) Innate immunity is the type of immunity an individual is born with whereas acquired immunity is the resistance developed by the body during its life time exposure to different infections.
(ii) Natural active acquired immunity involves the body itself making antibodies after being exposed to an infectious agent e.g contracting flu and recovering from it without taking any drugs. While natural passive acquired immunity is where already formed antibodies from one individual are passed to another of the same species. e.g passing of antibodies passively from the mother to the foetus via placenta or to baby via breast feeding
(iii) In artificial active acquired immunity there is introduction of vaccine into the body through immunization/vaccination, which induces the body's immune system to produce corresponding antibodies towards

the pathogens. While in artificial passive acquire immunity there is introduction of usually manufactured chemical substance into the person's body to fight a disease or infection. e.g swallowing of antimalarial drugs when a person is suffering from malaria

(c) Causes of diseases include;

- Insufficient intake of nutrients hence causing deficiency diseases e.g Scurvy, Kwashiorkor,etc.
- Genetice abnormality which causes hereditary diseases e.g Haemophilia
- Misuse and abuse of drugs which causes mental dysfunctions
- Pathogenic bacteria e.g gonorrhea is caused by certain bacteria
- Some fungi causing fungal diseases e.g ringworm
- Some viruses causing viral diseases e.g AIDS is caused by HIV
- Some protozoans e.g Amoeba causing amoebic dysentery

28. (a)Growth is defined as the permanent increase in size or dry weight of an organism.

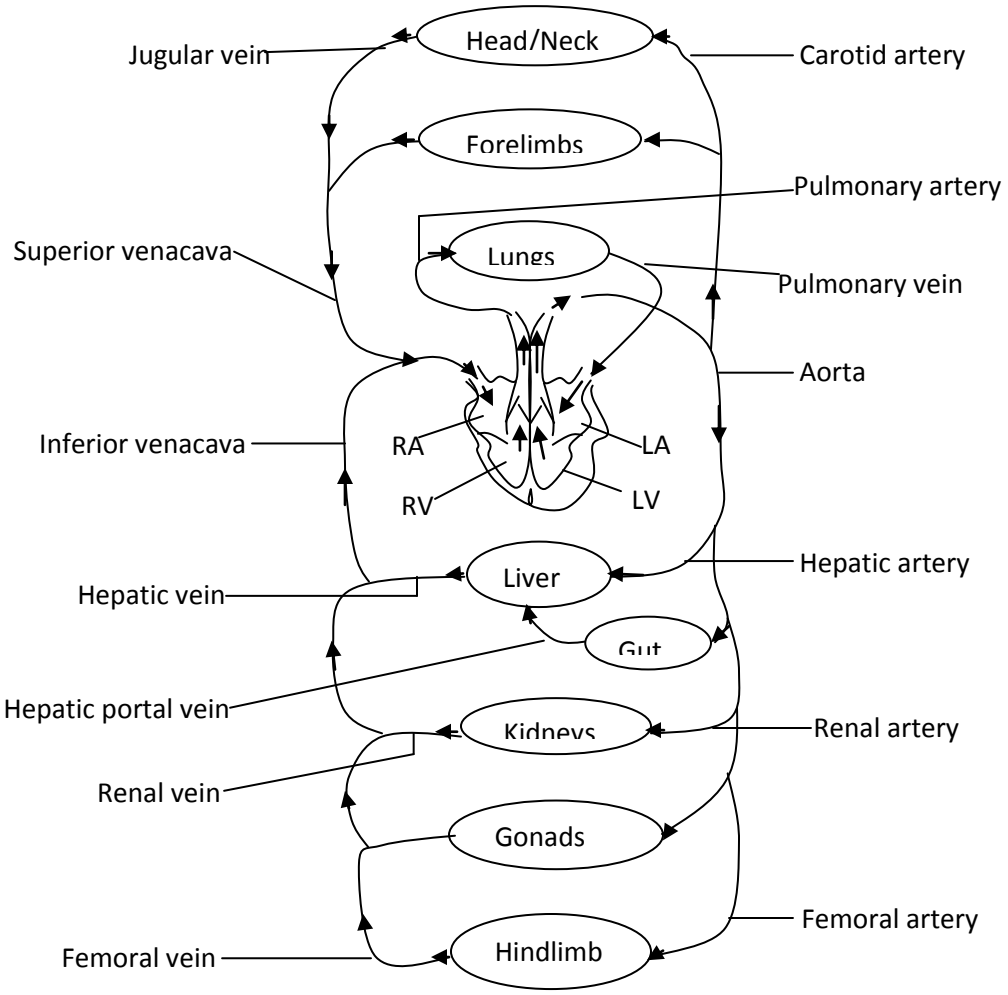
(b) **Factors that affect growth**

-Temperature
-Light
-PH
-Amount of nutrients available for the organism
-Hereditary factors
-Hormones
-Diseases
-Water, oxygen, etc

(c) (i) Primary growth is growth that occurs at the apexes of shoot or roots leading elongation or increase in length of shoot or roots while secondary growth refers to increase in girth or thickness of plant's shoot or roots.

(ii) Secondary growth leads to increase in thickness of the stem hence giving extra support to tall plants.

29. (a) A plan drawing of the mammalian circulatory system



(b) List the components of blood giving functions of each blood component

Blood is a red-coloured liquid consisting of the blood cells and plasma (a pale yellow fluid). Plasma contains serum (liquid component minus the clotting proteins), plasma proteins (e.g. globulin and albumin), hormones, digested food, antibodies, excretory products, respiratory gases etc. A normal adult person has about 4.5 litres of blood.

Blood components

1. Red blood cells: The function of erythrocytes is to transport oxygen to the tissues.
2. White blood cells: The function of leucocytes is to defend the body against diseases.
3. Platelets: they are important in formation of blood clot
4. Plasma proteins: contains antibodies which attack antigens
5. Serum: Responsible for causing immunological reactions.
6. Hormones: Are found in plasma and are for regulating body processes and functions.
7. Excretory products: contains wastes products which are eliminated from the body
8. Digested food: For growth and repair of cells
9. Oxygen: for respiration
10. Carndioxide: For removal from the body

(c) How are red blood cells adapted to their functions.

- Erythrocytes are many to increase the surface area for carrying oxygen.
- They have a thin membrane to minimize the diffusion distance.
- They have large quantities of haemoglobin (about 2.5×10^{8} haemoglobin molecules/red blood cell), which has a high affinity for oxygen.
- They lack nuclei when mature to increase the surface area for packing Hb hence more oxygen.
- The biconcave shape increases the surface area for packing oxygen.
- They lack mitochondria (therefore generate their ATP by anaerobic metabolism). This minimizes the consumption of the oxygen the erythrocytes carry.
- They are small (about 12 μm in diameter) to provide a large total area of the plasma membrane in a given volume of blood. This facilitates the diffusion of large amounts of oxygen into the erythrocytes.

30. (a) A pentadactyl limb is the limb composed of five digits possessed by all vertebrates

(b) Appendicular skeleton is the skeleton of the limbs [legs/hind limb and arms/fore limbs] and limb girdles [pectoral and pelvic girdle while axial skeleton is the skeleton of the trunk which is made of skull, bones of the vertebral column, ribs and sternum.

(c) -Cervical vertebra: Located at the neck region

-Thoracic vertebra: Located in the thoracic region where ribs are attached

-Lumber vertebra: Located in the abodominal region

(d) Differences between cartilage and bones

Cartilage	**Bone**
-They are soft and flexible	-Hard and compact
-Has no nerves	-Has nerves
-Does not produce R.B.C	-Most bones form R.B.C
-Occurs widely in foetus	-Widely occurs in adults
-Growth rate is more rapid	-Growth rate is low
-Low Calcium content	-High calcium content
-Contains no blood vessels	-Contains blood vessls
-Lacks marrow	-Long bones have marrow
-Cartilage isn't long lasting	-Bone is long-living
-Cartilage cells are arranged singly in pairs or rows scattered in ground substance	-Bone cells (osteoblasts) are arranged concentrically around nerves and blood vessels.

THE END