UNIT 1: PLANT STRUCTURE AND FUNCTION

- Flowering plants consist of the shoot system (structures above the ground) and the root system (structures below the ground).
- The shoot system consists of the stems, leaves and flowers.

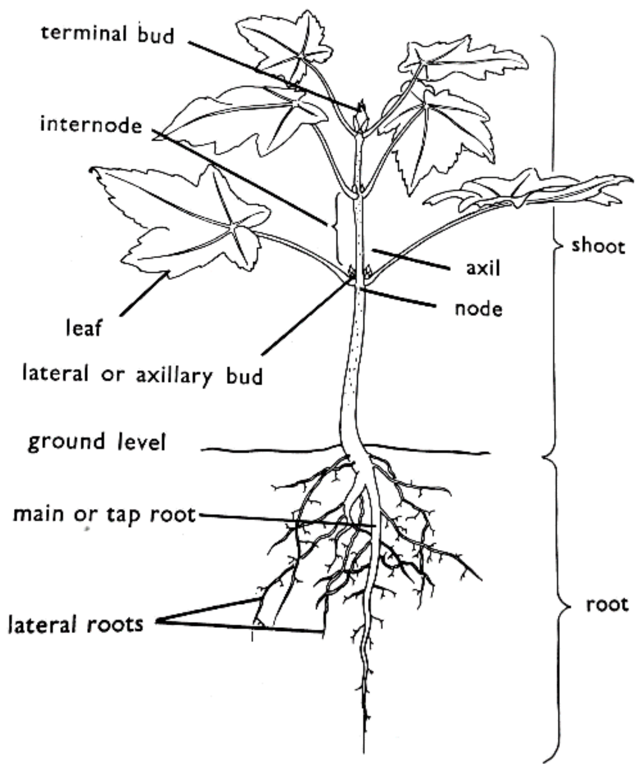
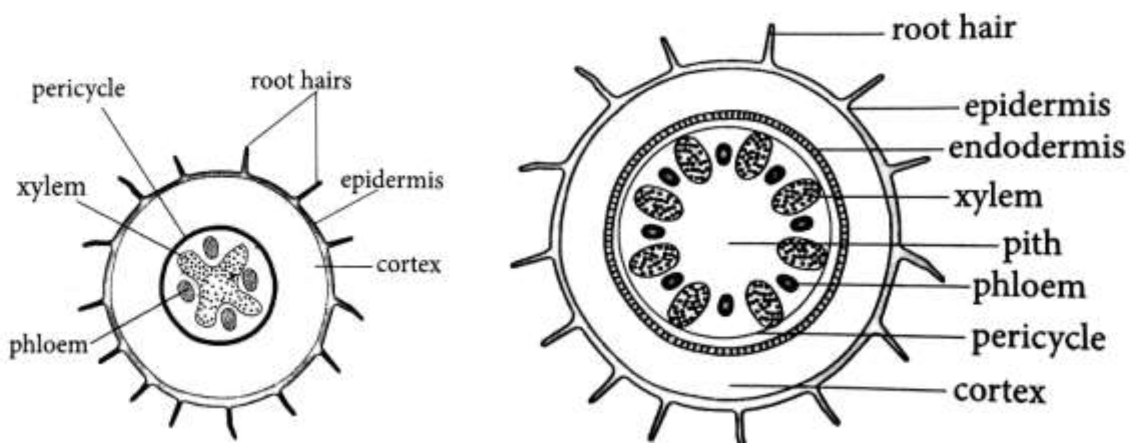


Fig. 1.1:The structure of typical flowering plant

Structure and Function of Roots, Stems and Leaves

Roots

- Roots of monocot and dicot plants contain the same types of tissues but the arrangement of the tissues is different.



(a) dicotyledonous root *(b) monocotyledonous root*

Fig. 1.2: Tissue arrangement in monocot and dicot roots

- The root consists of the following parts:

Epidermis

- It is a layer of closely packed cells
- There is no waxy material covering the epidermis. This allows water to be taken up by the root.
- Near the tip of the root, there are root hair cells. Root hair cells increase the surface area so that more water can be absorbed.
- The epidermis protect the root from injury.

Cortex

- The cortex is beneath the epidermis.
- It is made up of many layers of thin- walled parenchyma cells.
- The function of these cells is to transport water from the root hairs to the xylem.
- The cortex also store starch.

Endodermis

- It is a single layer of cells found around the central vascular tissue
- The cell wall of the endodermis have a waxy, waterproof band called **Casparian strip**. This helps to channel the movement of water into the xylem.

Pericycle

- The pericycle is formed by a single layer of parenchyma cells
- Lateral roots are formed from this layer.

Vascular Tissue

- It consists of xylem and phloem.
- Xylem conduct water and mineral salts
- Phloem conduct organic food
- Xylem tissue in dicots form a star shape with the phloem between the rays of xylem.
- In monocots the xylem and phloem are arranged in a circle.

Cambium

- These are cells in dicot roots that can divide by mitosis and produce more xylem and phloem cell.
- They are found between xylem and phloem cells.

Pith

- It is found in monocots roots.
- It is made of parenchyma tissue and has storage function.

Functions of Roots

- It anchor the plant in the soil.
- It absorb water and mineral salts from the soil.

Stems

- The stem is made up of the following parts: epidermis, cortex, vascular bundles and pith.

Epidermis

- The epidermis in young, green plants is a single layer of cells that are closely packed together. The cells are covered with waxy cuticle to reduce water loss.
- In woody stems, the epidermis is made of a number of layers and is known as bark.

Cortex

- The cortex is made up of thin walled parenchyma cells with large air spaces.
- The cortex store organic food
- It also assist in gaseous exchange
- It also provide support to the plant.
- A layer of collenchyma cells with thickened corners may be present in the cortex, forming an endodermis.

Vascular Bundles

- The xylem is on the inner side and phloem is on the outer side of the vascular bundle. The cambium separates the xylem from the phloem.
- The cambium produces secondary phloem and xylem through cell division which increases the diameter of the stem
- A cap of sclerenchyma tissue is found between the endodermis and the phloem to provide strength and support for the vascular bundles.
- In dicotyledonous stem e.g. bean stem the vascular bundles are arranged to form a ring.

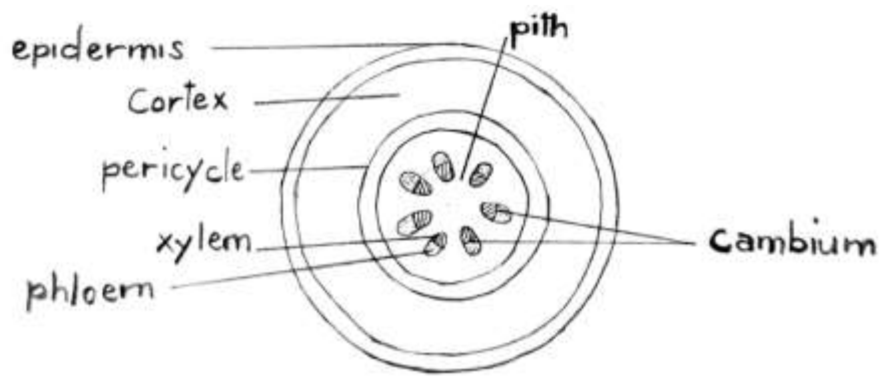


Fig. 1.3: Distribution of vascular tissues in stem of dicotyledonous plants

- In monocotyledonous stem e.g. maize stem the vascular bundles are scattered in no pattern.

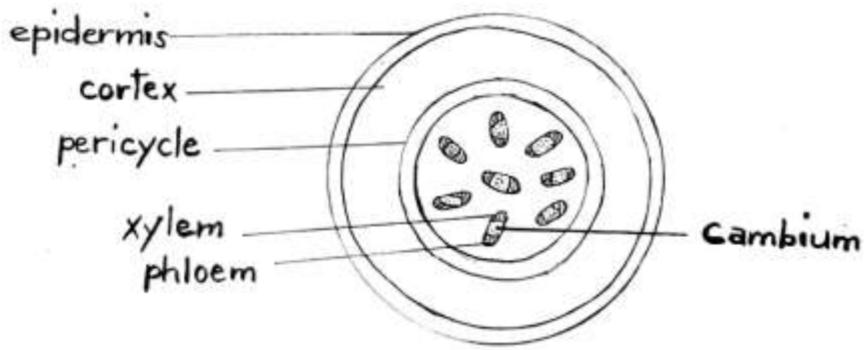


Fig 1.4: Distribution of vascular tissues in stem of monocotyledonous plants

Pith

- The central pith is made up of parenchyma cells. Starch is stored in these cells.

Functions of Stems

- It gives support to the parts above the ground.
- Transport substances across the plant.

Leaves

- Make food for the plant during photosynthesis.
- Contain small openings called stomata which allows gaseous exchange

The Structure of Leaves

- A leaf consists of a broad, flat part called the **lamina**, which is joined to the stem of a plant by a leaf stalk or **petiole**.
- Inside the leaf stalk and veins there are the vascular bundles which contain tubes called **xylem** and **phloem**. The xylem brings water and mineral salts to the leaf and the phloem takes away the organic substances (food) to other parts of a plant after being produced.

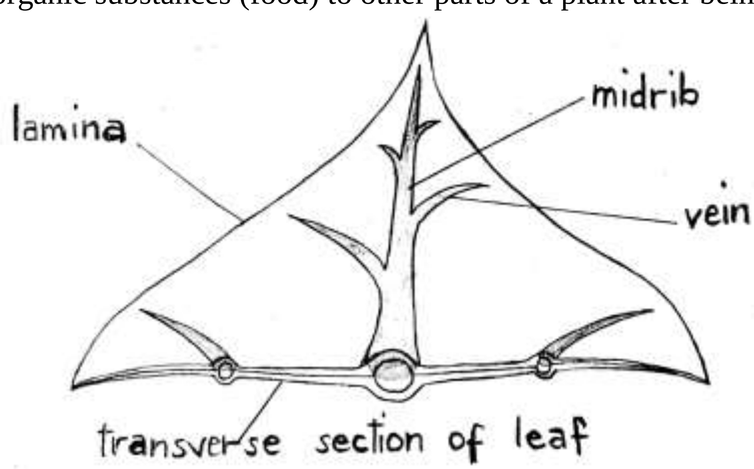


Fig. 1.5: The external parts of a leaf

- Even though the leaf is so thin; it has several layers of cells inside with different functions. These layers can be seen if you look at a transverse section of a leaf under a microscope.

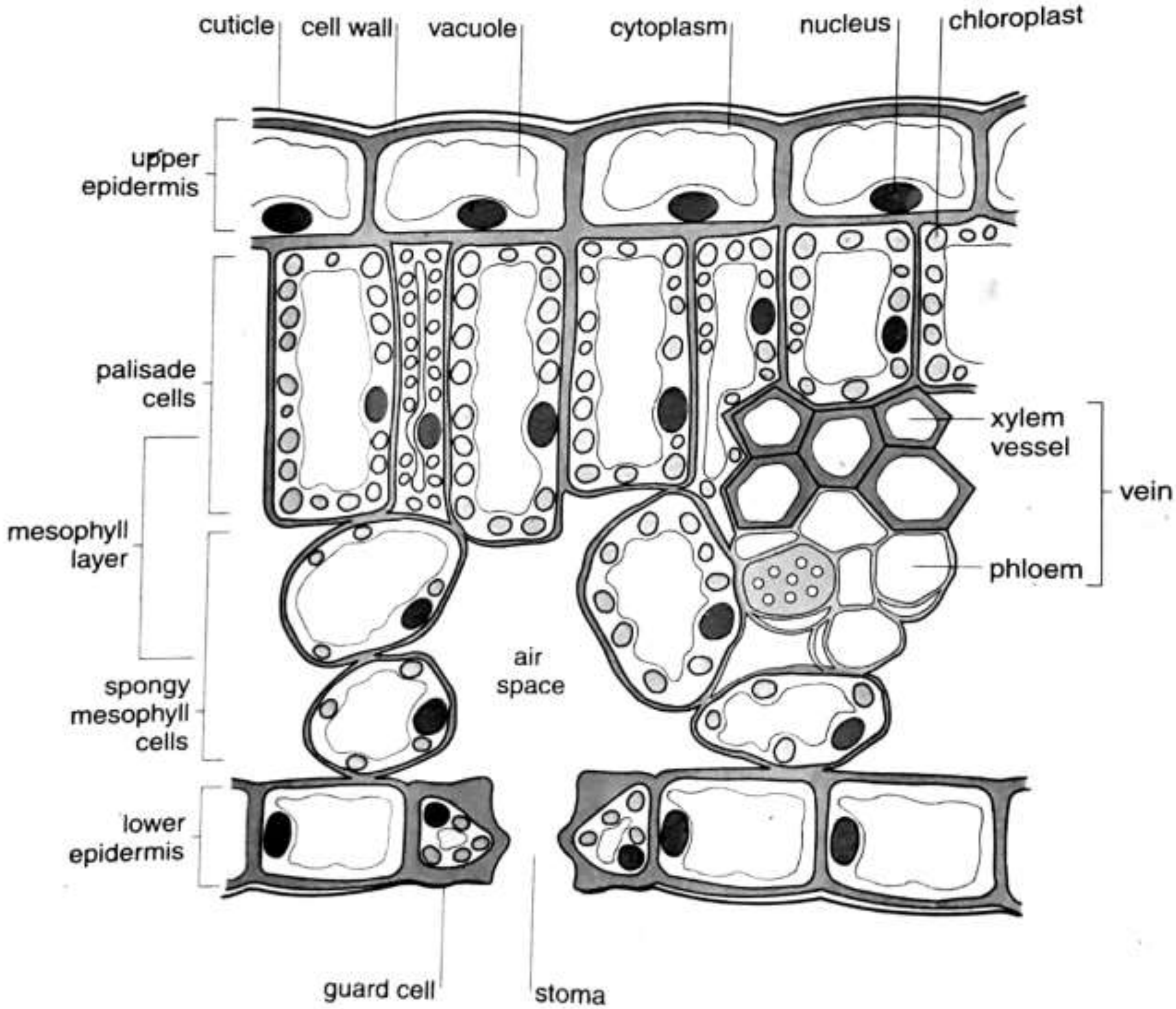


Fig. 1.6: Transverse section through part of a leaf

Functions of Parts of a Leaf

Cuticle

- It is a thin waterproof layer found on both upper and lower surfaces of the leaf.
- It is transparent to allow light to pass through.
- It prevents excess loss of water by evaporation.
- It prevents unnecessary entry of water through the leaf surfaces.
- It protect the internal parts from physical forces.
- Hairy cuticle protects the leaf from predators as it is not palatable.

Upper and Lower Epidermis

- They consist of one layer of thin flattened cells which do not contain chloroplasts so sunlight can pass through them to the layers of cells below.
- They protect the inner layers of cells in the leaf.
- They secrete a waxy substance called **cuticle**.

Mesophyll Layer

- The mesophyll layer forms the middle part of leaf ($meso = middle\ and\ phyll = leaf$).
- It consists of two tissues:
  1. Palisade mesophyll and
  2. Spongy mesophyll.

1. Palisade Mesophyll Tissue

- This is a layer of cells located below the upper epidermis.
- It contains cylindrical cells called **palisade cells**.
- It is the main site of photosynthesis in the leaf.

Adaptations of Palisade Mesophyll Tissue to its Function

(i) Palisade cells contains numerous chloroplasts, which traps more sunlight energy.
(ii) Palisade cells are tightly packed. This provide a large surface area for photosynthesis.
(iii) Palisade cells are arranged in a single layer for easier penetration of light.

2. Spongy Mesophyll Tissue

- This is a layer of cells just above the lower epidermis.
- It contains irregular- shaped cells called **spongy cells**. The cells are loosely arranged.
- Spongy mesophyll cells are lined with moisture to facilitate uptake of oxygen and release of carbon dioxide gases.
- They have fewer chloroplasts than the palisade mesophyll cells hence they photosynthesise a little.
- They have large air spaces between them which allow gaseous exchange between the cells and the air surrounding them.
- The spongy cells store starch produced by photosynthesis.

Vascular Bundles

- The network of veins in the leaves is made up of vascular bundles.
- Vascular bundles consist of two kind of cells:
  1. **Xylem** which supply water and mineral salts to the leaf.
  2. **Phloem** which take away the manufactured food substances from the leaf to other part of the plant.

Stomata

- These are pores on the surface of the leaf.
- There are more stomata on lower surface of a leaf than on the upper surface. The advantage for this is that evaporation is prevented since the lower surface is not directly exposed to the sunlight.
- Stomata has the following functions:

  (i) For gas exchange

  - The stomata allows oxygen produced within the leaf during photosynthesis to diffuse into the atmosphere. The stomata also allows carbon dioxide from the atmosphere to diffuse into the leaf. This happens during the day since the rate of photosynthesis is higher than the rate of respiration, therefore more oxygen is produced than is used for respiration hence a surplus of oxygen diffuses out of the leaf into atmosphere. The carbon dioxide produced as a result of respiration is used by photosynthesing mesophyll cells for photosynthesis, but since the rate of respiration is lower than the rate of photosynthesis, the amount of carbon dioxide in the leaf becomes less than that outside hence carbon dioxide from the atmosphere diffuses into the leaf.

- At night carbon dioxide produced during respiration diffuses from the leaf into atmosphere through stomata, since there is no photosynthesis to use the carbon dioxide, and oxygen which is used for respiration diffuses from atmosphere into the leaf through stomata, since there is no photosynthesis to produce oxygen.

(ii) For transpiration

- Excess water diffuses from the leaf into the atmosphere through stomata. Each stoma is surrounded by the bean- shaped epidermal cells called **guard cells**. These cells open and close the stoma. The loss of water in guard cells leads to the closing of stomata. The gain of water leads to the turgidity (swelling) of guard cells through pulling away of thinner sides thereby opening the stomata.

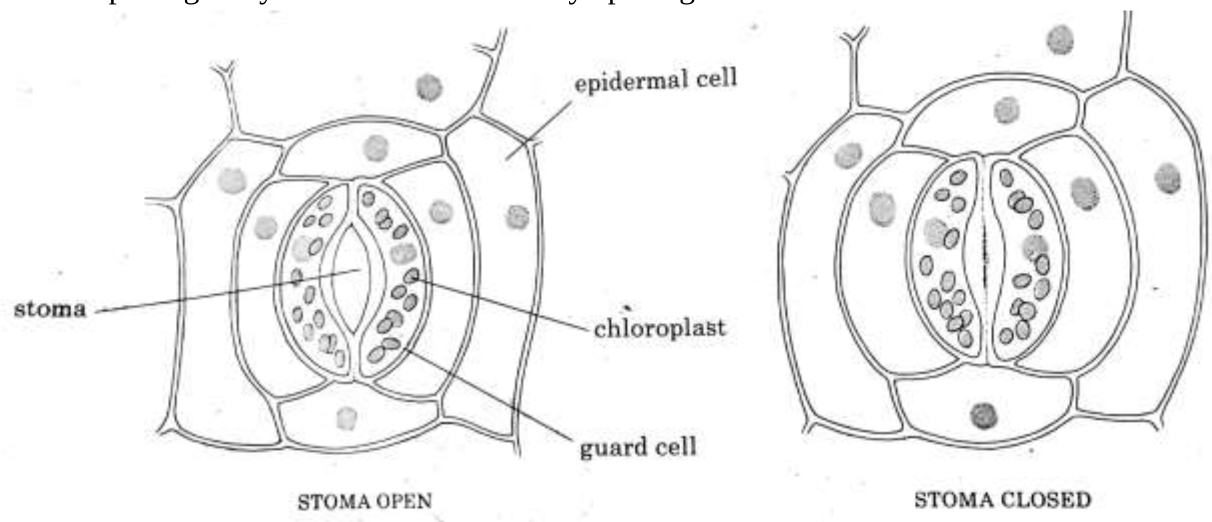


Fig. 1.7: Appearance of stoma in leaf epidermis

- A guard cell is different from an epidermal cell in the following two ways;
  1. The guard cell is bean- shaped while the epidermal cell is not bean- shaped.
  2. The guard cell has chloroplasts while the epidermal cell has no chloroplasts.

Adaptation of the leaf in photosynthesis

1. The leaf has broad and flattened surface which increases the surface area for absorption of carbon dioxide and trapping light for photosynthesis.
2. The leaf is supported by the stem and petiole. This exposes as much of the leaf as possible to sunlight and air.
3. The leaf has thin lamina.
   - This allows sunlight to penetrate to mesophyll cells where photosynthesis occurs.
   - This also reduces the distance across which carbon dioxide diffuses from stomata to the photosynthetic cells.

4. The spongy mesophyll layer cells are loosely packed with large intercellular air spaces. These acts as storage space for carbon dioxide and therefore, facilitate gaseous exchange.
5. The leaf has network of veins. These provide a good water supply to the photosynthesing mesophyll cells.
6. The upper epidermis is thin and transparent and hence allows easier penetration of light to the palisade cells which contain chloroplast.
7. Palisade mesophyll cells are cylindrical, closely packed in a single layer for easier penetration of light
8. Mesophyll layer contain chloroplasts which has chlorophyll. Chlorophyll traps light energy which is used in the process of photosynthesis.
9. The leaf has stomata on its surface. These allow carbon dioxide and oxygen to diffuse in and out.
10. The leaves of the plant are arranged in an orderly pattern without overlapping with one another to ensure maximum exposure to sunlight.
11. Inside the chloroplasts, the chlorophyll is spread out on flat membrane, so exposing as much chlorophyll to sunlight as possible.
12. The surface of the leaf is covered by a waxy cuticle that is waterproof, which reduces water loss.
13. Leaves have guard cells which control the opening and closing of stomata hence controlling water loss through stomata.

The Structure of a Mesophyll Cell

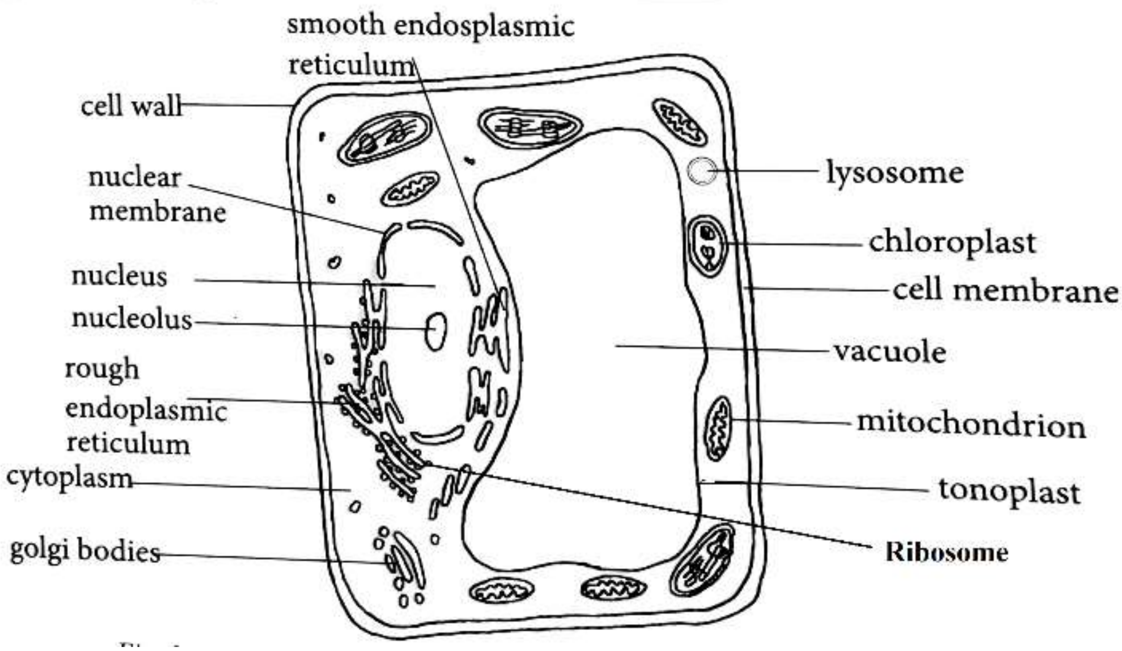


Fig. 1.8: A generalised mesophyll cell (as seen through an electron microscope)

The Nucleus

- It is surrounded by the nuclear membrane and contains nucleoplasm and nucleolus.
- It has nuclear pores within the nuclear membrane.

Functions of Nucleus

(i) It controls all activities of the cell such as cell division

(ii) It stores the genetic material of the cell in form of chromosomes.

(iii) Nucleolus synthesises ribosomes using the information contained in DNA.

Cell Membrane

- This is a thin layer of protein and fats
- It is semi-permeable (selective) i.e. it allows some particles to pass across it but not others depending on their sizes.

Functions of Cell Membrane

(i) It encloses the contents of the cell.

(ii) It regulates the movement of materials in and out of the cell.

Cell Wall

- The cell wall is the most outer part of plant cells.
- It is fully permeable.
- It is made of carbohydrate called **cellulose**. Cellulose is tough and resists stretching.

Functions of Cell Wall

(i) It gives firmness and fixed shape of a plant cell. This is due to the presence of cellulose.

(ii) It has pores called **plasmodesmata** which allow movement of substances between cells.

(iii) It protects the cell from bursting due to osmosis.

Cytoplasm

- It is composed of all the cell contents except the nucleus. Cytosol is the fluid and semi-liquid part of cytoplasm.

Functions of Cytoplasm

(i) It is the site for various chemical processes.

(ii) Cytosol support various organelles. Organelles are small structures which perform particular functions in a cell.

(iii) It contain many various substances (food nutrients, mineral ions, dissolved gases and vitamins).

Vacuoles

- It is a fluid- filled sac bounded by a single membrane called **tonoplast**.
- It is filled with cell sap (an aqueous solution of sugars and other substances).

Functions of Vacuole

(i) They store food substances (amino acids and sugars) for the cell.

(ii) They hold the plant upright when filled with water.

(iii) They store organic waste products e.g. tannins.

Mitochondria (Mitochondrion- singular)

- It has outer and inner folded membrane enclosing a liquid matrix. The folds are called **crista**.

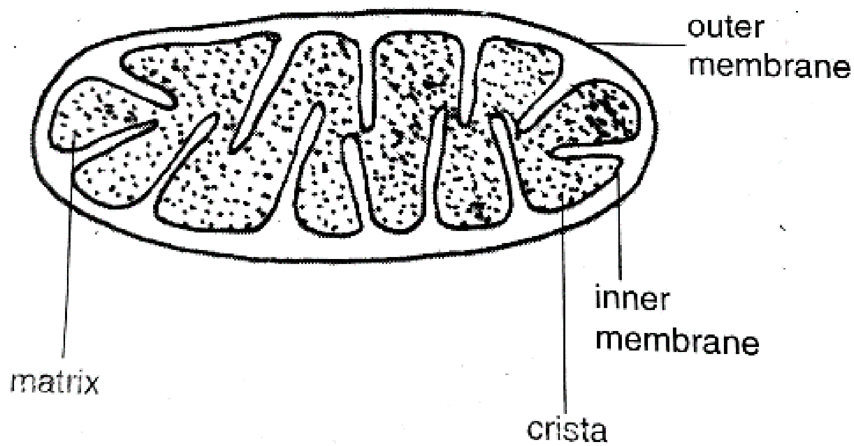


Fig. 1.9: Structure of mitochondrion

Functions of Mitochondria

(i) It is a place where respiration takes place hence a place where energy is produced.

Adaptations of Mitochondria to its Function

(i) It has enzymes which speed up the rate of respiration.
(ii) The inner membrane is highly folded. This increases the surface area on which respiration occur.

Endoplasmic Reticulum

- It is a network of tubes surrounded by membrane which spread throughout the cytoplasm
- There are two types:
    1. Rough endoplasmic reticulum- covered with ribosomes.
    2. Smooth endoplasmic reticulum- does not have ribosomes.

Functions of Endoplasmic Reticulum

(i) Rough endoplasmic reticulum transport proteins made by ribosomes.
(ii) Smooth endoplasmic reticulum is a site of lipid synthesis.

Ribosomes

- Ribosomes are small and spherical organelles.
- They exist in three forms. Some are associated with endoplasmic reticulum, some occur in groups (polysomes) while other float freely in the cytoplasm.

Functions of Ribosomes

(i) They are places where proteins are produced.

Chloroplasts

- It is an organelle in plant cell where photosynthesis takes place.
- They contain chlorophyll that absorbs sunlight for photosynthesis.
- Chloroplasts are found in the cytoplasm of cells of palisade mesophyll, spongy mesophyll and guard cells.
- The chloroplast consist of two regions:
  (i) Grana (singular- granum) and
  (ii) Stroma
- The granum consists of a number of disc placed on each other like a pile of coins called **thylakoids**. Thylakoids contains chlorophyll. Chlorophyll is a green pigment which traps energy of light and so making it available for plant use.
- Grana are inter connected to each other by structures called **intergranal lamellae**.
- The stroma is the remaining part of the chloroplast filled with a fluid. The stroma contains enzymes that speed up the rate of photosynthesis.

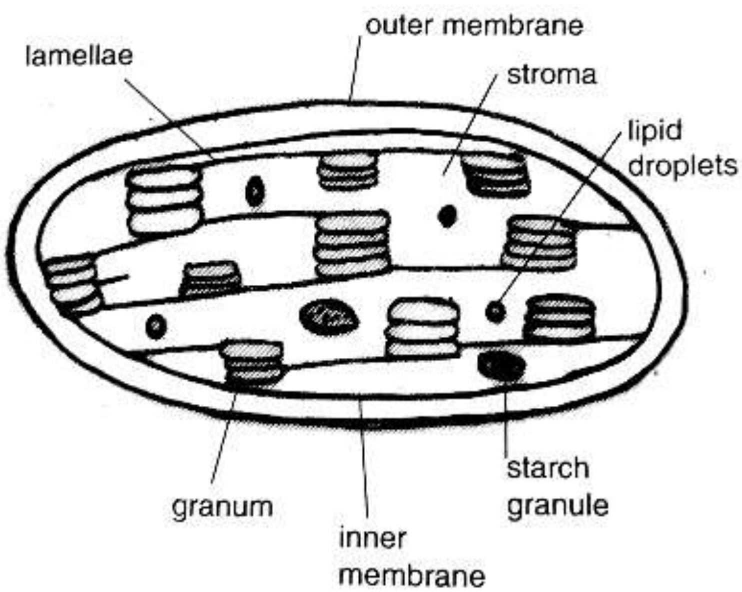


Fig. 1.10: Structure of chloroplast

- Starch granule is the temporary storage site of synthesised food in form of starch within the chloroplast.

Photosynthesis

- Photosynthesis is the chemical process in which green plants make their own food from water and carbon dioxide in the presence of sunlight and chlorophyll.

Word Equation for Photosynthesis

$$\text{Carbon dioxide} + \text{Water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Glucose} + \text{Oxygen}$$

Chemical Equation for Photosynthesis (Balanced)

$$6CO_2 + 6H_2O \frac{Sunlight}{Chlorophyll} > C_6H_{12}O_6 + 6O_2$$

Stages of Photosynthesis

- The process of photosynthesis occurs in two stages:
  1. The light stage and
  2. The dark stage

1. The Light Stage

- This requires light to take place. Light energy is trapped by chlorophyll in the chloroplast and converted into chemical energy. The chemical energy is used to split water molecules into **hydrogen ions** and **oxygen atoms**. This process is called **photolysis**. The hydrogen ions produced are used in the dark stage. Some of the oxygen formed is released from the leaf through the stomata into atmosphere. The rest of oxygen is used up in the plant cells for respiration.

$$2H_2O \rightarrow 4H^+ + O_2$$

- Some of the chemical energy is used to combine a molecule called Adenosine diphosphate (ADP) with phosphate group to form the rich energy molecules called Adenosine Tri-Phosphate (ATP).

$$ADP + P \rightarrow ATP$$

- During light stage, two important products formed are **hydrogen ions** ($\boldsymbol{H^+}$)and **ATP molecules** which are needed in the dark stage.
- Light stage occur in the grana of chloroplast.

2. The Dark Stage

- This does not require light to take place.
- The reaction is controlled by enzymes.
- The hydrogen ions formed in light stage are combined with carbon dioxide to form glucose using energy form ATP. The manufacture of a carbohydrate (glucose) from carbon dioxide is called **carbon fixation**.
- The source of oxygen atoms present in glucose is carbon dioxide.
- The dark stage takes place in **stroma** of chloroplast.

Summary of what Happens during Light and Dark Stages of Photosynthesis

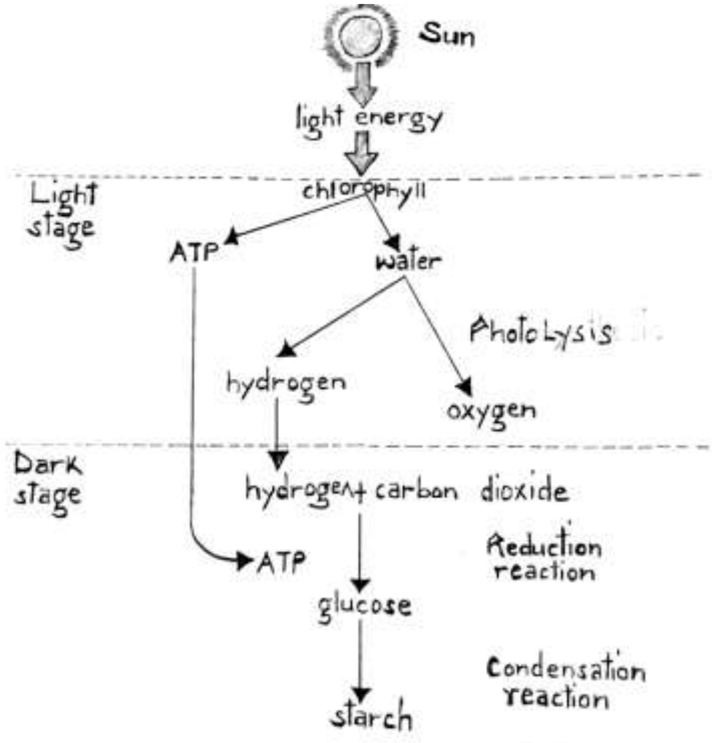


Fig. 1.11:Summary of the main events in photosynthesis

The Fate of Glucose after Photosynthesis

1. It is used for respiration which produces energy for growth.
2. It is converted to cellulose which is used to form cell wall that protects the cell from bursting due to osmosis.
3. It is combined with mineral elements such as nitrogen, phosphorous or sulphur to form proteins which is used to form enzymes.
4. It is converted to fats which are used to form cell membrane that control substances getting into the cell.
5. It is transported to storage organs where it is converted to starch for storage.

Factors Affecting Rate of Photosynthesis

1. **Light Intensity**
   - Increase in light intensity will lead to increase in the rate of photosynthesis up to a certain maximum when other factors become limiting.

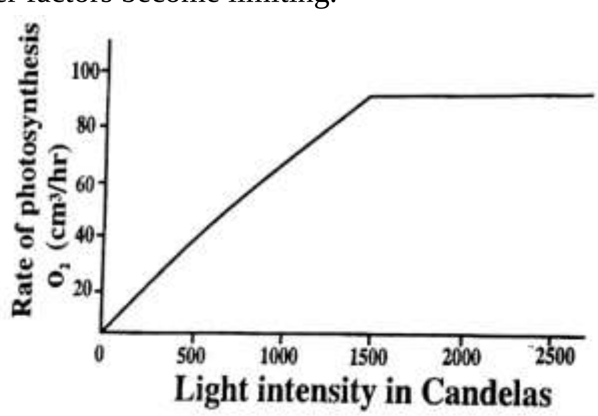


Fig. 1.12: Relationship between light intensity and rate of photosynthesis

2. Concentration of Carbon Dioxide

- As amount of carbon dioxide increases in the atmosphere, the rate of photosynthesis also increases until other factors become limiting.

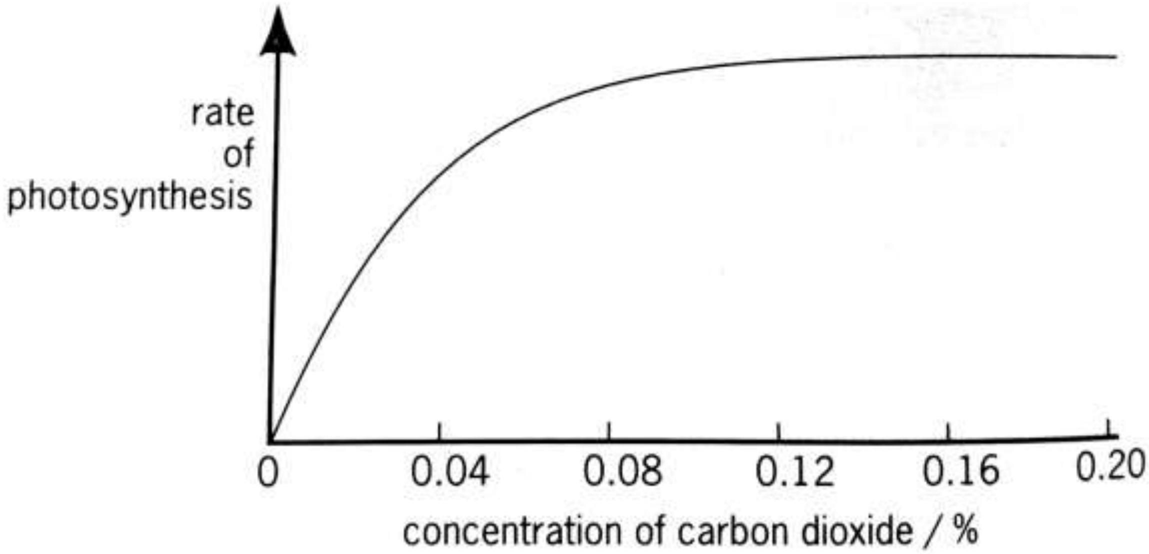


Fig. 1.13: Relationship between carbon dioxide and rate of photosynthesis

3. Temperature

- As temperature increases the rate of photosynthesis increases until the optimum temperature is reached around 35˚C, thereafter, the rate of photosynthesis decreases. This is because the enzymes become denatured.
- At low temperatures, the rate decreases because the enzymes become inactive lowering the rate of photosynthesis.

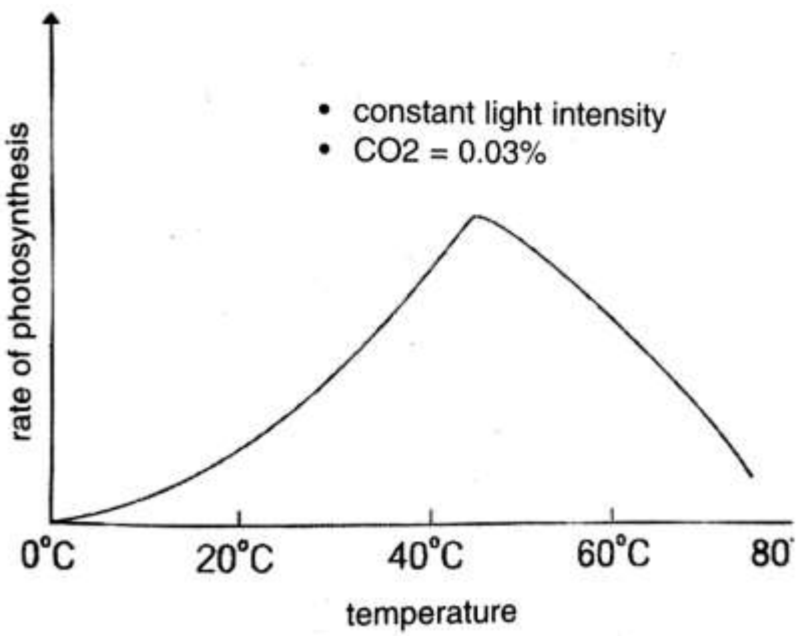


Fig. 1.14: Relationship between temperature and rate of photosynthesis

4. Availability of Water

- If water is in high concentration, more hydrogen ions are produced hence faster rate of photosynthesis.

5. **Chemicals and Pollutants**
   - Chemicals and pollutants inhibit enzyme action hence reduce rate of photosynthesis.

Steps in Testing for Starch in Plant Leaf

1. Dip the leaf in boiling water
   - To kill the leaf so as to prevent any further chemical reaction
   - To make the leaf more permeable to iodine solution. Boiling the leaf breaks the cuticle of the leaf.

2. Boil the leaf in alcohol.
   - To dissolve chlorophyll so that the leaf turns whitish to make any colour change easy to observe when iodine solution is put on the leaf.
3. Dip the leaf in warm water for two minutes.
   - To soften the leaf so that it can be easily spread out. The alcohol makes the leaf hard and brittle.
4. Spread the leaf on a white tile and add a few drops of iodine solution on the leaf.
   - The white tile enables any colour change on the leaf to be very conspicuous.
   - The drops of iodine solution are added on the leaf in order to find out whether there is starch or not in the leaf.

Expected Results

- If a blue – black colour is observed on the leaf then starch is present.
- If starch is absent the leaf maintains a brown colour of iodine.

Investigating the Conditions Necessary for Photosynthesis

Experiment to show that Light is Necessary for Photosynthesis

1. Take a potted green plant and put it in darkness for 24 hours to destarch it.
2. Puck one of its leaves and test for starch, to make sure the plant has been destarched.
3. Using a folded piece of black paper cover part of both sides of a leaf on the potted plant. Do not pluck the leaf. The whole set up should look as follows:

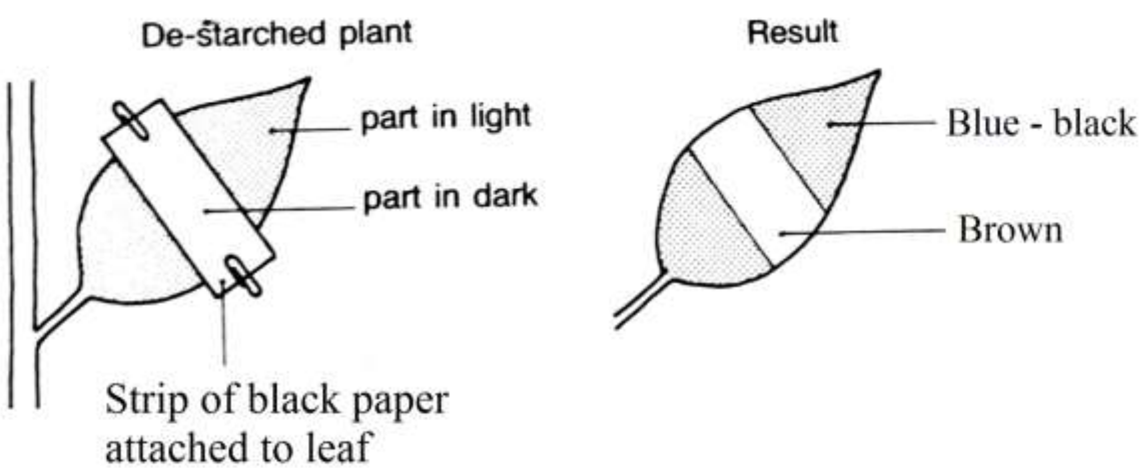


Fig. 1.15: An experimental procedure to show that light is needed for photosynthesis

4. Leave the plant in the sun for 6 hours.
5. Pluck the leaf and remove the black paper and test the leaf for starch.

Results

- The part that had been covered with a black paper turns brown indicating the absence of starch while the parts exposed to light turned blue black confirming the presence of starch.

Conclusion

- Part of the leaf covered with black paper did not receive light and therefore photosynthesis could not take place there. Therefore light is required for photosynthesis.

Experiment to show that Carbon dioxide is Necessary for Photosynthesis

1. Take a potted plant and put it in darkness for 24 hours to destarch it.
2. Put potassium hydroxide or sodium hydroxide solution in a conical flaskand cover one of the leaves on the potted plant with a bag. Potassium hydroxide solution absorb carbon dioxide in the flask.
3. Put sodium hydrogen carbonate solution in another conical flask and cover another leaf on the potted plant with a flask. The whole set up should look as follows:

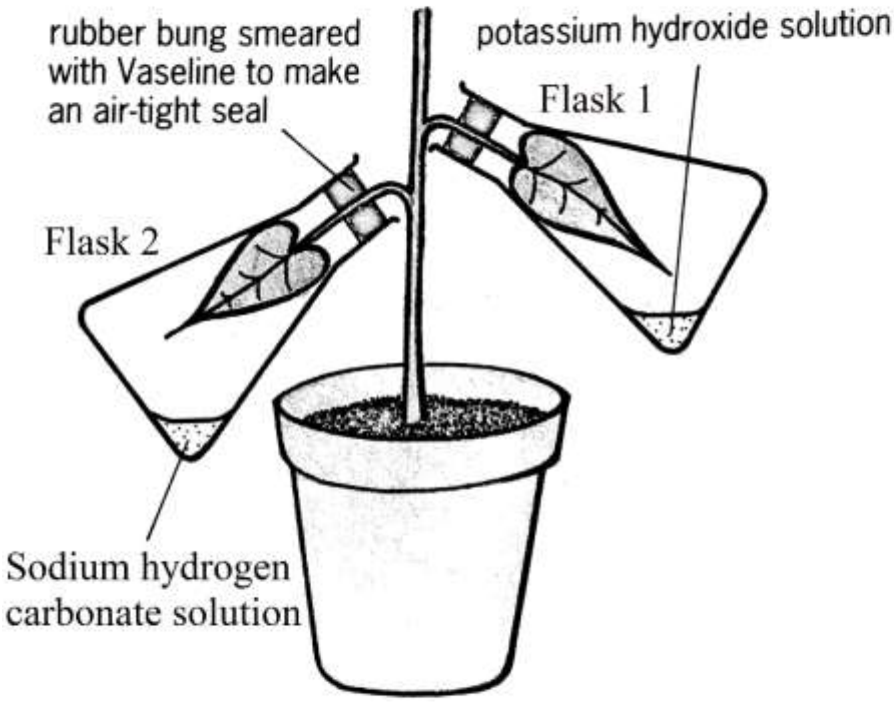


Fig. 1.16: An experimental procedure to show that carbon dioxide is essential for photosynthesis

4. Leave the plant in sun for 6 hours.
5. Remove the flask from each leaf and test each leaf for starch.

Results

- The leaf which was covered with a flask containing potassium hydroxide solution turn brown indicating the absence of starch while the leaf which was covered with a flask containing sodium hydrogen carbonate solution turned blue black confirming the presence of starch.

Conclusion

- Potassium hydroxide solution absorb carbon dioxide in the flask and therefore photosynthesis does not take place.
- Sodium hydrogen carbonate solution provides carbon dioxide which enable the plant to carry out photosynthesis therefore forming starch.
- Therefore carbon dioxide is necessary for photosynthesis.

Experiment to show that Chlorophyll is Necessary for Photosynthesis

- In this experiment, a variegated leaf is used. A variegated leaf is a leaf that has both green and non- green parts on it.

1. A variegated leaf is detached from a plant that has been exposed to sunlight.
2. The leaf is then tested for starch.

Results

- The part of the leaf that was green turned blue- black while the white part turned brown.

Conclusion

- The white part of the variegated leaf contain no chlorophyll. Photosynthesis does not occur in this region of the leaf so no starch is formed here. This part of the leaf does not turn blue-black with iodine, while the remainder of the leaf does. Therefore chlorophyll is necessary for photosynthesis.

Experiment to show that Oxygen is produced during Photosynthesis

- A beaker is filled with water and small amount of sodium hydrogen carbonate is dissolved in the water. Sodium hydrogen carbonate supply extra carbon dioxide to the plant.
- The water plant (e.g. Elodea) is placed in the beaker and a funnel is inverted over the plant, as shown in **figure 1.17**.
- A boiling tube is filled with water and then inverted over the funnel.
- Then apparatus is placed in a strong sunlight.

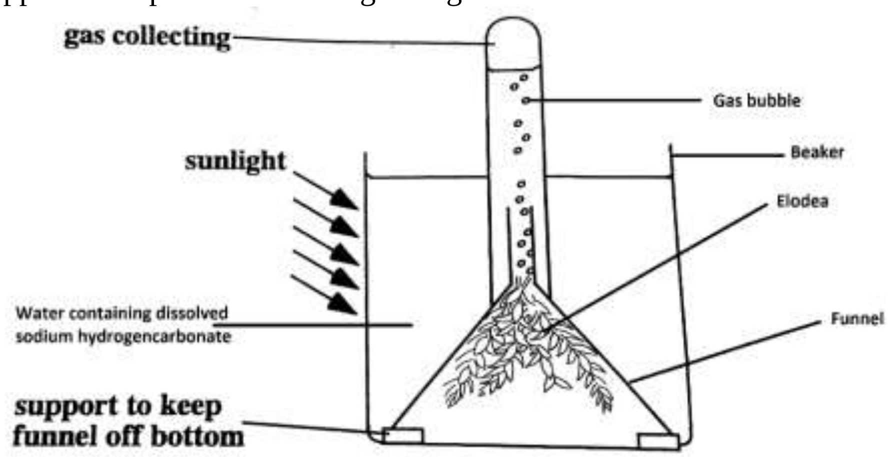


Figure 1.17: an experimental procedure to show that oxygen is produced during photosynthesis to show that oxygen is produced during photosynthesis

Observation

- The gas that collects in the boiling tube can be tested with a glowing splint.

Conclusion

- The water plant produces bubbles of gas when placed in a strong sunlight. The gas collects in the boiling tube and reignites a glowing splint. Therefore the gas is oxygen.

Functions of Mineral Elements in Plant growth and Photosynthesis

- Mineral elements are inorganic substances that are essential to all living organisms.
- Mineral elements are involved in chemical reactions taking place in the body of living organisms.

- In photosynthesis, mineral elements involved include:
  - Nitrogen
  - Carbon
  - Oxygen
  - Magnesium
  - Potassium
  - Phosphorus
  - Hydrogen
  - Sulphur
  - Iron

Nitrogen

1. It combines with glucose to form amino acids which forms proteins.
   - Proteins are used to form enzymes that are involved in the process of photosynthesis.
   - Proteins are the building blocks of plant tissues during growth
2. It is a component of chlorophyll molecule hence involved in photosynthesis.
3. It is also a component of nuclei acids that forms the hereditary materials in the nucleus.

Magnesium

1. It helps in the formation of chlorophyll hence important in the process of photosynthesis.
2. Involved in the formation of ribosomes that manufacture proteins.

Iron

1. Involved in the formation of chlorophyll.
2. Activates chemical reactions in plants (the light stage of photosynthesis)

Carbon

1. It help in the formation of chlorophyll.

Oxygen

1. It helps in the formation of chlorophyll.
2. It is involved in the process of respiration to release energy.

Hydrogen

1. It helps in the formation of glucose.

Potassium

1. It helps in activation of enzymes involved in the process of photosynthesis.
2. It helps in the opening and closing of stomata. Accumulation of potassium ions in the guard cells makes water to enter into the vacuole of guard cells. This makes the guard cells to swell and become turgid. When guard cells are turgid, they open stomata.

Phosphorus

1. It helps in the formation of ATP.
2. It helps in activation of enzymes involved in the process of photosynthesis.

Sulphur

1. It helps in the formation of proteins which are used to form enzymes that are involved in the process of photosynthesis.

Types of Pigments in Leaves

- A pigment is any coloured substance found in cells.

- Leaves have three types of pigments:
    1. Chlorophyll
    2. Carotene
    3. Xanthophylls

1. Chlorophyll

- This is the main pigment found in plant leaves.
- It is green in colour.

2. Carotene

- It is an orange pigment.
- It found in carrot and many flowers.

3. Xanthophylls

- It is a yellow pigment.
- It is found in many fruits and flowers.

To Investigate Types of Pigments in Plant Leaves

- Collect fresh green leaves from plants in the school compound.
- Grind the leaves using pestle and mortar.
- Squeeze the ground leaves to obtain an extract.
- Cut a strip of filter paper.
- Put a drop of the extract on the strip about 4 cm from the edge.
- Dip the edge of the filter paper with the drop of the extract in alcohol in a beaker about 2 cm from the spot of the extract.
- The alcohol rises up the strip to the spot of the extract.
- The pigments in the extract dissolve as alcohol passes through the spot and they move up with the alcohol at different rates.
- This leads to separation of the pigments into three different coloured spots.
- The three different coloured spots indicate that leaves have three different types of pigments.

Importance of Photosynthesis

1. It produces food
    - Glucose produced by photosynthesis is food and source of energy for living organisms.
    - Glucose is also a source of raw material for the making of other food substances such as starch, sucrose, protein and lipids.
2. It produces oxygen which is used in respiration.
3. It removes carbon dioxide in the atmosphere.
    - Photosynthesis prevents accumulation of carbon dioxide in the atmosphere thereby preventing global warming.

UNIT 2: TRANSPORT IN PLANTS

- Transport is a process whereby substances move from one part of a plant to another. These substances include water, mineral salts and manufactured food.These substances are transported from one part of the plant to another through a system of tubes known collectively as vascular tissue (transport tissue) these transport tissue are found in the roots, stems and leaves.
- There are two types of vascular tissue:
    1. Xylem and
    2. Phloem

Xylem Tissue

- The xylem is made up of different types of cells. The cells include:
    a. Xylem vessels (woody vessels)
    b. Tracheids
    c. Xylem parenchyma and
    d. Xylem fibers

a. Xylem Vessels

- Xylem vessels are made of long dead cylindrical cells called **vessel elements**. Vessel elements are open at both ends.
- They do not contain cytoplasm.
- Their walls are thickened with lignin to give support and prevent them from collapsing when conducting water under high pressure.
- They do not contain nuclei
- Their walls have tiny pores called **pits**. The pits allows the passage of water in and out of the lumen. The pits of adjacent cells are separated by a porous membrane called torus, which controls the opening of the pit, and therefore water flow.

b. Tracheids

- Tracheids are similar to xylem vessels except that:
  (i) They are typically five- or six- sided in cross- section and
  (ii) Instead of being open at each end, their tapering end walls are perforated with pits.

c. Xylem Parenchyma

- Parenchyma cells are the only living cells in the xylem.
- They surround conducting elements.
- They assist in conducting water upwards through vessels and tracheids.

d. Fiber Cells

- Fiber cells provide structural support for the xylem vessels.

The Structure of Xylem Vessels

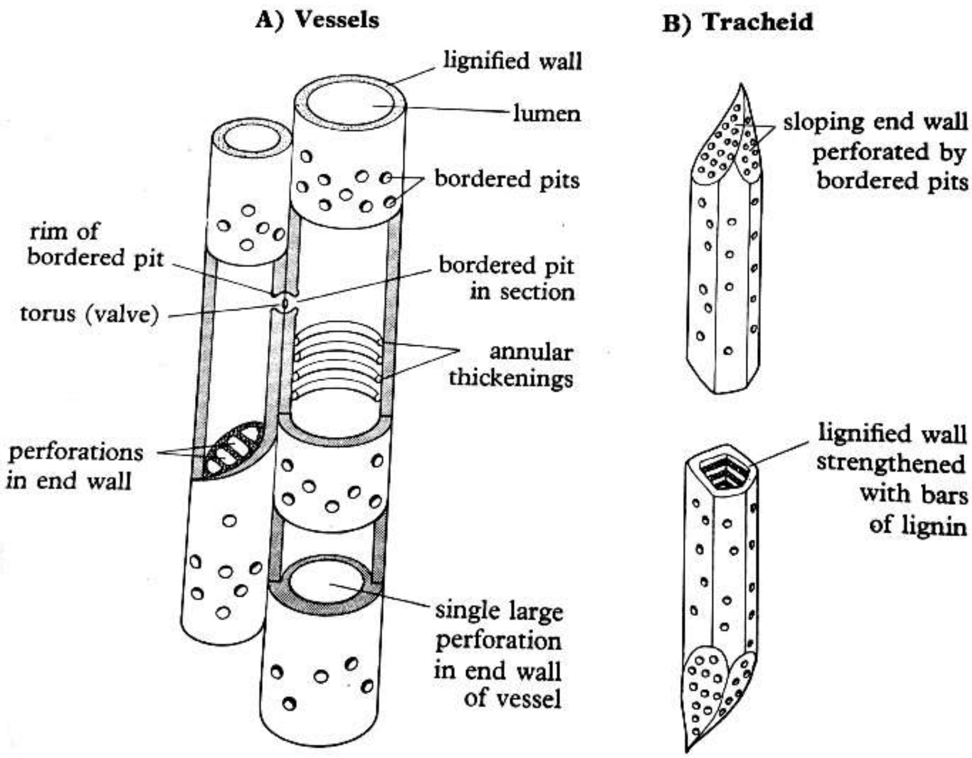


Fig. 2.1: Xylem vessels

Functions of Xylem

1. To transport water and mineral salts to the leaves
2. To give support to the plant

Adaptations of Xylem Vessels for Water Conduction

1. They are hollow to reduce resistance to the flow of water
2. They have narrow lumen to facilitate capillary action
3. They are lignified to strengthen them and prevent them from collapsing while conducting water.

Phloem Tissue

- Phloem tissue consists of two types of cells

1. Sieve Tubes

- They are made of living cells called sieve elements arranged end to end with each other.
- Sieve elements are separated from each other by structures called **sieve plates** which have pores or perforations in them.
- They have cytoplasmic filaments which aid in the flow of food along the sieve tube
- They do not have nucleus
- Their walls are not lignified.

2. **Companion Cell**
   - They are associated with sieve tubes
   - The companion cell has dense cytoplasm, nucleus and other cell organelles
   - They produce energy for translocation.

The Structure of Phloem

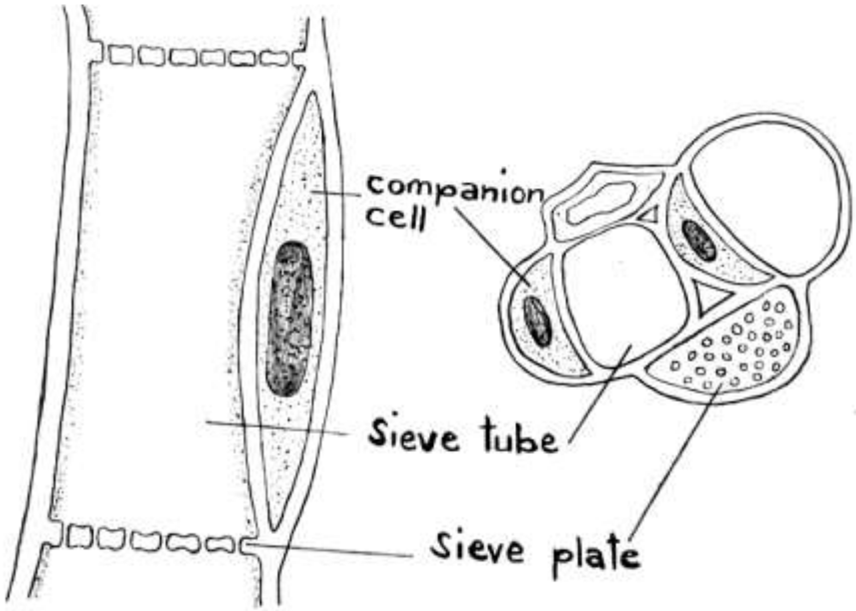


Fig. 2.2:Phloem tubes

Functions of Phloem

- It transport manufactured food substances from the leaves to all other parts of the plant.

Adaptations of the Phloem Tissue to its Function

1. It has companion cell with numerous mitochondria which provide energy for translocation
2. It has sieve plate which provide support to the phloem tissue
3. It has sieve pores which act as a path way for movement of materials
4. The sieve elements lack other component of cell e.g. nucleus in order to create space for transportation
5. They have cytoplasmic filaments which aid in the flow of food along the sieve tube

Structural differences between Xylem and Phloem

Xylem	**Phloem**
1. Made up of dead cells	Made up of living cells
2. Walls are lignified	Walls are not lignified
3. Have no companion cells	Have companion cells
4. Have no end walls (cross walls)at the end	Have the end walls called sieve plates which are perforated

Functional differences between Xylem and Phloem

Xylem	Phloem
1. Transport water and mineral salts from the roots to the leaves	Transport manufactured food from the leaves to all other parts of the plant
2. Provide support to the plant	Does not provide support to the plant

Vascular Bundles

- Vascular bundles is group of xylem vessels and phloem tubes

How Substances are transported in the Xylem and Phloem

- There are three processes by which substances move in and out of cells. These are:
  1. Diffusion
  2. Osmosis
  3. Active transport

Diffusion

- Diffusion is the movement of particles from a region of high particle concentration to a region of low particle concentration.
- The difference in the concentration of particles between two regions is called a **concentration gradient**.
- Diffusion occurs in liquids and gases.
- Diffusion does not take place in solids.
- When particles move from a region of high concentration to a region of low concentration, they are said to diffuse along a concentration gradient. As long as concentration gradient is maintained the movement of particles continue until they reach equilibrium i.e. evenly distributed in the available space.

Factors Affecting Rate of Diffusion

- The rate of diffusion of particles is the time taken for the particles to diffuse within an available space until they are evenly distributed.

1. **Temperature**
   - An increase in temperature increases the movement of particles hence increasing diffusion rate.

2. **Size of Particles**
   - Small particles diffuse faster than large particles. This is because small particles are light and pass through air or water easily

3. **Difference in concentration of substance**
   - The bigger the difference in concentration of a substance between two points, that is the steeper the concentration gradient, the faster the rate of diffusion.

4. **Distance a particle has to move**
    - The shorter the distance over which diffusion takes place, the faster rate of diffusion.

5. **Surface Area to volume ratio**
    - The higher the ratio, the greater the rate of diffusion. Lower organisms have higher surface area

6. **Thickness of membranes and tissues**
    - Thin membranes enhances higher rate of diffusion than thick membranes.

Significance of Diffusion

1. It is involved in movement of gases in and out of plant tissues.
    - Oxygen and carbon dioxide move in and out of plant leaves through stomata by diffusion.
2. It is involved in the absorption of some mineral salts from the soil.
    - Plant root hair cells take up some mineral salts from the soil by diffusion.

Osmosis

- Osmosis is movement of water molecules from a region of high concentration of water molecule to region of low concentration of water molecules across a semi- permeable membrane

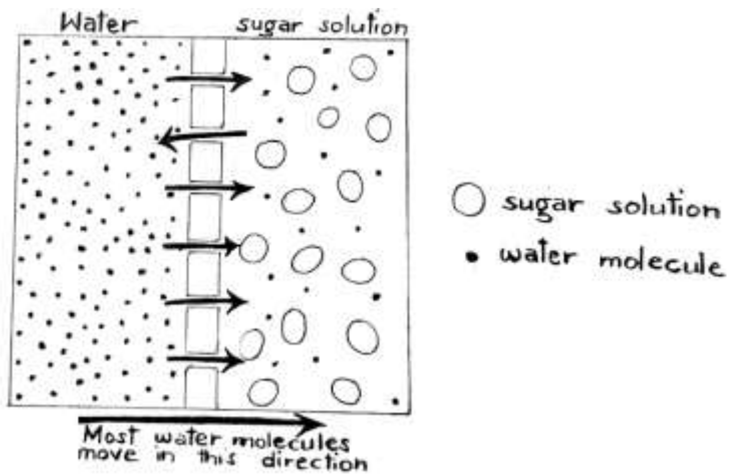


Fig. 2.3: Osmosis

- A solution is made up of solvent and solute molecules.
- A solute is the solid that dissolve in the solution
- A solvent is the liquid that dissolves the solid
- A **dilute solution** has more water (solvent) molecules as compared to solute molecules
- A **concentrated solution** has more solute molecules than water molecules.

To Demonstrate Osmosis Using a Visking Tubing

- Osmosis can be demonstrated in the laboratory using a partially permeable membrane such as a **visking tubing**.

- A laboratory experiment set up is shown in figure below.

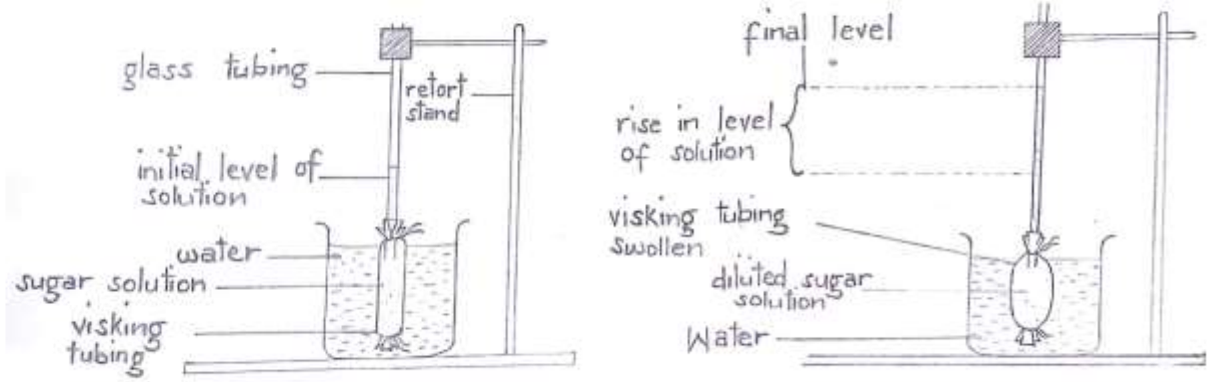


Fig. 2.4: Apparatus to demonstrate osmosis

- As shown in **figure (ii)** water molecules from the beaker (dilute solution) will enter in the visking tubing (concentration solution) causing it to swell up. This is because the dilute solution has more water molecules than the concentrated one. Water molecules pass easily through the holes of visking tubing because they are very small. Sugar molecules are too large to pass through the holes.
- The increase in volume of solution in the visking tubing will also cause the level of solution in the glass tubing to rise.

To Demonstrate Osmosis using Irish Potatoes

- Osmosis can also be demonstrated in the laboratory using irish potatoes
- A laboratory experiment set- up is shown in figure below.

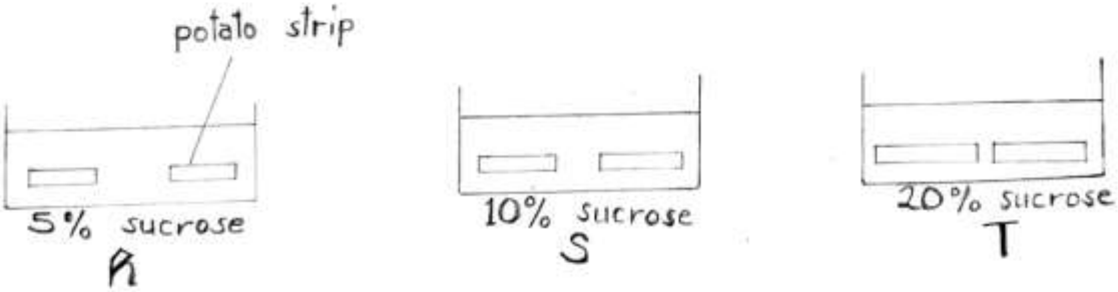


Fig. 2.5: Experiment to demonstrate osmosis using potatoes

- In container **T** the strips will decrease in length most. This is so because they will lose alot of water due to osmosis as these are in a highly concentrated solution
- In container **R** the strips will increase in length most. This is so because the strips will gain water much water as a result of osmosis since they are in a highly dilute solution

Hypotonic and Hypertonic Solutions

- Hypotonic solution is a solution which contains more water molecules than solute molecules.
- Hypertonic solution is a solution which contains more solute molecules than water molecules.

- Therefore osmosis can also be defined as the movement of water molecules from hypotonic solution to hypertonic solution across a partially permeable membrane.
- Isotonic occurs when two solutions have the same concentration of water molecules and there is no net movement of water molecules.

Osmotic Potential

- Osmotic potential is the difference in solvent concentration between two sides.
- A solution with many water molecules has a high osmotic potential, and a solution with few water molecules has a low osmotic potential.

Osmosis in Animal Cells

- Animal cell take in and lose water by osmosis
- Free floating animal cells such red blood cells will expand until they burst if they are placed in liquid which has a much higher osmotic potential than their cell content because animal cell are not surrounded by a cell wall.

Osmosis in Plant Cells

- When a plant cell is placed in a dilute, solution water molecules enter the cell by osmosis. However, the plant cell does not burst. This is because the plant cell has a strong outer covering- its cell wall. As more and more water goes into the cell, the cytoplasm and sap swell up.
- The cytoplasm, as a result of being filled with water, exerts an outward pressure on to the cell wall, but the cell wall presses back on the cytoplasm.
- The outward pressure that the cytoplasm exerts on to the cell wall is called **turgor pressure**. The cell is said to be **turgid** (hard).
- The inward pressure that the cell exerts on to the cytoplasm in a plant cell is called **wall pressure**. The wall pressure prevents the plant from bursting as it swells up.
- When the wall pressure equals the turgor pressure osmosis stops the plant cell is fully turgid.

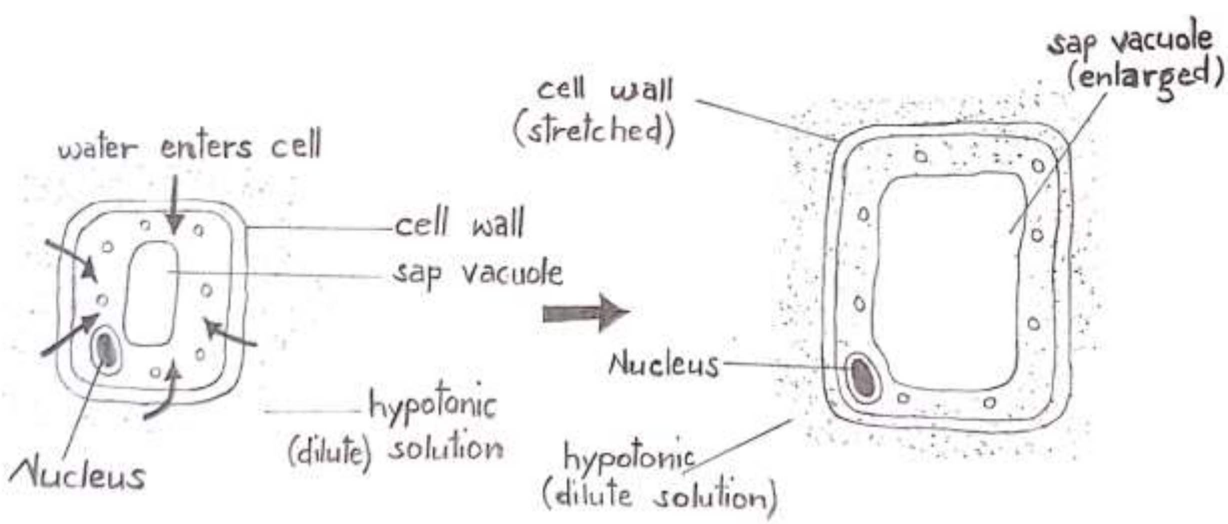


Fig. 2.6:Plant cell placed in hypotonic (dilute) solution

- When a plant cell is placed concentrated solution, water moves from the cytoplasm into the solution around the cell across the cell membrane by osmosis.
- The cytoplasm shrinks. As the cytoplasm shrinks, it stops exerting the turgor pressure on the cell wall and the cell becomes floppy. The condition in which the cytoplasm shrinks is called **flaccidity**. The cell is called to be **flaccid**.
- If the solution around the plant cell is very concentrated, a lot of water will diffuse out of the cell making the cytoplasm to shrink further and further into the centre of the cell. The cell membrane tears away from the cell wall.
- The condition in which the cytoplasm of a plant cell shrinks to the centre of the cell so much that the cell membrane tears away from the cell wall is called **plasmolysis**. The cell is said to be **plasmolysed**.

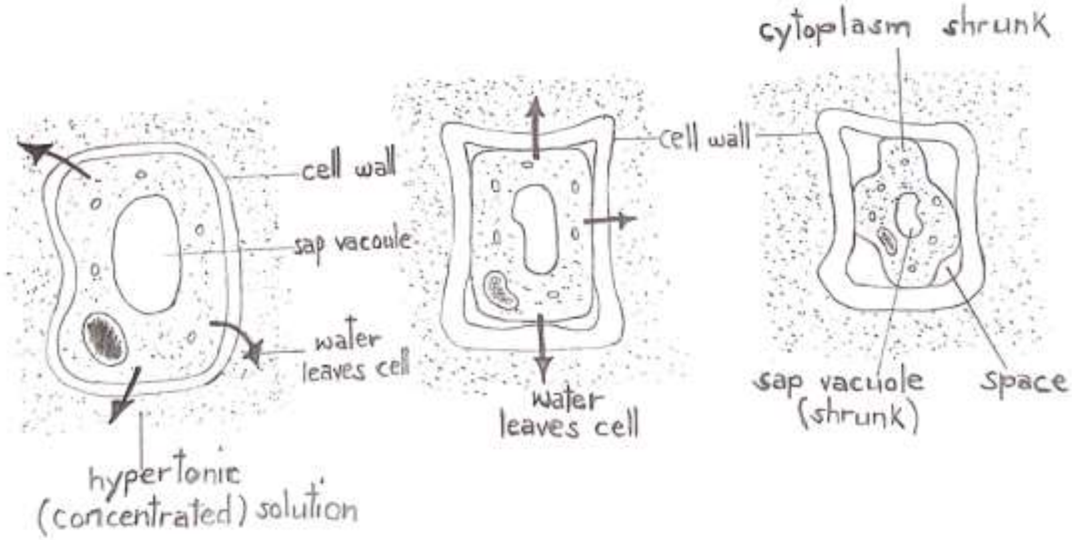


Fig. 2.7: Plant cell placed in hypertonic (concentrated) solution

Significanceof Osmosis

1. It helps plants to absorb water
2. It brings about the transport of water within the plant tissues i.e. from cell to cell

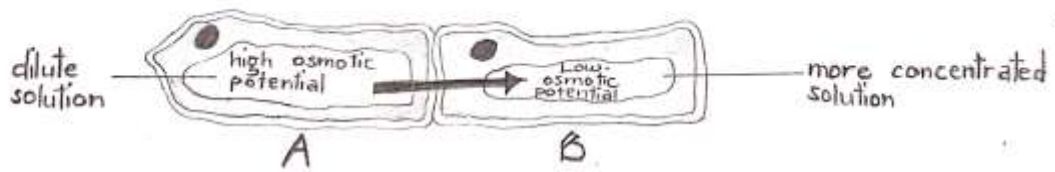


Fig. 2.8: Movement of water through cells

3. It leads to the development of turgor pressure within cells which gives them turgidity.
   - Turgidity helps to keep soft parts of a plant, such as its leaves and flower petals, firm and in shape.
   - Turgidity also helps to support the plant.
4. Helps in opening and closing of stomata.
   - Guard cells obtain water and also lose water by osmosis to enhance the opening and closing of stomata.

Active Transport

- Active transport is the movement of molecules or ions from a region of low concentration to a region of higher concentration across a living cell membrane.
- The movement of particles is against the concentration gradient so active transport requires the use of energy.
- The energy is in form of ATP. In cells, this energy is supplied through cell respiration.
- Cells that are involved in active transport have high rates of respiration. The cells contain a lot mitochondria which produce the ATP required.
- Active transport takes place only in living cells since the cell must use its own energy to move the molecules against a concentration gradient.

Significance of Active Transport

1. It is involved in the uptake of some mineral salts from the soil.
   - Plant root hair cells take up some mineral ions such as calcium, sodium, potassium, nitrate and magnesium from the soil by active transport. This so because the concentration of these ions within the root cells is much higher than in the soil.
2. It is involved in transport and accumulation of substances in storage tissues such as tubers, seeds and fruits.

Absorption of Water and Mineral Salts in Plants

- Water is absorbed by the root hairs by osmosis. Root hairs are extension of epidermal cells.
- The cell sap of the cells in the root hair has higher concentration of mineral salts than soil water. Water is therefore drawn by osmosis from the soil into the root hair cell.
- When water reaches the root hair cell, the cell sap of root hair is diluted in relation to adjoining cortex cells. The adjoining cortex cells, being more concentrated than the root hair cells, absorb water by osmosis. The process continues until water reaches the xylem vessels.
- Mineral salts in the soil water enter the root hair by either diffusion or active transport.

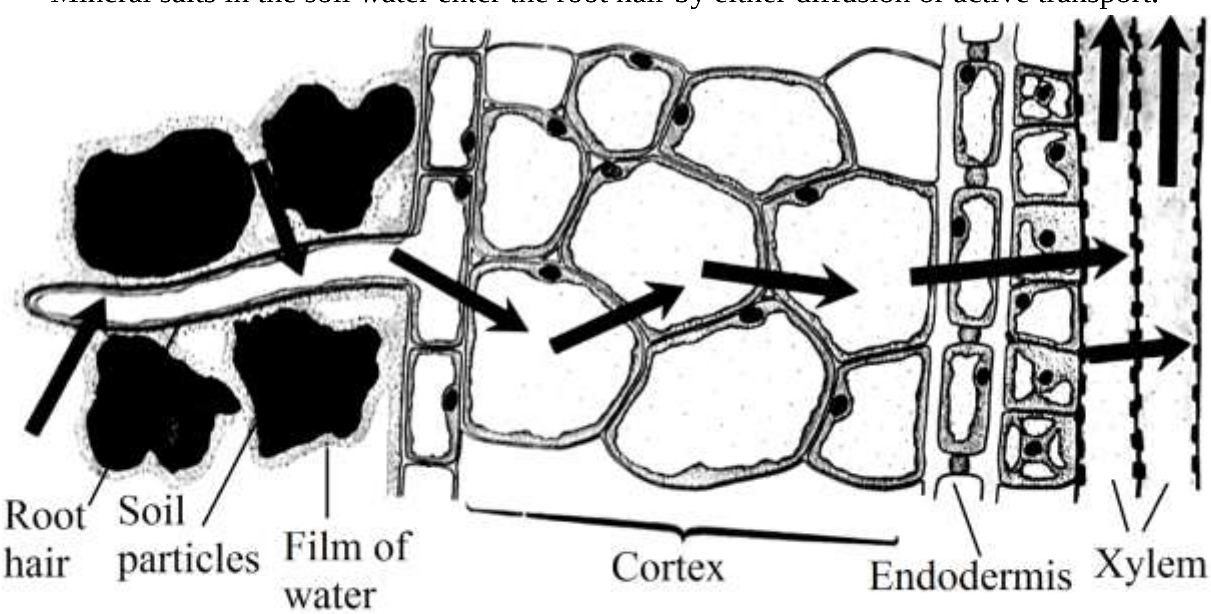


Fig. 2.9: How water is absorbed by plant

Cytoplasmic Streaming

- It is the directed flow of the liquid component of the cytoplasm and organelles around plant cells.
- This movement aids the delivery of nutrients, genetic information and other materials to all parts of the cell.
- Cytoplasmic streaming uses energy of ATP.
- It moves the substances much faster than diffusion.

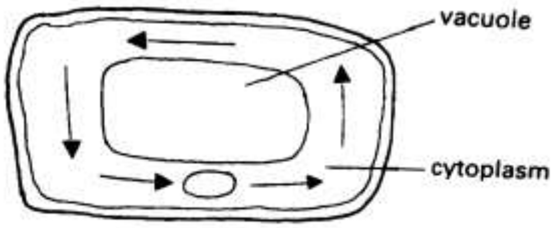


Fig. 2.10: Cytoplasmic streaming in a cell

Translocation

- It is the movement of manufactured food throughout the plant.
- Manufactured foods are transported through phloem.
- The movement of food is both up and down the plant.

Movement of Water in the Xylem

- There are four forces that cause the movement of water through the xylem:
  1. Root pressure
  2. Capillary
  3. Transpiration pull
  4. Cohesion and adhension

1. Root Pressure

- This is the pressure generated by roots that pumps water and dissolved mineral salts up the xylem.
- As long as the soil is damp there will be water taken in by the root hairs. As more water is taken in, the water that is already in the xylem vessels will be pushed up the plant. This is called **root push** or **root pressure** and helps to push the water up to the leaves.

2. Capillarity

- Liquids tend to rise in a narrow space – this is called **capillarity**. Water tends to rise in the xylem vessels which are very narrow.

3. Transpiration Pull (Suction Force)

- This refers to mechanical force that pulls water from below.
- The suction force is generated as a result of transpiration occurring in the leaves. As water evaporates through stomata in the leaves, it creates a negative pressure (also called tension or suction) in the leaves and tissues of the xylem. The negative pressure exerts a pulling force on water in the plant's xylem and draws the water upwards.

4. **Cohesion and Adhesion**
   - Water molecules have the ability to attract to each other. This force by which water molecules attract each other is known as **cohesion force**.
   - The water molecules also have a strong attraction to the walls of the xylem vessels. The forces of attraction between unlike molecules is called **adhesion forces**.
   - Cohesion and adhesion forces hold water molecules to the xylem walls such that a long continuous column of water from the roots to the leaves is maintained.

Transpiration

- It is the loss of water from leaves of plants into the atmosphere in form of water vapour.

Transpiration Stream

- This refers to the flow of water in a plant due to transpiration.
- The following processes take place during transpiration stream:
  1. Water vapour diffuses out of intercellular air spaces to the atmosphere via the stomata.
  2. The spongy mesophyll cells lose water by evaporation to the intercellular spaces.
  3. Spongy mesophyll cells that have lost water become more concentrated than their neighbours and therefore draw water from the neighbouring cells by osmosis.
  4. The spongy mesophyll cells next to the xylem draw water from the xylem by osmosis.
  5. Transpiration pull, capillarity and root pressure keep a water column in the xylem vessel.
  6. At the other end of the xylem in the roots, water is drawn from the adjacent cells.
  7. The cell become more concentrated and draws water from adjacent cell. The cell in the root hair draw water from the soil and water continues to move to the leaf.

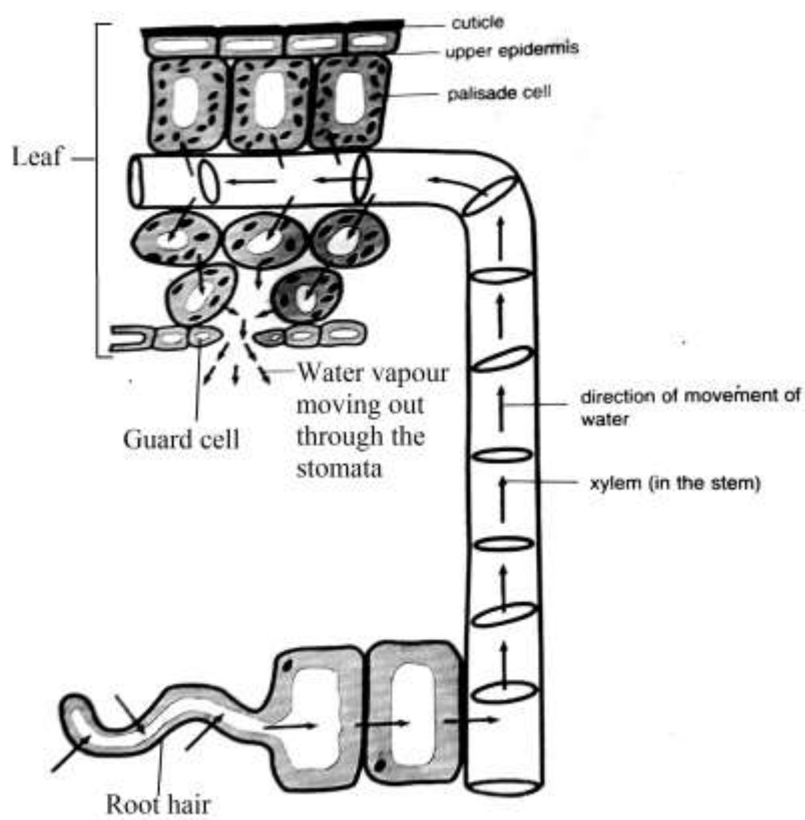


Fig. 2.11: Transpiration stream

Measuring the Rate of Transpiration

- The rate of transpiration is determined using an apparatus called **potometer**. The instrument measures the rate of absorption of water from the soil. As the shoot above the ground undergoes transpiration, water is absorbed from the potometer causing water column to move from **A** to **B** in the capillary tube.
- The rate of transpiration can be determined by measuring the distance moved by water column for a given period of time and then divide distance moved by time taken.

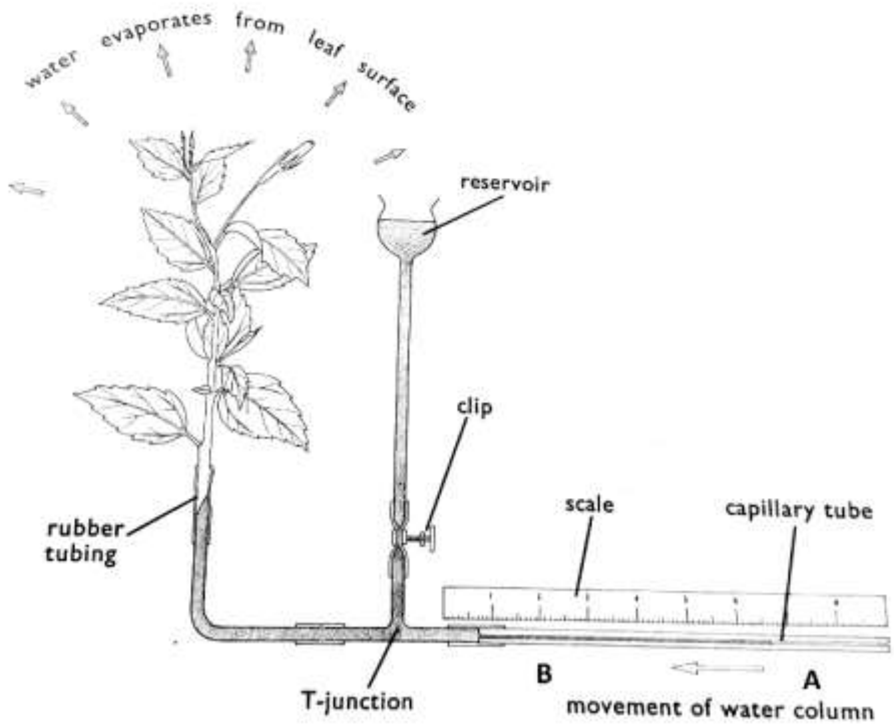


Fig. 2.12: Potometer

Importance of Transpiration

- Transpiration is important in plants in the following reasons:

1. **Cooling the Plants**
   - Transpiration cools the plant during hot weather since as the water is evaporating it draws heat out of the plant.

2. **Distribution of Mineral Salts throughout the Plant**
   - Transpiration causes water to flow through the plant. As the water flows through the plant, it carries with it the mineral salts dissolved in it which are distributed throughout the plant.

3. **Uptake of Water**
   - The water lost by transpiration is replaced by water absorbed from the soil which is then distributed to all parts of the plant where it performs various functions in the plant.

Factors Affecting Rate of Transpiration

1. **Light Intensity**
   - When light intensity increases, more stomata open to allow carbon dioxide to diffuse from air surrounding the leaf for photosynthesis hence increases rate of transpiration since transpiration mostly occur through stomata.

2. **Temperature**
   - An increase in environmental temperature result into increased rate of transpiration. This because water molecules move around faster at high temperature than low ones, so they diffuse out of the leaves more quickly.

3. **Humidity**
   - Humidity is the amount of water vapour in the air.
   - Transpiration happens faster when the air is dry than when it is humid. This because there is steeper diffusion gradient for water vapour between air spaces inside the leaf and the air when the concentration of water in the air is low.

4. **Wind or Air Movement**
   - The faster the wind speed, the faster transpiration takes place. This because the wind takes away the humid air just outside the leaf. This helps to maintain a diffusion gradient for water vapour from the leaf and into the air.

5. **Water Supply**
   - If water is in short supply, the plant will close its stomata. This cut down the rate of transpiration. Transpiration rate decrease when water supply decreases below a certain level.

UNIT 3: HUMAN NUTRITION

- **Nutrition** is the process by which an organism obtains food for use in the body.
- Food is made up of components known as food nutrients.

Food Nutrients

- Nutrients are chemical substances obtained from food which the body uses in order to grow, to repair or replace damaged tissue, to obtain energy for daily activity, and also build up its structure.
- There are six classes of nutrients:
    1. Carbohydrates
    2. Proteins
    3. Fats
    4. Water
    5. Mineral salts
    6. Vitamins
- Food nutrients are grouped into:
    (i) **Macro- Nutrients**– refers to nutrients required in large amounts. Carbohydrates, lipids, proteins and water are macro-nutrients.
    (ii) **Micro-Nutrients** – refers to the nutrients required in small amounts. Vitamins and mineral salts are micro- nutrients.

1. Carbohydrates

- These are organic compounds that are required in large quantities in the body.
- The basic structure of all carbohydrates is the same. They are made up of carbon, hydrogen and oxygen.
- There are three main types of carbohydrates depending on their complexity of molecules. These are:
    (i) monosaccharides
    (ii) disaccharides
    (iii) polysaccharides

(i) Monosaccharides (Simple sugars)

- Monosaccharides $(mono = single, saccharide = sugar)$ consist of single molecule.
- They have a general molecular formula of $C_6H_{12}O_6$.
- Examples of monosaccharides are glucose, fructose and galactose.

Properties of Monosaccharides

a. They are soluble in water.
b. They have a sweet taste.
c. They are crystalline in their pure state.

d. They are reducing sugars. They can reduce copper (II) ions (blue) to copper (I) oxide (orange-brown) in the presence of an alkali.

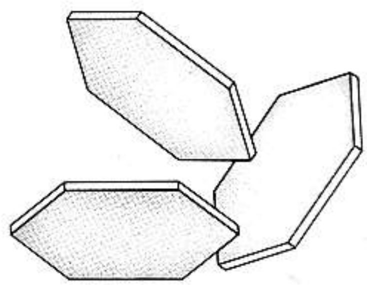


Fig. 3.1: Simple sugar molecule e.g. glucose

(ii) Disaccharides- Double Sugars

- A molecule of disaccharide is formed when two monosaccharide units combine and a molecule of water is released. Such chemical reactions involving the removal of a water molecule are called **condensation**.
- **Condensation** is the process in which large nutrient molecule is formed from a small nutrient molecule.

$$Glucose + Fructose \rightarrow Sucrose + Water$$

$$C_6H_{12}O_6 + C_6H_{12}O_6 \rightarrow C_{12}H_{22}O_{11} + H_2O$$

- **Hydrolysis** is the reverse reaction of condensation i.e. the uptake of water molecules during a chemical reaction.
- Hydrolysis is the process in which a large nutrient molecule is reconverted to a small nutrient molecule from which it was made.

$$Sucrose + Water \xrightarrow{enzyme} Glucose + Fructose$$

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{enzyme} C_6H_{12}O_6 + C_6H_{12}O_6$$

- In laboratory a disaccharide can be hydrolysed by boiling it with hydrochloric acid.

Examples of Disaccharides

Disaccharide	Source	Monosaccharide unit
Sucrose	Sugarcane and Sugar beet	Glucose + Fructose
Lactose	Milk	Glucose + Galactose
Maltose	Germinating seeds e.g. barley	Glucose + Glucose

- Disaccharides have a general formula $C_{12}H_{22}O_{11}$.

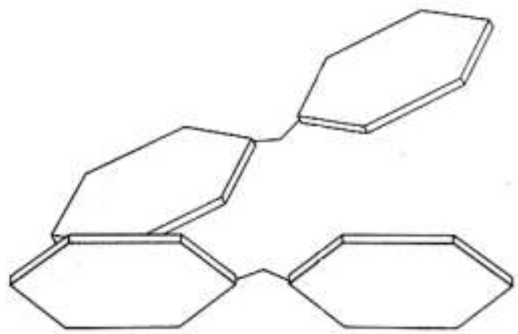


Fig. 3.2:Disaccharide molecule e.g. maltose

Properties of Disaccharides

a. They are soluble in water.
b. They have a very sweet taste.
c. They are crystalline in their pure form.
d. Some are reducing sugars while others are non-reducing sugars. Maltose and lactose are reducing sugars while sucrose is not.

(iii) Polysaccharides

- They are made up of many molecules of monosaccharides joined together through condensation i.e. are polymers of monosaccharides.

Examples of Polysaccharides

A. Starch

- It is the storage form of glucose by plants.
- Storage organs of plants such as tubers of sweet potatoes are packed with starch.
- This starch can be broken down by enzymes to give back glucose when there is inadequate supply.

B. Cellulose

- It is a structural compound in plants.
- Cellulose is made of glucose molecules linked in chains which are difficult for enzymes to break.

C. Glycogen

- It is the storage form of glucose in the bodies of animals.
- It is mainly found in liver and in skeletal muscles.
- In case of inadequate supply of glucose in the body, it is broken down to release glucose which is then used as energy source.

Properties of Polysaccharides

a. They are insoluble in water.
b. They have no sweet taste.
c. They are non-reducing sugars.

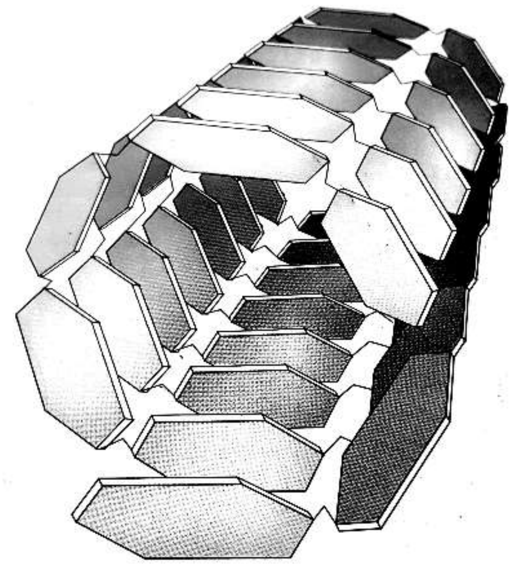


Fig. 3.3:Polysaccharide molecule e.g. starch

Functions of Carbohydrates

(i) They provide energy in the body. One gram of carbohydrates releases ***17KJ*** of energy in the body. The energy is released during respiration.
(ii) They serve as energy storage compounds in the tissue of living organisms.
(iii) They are structural compounds forming part of the structure of plants e.g. the cell wall of plant cells is made of cellulose.

Food Tests

- Refers to the tests that are used to determine nutrients contained in foods.
- Most food tests use **reagents** to test for the presence of food nutrients.
- **Reagents** are chemicals that change colour when they react with certain specific substances. The change in colour of the reagent shows presence of a nutrient material.

Starch Test

a. If the food is in liquid form, go straight to b. If the food is solid, make an extract by grinding or crushing a small amount. Put it into a test tube to a depth of about 2 cm. Add a similar amount of distilled water and stir with a glass rod.
b. Draw up 2 cm^3 of food sample into a dropper and then either transfer it into another test tube or put drops onto a white tile.
c. Add two drops of iodine solution to the test tube and observe the colour changes. A blue-black colour means that starch is present.

Sugar Test

Reducing Sugar (Benedict's Solution)

a. Put 1 cm^3 of food sample into a test tube.
b. Add 2 cm^3 of benedict's solution to the food sample.

c. Heat the test tube in boiling water for 5 minutes and observe the colour changes. A brick-red precipitate shows the presence of reducing sugar.

- Benedict's solution is a blue coloured liquid (a mixture of the chemicals copper sulphate and sodium hydroxide). When Benedict's solution and simple carbohydrates are heated, the solution changes colour. This reaction is caused by reducing property of simple carbohydrates. The copper (II) ions, which are blue, in Benedict's solution are reduced (chemically, they gain electrons from reducing sugar) to copper (I) oxide, which is an orange red precipitate.

Non- Reducing Sugar (Acid and Benedict's Solution)

a. Put 1 cm^3 of food sample into a test tube.
b. Add 1 cm^3 of dilute hydrochloric acid to the food sample in the test tube.
c. Heat the test tube in boiling water for about 3 minutes to break down (hydrolyse) any sugar into reducing sugars.
d. Allow the contents of the test tube to cool and then add sodium hydrogen carbonate until fizzing stops (this neutralizes the acid)
e. Measure 2cm^3 of Benedict's solution and add it into the test tube and then heat the test tube in boiling water for 5 minutes. Observe the colour changes. A brick red precipitate shows reducing sugar in food, which was produced from non-reducing sugar.

Sources of Carbohydrates

- The major sources of carbohydrates include:

- Maize	- Yams
- Wheat	- Millet
- Cassava	- Sorghum

2. Proteins

- They are organic compounds containing carbon, hydrogen, oxygen and nitrogen.
- They may also contain other elements such as sulphur and phosphorous.
- Proteins are made up of **amino acids** as their building blocks.

Amino Acids- the Building Blocks of Proteins

- Amino acids have a basic structure of an amino $(-NH_2)$ group and a carboxyl $(-COOH)$ group attached to the same carbon.

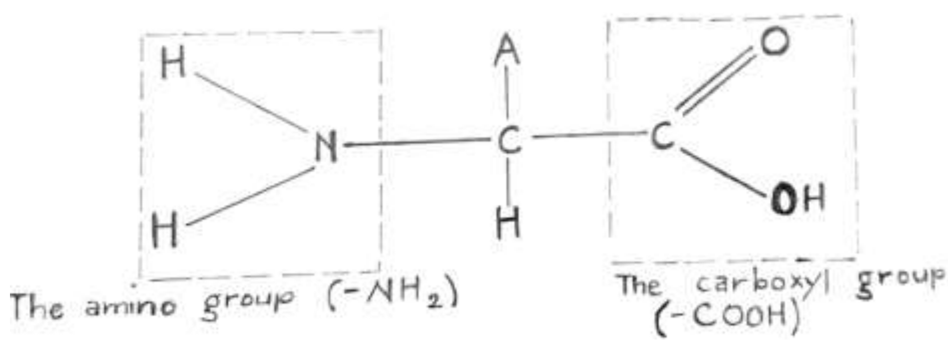


Fig. 3.4: General structure of amino acid

- There are up to 20 naturally occurring amino acids that combine to form proteins. Plants can synthesise all the 20 amino acids. Human beings **cannot** synthesise 9 of the amino acids and therefore have to be taken in the diet. These types of amino acids are referred to as **essential amino acids**. **Lysine** and **valine** are examples of essential amino acids. The remaining 11 amino acids can be synthesised in human body. They are called **non-essential aminoacids**.
- Amino acids are linked together through bonds called peptides bonds to form long **amino acids chains** referred to as **polypeptides**. Proteins are made up of either a single polypeptide or several polypeptide chains intertwined with one another. The process of linking the amino acids in a long chain through polyptide bonds is another example of condensation reaction just like in polysaccharides and involves loss of water.

Functions of proteins

a. Proteins are structural compounds forming structures in living organisms. Collagen is an example of a protein found in the walls of arteries, veins, tendons and ligaments.
b. They act as chemical messengers transmitting information in the body. Examples are hormones which are protein in nature.
c. They speed up the rate of metabolic reactions in the body. Reactions like respiration proceed with the help of enzymes which are protein in nature.
d. They provide the body with immunity against diseases. The antibodies that help the bodies of animals to fight foreign organisms that cause diseases are made up of proteins.
e. They help in respiration to produce energy, after deamination.
f. Haemoglobin, which transports oxygen from the lungs to other parts of the body, is a protein.
g. They are used to make new cells as an organism grow or as it repairs and replaces damaged cells.

Protein Test (Biuret's Test)

a. Put 2 cm^3 of food sample into a test tube.
b. Add 2 cm^3 of dilute sodium hydroxide solution to the test tube
c. Add two drops of copper sulphate solution
d. Shake the test tube gently and observe the colour changes. A purple colour means that protein is present.

Sources of Proteins

- Milk
- Beef
- Eggs
- Fish
- Pork
- Legumes such as soya and peanut.

3. Lipids

- Lipids are divided into fats and oils.
- Fats are solid at room temperature while oils are liquid at room temperature.
- Lipids are made from carbon, hydrogen and oxygen.

- Lipids are composed of two parts namely a glycerol molecule and three fatty acids molecules.
- One glycerol molecule combines with three fatty acid molecules in a condensation reaction to form a lipid called **triglyceride**.

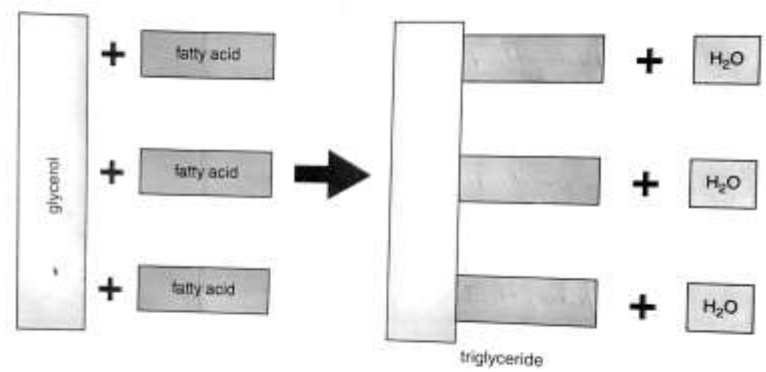


Fig. 3.5: Triglyceride are synthesised from glycerol and fatty acids

- There are different types of fatty acid molecules but only one type of glycerol. The type of lipid formed depends on the type of fatty acid molecules that it contains.

Functions of Lipids

- Lipids are used:
  (i) as source of energy. A gram of fat gives about 39 KJ of energy.
  (ii) to form part of cell membrane. Cell membrane is composed of lipid called **phospholipid**.
  (iii) as solvent for some vitamins such as vitamin A, D and E.
  (iv) for insulation under the skin to prevent heat loss from the body during cold conditions i.e. lipids help to keep the body warm.
  (v) as protective compounds. The fat found around body organs like heart and kidneys acts as protection against mechanical injury by cushioning the organs against physical impact.

Lipid Test (Emulsion Test)

a. Put 1cm^3 of food sample into a test tube.
b. Add 2 cm^3 of ethanol and shake well.
c. Tip the mixture into half a test- tube of water
d. A milky appearance shows the presence of fat.

Lipid Test (Greese Spot)

a. Rub food onto paper
b. A translucent greesy spot shows the presence of fat.

Sources of Lipids

- Groundnuts
- Coconuts
- Cooking oils
- Fatty meat
- Butter
- Margarine

4. Water

Importance of Water

a. It helps in digestion
b. It helps in absorption of food
c. It helps in normal functioning of the heart by maintaining blood volume
d. It dilutes harmful substances in the body and helps in their removal
e. It is used to transport substances in the cell and blood

5. Mineral salts

- These are inorganic elements which are required in very small quantities by the body. **Table below** shows some mineral elements.

Mineral element	**Source**	**Function**	**Deficiency disease**
Iodine	Fish, iodised salt, sea foods	- For making thyroxine hormone	Goiter
Calcium	Milk, cheese, bread, green vegetables, fish	- Formation of strong bones and teeth - Involved in blood clotting - Needed for muscle contraction	Rickets
Iron	Liver, egg yolk, green vegetables	- Formation of haemoglobin in red blood cells	Anaemia
Phosphorous	Milk, milk products, eggs	- Formation of strong bones and teeth	Weak bones and teeth
Potassium	Meat, fish, cereals, vegetables	- Proper functioning of nerves and muscles	Muscular weakness

6. Vitamins

- These are organic substances which are only needed in small amounts.
- They prevent deficiency diseases and play a role in reproduction.
- **Table below** shows some important vitamins.

Vitamin	Sources	Function	Deficiency Signs	Deficiency Disease
Vitamin A (Retinol)	Green vegetables , milk, milk products, liver, fruits, eggs	- Produces purple pigment called rhodopsin that promotes night vision - Promotes growth - Maintains health skin - Helps in immune system	- Inability to see in dim light - Dryness of eyes - Reduced immune system - Poor growth - Painful joints	- Night blindness
Vitamin B_1 (Thiamine)	Vegetables, milk, legumes, eggs, cereals, meat, fruits, mushrooms, pork	- Required in cell respiration - Needed for normal functioning of heart and nervous system - Maintains appetite	- Heart malfunction - Inflammation of the nerves leading to malfunctioning of nervous system - Loss of appetite - Mental confusion (worry) - Loss of memory	- Beriberi (characterized by muscle weakness, paralysis and oedema)
Vitamin B_2 (Riboflavin)	Milk, eggs, meat, liver, vegetables, groundnuts	- Helps respiratory enzymes - For health membranes and skin	- Sores in mouth - Inflammation and breakdown of skin	- Tiredness
Vitamin B_3 (Niacin)	Vegetables, beans, peas, meat, yeast	- Used in cell respiration	- Digestive disorders - Loss of appetite - Inflammation of nerves	- Pellagra
Vitamin B_{12} (Follic acid)	Vegetables	- Promotes haemoglobin formation	- Show paleness on mucous membranes	- Anaemia
Vitamin C (Ascobic acid)	Citrus fruits, green vegtables, potatoes, tomatoes	- Increases resistance to infection - Makes blood vessel wall strong - Promotes absorption of iron	- Bleeding of gums - Rough skin that fail to heal when wounded - Painful joints - Weak bones	- Scurvy
Vitamin D (Calciferol)	Liver, milk, butter, vegetables, formed under skin when exposed to sun	- Increases absorption of calcium and phosphorous from the gut - For hardening of bones	- Bow- shaped legs - Easy decay of teeth	- Rickets
Vitamin K (Quinone)	Liver, green vegetables, cereals, egg york	- Formation of prothrombin in the liver which brings about clotting of blood	- Slow healing of wounds due to impaired clotting - Severe bleeding from cuts	- Haemophilia

Vitamin C Test

a. Put 1 cm^3 of DCPIP in a test tube
b. Add the juice to DCPIP using a dropper. Observe the colour changes. If the DCPIP colour disappear means that vitamin C is present.

Roughages (Dietary fibre)

- Dietary fibre is an indigestible component of carbohydrate rich-foods.
- Vegetables, fruits and grain cereals are examples of sources of roughages.

Importance of Roughages

a. It promotes peristalsis thereby preventing constipation
b. It provides bulk to the digestive tract

Balanced Diet

- A balanced diet is one that that contains all the food nutrients in the required amount.
- A balanced diet must contain carbohydrates, proteins, fats, vitamins, mineral salts and fibre, in their correct proportion.
- When all the food nutrients are present in a diet, a person cannot suffer from any deficiency disease.

Deficiency Diseases

- These are diseases or disorders that occur in the body when nutrients in a diet are not sufficient.
- The inadequate nutrient make some body processes not to take place resulting to disorder in functioning of the body. These disorder bring about signs and symptoms that can be observed.

Common Deficiency Disease in Humans

1. **Goitre**
   - This is a swelling of thyroid gland in the throat.
   - It caused by lack of iodine in the diet.

   Signs and Symptoms

   a. Enlargement of the thyroid gland around the neck region
   b. Weight gain
   c. Constipation
   d. Weakness

   Prevention and Control

   a. Provide iodine in the diet through usage of iodised salt
   b. Surgical removal of thyroid gland in severe cases.

2. **Kwashiorkor**
   - It is caused due to lack of proteins in the diet.

- It occur mostly in children

Fig. 3.6: Kwashiorkor is the result of lack of proteins

Signs and Symptoms

a. Stunted growth
b. Odema of the face and legs (swelling of tissues because of water retention)
c. Weight loss
d. Diarrhoea
e. Loss of appetite
f. Miserable- looking appearance
g. Pale skin which peels easily
h. Large and protruding abdomen
i. The child becomes weak
j. Pale and non-curled hair

Prevention and Treatment

- Kwashiorkor can be prevented and treated by giving children regular, well balanced meals.

3. **Marasmus**
   - It occurs under conditions of starvation, a general shortage of protein and carbohydrate.

Fig. 3.7: Marasmus is caused by insufficient levels of all nutrients in the diet

Signs and Symptoms

a. Stunted growth
b. Weakness
c. Weight loss
d. Wrinkled skin
e. Good appetite
f. A child has monkey- like face looking like that of an old person
g. A child looks alert
h. Thin arms and legs

Prevention and Treatment

- Marasmus can be prevented and treated by giving children regular well balanced meals.

4. **Pellagra**
   - It is caused by lack of vitamin B_3 (niacin) in the diet.

Signs and Symptoms

a. Dry and rough skin
b. Diarrhoea
c. Nervousness
d. Dizziness

Prevention and Treatment

- It can be prevented and treated by including more sources of niacin in the diet.

5. **Rickets**

- It is caused by lack of vitamin D in the diet.

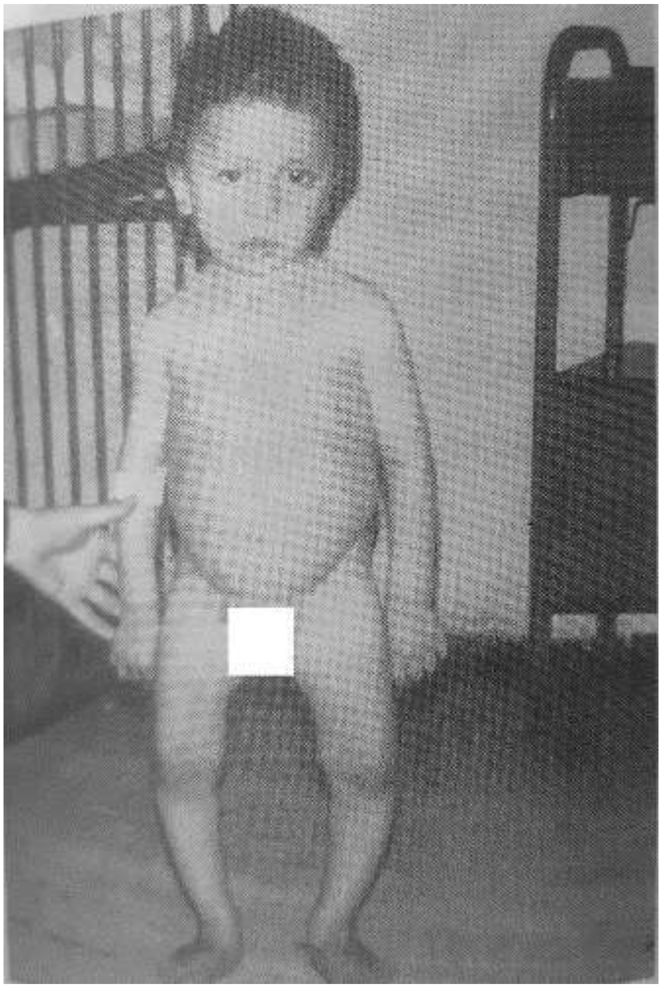


Fig. 3.8: Rickets is the result of not getting enough vitamin D

Signs and Symptoms

a. Curved legs
b. Enlarged and tender joints
c. Bony chest

Prevention

- It can be prevented by including more sources of vitamin D in the diet.
- Frequent exposure to sunlight especially to children also helps to prevent the disease.

6. **Night Blindness**

- It caused by lack of vitamin A in the diet.

Signs and Symptoms

a. Dry eyes
b. Loss of shine in the whites of the eye
c. Failure to see in dim light.

Prevention

- It can be prevented by including more sources of vitamin A in the diet.

7. Scurvy

- It is caused by lack of vitamin C in the diet.

Signs and Symptoms

a. Bleeding gums
b. Painful joints
c. Reduced resistance to infection
d. Loss of energy
e. Teeth become loose

Prevention and Control

- It can be prevented by including more sources of vitamin C in the diet.

8. Anaemia

- It is the shortage of red blood cells or haemoglobin in the blood.

Causes of Anaemia

a. Excessive bleeding due to injuries and accidents
b. Persistent menstruation
c. Diseases such as malaria and leukemia (cancer of blood)
d. Infestation by worms such as hookworms and bilharzia worms
   - The worms suck a lot of blood
   - They also cause injuries in alimentary canal leading to serious bleeding.
e. Lack of iron in the in the diet.
f. Hereditary defects such as sickle cell anaemia and haemophilia. Haemophilia is a condition whereby blood takes long to clot. This leads to excessive blood loss, in case of injury.

Signs and Symptoms

a. General body weakness
b. Pale mucous membranes
c. Heart palpitations

Prevention and Control

- It can be prevented by including more sources of iron in the diet.
- Controlling of worms by taking dewormers regularly
- Maintaining hygiene to prevent worm infestation

9. Beri- beri

- It caused by lack of vitamin B_1 in the diet.

Signs and Symptoms

a. Lack of appetite
b. Weakness of the limbs
c. Lack of nervous sensation in the ends of nerves leading to paralysis
d. Mental disturbances
e. Weakness and shrinking of muscles which leads to malfunctioning of muscular organs such as heart.

Obesity

- It is a condition whereby the body weight of a person is considered greater than what is normal.

Causes of Obesity

1. Consumption of more food than what the body requires.
2. Lack of physical activity
3. Sedentary lives – having lives with less walking and working.
4. Heredity – some individuals are born with traits of growing obese.
5. Eating an unbalanced diet – a diet high in fat or carbohydrates
6. Use of some medicine that reduce body activity. These medicine slow down break down of sugars to produce energy. All excess sugars are stored as fats.

Risk from Obesity

- Obesity is a health risk. An obese person may be at greater risk of:
  (i) Heart attack
  (ii) Diabetes
  (iii) High blood pressure
  (iv) Stroke in the brain
  (v) Heart disease
  (vi) Breathing problems

Prevention and Control of Obesity

- The problem of obesity can be solved by:
  (i) Avoid overfeeding
  (ii) Regular physical exercises which helps to control weight and reduce weight in obese persons.
  (iii) Feed on the diet with more vegetable and less starch

UNIT 4: HUMAN DIGESTIVE SYSTEM

Enzymes

- Enzymes are proteins that act as biological catalysts.
- A **catalyst** is a substance that speeds up the rate of chemical reaction, without being changed in the process.
- The substances which the enzymes work on are called **substrates**. The new substances that the enzymes make are called **products**.

Properties of Enzymes

1. All enzymes are protein in nature. They have molecules with precise three-dimensional shape, containing an **active site**.
2. Enzymes work best within a narrow range of temperature.

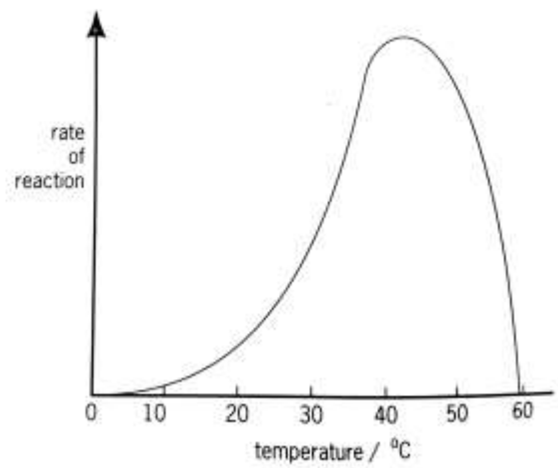


Fig. 4.1: How temperature affects the rate of an enzyme-catalysed reaction

   - The digestive enzymes in humans usually work best at about 40°C. The temperature at which an enzyme works best is called an **optimum temperature**.
   - When temperature is very high the enzymes are denatured (damaged) by heat since they are protein nature.
   - When the temperature is very low the enzymes become inactive and therefore the reaction rate is slow.

3. Enzymes are specific in the type of reaction they catalyse.
   - Each enzyme can only convert one kind of substrate molecule into one kind of product. This is because each enzyme has a binding site (active site) on its surface onto which only certain substrate molecules can bind (attach) in order to speed up the reaction. For example sucrase will break down sucrose only into glucose and fructose.
4. Enzymes are catalysts.
   - They are not changed in the chemical reaction which they catalyse. They are used over and over again, so a small amount of enzymes can catalyse the conversion of alot of substrate into a lot of products.

5. Enzymes are pH dependent.
    - Some enzymes work best in acidic conditions (low pH) e.g. pepsin. Others work best in alkaline conditions (high pH) e.g. trypsin.
    - The pH at which an enzyme works best is called the **optimum pH**.
    - Changes in pH beyond the optimum range leads to denaturing of the enzymes.

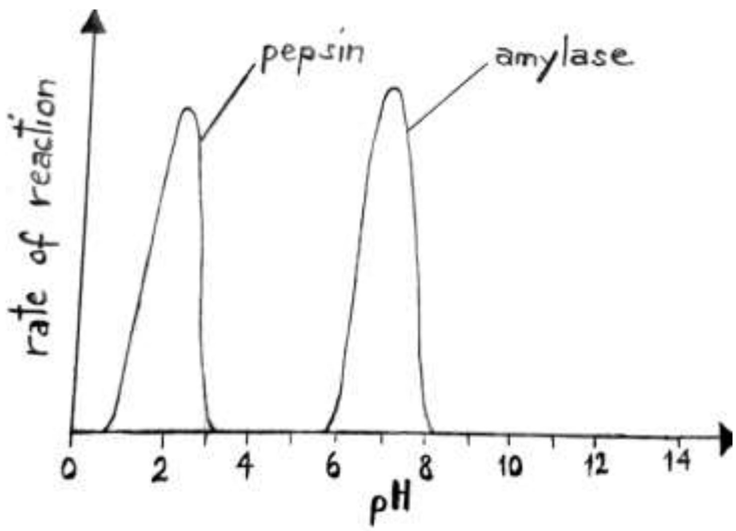


Fig. 4.2: How pH affects the rate of an enzyme-catalysed reaction

Digestion

- Digestion is the process by which ingested food is broken down into simple soluble molecules which can be utilized by the body.
- Digestion in humans takes place in the **digestive tract** or **alimentary canal** or **gut**, which begins at the mouth and ends at the anus.

Types of Digestion

- There two types of digestion:
    1. Physical digestion and
    2. Chemical digestion

1. Physical Digestion

- This is the breaking down of food into smaller pieces by exerting an external physical force on the food.
- Physical digestion occurs in the mouth when food is chewed by teeth and also in the stomach when food is churned.

Advantages of Physical Digestion

(i) It makes the food to be in a form which can be swallowed easily.
(ii) It increases the surface area for chemical digestion.

2. Chemical Digestion

- This is the breaking down of large insoluble molecules of food into smaller soluble molecules through the action of enzymes.

- Chemical digestion makes the food to be in form of small molecules which can be absorbed into the bloodstream for body use.

The Alimentary canal

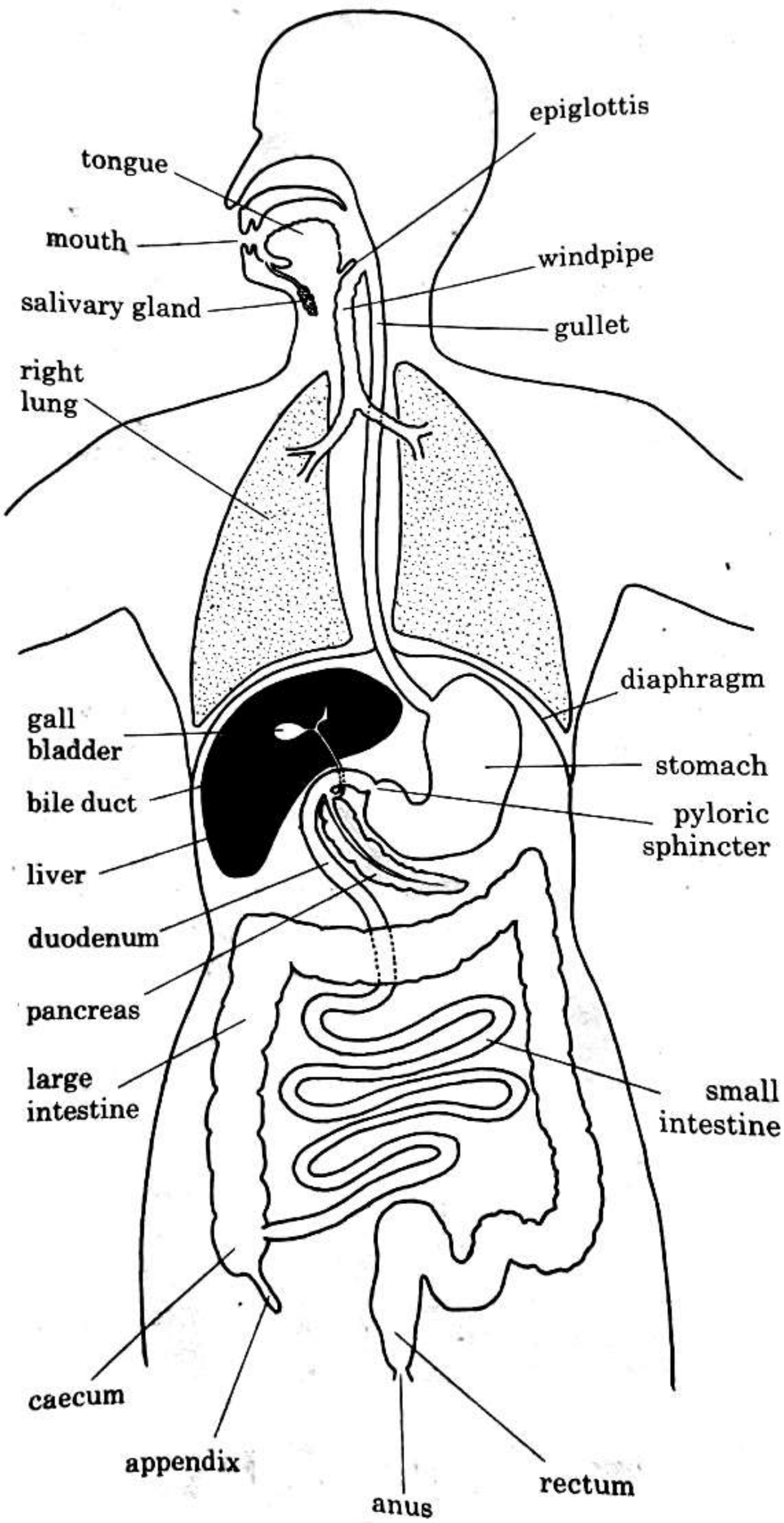


Fig. 4.3: The human alimentary canal

The Mouth Cavity

- The mouth cavity contains teeth, tongue and salivary glands.
- Food is chewed in the mouth breaking the large food particles into smaller pieces (physical digestion).
- Food is also mixed with saliva by the tongue. Saliva is produced by salivary glands.
- Saliva contains:
    a. Water that soften and dissolves food.
    b. Mucus that lubricates the food, make it easier to swallow.
    c. An enzyme called **salivary amylase** (**ptyalin**) which digests cooked starch to maltose.
    d. Salts which provide an alkaline environment in which ptyalin works well.
- The food is rolled into a bolus by the tongue and swallowed into the oesophagus.

The Oesophagus (Gullet)

- It is muscular tube which runs from the mouth to the stomach.
- The food is forced down the oesophagus by **peristalsis** of the walls of oesophagus.
- **Peristalsis** is the regular contraction and relaxation of the muscles in the walls of the gut which pushes food along the gut.

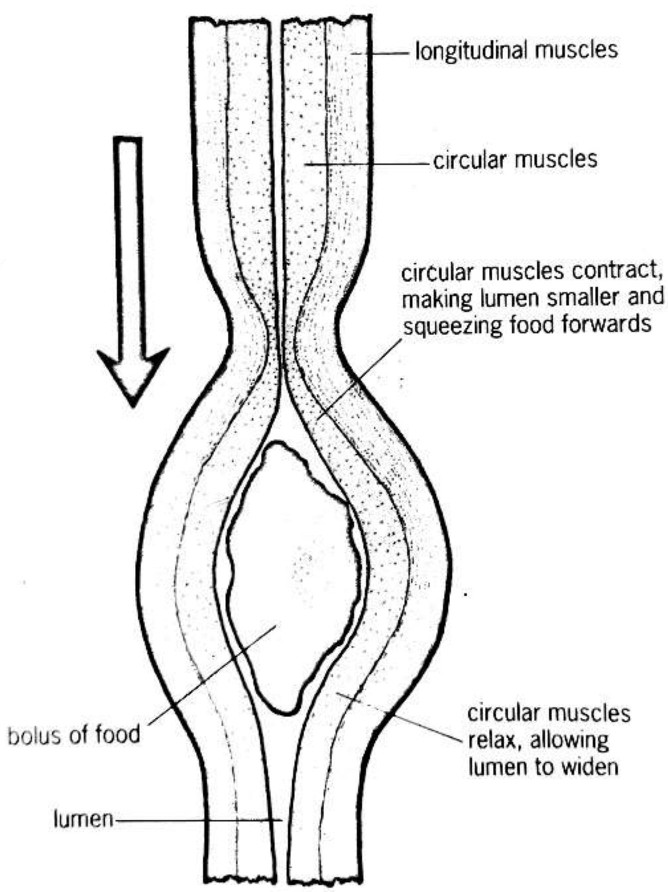


Fig. 4.4: Peristalsis

- When a piece of food is swallowed, the circular muscles just in front of it relax, so the tube gets wider. The circular muscles just behind the food contract, squeezing it forward. When the circular muscles are contracted, the longitudinal muscles relax, and virse versa.
- Starch digestion continues in the oesophagus until the food enters the stomach.

The Stomach

- Food from the oesophagus enters the stomach through the cardiac sphincter which closes to prevent the food from moving up the oesophagus.
- When the food enters the stomach, starch digestion stops because salivary amylase becomes inactive by the acidic pH.
- Entry of food into the stomach stimulates it secrete a hormone **gastrin**. Gastrin stimulates the gastric glands on the walls of the stomach to secrete gastric juice.
- Gastric juice contains:
  a. an enzyme called **pepsin** which catalyse the hydrolysis of proteins to peptides. Pepsin is secreted in an inactive state, pepsinogen, this is so that it does not digest cells lining the stomach which contain a lot of protein. Pepsinogen is activated where there is mucus. Mucus protects the cells lining the stomach from being digested by pepsin.

  b. **renin** which is usually secreted in young mammals because the diet of young mammals consist of milk. The function of renin is to make liquid milk to **curdle**. This is described as **coagulation** of milk. It does this by converting a soluble milk protein called**caseinogen** into an insoluble protein called**casein**. Pepsin digests casein to produce peptides. Coagulation of milk is also important because the solid milk stays in the stomach longer for digestion to occur.

  c. **hydrochloric acid** which
     1. kills the bacteria ingested with food
     2. provides an acidic medium (pH 2.0) required for the action of pepsin
     3. activates pepsinogen into pepsin
     4. softens or dissolves any bone that might have been taken together with food.

  d. a lot mucus which protects the stomach from being damaged by hydrochloric acid and protein digesting enzymes.

- The stomach has elastic muscular walls that contract rhythmically churning the food into a semi-liquid mixture called chyme.
- The food stays in the stomach for about three hours to ensure digestion takes place after which it moves to the duodenum.

The Small Intestine

- The small intestine is the longest part of the alimentary canal.
- It is divided into two main sections:
  (i) The duodenum and
  (ii) The ileum

The Duodenum

- The semi-liquid chyme leaves the stomach through the pyloric sphincter into the duodenum.
- The duodenum secretes a hormone called **secretin**, which in turn triggers the gall bladder to release stored bile, made by the liver and pancreas to secrete pancreatic juice. The pancreatic juice reach the duodenum through the pancreatic duct while bile reach it through the bile duct.

Bile

- It is alkaline green water fluid.
- Bile contains:
  1. inorganic salts which neutralise the acidic chyme coming from the stomach.
  2. organic salts, which help to break the fat into tiny droplets that can be digested fast by enzyme lipase. This is called **emulsification**. Emulsification of fats increases the surface area for action by lipase.
  3. no enzymes.

Pancreatic Juice

- It is an alkaline fluid with a pH of 7 -8
- It contains:
  (i) **sodium hydrogen carbonate** which neutralise the acidic chyme.
  (ii) Enzymes that are involved in chemical digestion:
    - **Pancreatic amylase** which digest starch to maltose.
    - **Trypsin** secreted in an inactive form **trypsinogen**. Trypsin digests polypeptides to peptides.
    - **Lipase** which digest lipids to fatty acids and glycerol.

The Ileum

- The walls of the duodenum and the rest of the ileum secrete the intestinal juice (succus entericus), which completes the process of digestion of food.
- Intestinal juice contains the following enzymes:
  1. **Lipase** which catalyse the hydrolysis of lipids to fatty acids and glycerol.
  2. **Maltase** which digest maltose to glucose.
  3. **Lactase** which digests lactose to glucose and galactose.
  4. **Sucrase** which digest sucrose to glucose and fructose.
  5. **Peptidase** which digests peptides to amino acids.
- Intestinal juice also contains **enterokinase** which activates trypsinogen into trypsin.
- The enzymes released into the small intestine do not digest the intestine wall, which made of proteins and lipids, because the wall has special mucus secreting cells. The mucus protects the lining of small intestine. Also, the enzymes are only secreted when food is present.

Adaptations of Small Intestines for Digestion

1. It is very long
   - This gives a large surface area for digestion

2. It is highly coiled to slow down the flow rate of food giving it more time for digestion
3. It has muscular walls to facilitate peristalsis. Peristalsis mix the enzymes with food substances thoroughly. This speed up the process of digestion.
4. The inner walls of the ileum are highly folded.
   - This gives a large surface area for digestion
5. The inner walls of the ileum have goblet cells that secrete mucus for lubrication and protection of the wall from digestive enzymes.

Absorption of Food Substances

- Absorption is the process by which small soluble molecules produced during digestion of food enter the blood and lymph from the lumen of the alimentary canal.
- Absorption mainly takes place in the ileum.
- When the small food molecules have been absorbed into the blood, they are taken to the liver, in the **hepatic portal vein**. The liver process some of it, before it goes any further. Some of the food is broken down, some converted into other substances, some stored and the remainder left unchanged.

Adaptation of Small Intestine to Absorption

1. It is very long
   - This gives a large surface area on which food is absorbed.
2. Its inner walls are highly folded. In addition, they have finger-like projections called **villi**that increase the surface area for absorption of the products of digestion.
3. It is highly coiled to slow down the flow rate of food giving more time for absorption.
4. It has muscular walls to facilitate peristalsis. Peristalsis expose the villi to digested food. This speed up the process of absorption of the digested food.

The Villus

- The villus is the actual place where food is absorbed into the blood stream in the small intestine.

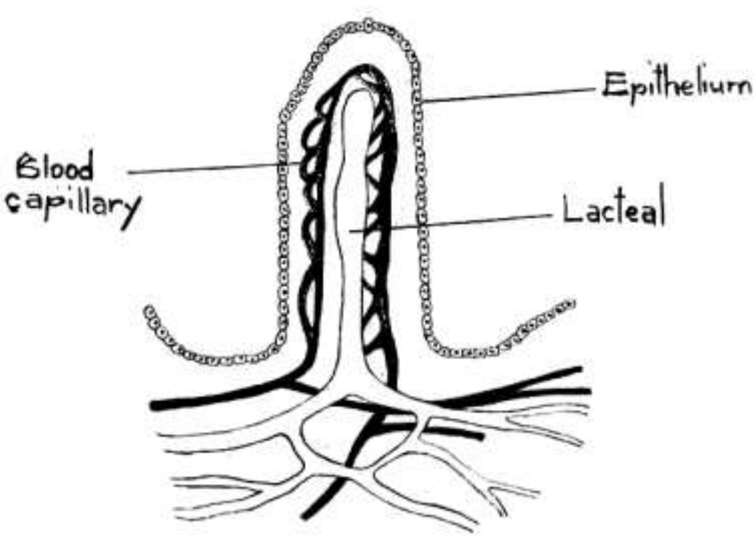


Fig. 4.5: Longitudinal section through a villus

Adaptations of the Villus for Food Absorption

1. It has thin epithelium, which is only one cell thick.
   - This makes diffusion of food faster.
2. It has a dense network of blood capillaries.
   - This ensures continuous blood flow in the villus into which food diffuses.
3. It has lacteal into which large molecules of fatty acids and glycerol diffuse and are absorbed.
4. It has many mitochondria in the epithelial cells.
   - Mitochondria provide energy for the uptake of digested food by active transport.

The Large Intestine

- The large intestine has two parts:
  1. The colon and
  2. The rectum, where the faeces can be stored before egested through the anus during defecation. Faeces is composed of undigested roughage material, food which may not be digested, dead cells from the lining of the alimentary canal, unwanted mineral salts, bile pigments, living and dead bacteria.
- The colon is wider than the ileum and its ridged lining contains many mucus secreting cells.
- There is no digestion in the colon.

Functions of Large Intestine

1. It reabsorbs water from the gut content. This makes the content of large intestine to become hard.
2. It absorbs vitamins that are produced by colonic bacteria, such as vitamins K.
3. It absorb some mineral salts.

Assimilation

- It is the process by which the body uses up absorbed products of digestion. These absorbed nutrients are mainly:
  1. Glucose
  2. Amino acids
  3. Fatty acids and glycerol

1. Glucose

- It is oxidised to release energy during respiration.
- Excess glucose is converted into glycogen and stored in the liver and muscles.
- Some glucose may be converted to fats for storage.
- Some of the glucose is combined with nitrogen containing compounds to form proteins in the body
- Other glucose remain in the general blood circulation e.g. blood sugar, thereby controlling osmotic pressure of blood.

2. Amino Acids

- They are used in the synthesis of bodily proteins e.g. haemoglobin.

- They are used in growth and repair of worn out tissues.
- When glucose and fats are unavailable (during starvation) amino acids are oxidised to release energy.
- Excess amino acids are deaminated by the liver cells to form nitrogenous wastes e.g. urea.

3. Fatty Acids and Glycerol

- Fatty acids and glycerol are combined to form fats.
- Fats are broken down in the absence of sugars to provide energy to the body.
- Some fats are stored underneath the skin where they insulate the body against heat loss. They are bad conductors of heat.
- Fats are also stored around the organs such as kidneys, alimentary canal and heart where they act as shock absorber.
- Fats are distributed to all parts of the body where they fill in spaces between tissues. These include the face, the hips, abdomen and in between the muscles.

Functions of the Liver Related to Digestion

1. It controls glucose concentration in the blood.
    - The liver converts excess glucose in the blood to glycogen for storage.
    - If there insufficient glucose in the blood, the liver breaks down glycogen into glucose for immediate use.
2. It controls the level of protein in
    - The liver makes amino acids that are deficient in the diet in a process called **transamination**.
    - Transamination is the transfer of amino group from one amino acid to another substance so as to form another amino acid. This process enables the liver to provide an important amino acid that may be lacking in the body. For example glutamic acid can be made by removing an amino group from alamine and combining it with an organic sugar.

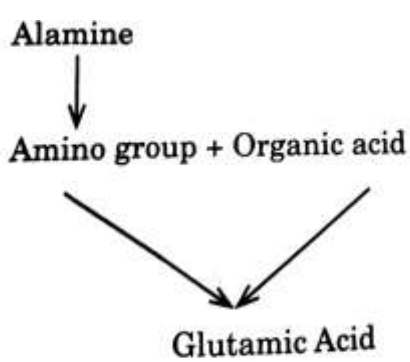


Fig. 4.6: Transamination

- If too much protein is eaten the excess amino acids are broken down (deaminated) in the liver into ammonia (a more poisonous substance) and carbohydrate.

- The liver then combines ammonia with carbon dioxide to form urea which is a less poisonous substance. This process is called **detoxification**. Urea is then sent to the kidneys for excretion.
- Carbohydrate is used for energy or stored.

Deamination

- It is the removal of amino groups from amino acid molecules by the liver.

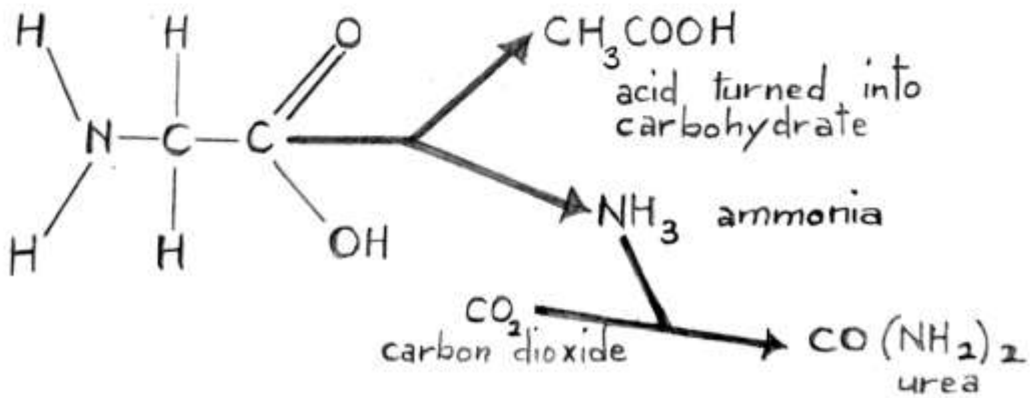


Fig. 4.7:Deamination and formation of Urea

3. The liver acts as storage organ. It stores vitamins A, D, E, K and B_{12} together with some mineral elements such as iron, copper and potassium until they are required by the body.
4. The liver produces bile which emulsifies fats and regulates pH in the intestines for proper action of pancreatic enzymes.
5. The liver regulates the level of lipids circulating in the blood.
   - The liver converts fatty acids and glycerol into fats for storage under the skin.
   - The liver also converts fatty acids and glycerol into glucose which can be used for respiration to release energy.

Abnormal Conditions of the Digestive System

1. Diarrhoea

- This is a disorder where an individual passes watery stool.

Causes of Diarrhoea

- It is caused by:
  a. Food poisoning
  b. Allergy to certain food substances
  c. Drug abuse such as the use of alcohol.
  d. Some diseases such as cholera, typhoid and diabetes

Control of Diarrhoea

- It can be controlled by:
  a. Treatment of disease infections using appropriate antibiotics

b. Oral rehydration where an individual is given rehydration solution orally and frequently so as to replace lost fluids.

2. **Ulcers**
   - This is a problem whereby small wounds develops on the lining of the alimentary canal.
   - Ulcers can be found in the gullet, the stomach and the small intestine.

Causes of Ulcers

- It is caused by:
  a. Infections by certain bacteria that attacks the walls of intestine.
  b. Over production of acids in the stomach. The acid corrodes the stomach walls.
  c. Use of some drugs such as strong painkillers
  d. Eating spicy foods that increase acidity in the stomach.
  e. Stress that results to over production of stomach acids.

Effects and Signs

a. Pain in the abdomen especially after eating meals.
b. Burning effect in the stomach due to contact of stomach acids with the open tissues
c. Bloating
d. Nausea
e. Loss of appetite

Control of Ulcers

- It can be controlled by:
  a. Eating a diet with less acids and spices
  b. Using anti- acid drugs to neutralise the acidity
  c. Controlling emotional stress
  d. Avoid excessive use of strong painkillers

3. **Heart Burn**
   - This is a burning feeling on the lower part of the chest followed by a sour or a bitter taste on the throart.
   - Heart burn develops when the acid contents of the stomach flows back into the oesophagus.

Causes of Heart Burn

- It is caused by:
  a. Over eating
  b. Eating too fast
  c. Pregnancy
  d. Stress
  e. Eating spicy food
  f. Smoking and use of alcohol
  g. Eating acidic foods such as citrus fruits, tomatoes and onions.
  h. Drinking coffee and other carbonate drinks
  i. Eating when lying down or when bending

Control of Heart Burn

- Heart burn can be controlled by:
  a. Avoid taking alcohol and smoking
  b. Avoid eating spicy or too salty foods
  c. Avoid stress
  d. Eat when seated at an upright posture
  e. Avoid carbonate and acid drinks

4. Indigestion

- This is a disorder where the food eaten takes too long to be digested thereby making the abdomen to be overly full.

Causes of Indigestion

- It is caused by:
  a. Inadequate enzyme secretion
  b. Anxiety
  c. Over eating
  d. Eating excessively spicy

Symptoms of Indigestion

a. Abdomen often over full
b. Accumulation of gases in the abdomen hence causing bloating
c. Discomfort or pain in the abdomen

Control of Indigestion

a. Doing physical exercises
b. Taking anti-acid tablets
c. Use of foods with low fat content

5. Nausea and Vomiting

- Nausea is uncomfortable feeling that comes before vomiting
- Vomiting is a reaction whereby the muscles at the joint between gullet and stomach opens resulting to food in the stomach being forced violently back to the mouth.

Causes of Nausea and Vomiting

- Nausea and vomiting can be caused by:
  a. Some diseases such as cholera
  b. Reaction to bad smell of human waste
  c. Motion sickness when travelling in fast moving cars.
  d. Stress
  e. Food poisoning
  f. Allergy to some food products
  g. Early stages of pregnancy
  h. Coughing and colds

Control of Nausea and Vomiting

a. Avoid heavy meals
b. Taking drinks between the meals and not after meals
c. Take sweet non-alcoholic drinks when having a feeling of nausea

6. Constipation

- Constipation occurs when one faces difficulties in expelling undigested waste matter from the body.
- Constipation is as a result of reduced peristaltic movement in the alimentary canal. Reduced peristaltic movement cause the faeces to stay longer in the alimentary canal making it to harden. This is because the alimentary canal absorb most of the water from faeces.

Causes of Constipation

a. Eating food with less fibre
b. Lack of water in the diet
c. Eating too much dairy products

Symptoms of Constipation

a. Taking too long before defecation (defecating only once or twice a week)
b. Difficulties when passing out faeces.
c. Pain during defecation
d. Swollen abdomen

Control of Constipation

a. Eat food rich in fibres such as vegetables, fruits and whole grains.
b. Increase water intake
c. Doing physical exercises to induce the movement of bowels.
d. Taking drugs such as laxatives.

UNIT 5: THE HUMAN CIRCULATORY SYSTEM

Functions of the Circulatory System

1. It transports oxygen from the lungs to the tissues
2. It transports carbon dioxide from the tissues to the lungs.
3. It transports food nutrients from the alimentary canal to all parts of the body.
4. It transports hormones from endocrine glands to the target organs.
5. It transports heat from the liver and skeletal muscles to all parts of the body.
6. It transports white blood cells around the body to sites of infection to help to fight against infection.

Why do Large Animals need Circulatory System?

- Large animals require a circulatory system for the following reasons:
  a. To ensure efficient transport of substances to organs that are far from the body surface.
  b. To bring waste substances from tissues deep in the body, closer to the tissues near the body surface where they can be easily eliminated.
  c. To transport substances in between organs far from each other in the same body.

Components of the Human Circulatory System

- The human circulatory system is composed of three main components:
  a. The blood,
  b. The heart, and
  c. Blood vessels.

The Blood

- Blood is made up of several different kinds of cells that float in a liquid. The liquid is called **plasma**.
- A sample of blood left to stand in a test tube in an open appear as shown in **figure 4.1**.

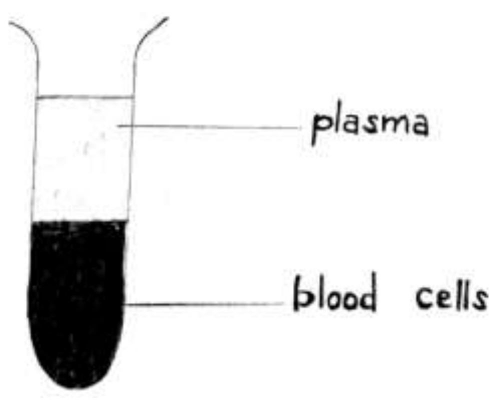


Fig. 5.1:The blood

- Plasma constitutes about 55% of the total blood volume.The other 45% of blood consists of **red blood cells** (erythrocytes), **white blood cells** (leukocytes) and **platelets** (thrombocytes).

Composition of Blood

- The composition of blood is shown in **figure 4.2**.

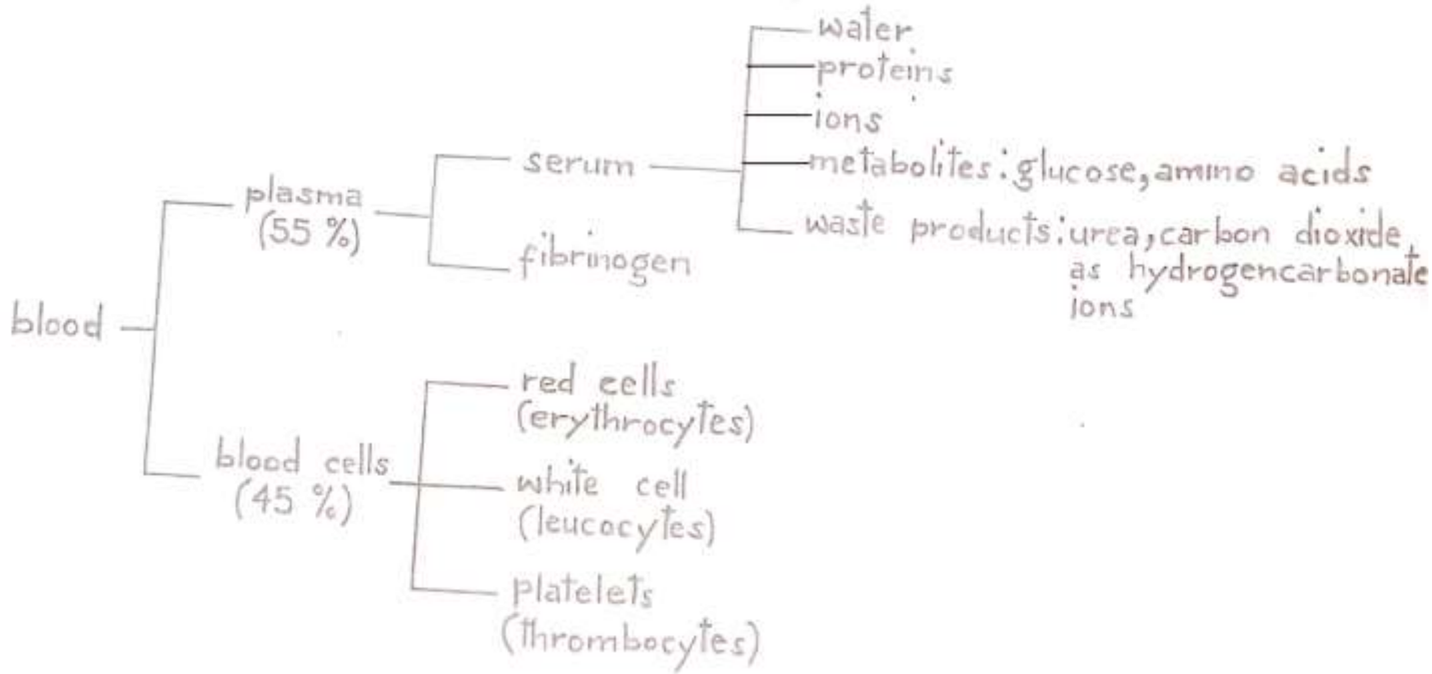


Fig. 5.2: Composition of blood

Plasma

- This is the fluid part of the blood.
- About 90% of plasma is water which serves as solvent for other 10% of dissolved substances. These substances include glucose, amino acids, salts and blood proteins (e.g. hormones and antibodies).

Functions of Plasma

1. It acts as a transport media. Plasma transport:
   a. Food substances from alimentary canal to all parts of the body.
   b. Waste products from the tissues to excretory organs.
   c. Hormones from endocrine glands to target organs.
2. It regulates body temperature by distributing heat generated by the liver and skeletal muscles throughout the body.
3. It provides a medium in which substances dissolve before they are transported.

Red Blood Cells (Erythrocytes)

- They have a biconcave shape i.e. edge is thicker than the middle
- They contain a red pigment called **haemoglobin**. Haemoglobin is a protein and contains iron.
- They have no nuclei.
- They are produced in the **bone marrow** of short bones such as ribs, vertebrae and sternum.

- They have a life span of 120 days. Old red blood cells are broken down in the liver and spleen releasing iron which is used to make more haemoglobin and the rest of the molecule is converted into bile pigment.

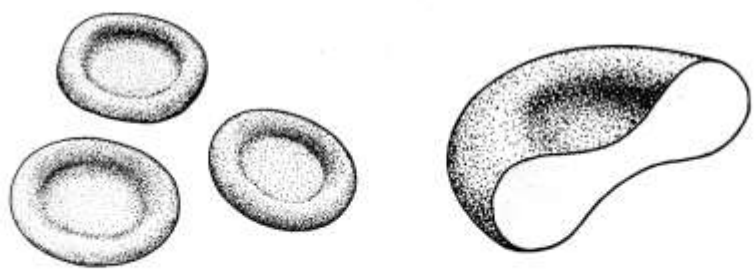


Fig. 5.3: Red blood cells

Functions of Red Blood Cells

1. It transports oxygen.
2. It transports carbon dioxide.
3. It prepares carbon dioxide for transport from all respiring tissues to the lungs.

Adaptations of Red Blood Cells to their Function

1. They have biconcave shape which increases the surface area for transportation of oxygen and carbon dioxide.
2. They lack nucleus and other organelles such as ribosomes. This increases the surface area for transportation of oxygen.
3. They contain haemoglobin. Haemoglobin has a site where oxygen and carbon dioxide binds. This facilitates transportation of oxygen and carbon dioxide.
4. They are elastic so can squeeze through narrow capillaries.
5. They are numerous. This increases the surface area for transportation of oxygen and carbon dioxide.

Properties of Haemoglobin

- Haemoglobin is a substance that enables blood to carry large quantities of oxygen. Haemoglobin has the following properties:
    a. It contains iron
    b. Haemoglobin molecule consists of protein with four haem groups attached to it. Each haem group contains an iron which is responsible for binding with the oxygen. Each haemoglobin molecule can bind with up to four oxygen molecules.
    c. It is red in colour. Haemoglobin gives the red blood cells it's colour.

Transportation of Oxygen

- Red blood cells are able to transport oxygen because they are filled with a red protein called haemoglobin.
- Haemoglobin has high affinity for oxygen and readily combines with it in conditions of high oxygen concentration, in the lungs.

- As the blood passes through the lungs, oxygen diffuses from the alveoli into the red blood cells where it combines with haemoglobin to form **oxyhaemoglobin** (a bright red compound). Oxyhaemoglobin is transported to various tissue cells with blood. In the tissues there is low oxygen concentration which stimulates oxyhaemoglobin to release its oxygen and becomes a dark red haemoglobin again. The cells take up the released oxygen and haemoglobin is free to be used again to carry more oxygen.

Summary of the Body's Oxygen Transport System

$$\text{Haemoglobin} + \underset{\text{(in the lungs)}}{\text{oxygen}} \underset{\textbf{in the tissues}}{\overset{\textbf{in the lungs}}{\rightleftharpoons}} \text{oxy haemoglobin}$$

$$\underset{\text{(dark red)}}{Hb} + 4O_2 \rightleftharpoons \underset{\text{(bright red)}}{HbO_8}$$

Fig. 5.4: Body's oxygen transport system

Transportation of Carbon Dioxide

- The carbon dioxide produced by respiration diffuses through the walls of capillaries into the cytoplasm of red blood cells where an enzyme called **carbonic anhdrase** catalyses the combination of carbon dioxide with water to form carbonic acid (H_2CO_3). The carbonic acid then splits to form hydrogen ions (H^+) and hydrogen carbonate (HCO_3^-) ions. The hydrogen carbonate ions diffuse out of red blood cells into the plasma where it is transported to the lungs.
- A very small amount of carbon dioxide dissolves directly in the plasma to form carbonic acid and is transported to the lungs as carbonic acid.
- Some of the carbon dioxide combines with the amino group of haemoglobin to form **carbamino-haemoglobin** and is transported to the lungs inside the red blood cells.
- In the lungs, carbon dioxide diffuses from the blood into the alveoli and `is breathed out.

White Blood Cells (Leukocytes)

- They are larger than red blood cells.
- They are fewer in number than red blood cells.
- They have nucleus.
- They do not contain haemoglobin.
- They are made in the bone marrow of long bones and in the lymph nodes.
- Their main function is to defend the body against disease causing micro-organisms.

Types of White Blood Cells

- There are two types of white blood cells, namely:
  1. Phagocytes
  2. Lymphocytes

1. **Phagocytes**
   - They have a large lobed nucleus.
   - They are irregular in shape.
   - They have granular cytoplasm.

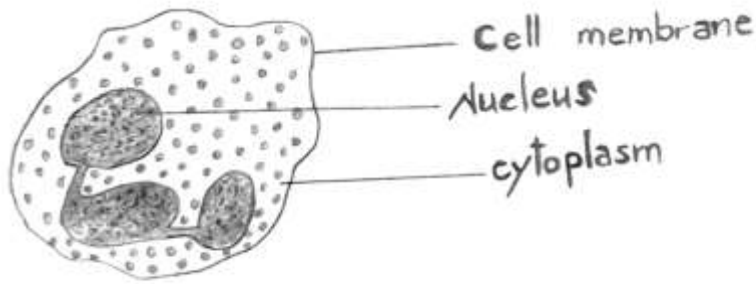


Fig. 5.5: Phagocyte

   - Phagocytes can move by a flowing action of their cytoplasm and can pass out of blood capillaries by squeezing between cells of the capillary wall in order to reach infected tissue.
   - They defend the body against infection by engulfing and digesting germs.

Adaptations of Phagocytes to their Function

(i) They have irregular shaped nucleus which allows the cell to squeeze through the gaps in the walls of capillaries.
(ii) They have enzymes in cytoplasm which digest micro-organisms once engulfed.
(iii)They have sensitive cell surface membrane which detects micro-organisms.

2. **Lymphocytes**
   - They have a large rounded nucleus.
   - They are more regular in shape.
   - Their cytoplasm is non-granular.

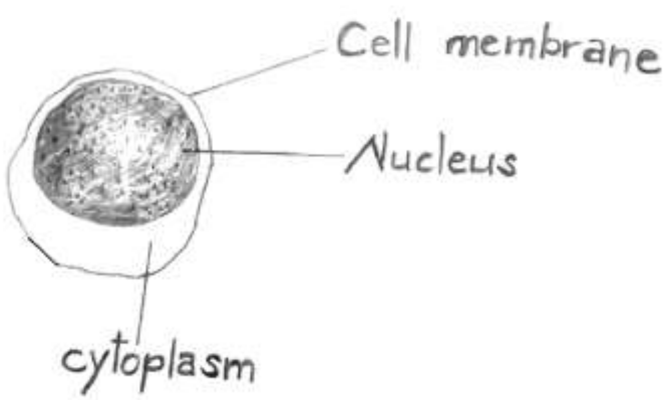


Fig. 5.6: Lymphocyte

   - They defend the body against infection by producing antibodies which destroy the germs.

Adaptations of Lymphocytes to their Functions

- They have large nucleus which contain many copies of genes for the control of antibody protein production.

Platelets

- These are irregularly shaped, fragments of blood cells.
- They have no nucleus.
- They are made in the bone marrow.
- They help blood to clot when a blood vessel is damaged.

Fig. 5.7: Platelets

The Process of Blood Clotting

- A blood clot is a semi-solid mass that is formed when a blood vessels is damaged.
- When a blood vessels are damaged, for example a cut on the skin, the damaged cells and platelets release a clotting factor called **thromboplastin** (thrombokinase). Thromboplastin acts like an enzyme to convert a blood protein called prothrombin to an enzyme called thrombin. This occur in the presence of calcium. Calcium helps to convert prothrombin into thrombin.
- The enzyme thrombin converts a soluble blood protein fibrinogen into a sticky mesh of fibrin fibres. These fibres trap cells and so form a blood clot and stop bleeding. Fibrin is an insoluble protein in the form of long threads.

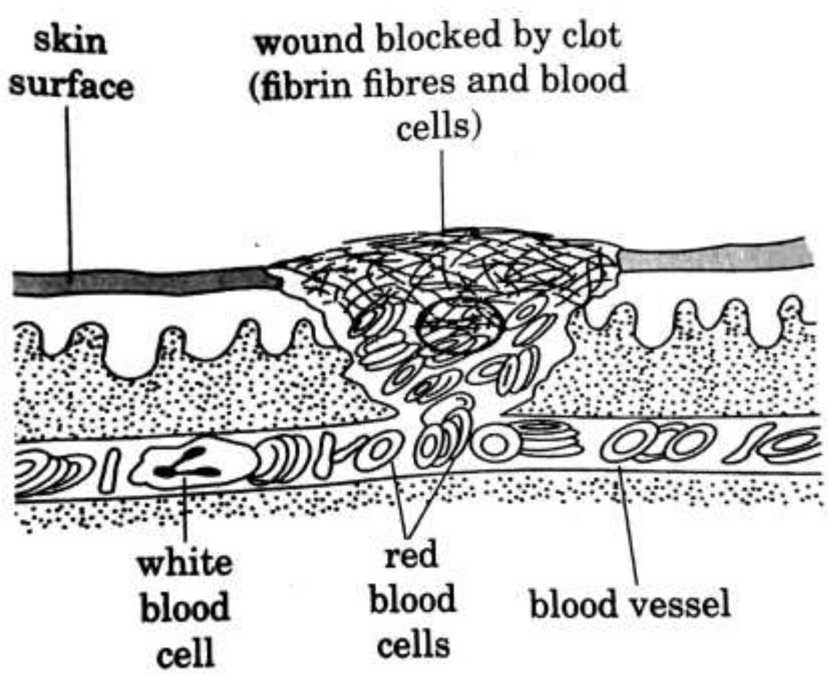


Fig. 5.8:Blood clot

Importance of Blood Clotting

1. It prevents excessive bleeding.
2. It prevents the entry of disease-causing micro-organisms into the body through wounds.
3. It initiates the healing process of damaged tissue.

The Heart

- The heart is a muscular organ which pumps blood around the body.
- The heart is made of special type of muscles called **cardiac muscles**. This muscle is special in two ways:
    a. It contract continuously without getting fatigue
    b. Cardiac muscle is **myogenic**, which means its contraction are started by muscle itself and not by nerves.
- The muscles of the heart are supplied with blood containing nutrients and oxygen by the **coronary artery**. It also has coronary vein which takes the deoxygenated blood back into the venacava.
- The heart is found in a cavity called pericardium. The pericardium is covered with two membranes called **pericardial membranes**. The pericardial membranes protect the heart. Between the pericardial membranes there is a fluid called **pericardial fluid**. The fluid helps to reduce friction between the two membranes as the heart beats.

The Structure of the Human Heart

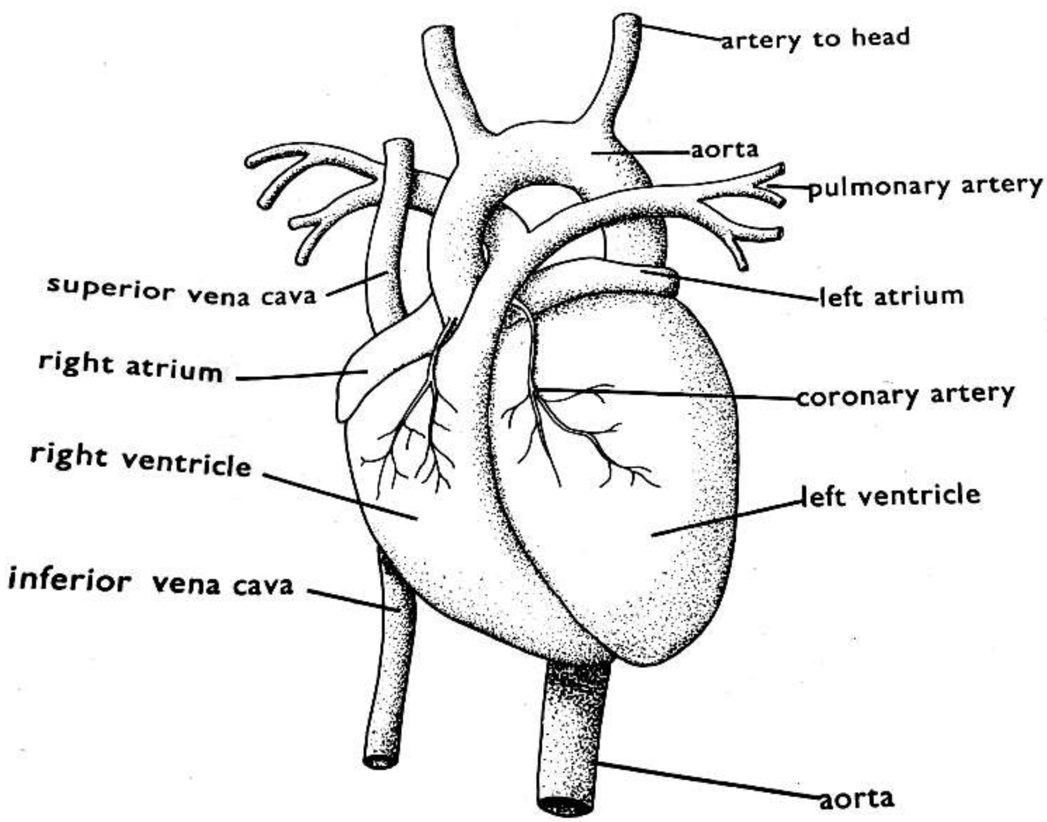


Fig. 5.9: External view of mammalian heart

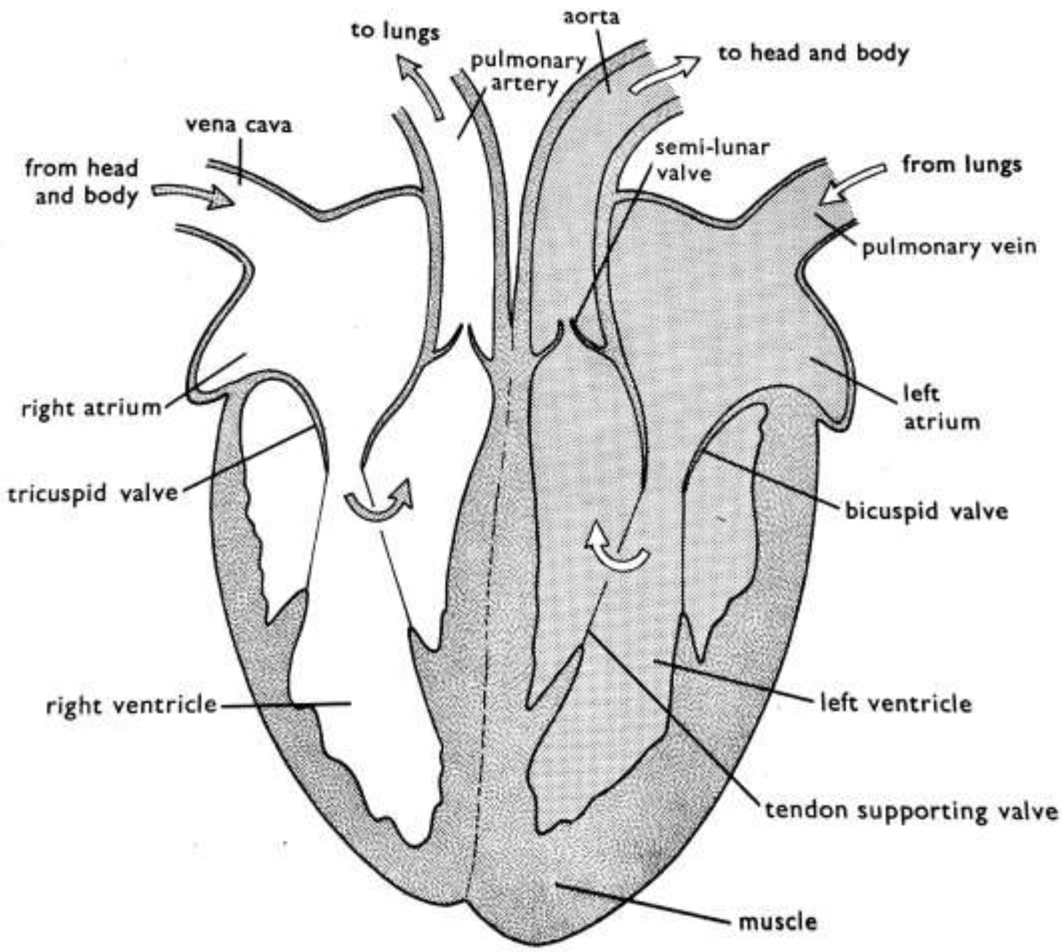


Fig. 5.10:Internal structure of the human heart

- The heart is composed of four chambers, two chambers on the right and the other two on the left with a central wall called **septum** completely separating the right and left halves of the heart. The septum prevents blood on the right side from mixing with blood that is on the left side.
- The upper chambers which are small with thin walls are called **atria** (singular- atrium) or **auricles**- left and right auricles. The atria receive blood which they pump to the ventricles.
- The lower chambers, which are relatively large with thick walls, are called **ventricles**- forming left and right ventricles. The ventricles pump blood out of the heart. The left ventricle has much thicker walls because it exert a greater force on blood when it contract to push blood to the whole body while the right ventricle has thinner walls and this because it exert less force on the blood when it contract to push it to the lungs, a relatively short distance.
- The direction of flow of blood through the heart is controlled and maintained by a system of valves which include:
   a. **The Tricuspid Valve**- which controls the opening between the right atrium and right ventricle.

b. **The Bicuspid Valve**- which controls the opening between the left atrium and left ventricle.
c. **The Semi-Lunar Valves**- are found at the base of aorta and pulmonary artery.

- The valves prevent the backflow of blood.

Blood Circulation in the Human Heart

- Blood from the body tissues enters the right atrium through the venacava.
- This blood has very little oxygen dissolved in it because most of the oxygen has been used up for respiration by the tissues. This blood is described as **deoxygenated blood**. It is however rich in carbon dioxide and it is **dark red** in colour.
- The right atrium contract to push the blood into the right ventricle via the tricuspid valve. The right ventricle contracts and pushes the blood to the lungs though the pulmonary artery.
- In the lungs, blood picks up oxygen and gives up carbon dioxide. It said to be **oxygenated** and is **bright red** in colour.
- The oxygenated blood from the lungs enters the left atrium through the pulmonary vein. This portion of the circulatory system where blood flow to the lungs from heart and back is called **pulmonary circulation**.
- The left atrium pumps blood into the left ventricle via the bicuspid valve. The left ventricle contracts and pushes the blood to all parts of the body except the lungs through the aorta. The circulation of blood from the heart to the tissues and back is called **systematic circulation**.
- The mammalian heart therefore act as a **double pump**. The left side sends blood rich in oxygen to the rest of the body and the right side sends blood poor in oxygen to the lungs.

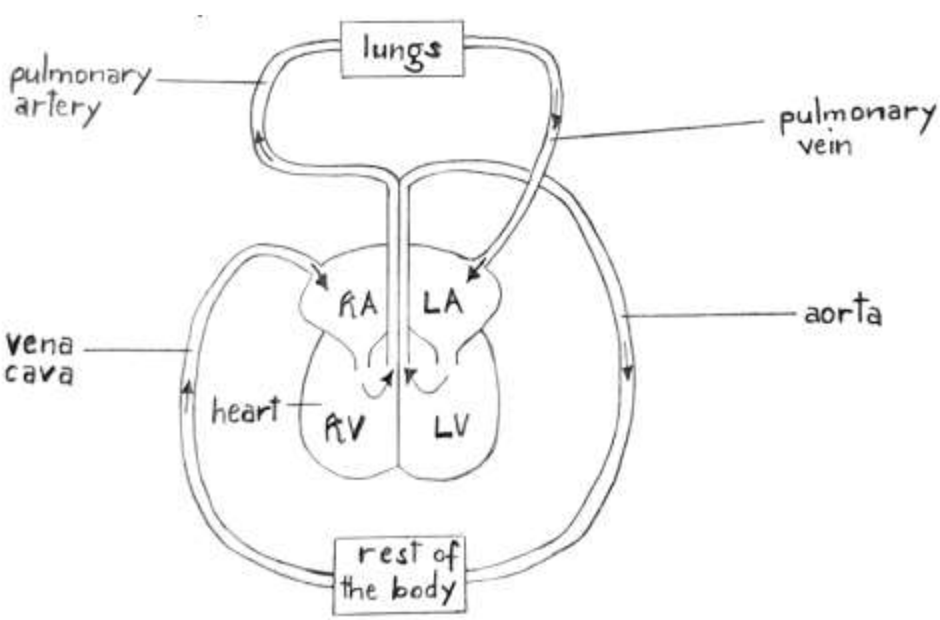


Fig. 5.11: A plan of human circulatory system

How the Heart Works?

- The function of the heart is to receive and pump blood. The heart receives blood when its muscles relax. It pumps blood when its muscles contract. These two processes take place in repeated sequence known as **heart beat** or **cardiac cycle**.
- The cardiac cycle has two alternating phases known as **systole** and **diastole**.
- During **systole**, the muscles of the heart chambers contract to pump out blood.
- During diastole, the muscles of the heart chambers relax for them to receive blood.

Cardiac Cycle

- Each cardiac cycle is made up of the following stages:

1. Atria Systole

- The atria contracts thereby opening the bicuspid and tricuspid valves. Blood is then forced into the ventricles.
- The ventricles are relaxed to receive blood.
- The semi-lunar valves are closed, preventing blood from flowing back into the ventricles from the pulmonary artery and aorta.
- The pulmonary vein and venacava contracts to prevent blood from being squeezed out of the atria back into the veins.

2. Ventricular Systole

- The ventricles contracts thereby increasing blood pressure in the ventricles which opens the semi-lunar valves and closes bicuspid and tricuspid valves. Blood is forced into the aorta and pulmonary artery.
- The atria are relaxed to receive blood from the venacava and pulmonary vein.

3. Diastole

- The atrial and ventricles walls relax briefly.
- The semi-lunar valves close.
- More blood flows into the atria which are dilated. When they fill up a new cardiac cycle begin.

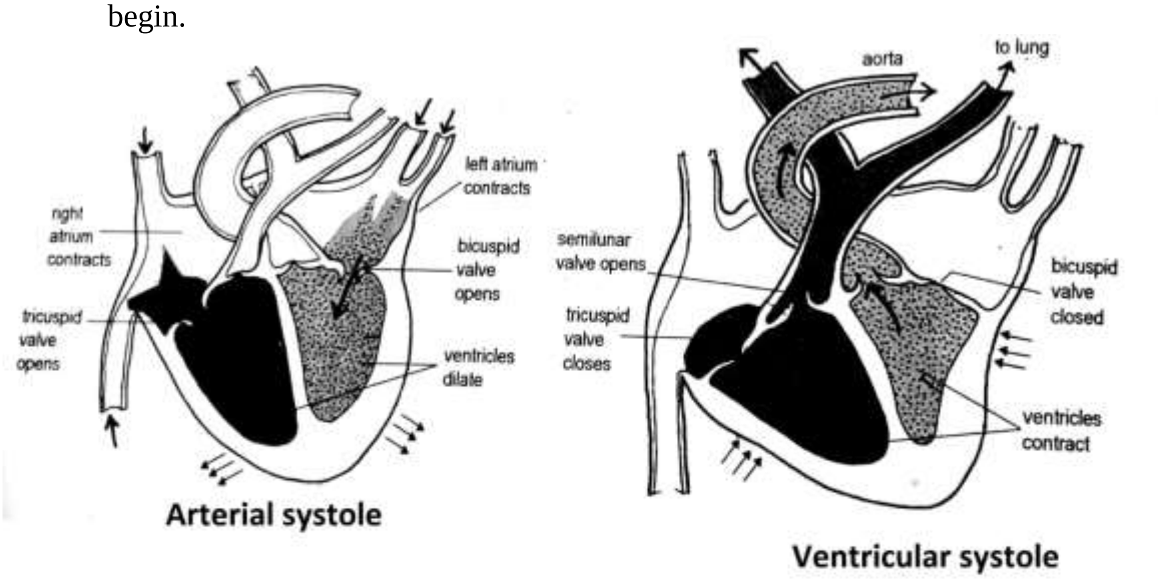


Fig. 5.12: Cardiac cycle

Pulse Rate

- Pulse rate is the number of times the heart beats per minute.
- Pulse can be felt by putting your finger at the wrist, side of the neck and on top of the foot. The pulse you feel is the contraction and relaxation of the artery as the blood is pumped from the heart.

Effects of Physical Activity on Pulse Rate

- The normal average heartbeat of an adult person at rest is 72 beats per minute. This is known as pulse rate and it increases during a vigorous activity.
- An increased heart beat helps to circulates blood with oxygen and glucose needed to produce energy for the vigorous activity in the muscle tissue faster and takes away carbon dioxide and other wastes away from the tissue.

The Blood Vessels

- These are the passage of the blood.
- There are three main types of blood vessels:
  1. Arteries
  2. Veins and
  3. Capillaries

1. Arteries

- These are blood vessels that carry blood away from the heart.
- Arteries branch to form a network of smaller arteries called **arterioles**.

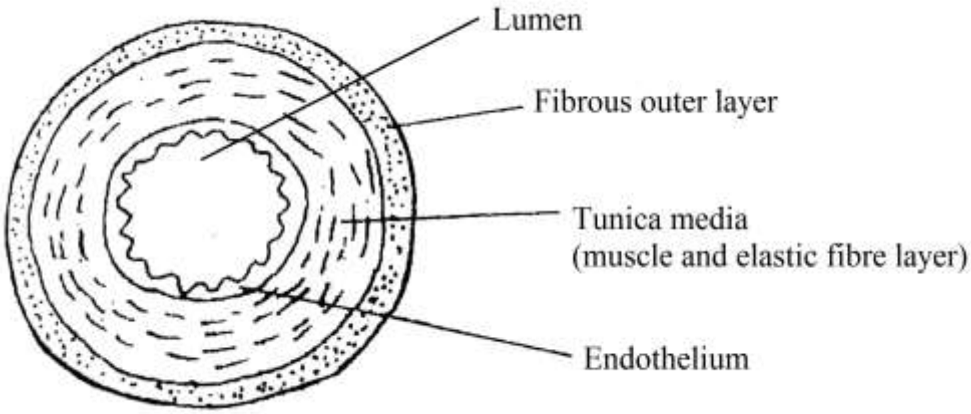


Fig. 5.13: Transverse section through an artery

Characteristics of Arteries

(i) They have thick muscular wall to withstand and maintain higher pressure of blood flowing through them.

(ii) They have an outer fibrous coat for strength and protection.

(iii) They have a thick layer of muscle and elastic fibres which contract and relax to adjust their diameter as the blood flow through them.

(iv) They have narrow lumens to maintain higher pressure of blood inside them.

(v) They have no valves.

(vi) Blood flows in arteries with high pressure because of the force exerted by the pumping action of the heart.
(vii) They carry oxygenated blood, except the pulmonary artery.

2. Veins

- These are blood vessels that carry blood towards the heart.
- Veins branch into **venules**.

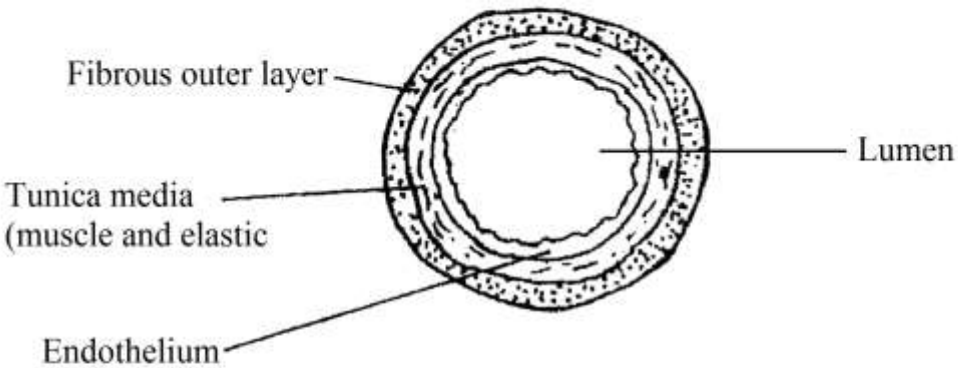


Fig. 5.14: Transverse section through a vein

Characteristics of Veins

(i) They have thin walls.
(ii) They have wide lumens.
- The wide lumen reduces resistance to the flow of blood.
- The wide lumen provides more space to the flow of blood.

(iii) They have valves at intervals. The valves help to prevent the backflow of blood.
- Blood is also kept moving in the veins by the contraction of muscles around them. When the skeletal muscles contract during movement, they squeeze the veins. This help to push blood back to the heart.

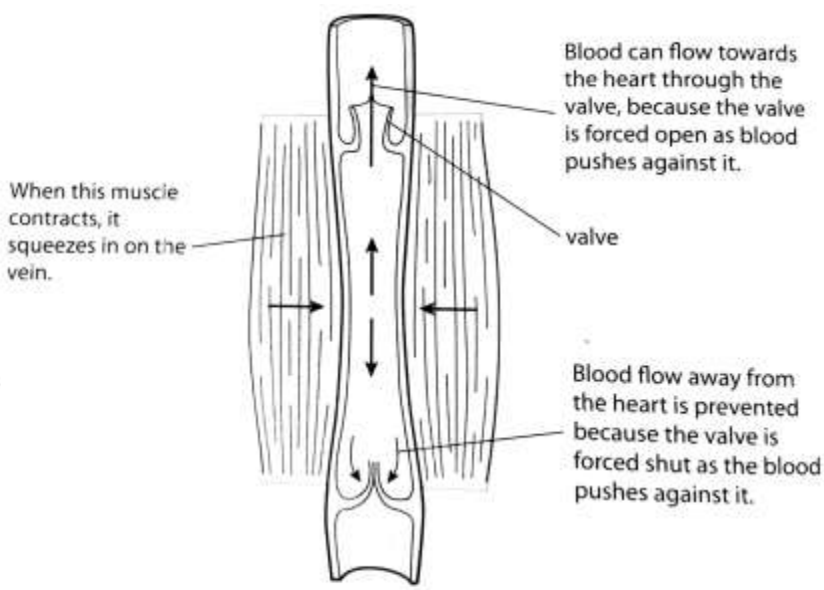


Fig. 5.15: Longitudinal section through a vein

(iv) Blood flows in the veins with low pressure since the pumping effect of the heart is not felt.
(v) They carry deoxygenated blood, except the pulmonary vein.

3. Capillaries

- These are network of blood vessels which link the arterial and venous systems.

Characteristics of Capillaries

(i) Their walls are one cell thick. This enables useful substances such as oxygen and glucose, and wastes such as carbon dioxide to diffuse through them easily. Therefore, capillaries are places of exchange of substances in the blood.
(ii) They have the narrowest lumens. This ensures that blood moves slowly through them, giving more time for exchange of substances.
(iii) They have no elastic tissue or smooth muscles. This ensures efficient diffusion of materials and also enables the capillaries to penetrate between individual cells.
(iv) They form a dense network. This creates a large surface area over which exchange of substances takes place.
(v) They transport blood from arterioles to the venules.

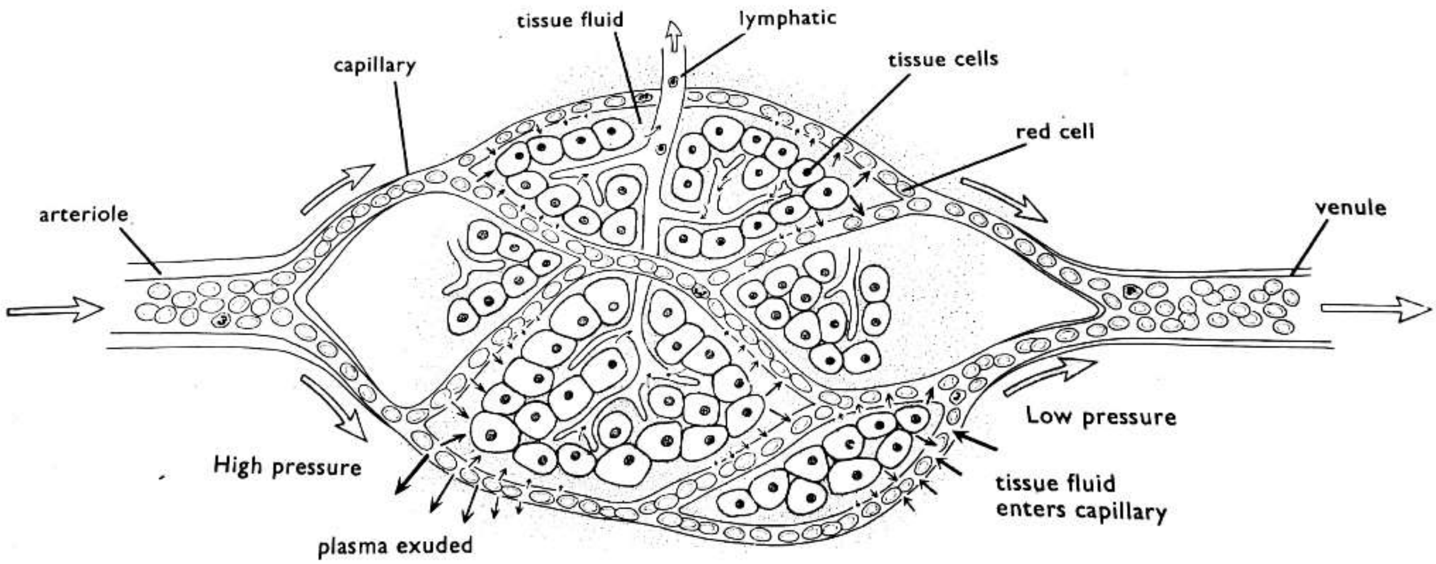


Fig. 5.16: Relationship between capillaries, cells and lymphatics

Functions of Capillaries

- They supply the body cells with their requirements, and take away waste products.

Abnormal Conditions Associated with Circulatory System

- These are diseases and conditions which may interfere with the proper functioning of the heart and blood vessels.

1. Heart Attack

- It is when blood flow to the heart is blocked.
- A heart attack occurs when a blocked coronary artery prevents oxygen- rich blood from reaching a section of the heart. A coronary artery may become blocked as a result of

build- up of fatty substances. The fatty substances stick to the walls, narrowing the artery and slowing down the flow of blood. A blood clot may form, blocking the blood vessel.

- If the blocked coronary artery is not reopened quickly, the part of the heart nourished by the artery begins to die. The longer the person goes without treatment, the greater the damage.
- The risk of developing heart attack is increased by:
  a. Poor diet- high levels of cholesterol or saturated fatty acids in blood. Cholesterol settles in the lining of arteries so that the lining of the arteries becomes thicker. This may cause blockage of the coronary arteries.
  b. Smoking
  c. Lack of physical exercises
  d. Stress

2. Cardiac Arrest

- It occurs when the heart suddenly stops pumping blood around the body.
- Cardiac arrest may follow after heart attack. This happens when there is a complete blockage in the coronary arteries and there is no oxygen supply to the heart.
- A person with cardiac arrest losses consciousness and has no pulse. Death occurs within minutes if the victim does not receive treatment.

3. High Blood Pressure (Hypertension)

- High blood pressure is a condition whereby the pressure of blood flowing in the blood vessels is higher than normal.
- High blood pressure can be caused by:
  a. Mental stress
  b. Anxiety
  c. Heavy smoking
     - Smoking constricts blood vessels.
  d. Obesity
  e. Diabetes
  f. Excessive salt in food
  g. Excessive alcoholic drinking
- Too much pressure causes the bursting of blood capillaries in the brain which leads to stroke.

4. Fainting/ Syncope/ Passing out

- It is a temporary loss of consciousness and posture.
- It occurs when there is temporary insufficient blood flow to the brain.
- It most often occurs when blood pressure is too low and the heart doesn’t pump a normal supply of oxygen to the brain.

Causes of Fainting

- It may be caused by
  a. Emotional stress
  b. Dehydration
  c. Pooling of blood in the legs due to sudden changes in body position
  d. Panic
  e. Low blood sugar
  f. Violent coughing due to rapid changes in blood pressure
  g. Side effects of some medicines also causes fainting
  h. It may result from severe heart, brain, metabolic and lung disorders.

5. **Heart Failure**

- It is a condition in which the heart muscle is unable to pump enough blood to meet the body's need.
- Heart failure may occur when permanent damage to heart muscle occur as a result of heart attack. If a large amount heart muscle is damaged, it can affect the beating action of the heart.

Signs and Symptoms of Heart Failure

a. Fatigue and weakness
b. Shortness of breath
c. Irregular heartbeat
d. Reduced ability to exercise
e. Chest pains

6. **Arteriosclerosis**

- It is a condition when the wall of the arteries become thick, hard and less elastic.
- This occurs when fats (cholesterol) and other substances build up along the artery wall. This forms a substance called **plugue**, which can restrict blood flow.
- As the plague enlarges, it hinders diffusion of nutrients from the blood to deeper tissues of the artery wall. Smooth muscle cells in the tunica media die and the elastic fibers deteriorate and are gradually replaced by non- elastic scar tissue. Then, calcium salts are deposited in the lesions. Collectively, these events cause arterial wall to fray and ulcerate, conditions that encourage thrombus (blood clot) formation. The increased rigidity of vessels leads to hypertension.
- The plague can also burst, triggering a blood clot. If the coronary artery is affected, the heart lacks enough oxygen that can lead to a heart attack.

Factors that increase the risk of Arteriosclerosis

a. High cholesterol
b. Diabetes
c. Obesity
d. Smoking

e. Lack of exercise
f. A family history of early heart disease
g. An unhealthy diet

7. Varicose Veins

- These are enlarged, swollen veins that often appear on the legs and feet.
- Varicose veins occurs when the valves in the veins do not work properly, so blood does flow effectively.

Causes of Varicose Veins

a. Congenital condition where people are born with defective veins.
b. Any injuries causing obstruction of venous blood flow.
c. Infections and inflammation of veins.
d. Obesity. Being overweight put added weight on the veins.
e. Prolonged standing or sitting. Blood doesn't flow well if you are in the same position for long periods.

Ways of Preventing Problems Associated with Circulatory System

a. **Avoid Smoking**
   - Cigarettes contain nicotine which makes arteries to constrict. Constriction of the arteries raises blood pressure.
b. Reducing the amount of high cholesterol foods by eating less fatty or red meat, instead one should eat white meat such as fish that has no cholesterol and eat more fresh fruits and vegetables.
c. Reduce salt intake to prevent high blood pressure.
d. Exercise regularly to strengthen the heart and improve circulation of the blood.
e. Learn to be organise to avoid stress.
f. Avoid alcohol consumption.
g. Managing your weight- doing exercises and eating healthy foods will reduce your weight and reduce the risk of coronary diseases.

Lymphatic System

- Lymphatic system is an additional transport system besides the blood transport in the body.
- It consists of:
  a. Lymph (a fluid)
  b. Lymph vessels
  c. Lymphatic organs

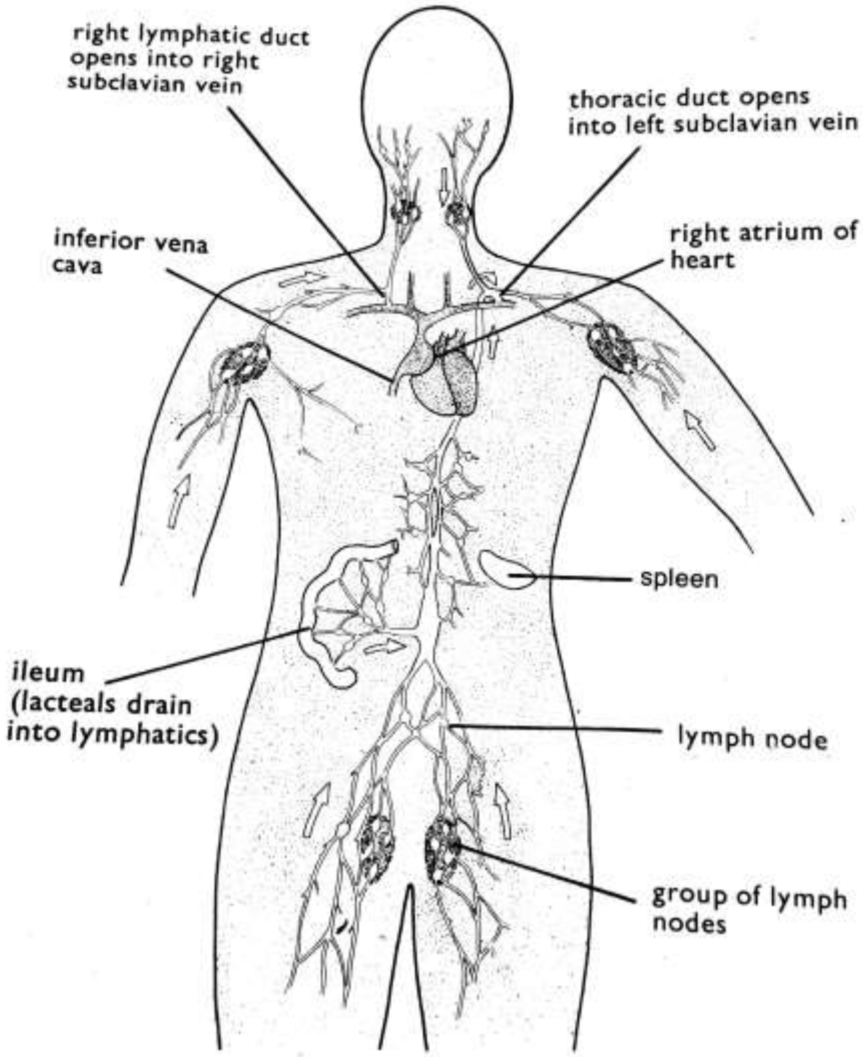


Fig. 5.17: Main drainage routes of lymphatic system

Fluids Derived from Plasma

- The main fluid derived from plasma are:
  1. Tissue fluid and
  2. Lymph

1. Tissue Fluid

- Tissue fluid is leaked plasma.
- Blood capillaries have tiny holes between the cells in their walls which cause plasma to leak out from the blood.
- On the arterial side there is high blood pressure because of the two factors:
  a. The pumping action of the heart exerts a force on the blood, which creates high blood pressure since the blood on arterial side comes from the heart.

b. As blood flows from arteries to the arterioles to the capillaries it flows from wider lumens to narrower lumens; this creates high blood pressure on the arterial side.

- This high blood pressure forces some plasma fluids to seep out from the blood across the walls of capillaries to the cells surrounding the capillaries (tissue cells). This fluid spreads throughout the tissue cells and it is called **tissue fluid**.
- Tissue fluid contains water, glucose, oxygen, fatty acids, glycerol, amino acids, vitamins, hormones and some white blood cells. These white blood cells can squeeze out of capillaries by amoebic movement.
- Red blood cells however, although they are small, cannot squeeze out of capillaries because they cannot change their shape very much. Large protein molecules, such as prothrombin and fibrinogen, are too large to go through the walls of capillaries. These materials are held back into capillaries.

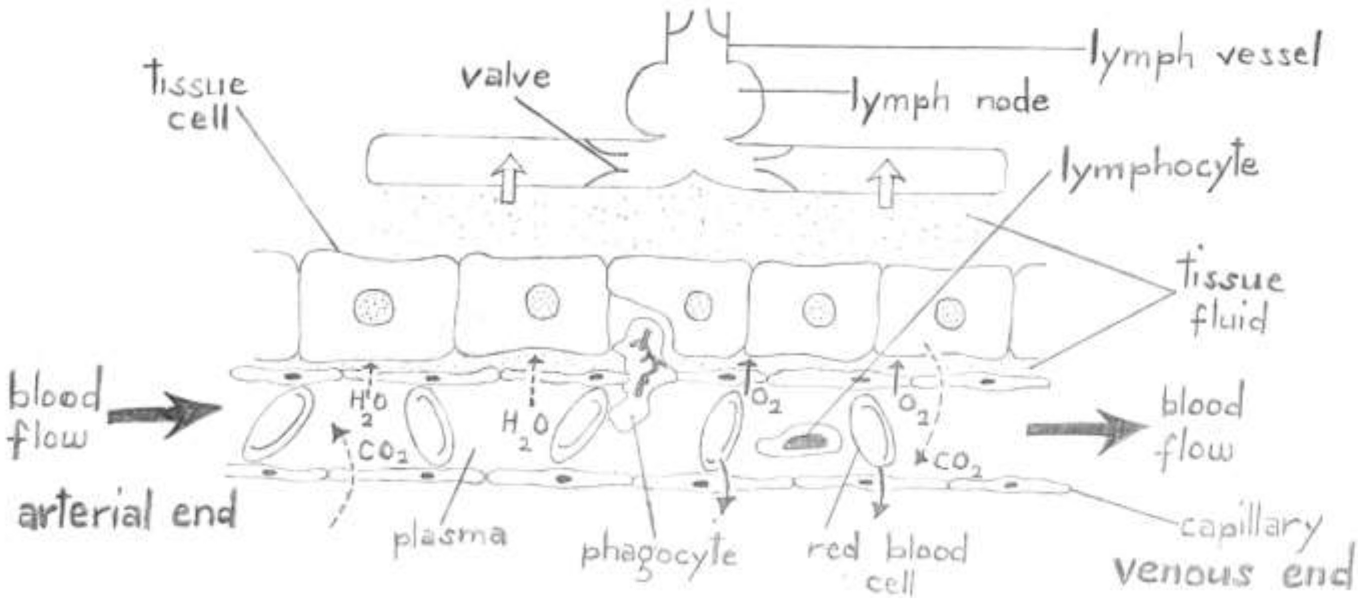


Fig. 5.18: Blood, tissue fluid and lymph

Functions of Tissue Fluid

(i) It supplies oxygen to tissue cells.

(ii) It supplies nutrients such as glucose to tissue cells.

(iii) It carries carbon dioxide and other wastes away from tissue cells to the blood for excretion.

(iv) It cleanse dirt, e.g. dead tissue cells, around the tissue cells, and poured them to lymph vessels, which are more permeable than capillaries.

2. The Lymph

- Lymph is tissue fluid that is drained into lymph vessels.

Formation of Lymph

- Some of the tissue fluid is reabsorbed back into the circulation at the venule end of the capillary by osmosis. The remaining tissue fluid is drained into the lymph capillaries. Once inside the lymph capillaries, the fluid is called lymph.

- Lymph consist of water, dissolved nutrients such as glucose, waste materials and white blood cells.
- The lymph capillaries join to form lymph vessels, which have valves that prevents the backflow of lymph.
- The lymph vessels return the lymph into blood circulatory system through subclavian veins which bring blood back from the arms.
- Lymph is also found in pleural and pericardial cavities. In these places, the lymph:
  a. Supplies oxygen to the organs it encloses e.g. lungs.
  b. Supplies food nutrients to the organs it encloses.
  c. Acts as lubricant, preventing friction between surfaces.

Flow of Lymph

- The lymphatic system has no pump, so the movement of lymph is slow.
- Lymph vessels have semi lunar valves that ensure that the lymph travels in one direction only.
- The contraction of surrounding muscles helps to squeeze the lymph along, and the semi lunar valves prevent the backflow of lymph.

Lymphatic Organs

- The lymphatic system is composed of several organs that are involved in providing immunity to the body against diseases. They include:
  a. The lymph nodes
  b. The tonsils
  c. The spleen
  d. The thymus

a. Lymph Nodes

- Lymph nodes are small bean- shaped structures.
- They are widely distributed throughout the body along the lymphatic vessels.
- Most lymph nodes are found in the groin, in the armpits and around the neck.
- Their role is to filter the lymph before it is returned to the blood.
- Lymph nodes also contains phagocytes which engulf and digest any bacteria which have gain access to lymph vessel.
- They also produce lymphocytes.

b. Tonsils

- Tonsils are clusters of lymphatic tissue just under the mucous membranes that line the nose, mouth and throat (pharynx)
- Lymphocytes in the tonsils provide protection against harmful substances and pathogens that may enter the body through the nose or mouth.

c. Spleen

- It is the largest lymph gland which lies below the stomach.
- It produces lymphocytes.
- It also destroys worn out red blood cells.

d. Thymus

- The thymus is a soft organ with two lobes that is located just below the sternum on the chest region.
- It produces a hormone, thymosin, which stimulates maturation of lymphocytes in other lymphatic organs.

Importance of Lymphatic System

(i) It transport excess tissue fluid back to the blood.
(ii) It produces lymphocytes which protect the body against diseases.

UNIT 6: HUMAN RESPIRATORY SYSTEM

- The respiratory system is a group of organs that deliver oxygen to the circulatory system for transport to all body cells and remove carbon dioxide made in cellular respiration, preventing the harmful build-up of this waste product in the body tissues.

The Structure of Human Respiratory System

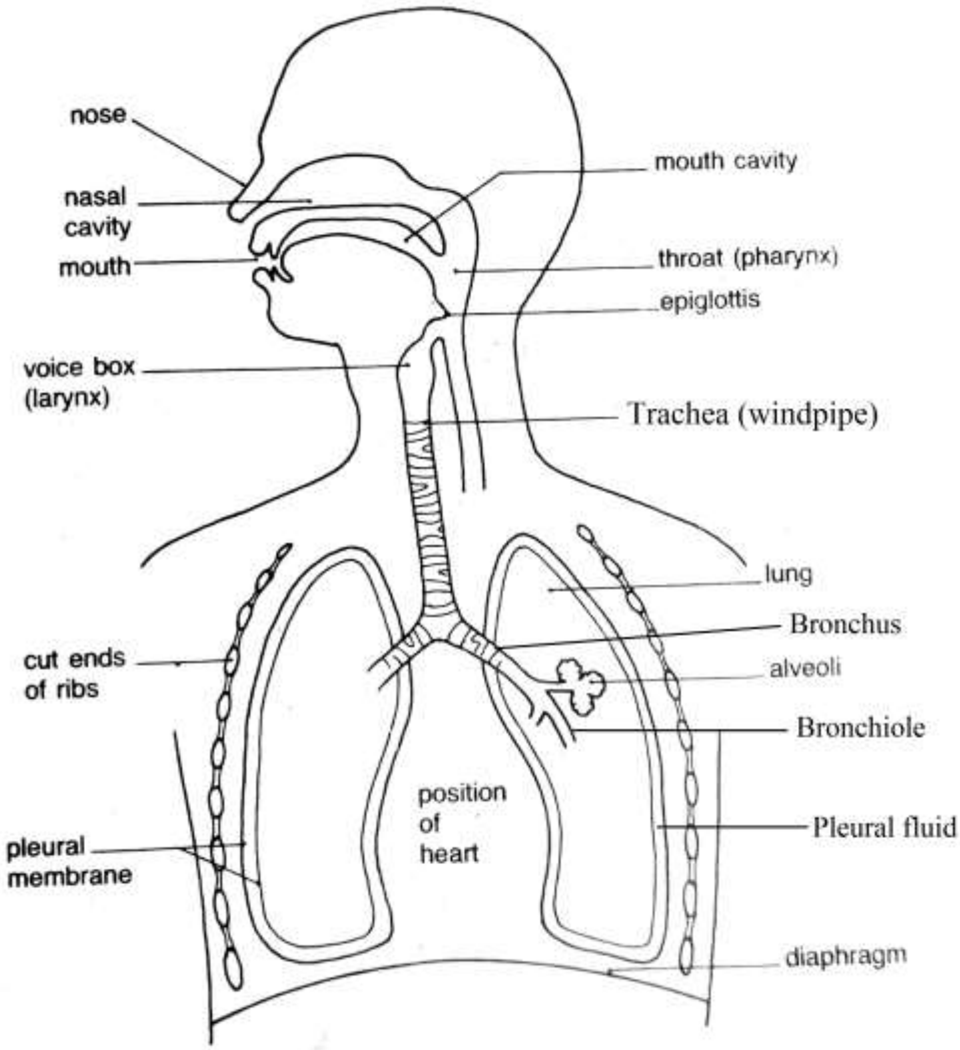


Fig. 6.1: Human respiratory system

- The human respiratory system consists of two lungs, each covered by a thin membrane called **pleural membrane**. This membrane produces **pleural fluid**. Pleural fluid helps to reduce friction between the lungs and ribcage when breathing.
- The lungs are connected to one another through tubes called **bronchi** (singular: bronchus).
- The bronchi join together to form the **trachea** or wind pipe.
- Inside the lungs, the bronchi divide further into smaller branches called **bronchioles**. The bronchioles end in millions of tiny pockets called **air sacs** or **alveoli**.
- The trachea leads into the space at the back of the mouth called **pharynx** (throat). The pharynx opens into the nosal passages.

Functions of the Parts of the Human Respiratory System

Nasal Cavity

a. It filters the air.
b. It moistens the air
c. It warms the air.

Epiglottis

a. It prevents food from entering the trachea.

Pharynx

a. It makes the air entering the lungs warm and moist.

Larynx

a. It contains vocal cords that make sound when air passes over them.

Trachea (Wind Pipe)

a. It is a tube through which air passes into the lungs.

Bronchi (singular- Bronchus)

a. They help in delivering air from trachea to bronchioles.

Bronchioles

a. These are finer tubes that deliver the air into the air sacs (alveoli).

Alveoli

a. These are sites for gaseous exchange in the lungs.

Diaphragm

a. This a sheet of muscles that separate chest cavity from abdominal cavity.
b. It contracts and relaxes to bring about changes in volume of chest cavity hence facilitates exhalation.

Adaptations of Respiratory Structures in Human Beings to their Functions

Trachea

a. It has cartilage rings which prevents the trachea from collapsing when air moves in and out at high pressure.
b. It is lined with columnar epithelium that secretes mucus which traps foreign particles, such as dusts or germs. These particles are swallowed, coughed up or sneezed out.
c. It is lined with ciliated cells. Cilia sweep the mucus containing dust and germs upwards towards the back of the throat. Then mucus is swallowed, together with its trapped dust particles and bacteria. The bacteria are killed in the stomach by hydrochloric acid and enzymes.

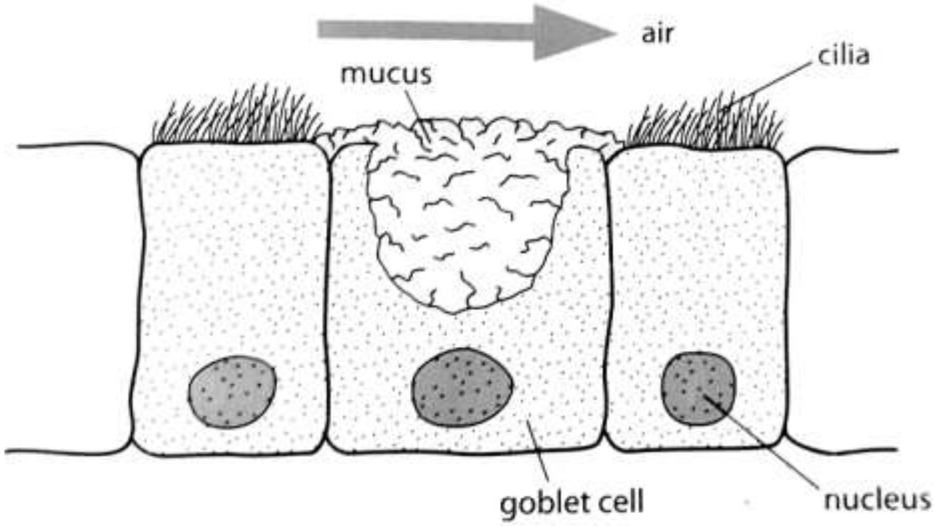


Fig. 6.2: The lining of trachea

Nosal Cavity

a. It is lined with hairs which filters incoming air.
b. It has mucus which filters incoming air. The mucus traps any bacteria or foreign particles, and moistens the incoming air.
c. It is lined with dense network of blood capillaries. The capillaries bring in warm blood raising the temperature in the nosal cavity. This warms inhaled air before the air enters into the lungs.
d. The epithelium of the nosal cavity has smell sensory cells called **olfactory cells** which detects chemical substances in the incoming air as smell. This enables the individual to identify different chemical substances in air to avoid inhalation of toxic substances.

Larynx (Voice box)

a. It has a cartilage called epiglottis. This tissue closes the trachea during swallowing to prevent entry of food into the trachea.

Lungs

a. It has numerous alveoli which provide a large surface area for gaseous exchange.
b. The lungs are located in the chest cavity for protection by ribcage.

Bronchi and Bronchioles

a. They are lined with ciliated epithelium that helps to move air from the trachea to the alveoli.

Alveoli

a. They have thin wall. This ensures that the diffusion of gases is fast since there is a short distance for the gases to move across.
b. The inner wall of alveolus is lined with a thin firm of moisture. This allows easy diffusion of oxygen since oxygen dissolves in the liquid.
c. They are surrounded by a network of blood capillaries for efficient transport of gases being exchanged.

d. There is a concentration gradient of gases between the alveolar air and the blood to allow diffusion to occur.
   - Inhalation maintains a higher concentration of oxygen in the alveolar air than in the blood in the surrounding capillaries. Exhalation maintains a lower concentration of carbon dioxide in the alveolar air than in the blood in the surrounding capillaries.

Mechanism of Breathing in Human Beings

- Breathing is the movement of air into and out of the lungs.
- It occurs in two phases:
  1. Inspiration – Breathing in
  2. Expiration – Breathing out

1. Inspiration (inhalation)

- When breathing in, the muscles of the diaphragm contract. This pulls the diaphragm downwards causing it to flatten hence increasing the volume in the thorax. At the same time, the external intercostal muscles contract and internal intercostal muscles relax. This pulls the ribcage upwards and outwards. Together, these movements increase the volume of the thorax. The lungs inflate (increase in volume).
- As the volume of thorax increases, the pressure inside it falls below atmospheric pressure hence air rushes in along the trachea and bronchi into the lungs.

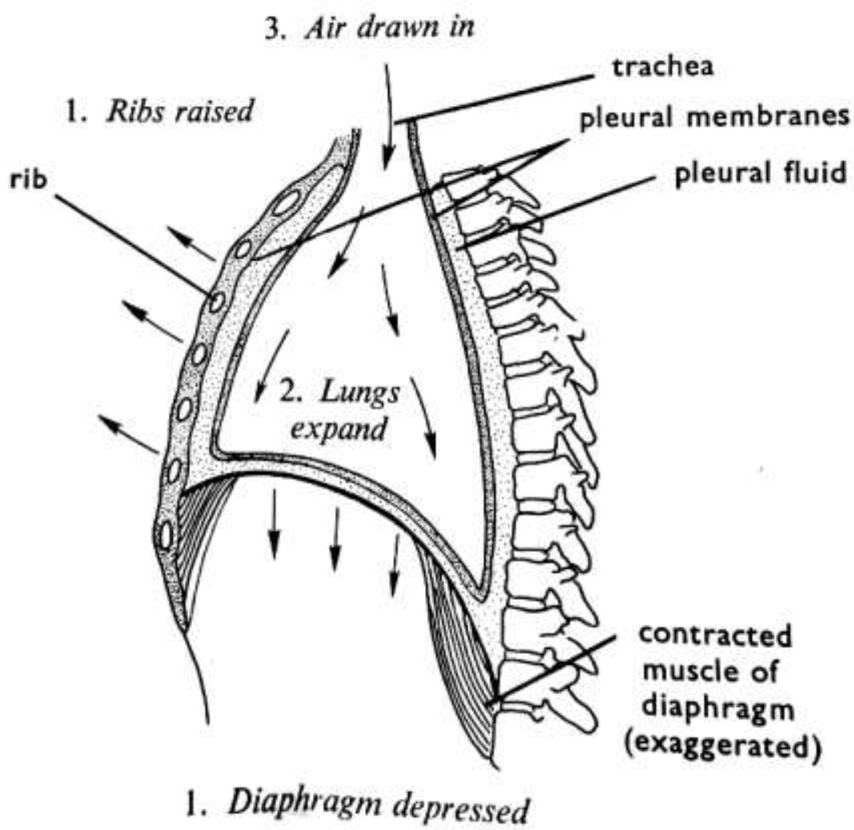


Fig. 6.3: Inspiration

2. **Expiration (exhalation)**
   - When breathing out, the muscles of the diaphragm relax. This allows the diaphragm to return to its dome shape, which decreases the volume in the thorax. The external intercostal muscles relax and internal intercostal muscles contract. This pulls the ribcage downwards and inwards. This also decreases the volume of the thorax. The lungs deflate (reduce in volume).
   - As the volume of the thorax decreases, the pressure inside it increases so that air is squeezed out of lungs.

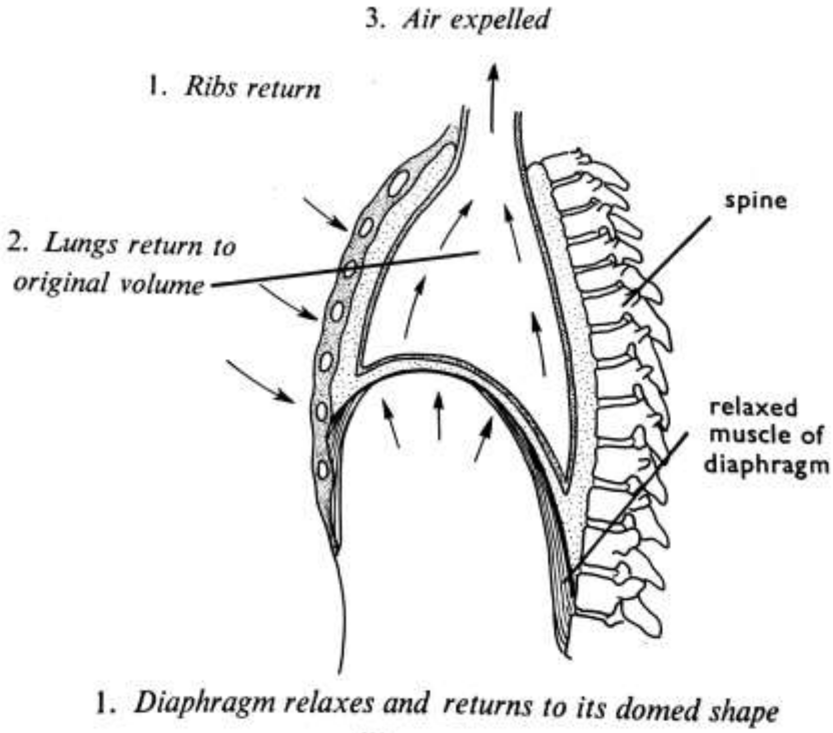


Fig. 6.4: Expiration

To Demonstrate Mechanism of Breathing using the Lung Model

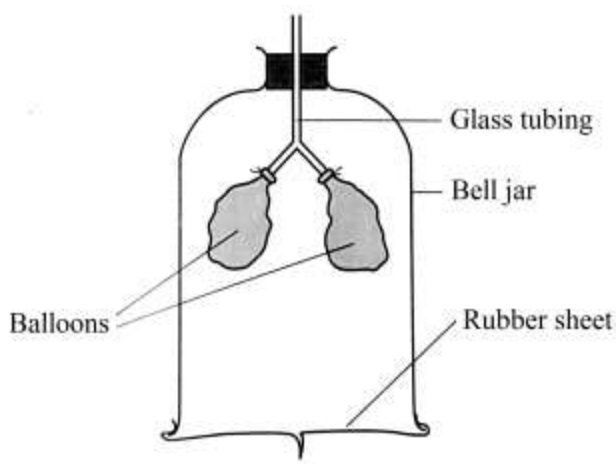


Figure 6.5: shows apparatus that illustrates how the diaphragm helps to draw air into the lungs

- The model illustrates the role of the diaphragm during breathing. It shows how the lungs (represented by the balloons) fill with air as a result of contraction of the diaphragm (represented by the rubber sheet)
- When the rubber sheet is pulled down, (diaphragm contracts), it increases the volume in the jar and reduces pressure in it. Since the outside air pressure is higher than the pressure inside the bell jar, air rushes into the balloons and they swell. This is what happens during inhalation.
- When the rubber sheet is pushed up (diaphragm relaxes), it reduces the volume in the bell jar and increases the pressure inside it. This is what happens during exhalation.

Limitations of Lung Model

1. The bell jar cannot move upwards or inwards, unlike the ribcage which move to change the volume of the thoracic cavity.
    - The bell jar represents the ribcage.
2. The rubber sheet curves downwards as you pull it, whereas the diaphragm flattens out during inspiration.
3. The rubber sheet does not become dome- shaped, whereas the diaphragm becomes dome shaped during expiration.

Gaseous Exchange in the Alveoli

- When inhaled air reaches the alveoli inside the lungs, oxygen from the inhaled air diffuses into the blood and carbon dioxide from blood diffuses into the air in the alveoli. This is called **gas exchange**.
- Oxygen is at a higher concentration in the alveolar space than in the blood capillaries. This creates a diffusion gradient hence; oxygen diffuses into the blood capillaries. The blood becomes oxygenated blood; which is carried to the heart by the pulmonary vein. From the heart, the oxygenated blood is pumped to various body tissues to supply the oxygen to the tissues.
- Carbon dioxide is more in the blood than in the air in the alveolar space. The carbon dioxide diffuses across the capillary wall and alveolus wall into the alveolar space and is eventually expelled during exhalation.

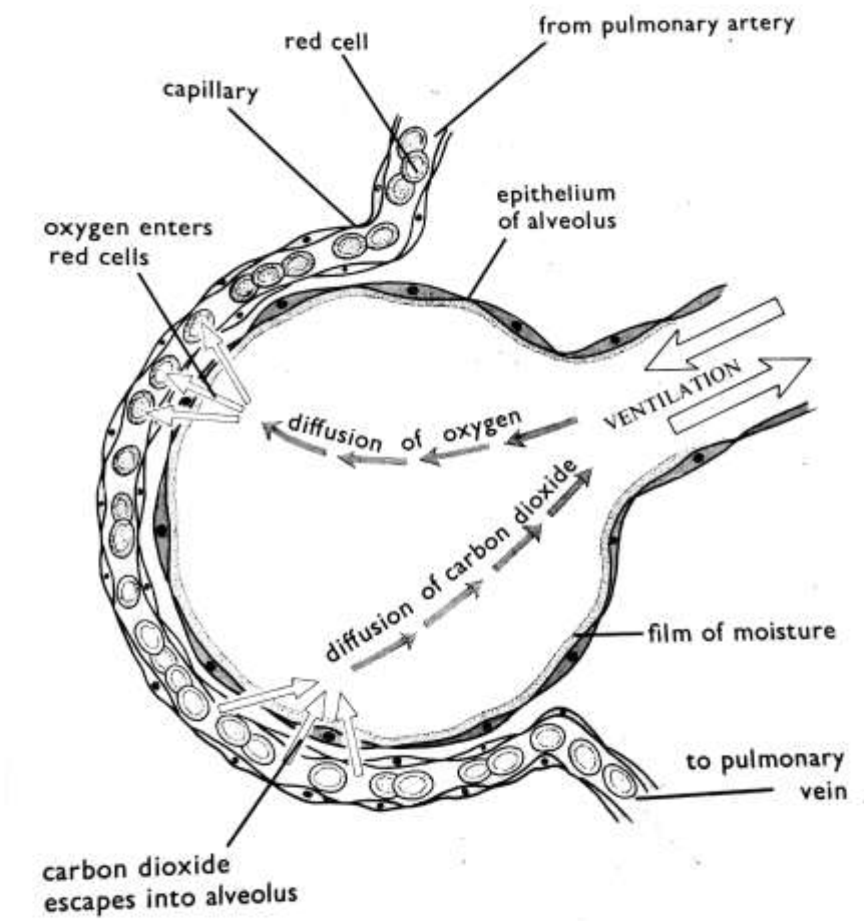


Fig. 6.6: Gaseous exchange in the alveolus

Gaseous Exchange in the Tissue

- The cells of the body tissues have low concentrations of oxygen because oxygen is constantly used up during cellular respiration. Oxygen diffuses along a concentration gradient from the blood where the oxygen concentration is high, through the walls of the capillaries into the tissue fluid and then into body tissues where the oxygen concentration is low.
- The carbon dioxide concentration in the tissues is high as carbon dioxide is formed as a waste product of cellular respiration. Carbon dioxide diffuses along a concentration gradient from the tissue fluid and finally into the blood plasma in the capillaries. The carbon dioxide is carried in the blood back to the lungs.

Similarities between Exchange of Gaseous in Lungs and Tissues

a. In both, oxygen and carbon dioxide diffuse along their concentration gradients.
b. In both, haemoglobin found in red blood cells is the transport agent.

Differences between Exchange of Gaseous in the Lungs and in Tissues

In Lungs	In Tissues
1. Gaseous exchange is between the air and the blood cells	Gaseous exchange is between tissue fluid and tissues cells
2. Oxygen diffuses into blood cells while carbon dioxide diffuses out into the air	Carbon dioxide diffuses into blood cells while oxygen diffuses out into tissue cells
3. Gases must first dissolve in the moisture that line alveolus wall	Gases are already in solution in the plasma.
4. It is a rapid process and takes the duration between breathing in and out.	There is plenty of time for exchange to take place as the tissue fluid bathes the cells

Importance of Gaseous Exchange

1. It enables organisms to obtain useful gases (oxygen- for animals and carbon dioxide- for plants) from their environment.
2. It enables organisms to get rid of waste gases (carbon dioxide- for animals and oxygen- for plants) into the environment.

The composition of Inhaled and Exhaled Air

Gas	Inhaled air (%)	Exhaled air (%)
Oxygen	20.95	16.20
Carbon dioxide	0.04	4.00
Nitrogen	79.00	79.00
Water vapour	Variable	Saturated

- The table above shows that the percentage of oxygen in exhaled air is lower than in the inhaled air. This is so because the body cells use oxygen for respiration.
- The carbon dioxide content of expired air is greater than inspired air. This because the body cells produce carbon dioxide in respiration which diffuses from the blood into alveolar air.
- The nitrogen content of the two kinds of air is the same. This because the body does not use it for anything, nor does the body makes any nitrogen so the rate of diffusion into and out of the blood is the same.
- The water vapour in the exhaled air is always high because the respiratory surfaces are always moist so some of the moisture evaporates and is lost as air is breathed out.

Components of Lung Volume

- The following are the components of lung volume:

Tidal Volume

- It is the volume of air that enters and leaves the lungs at each natural resting breath. This about $\frac{1}{2}l$.

Inspiratory Reserve Volume

- It is the additional air that can be forcibly inhaled after inspiration of a normal tidal volume.

Expiratory Reserve Volume

- It is the additional air that can be forcibly exhaled after the expiration of a normal tidal volume.

Vital Lung Capacity

- It is the volume of air that can be exhaled after a full inhalation.
- The vital lung capacity in adult person is *3.5 l*.

Residual Volume

- It is the volume of air left in the lungs after the expiratory reserve volume is exhaled.
- The residual volume is *1.5 l*.

Inspiratory Capacity

- It is the maximum amount of air that can be inspired.

Total Lung Capacity

- It is the maximum amount of air that can fill the lungs.
- It is about *5.5 l* for adult male and about *4 l* for an adult female.
- Lung capacity is measured with respirometer.

Functional Residual Capacity

- It is the amount of air remaining in the lungs after a normal expiration.

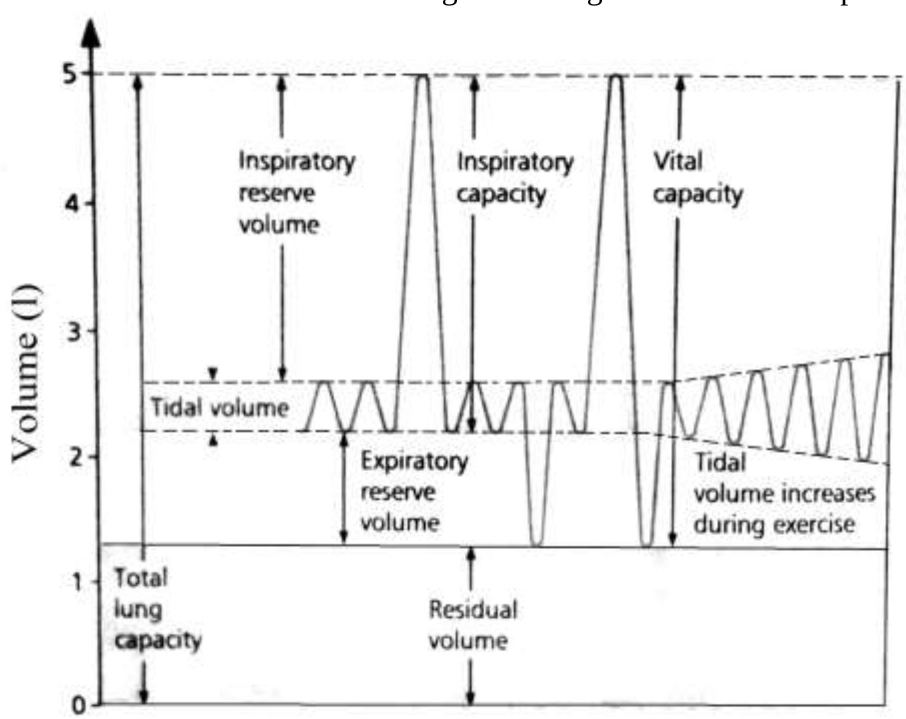


Fig. 6.7: Lung volumes

Breathing Rate

- Breathing rate is the number of complete breaths per minute.
- A complete breath is composed of one inhalation and one exhalation.
- The average breathing rate of a person at rest is about 16 times per minute.

Example

- **Figure 6.8** is a graph showing changes in the volume of air breathed by a person soon after exercise.

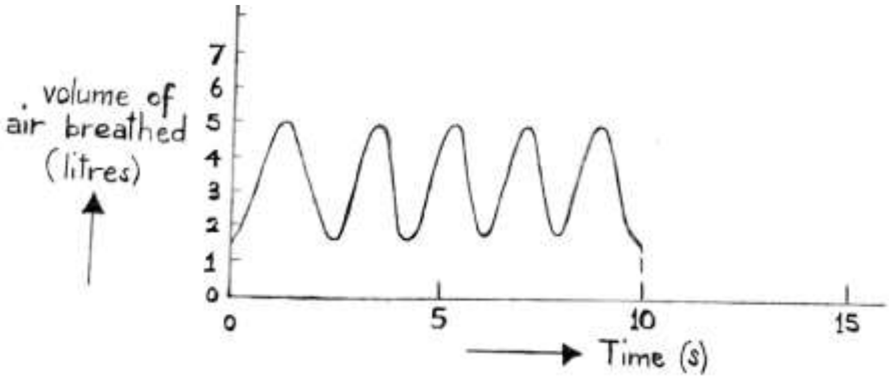


Fig. 6.8

a. Calculate the total number of breaths the person takes per minute. Show your working.

$$10\ seconds \quad = 5\ breaths$$
$$60\ seconds \quad = more$$

$$= \frac{5\ breaths \times 60\ seconds}{10\ seconds}$$

$$= \underline{30\ breaths/minute}$$

b. What volume of air remains in the lungs?
= 1.5 litres

c. How much air is exchanged per breath?

$$5\ litres - 1.5\ litres = 3.5\ litres$$

d. Calculate the volume of air that is exhaled in one minute. Show your working.

$$1\ breath \quad = 3.5\ litres\ exhaled$$
$$30\ breaths = more$$

$$= \frac{3.5\ litres\ exhaled \times 30\ breaths}{1\ breath}$$

$$= \underline{105\ litres}$$

Role of Medulla Oblongata in Regulating the Breathing Process

- The brain controls the rate at which breathing takes place through **medulla oblongata**.
- The main factor that increases the breathing rate is the concentration of carbon dioxide in the in the blood.
- During exercises, the muscle cells respire rapidly in order to release energy from glucose for contraction. This generates more carbon dioxide which dissolves in blood plasma to produce more carbonic acid (H_2CO_3). An increase in carbonic acid in the blood increases hydrogen ions concentration in the blood.
- The chemoreceptors in the medulla oblongata detect an increase in hydrogen (H^+)ion concentration in the blood. As a result the medulla oblongata sends impulses to the intercostals muscles and the diaphragm. This causes the diaphragm and intercostal muscles to contract harder and faster. The result is an increase in rate and depth of breathing. This is useful because it means the rapidly respiring muscles will get faster deliveries of oxygen, and their waste carbon dioxide will be removed more rapidly. Finally, the level of carbon dioxide falls and breathing rate goes back to normal.

Factors that Influences Breathing Rate

1. **Age-** The rate of breathing changes with age. Babies and children normally breathe faster and less deeply than older children and adults.
2. **Diseases**- Diseases that cause decreased levels of oxygen in the blood and increased levels of carbon dioxide, such as emphysema lead to faster breathing rate.
3. **Haemoglobin concentration or amount of red blood cells in the body-** When the concentration of haemoglobin is low in the blood, less oxygen reaches the cells. The breathing rate increases in a bid to compensate the shortfall and meet the oxygen demand in the body.
4. **Altitude-** Increased height above sea level causes an increase in breathing rate to accommodate the reduction in the amount of oxygen available.
5. **Physical exercises-** Breathing rate increases when the body is undergoing physical exercises such as jumping and running. During such activities, more oxygen is required to burn glucose and produce additional energy required by muscles.
6. **Posture-** If we sit and stand upright, with our shoulders pulled back, the chest cavity can expand and contract fully during breathing. Poor posture, such as rounded shoulders, restricts the inhalation and exhalation of air.
7. **Emotional Changes in the Body-**Emotional changes in in the body may include things like panicking, fright and stress. When these occur, the body requires more energy than normal hence increased rate of respiration. There is therefore need for more oxygen and the breathing rate is increased.
8. **Carbon dioxide Concentration in the Blood-** High amount of carbon dioxide in the blood leads to increased rate of breathing.

Effects of Exercise on Breathing

1. It increases the rate of breathing in order to inhale more oxygen and expel more carbon dioxide per minute.
2. It increases the depth of breathing in order to expel a lot of carbon dioxide and inhale a lot of oxygen.
3. More carbon dioxide due to increased rate of respiration.
4. Oxygen concentration decreases due to increase in the rate of respiration.
5. Increase in lactic acid due to inadequate oxygen supply.

Tissue Respiration (Cellular Respiration)

- It is the process by which organic food substances are broken down in cells to release energy.
- The energy contained in glucose molecules is transformed into stored energy (ATP) and heat energy. The heat energy is lost from the body.
- Tissue respiration takes place in the mitochondria of body cells.

Uses of stored Energy

a. It is used for muscle contraction which brings about locomotion, peristalsis and breathing.
b. It is used for building up protein molecules inside cells, by linking amino acids together into long chains.
c. It is used in the transmission of nerve impulses along nerve cells.
d. It is used for moving substances across cell membranes against their concentration gradient, by active transport.
e. It is used for generation of heat to keep the body temperature constant.
f. It enables a cell to divide into two, to produce new cells for growth or to repair damaged parts of the body.

Types of Tissue Respiration

- There are two types of tissue respiration :
  1. Aerobic respiration and
  2. Anaerobic respiration

1. Aerobic Respiration

- This where energy is released from food in the presence of oxygen.
- During aerobic respiration, glucose is broken down completely to form water and carbon dioxide.
- The word and chemical equation for aerobic respiration:

Word Equation

$$Glucose + Oxygen \xrightarrow{Enzyme} Water + Carbon\ dioxide + Energy\ \ (ATP + Heat)$$

Chemical Equation

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{Enzyme} 6H_2O + 6CO_2 + Energy\ (2\,880\ KJ)$$

How the Energy Produced during Aerobic Respiration is utilised

a. Up to 60% of the energy released is in form of heat energy, which is lost or used to warm the body.
b. The cells uses some energy immediately for ongoing processes in the cell.
c. The rest of the energy is converted into a more stable form known as **adenosine triphosphate(ATP)** for storage. ATP is made from ADP (Adenosine diphosphate) using the energy released during respiration. The energy is used to combine ADP with an inorganic phosphate molecule to form ATP i.e.

$$ADP + P_i \rightarrow ATP$$

- In order to release the energy for use, ATP is split to ADP and a free phosphate i.e.

$$ATP \rightarrow ADP + P_i + Energy$$

2. Anaerobic Respiration

- This is when energy is released from food in the absence of oxygen.
- During anaerobic respiration, glucose is partially broken down to form carbon dioxide and ethanol.
- Anaerobic respiration takes place in both plants and animals.

Anaerobic Respiration in Plants and Micro-Organisms

- Anaerobic respiration in plants and micro-organisms is known as **alcoholic fermentation** because alcohol (ethanol) is produced.
- The word and chemical equation for anaerobic in plants and micro-organisms.

Word Equation

$$Glucose \xrightarrow{Enzyme} Ethanol + Carbon\ dioxide + Energy\ (ATP + Heat)$$

Chemical Equation

$$C_6H_{12}O_6 \xrightarrow{Enzyme} 2C_2H_5OH + 2CO_2 + Energy\ (210\ KJ)$$

- Ethanol is poisonous to living cells, and the organism will not survive if ethanol accumulates in its cells. It is therefore released by cells as a waste product.
- The ethanol that is produced contains a lot of energy and can be used as fuel.
- Ethanol can also be used to make alcoholic drinks such as beer.

Anaerobic Respiration in Animals

- In animals, it is called lactic fermentation because lactic acid is produced.

Word Equation

$$Glucose \xrightarrow{Enzyme} Lactic\ acid + Energy\ (ATP + \ Heat)$$

Chemical Equation

$$C_6H_{12}O_6 \xrightarrow{Enzyme} 2C_3H_6O_3 \ + Energy\ (150\ KJ)$$

- During anaerobic respiration in animals, muscle cells break down glucose to produce lactic acid and energy only. Lactic acid is toxic (poisonous). As it builds up in the muscles, it makes them feel tired and can cause muscle cramps. Because of this, muscles can only respire anaerobically for a short period of time.
- The lactic acid diffuses from muscles into the blood, and is taken to the liver. The liver break it down by combining it with oxygen to less toxic substances like water and carbon dioxide. Because of this, extra oxygen is needed. This is why a person breathe faster after exercising. The amount of oxygen needed to eliminate lactic acid produced by anaerobic respiration is called **oxygen debt**.

Application of Anaerobic Respiration

- Application of anaerobic respiration in industry include:
  a. Manufacture of bread in baking industry.
  b. Production of biogas used for cooking and lighting.
  c. Production of vinegar
  d. In beer brewing industry
  e. In production of compost manure
  f. Manufacture of acids synthetically
  g. Production of power alcohol used to drive heavy engines such as those of vehicles and in factories.

Similarities between Aerobic and Anaerobic Respiration

1. In both energy is released by breakdown of glucose.
2. In both ATP is made.
3. In both some energy is lost as heat.

Differences between Aerobic and Anaerobic Respiration

Aerobic Respiration	Anaerobic Respiration
1. More energy is produced per glucose	Little energy is produced per glucose molecule
2. Oxygen is used	Oxygen is not used
3. Water is produced	Water is not produced
4. No alcohol or lactic acid is made	Alcohol or lactic acid is made
5. The by- products are simple substances that cannot be broken further	The by- products are complex substances, which can be broken further

Abnormal conditions Associated with the Respiratory System

1. **Asthma**
   - It is a disorder resulting from inflammation or swelling of the lining of the bronchi and bronchioles.
   - The inflammation can be caused by breathing in polluted air. Air pollutants, including cigarette smoke, chemical fumes and dust, irritate the lining of bronchi and bronchioles and trigger an asthma.
   - Asthma may also be caused by viral infections.
   - Cold humid weather and car exhausts also accelerate asthma.
   - Asthma may also be inherited. Presence of asthma in the family members like parents increases the probability of occurrence of the disease in the children.

   Sign and Symptoms of Asthma

   a. Coughing, especially at night or when the weather becomes cold.
   b. Wheezing sound when breathing
   c. Shortness of breath and difficulties in breathing
   d. A feeling of tightness in the chest
   e. Pain in the chest especially when breathing.

   Prevention, Control and Treatment

   a. Use of medicine that prevent inflammation of air tube. These medicine act by reducing swelling and mucus production in the airways. As a result, the air ways are less sensitive and less likely to react to air pollutants.
   b. Use of medicine that cause widening of bronchi and bronchioles. These medicine act by relaxing the muscles of the bronchi and bronchioles, and makes it easier to breathe.
   c. Asthma patients should avoid as much as possible to air pollutants.

2. **Pulmonary Tuberculosis**
   - Tuberculosis is caused by a bacterium called *Mycobacteriumtuberculosis*.
   - Tuberculosis bacteria may attack any part of the body but they usually attack the lungs causing pulmonary tuberculosis. The bacteria destroys the lung tissues making it difficult for infected person to breathe.

   Mode of Transmission

   - Tuberculosis is spread by droplet infection, that is, through tiny water or mucus droplets expelled when a patient coughs without covering his mouth with a handkerchief.
   - Drinking unboiled milk from infected cows.

   Signs and Symptoms of Tuberculosis

   a. Fatigue
   b. Fever and chills
   c. Weight loss

d. Cough usually with mucus production
e. Chest pains
f. Damage to the lung tissue hence causing wheezing.
g. Night sweats
h. Breathing difficulty
i. Coughing blood
j. Loss of appetite
k. Persistent diarrhoea

Prevention of T.B.

a. Immunisation of children with B.C.G. vaccine.
b. Avoid overcrowded environments.
c. Isolate the patient to prevent spread of the disease.
d. Avoid taking raw milk. Boil all milk or drink pasteurised milk
e. Dairy cow must be vaccinated
f. Patients should cover their mouths with handkerchief while coughing to prevent drops from getting to others.
g. Live in well ventilated homes

Treatment of T.B.

- It can be cured in early stages by treatment with antibiotics such as streptomycin.

3. Bronchitis

- This is the inflammation of the bronchial tubes.
- The cells lining the bronchi and bronchioles secrete more mucus than normal, making it difficult for air to move in and out of bronchiole. Less air enters and leaves the lungs (reduced tidal volume) and gaseous exchange is reduced.
- Bronchitis is commonly caused by air pollutants.
- Cigarette smoke can also lead to bronchitis. Cigarette smoke damages the cilia that sweep the mucus out of the bronchi. This causes the excess mucus to build up in the bronchi, which provide perfect conditions for bacteria and viruses to multiply and cause infection.
- It can also be caused by infections (such as bacterial and viral illness).

Signs and Symptoms of Bronchitis

a. Production of thick sputum, which could be green or yellow in colour due to accumulation of pus from respiratory surfaces.
b. Dry cough
c. Wheezing sound when breathing
d. Shortness of breath.
e. Fever
f. Chest pains

g. Headache
h. Nosal congestion
i. Uncomfortable feeling behind the sternum
j. A general feeling of tiredness

Control of Bronchitis

a. Avoid cigarette smoke
b. Wash your hands. To reduce risk of catching viral infections.
c. Wear a surgical mask when working in dusty environments.
d. Get vaccinated against flu. Influenza virus may also cause bronchitis.

Treatment of Bronchitis

a. Use medications to relieve muscle aches and pains, headaches and to reduce fever.
b. Use of cough suppressants for a dry cough
c. Stopping smoking and avoiding other airborne irritants.

4. Carbon Monoxide Poisoning

- Carbon monoxide is a poisonous gas. It has no smell or taste and therefore can be inhaled without realising it. Carbon monoxide is produced when fuels are not fully burned or where fuels are burnt in insufficient supply of air; for instance, in poorly ventilated room. Engines also produce carbon monoxide.
- Haemoglobin has higher affinity for carbon monoxide gas than oxygen. In the presence of both gases, haemoglobin combine with carbon monoxide more readily compared with oxygen to form a compound called **carboxyhaemoglobin**. Unlike oxyhaemoglobin, which splits easily in the cells to release oxygen, carboxyhaemoglobin does not easily split and so lowers the capacity of red blood cells to take up oxygen. Lack of enough oxygen results to less respiration hence reduced amount of energy. Due to lack of energy, body processes stops taking place and the person may die due to suffocation. When this happens **carbon monoxide poisoning** is said to have taken place.

Symptoms of Carbon Monoxide Poisoning

a. Severe headache
b. Loss of hearing
c. Weakness
d. Blurred vision
e. Loss of consciousness
f. Cardiac arrest
g. Chest pains
h. Dry cough
i. Dizziness
j. Nausea
k. Abdominal pain
l. In severe cases, death.

First Aid for Carbon Monoxide Poisoning

a. Take the person out of the room and make him lie comfortably on open space.
b. Administer mouth to mouth resuscitation.
c. Take the person to the nearest health facility for treatment.

Ways of Preventing Carbon Monoxide Poisoning

a. Avoid keeping a low burning stove or charcoal burner in a poorly ventilated room.
b. Do not run generators or small engines inside a house or enclose spaces.
c. Make sure that the house where cooking or heating is done in well ventilated.
d. Ensure that at night, any charcoal burner with charcoal still burning is kept outside the house.
e. Monitoring devices can be installed to check the carbon monoxide levels in the building.

5. **Lung Cancer**

- Lung cancer occurs when cells in the lining of alveoli start to divide too rapidly producing a tumour. These cells invade other parts of the lungs reducing its capacity to exchange gases efficiently.
- The commonest cause of lung cancer is the tar from the tobacco. Tar may damage the cells' ability to control their division so that the cells may begin to divide rapidly, uncontrollably, forming a lump called a **tumour**. This cause lung cancer.
- Increased use of cigarettes per day increases the risk of lung cancer and cancer of respiratory system in general.

Artificial Respiration (Artificial Resuscitation)

- Artificial respiration is a first Aid practice carried out on a person who is having difficulties in breathing due to an accident, fainting or health complications.
- Artificial respiration (artificial ventilation) is done by blowing air using one's mouth into the mouth of the patient. This makes artificial ventilation to be referred to as **mouth-to- mouth resuscitation**.

Procedure for carrying out Artificial Resuscitation

1. Remove any object from the mouth and loosen any tight- fitting clothes covering the chest. Loosening tight- fitting clothes covering chest will allow the chest cavity to expand and contract fully during breathing.
2. Lay the person on his or her back on flat surface and tilt the head backwards. These movements ensures that there is a clear passage for air to reach the lungs.
3. Close the person's nose and take a deep breath.
4. Seal your lips round the person's mouth, close the person's nose and blow into the lungs through the mouth. Give one breath every five seconds for an adult and one breath for every three seconds for a child. Watch for the chest to rise as you give these breath. If the person's chest rises as you blow, then the lungs are filling with air.
5. Stop blowing and observe the falling movement of the chest.

6. Repeat the procedure from step 4 to 5 at your normal breathing rate, until you observe from the chest movement that the person is breathing without your help.
7. Call an ambulance to take the person to the hospital for proper medical attention.

Effects of Smoking on Human Health

- Smoking has the following effects on the human health:
    1. Respiratory infections
    2. Addiction
    3. Harm to the foetus and
    4. Lung cancer

1. Respiratory Infections

- Smoking leads to respiratory infections which include:

a. Bronchitis

b. Emphysema

- Emphysema is a breakdown of the alveoli.
- The action of some substances in tobacco smoke weakens the walls of alveoli. The accumulation of mucus in the lungs causes a ‘smokers cough’ which bursts some of the weakened alveoli. As result there is less surface area for gas exchange, and breathing becomes very difficult.
- The emphysema suffer short of breath after exercise and wheezes while breathing.

2. Addiction

- One of the products from cigarettes is nicotine which is addictive. This means that once your body has got used to it, it is very hard to do without it. This leads the person to depend on the smoking habit.

3. Harm to the Foetus

- The harmful effects of tobacco smoke on pregnancy are as a result of carbon monoxide and nicotine the mother and foetus are exposed to.
- Carbon monoxide combines with foetal haemoglobin reducing oxygen supply which lead to retarded growth and result in still born or miscarried foetus. It also hinders mental development in the foetus.
- Nicotine may diffuse from maternal blood to that of foetus leading to increased heartbeat and at the same time makes blood vessels narrow. Together these two effects raise blood pressure. High blood pressure causes long- term damage to the circulation which may be fatal to the foetus. This may result to miscarriage. Nicotine may also make the foetus develop addiction to smoking after birth takes place.

4. Lung cancer

Future Wheel on Effects of Smoking

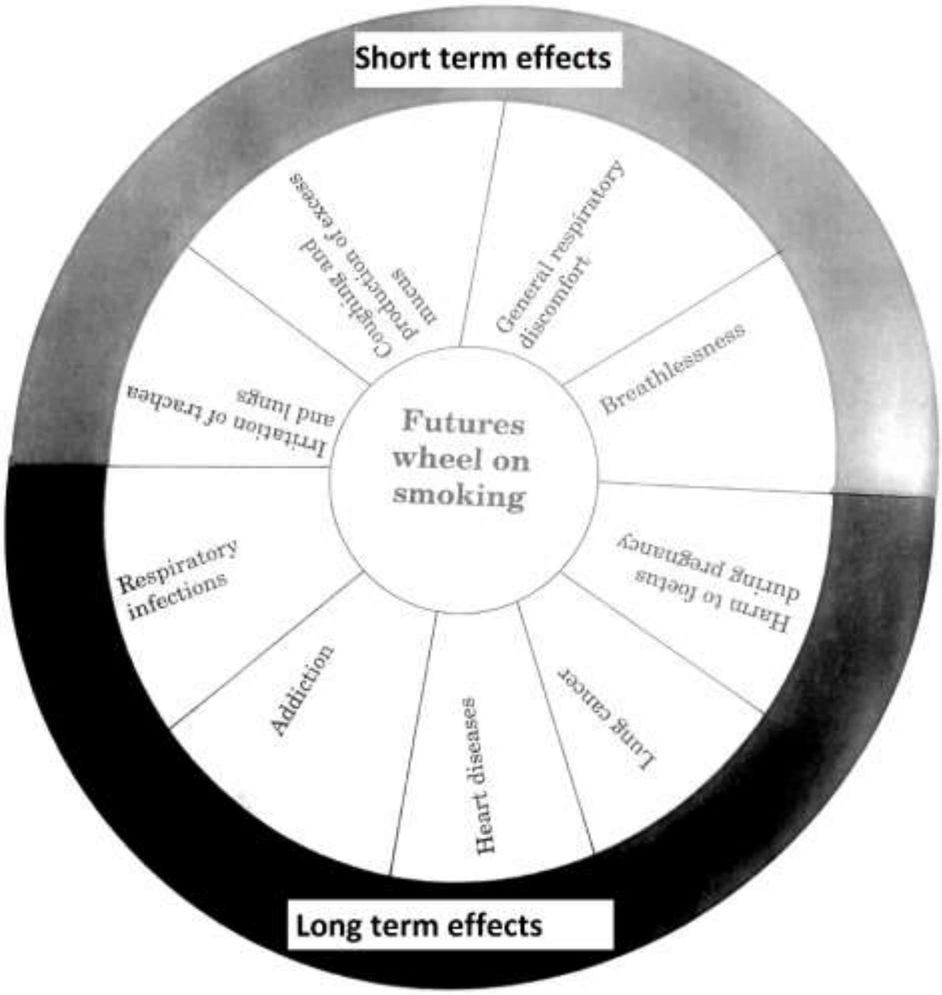


Fig 6.9: Future wheels on effects of smoking

UNIT 7: LOCOMOTION IN HUMAN BEINGS

- Locomotion is the movement of the whole organism from one place to another.
- In humans locomotion is made possible by the combined action of the skeleton, joints and muscles.

The Human Skeleton

- The human skeleton consists of 206 bones joined together to form a rigid framework.

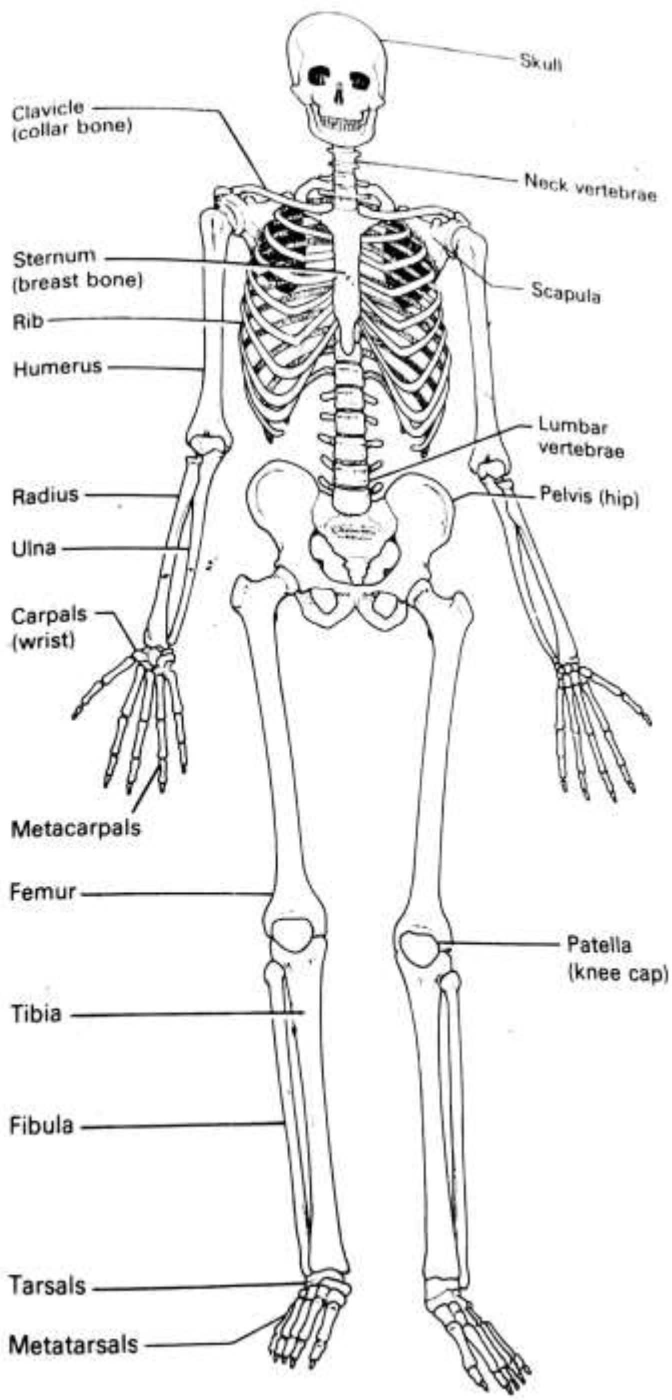


Fig. 7.1: The human skeleton

Parts of the Human Skeleton

- The human skeleton is made up of main parts:
  1. The axial skeleton and
  2. The appendicular skeleton

1. **The Axial Skeleton**
   - This consists of the skull, vertebral column, ribs and sternum.

   a. **Vertebral Column**
      - This is the main axis of the body to which other bones of the body are attached by muscles and ligaments.
      - It consists of series of bones called **vertebrae** placed end to end.
      - The cavity running through the centre of each vertebra is occupied by the spinal cord.

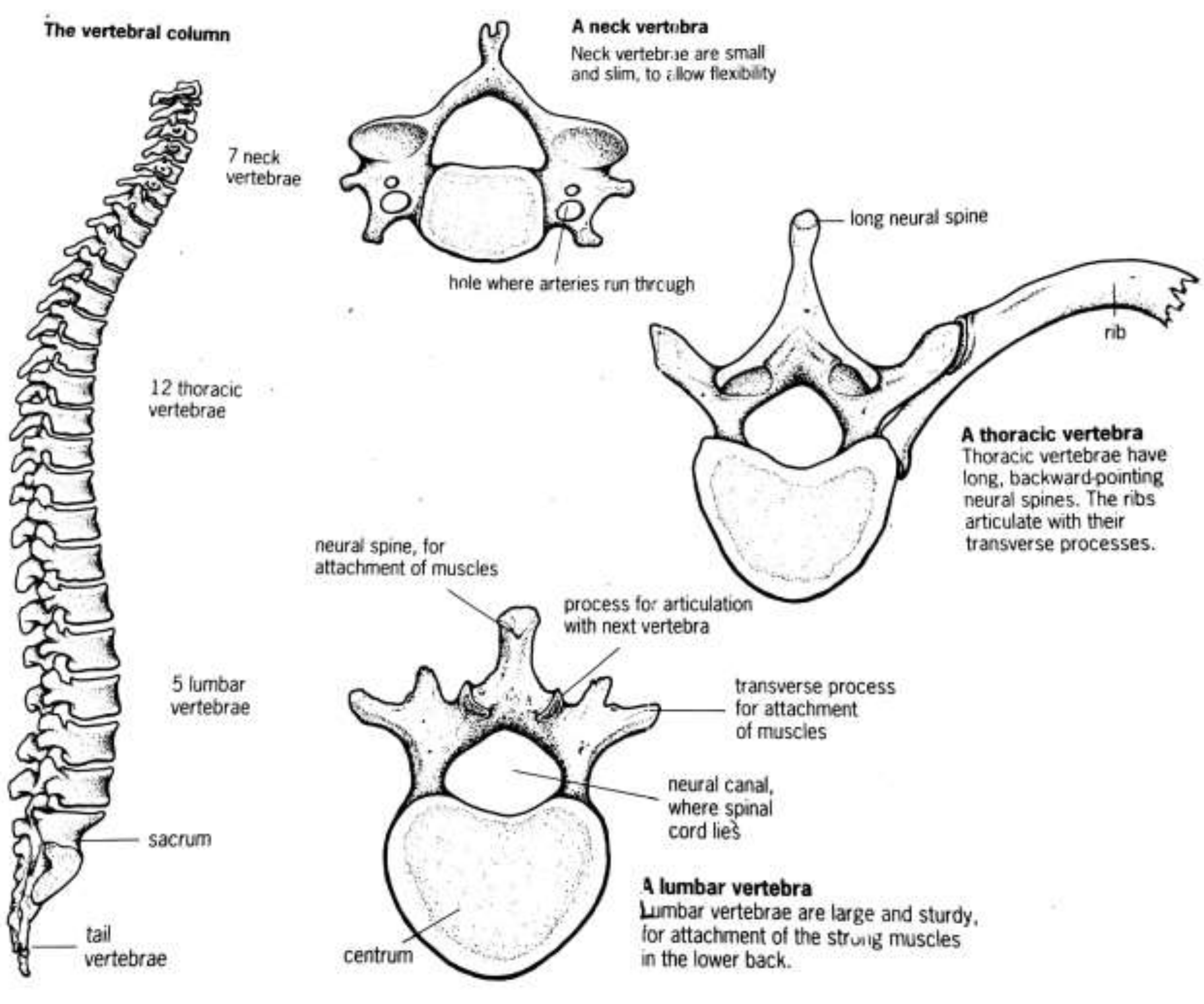


Fig. 7.2: Vertebrae

Functions of Vertebral Column

(i) It protects the spinal cord from external physical forces.

(ii) It supports the head.

(iii) It provides point of attachment for pelvis and ribcage.

b. **The Skull**

- The skull consists of several small bones joined through joints called **sutures** to form the cranium.
- The cranium encloses and protects the brain.

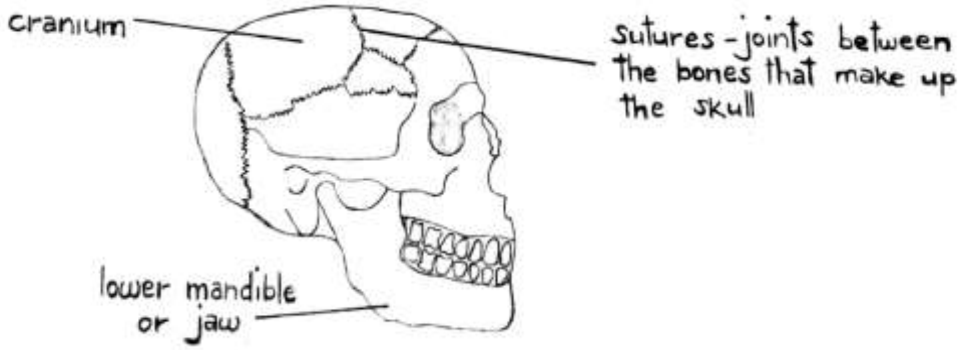


Fig. 7.3: The skull

c. **The Rib and Sternum**

- Ribs with the sternum and vertebral column form a ribcage.
- The ribcage protect the heart and lungs against mechanical injury.

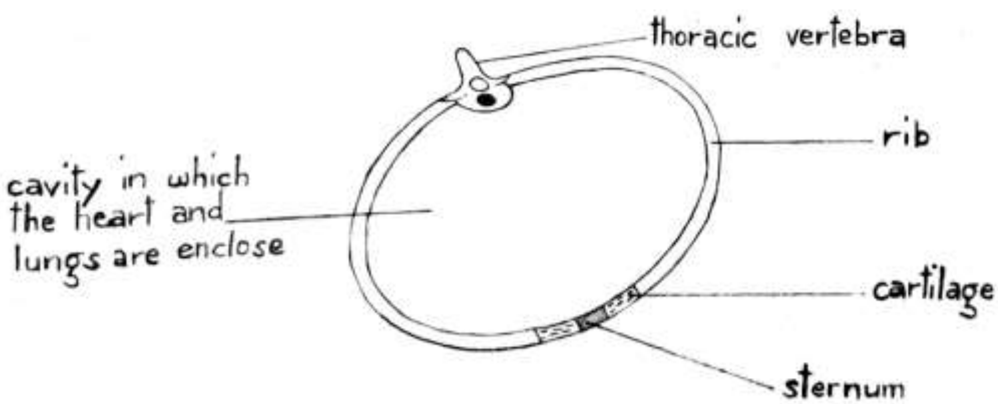


Fig. 7.4: Ribcage

2. Appendicular Skeleton

- The appendicular skeleton consists of the pelvic girdle (hip), pectoral girdle (shoulder blades), arms and legs.
- The girdles absorb any stress that the limbs may experience.

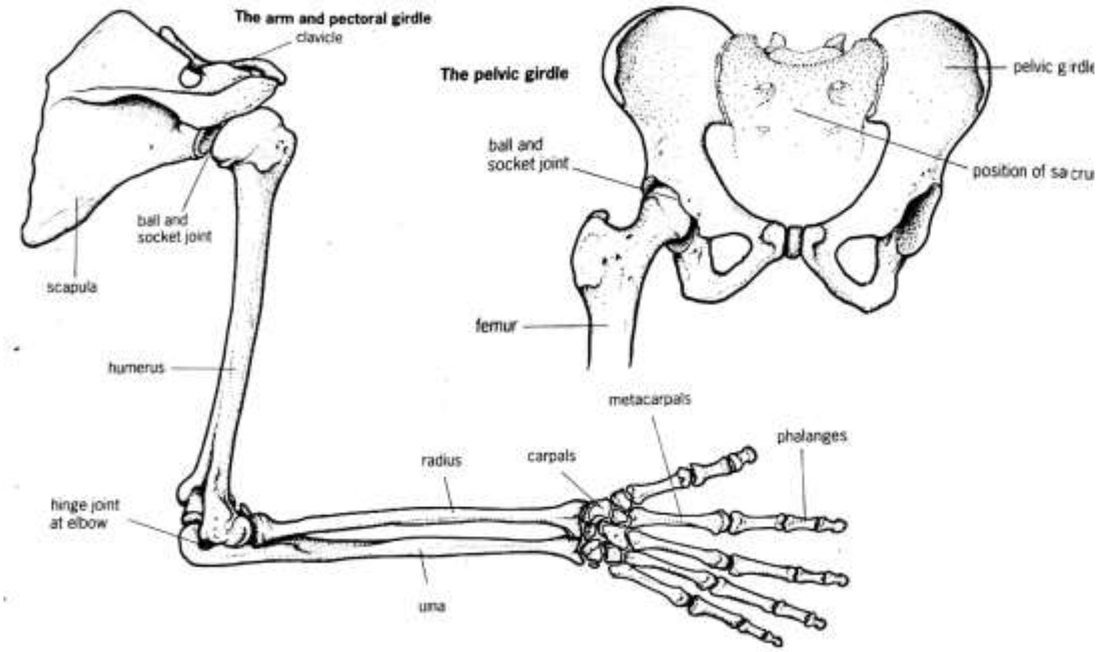


Fig. 7.5: Limbs and girdles

The Structure of the Bone

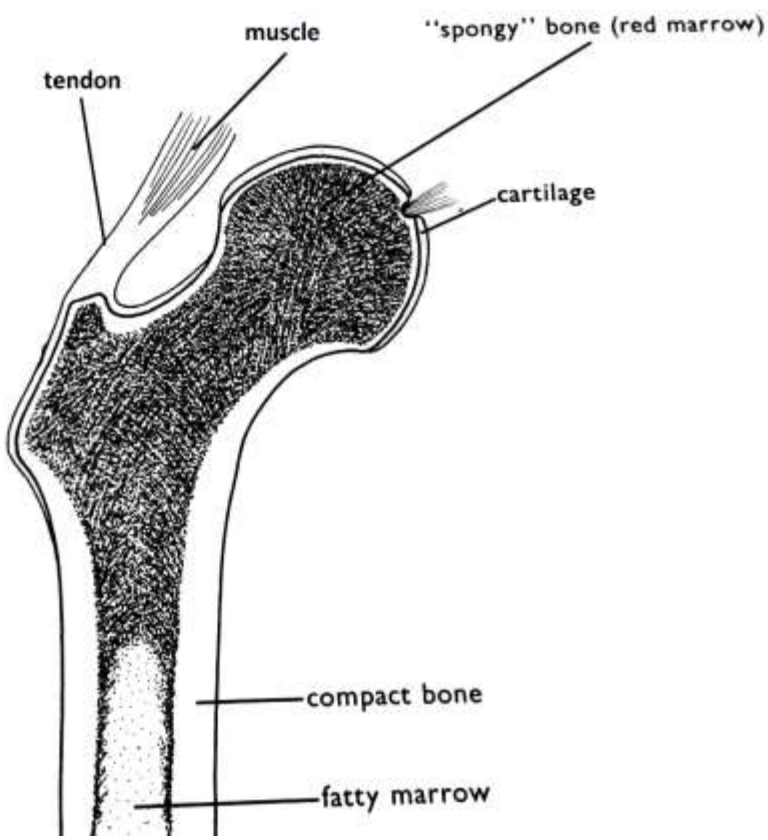


Fig. 7.6: Section through head of femur

Cartilage

- This is a hard and flexible supporting tissue.

Functions of Cartilage

1. It covers the ends of the bones which joints form thereby absorbing shock and preventing friction.
2. It connects ribs to the sternum.
3. It provides support to structures such as nose and the ear.

Compact Bone

- This the hardest part of the bone.
- It is mainly made up of calcium salts secreted by the living cells that lie inside the bone.

Spongy Bone

- This is the interior region of a bone.
- It contains many spaces. The spaces stop the bone from being too heavy.
- The spaces are filled with another with another tissue called the **bone marrow**.

Bone Marrow

- It is very soft and contains many blood capillaries.
- It where the red blood cells, white blood cells and platelets are made.

Joints

- A joint is place where two or more bones meet.

Types of Joints

- There are two categories of joints in human body:
  1. Immovable or fixed joints
  2. Movable or synovial joints

1. Immovable (fixed) Joints

- These are joints formed where two or more bones come into very close contact but do not permit movement of the bones. The bones are fused by a protein called collagen.
- Examples of immovable joints include the sutures in the skull and between the sacrum and pelvic girdle.

2. Movable (Synovial) Joints

- These are joints that allow some movement of the bones.
- There are three types of movable joints:
  a. Hinge joints
  b. Ball and socket joint
  c. Gliding joints
  d. Pivot joint (peg and socket joint)

a. **Hinge Joint**

- These are joints which allow movement of the bones in one plane only.
- Examples of hinge joints include:
  - (i) The knee joint and
  - (ii) The elbow joint

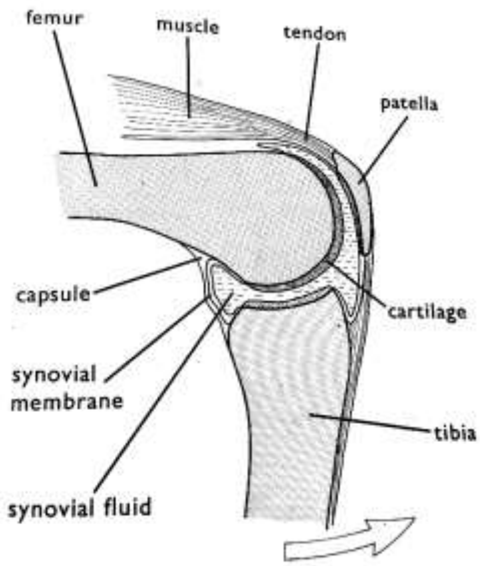


Fig. 7.7: Hinge joint of knee

b. **Ball and Socket Joint**

- These are joints where the rounded head of one bone fits into a socket or cavity of another bone, allowing movement in all planes.
- Examples are:
  - (i) The shoulder joint (formed between head of humerus and scapula)
  - (ii) The hip joint

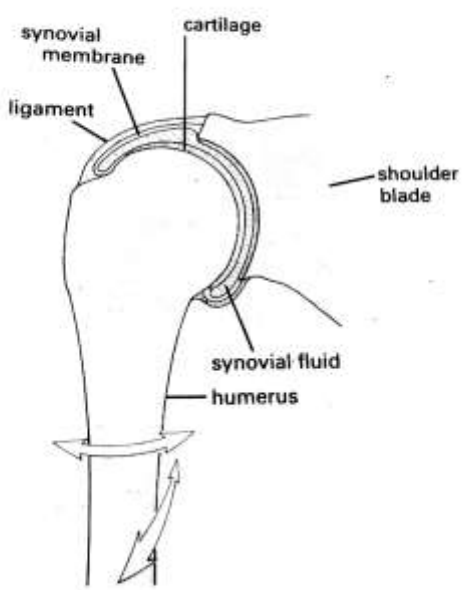


Fig. 7.8: Ball and socket joint of shoulder

c. **Gliding Joints**
- These are joints that occur where bones meet at flat surface and slide over one another.
- Examples are:
  (i) Joint between vertebrae and
  (ii) Between the carpals in the wrist.

d. **Pivot Joint (Peg and Socket Joint)**
- It is found between the first and the second vertebrae in the neck. It allows rotation of the head.
- **Figure 7.9** below is a simple illustration of the peg and socket joint at the neck.

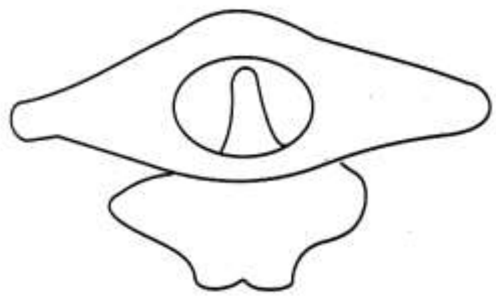


Fig. 7.9: A simple illustration of the peg and socket joint at the neck

The Structure of a Typical Movable Joint

Cartilage
- It is smooth.
- It prevents friction between the bones during movement.
- It absorb shock

Synovial Membrane
- This is a thin membrane which encloses the joint.
- It secretes synovial fluid.

Synovial Fluid
- It is a thick fluid.
- It lubricates the joints thereby preventing friction during movement.

Tendon
- It joints muscles to bones.
- Tendons are very strong, and do not stretch.
- They are made of collagen fibres.

Ligament
- It holds two bones together.
- Ligaments are very strong, but can stretch when the bones move.

Muscles

- A muscle is a tissue made of many elongated cells.
- There three types of muscles in human body:
    1. Smooth muscles (Involuntary muscles)
    2. Cardiac muscles and
    3. Skeletal muscles (Voluntary muscles)

1. Smooth (Involuntary) Muscles

- The smooth muscles are found in the walls of the internal organs of the body e.g. the alimentary canal, blood vessels and urinary bladder.
- They contract and relax without the control of mind and cause the movement of materials through them e.g. blood, gut content and urine.
- Each muscle cell is spindle shaped and has no striation.

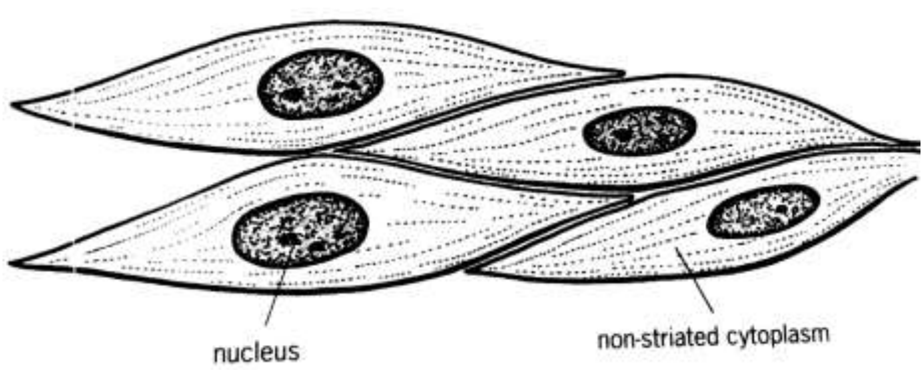


Fig. 7.10: Microscopic appearance of smooth muscle

2. Cardiac Muscles

- The cardiac muscles are only found in the walls of the heart.
- They work by contracting and relaxing to pump blood around the body.
- They have special muscle tissue which never gets tired.
- The cardiac muscles receive nerves from autonomic nervous system. The work of the nerves is to modify the rate at which the muscles contract i.e. increase or slow down but does not initiate the contraction.

3. Skeletal (Voluntary) Muscles

- Skeletal muscles are attached to the bones of the skeleton.
- Their contractions lead to movement of the skeleton and therefore cause locomotion.
- They contract suddenly and powerfully, but they get tired quickly.
- They contract by the conscious control of the brain hence they are also known as **voluntary muscles**.
- When viewed under a microscope, its fibres are seen to have stripes running across them hence the name **striated muscles**.

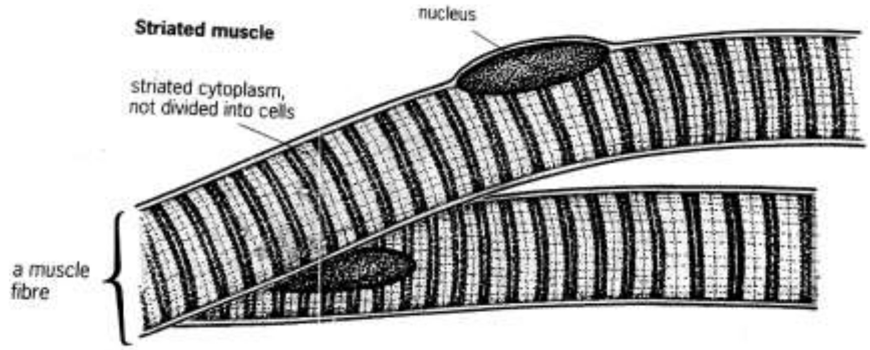


Fig. 7.11: Microscopic appearance of skeletal muscle

- The skeletal muscles are attached to the bones by means of tendons.

Movement of Forearm

- The arm can bend at the elbow, which is a hinge joint.
- Bending a hinge joint is called **flexon** and straightening is called **extension**.
- When the biceps muscles contracts, it pulls the radius and ulna towards the scapula, so that the arm bends. The biceps is called **flexor muscle**.
- When the triceps muscle contract, it lowers the arm. The triceps muscle is called **extensor muscle**.
- During contraction, biceps and triceps shorten to form a lump, which flattens out again as the muscles relax.
- The flexor and extensor work together. When the biceps contracts, the triceps relaxes. When the triceps contracts, the biceps relaxes. The muscles that work in opposition to each other are called **antagonistic muscles**.

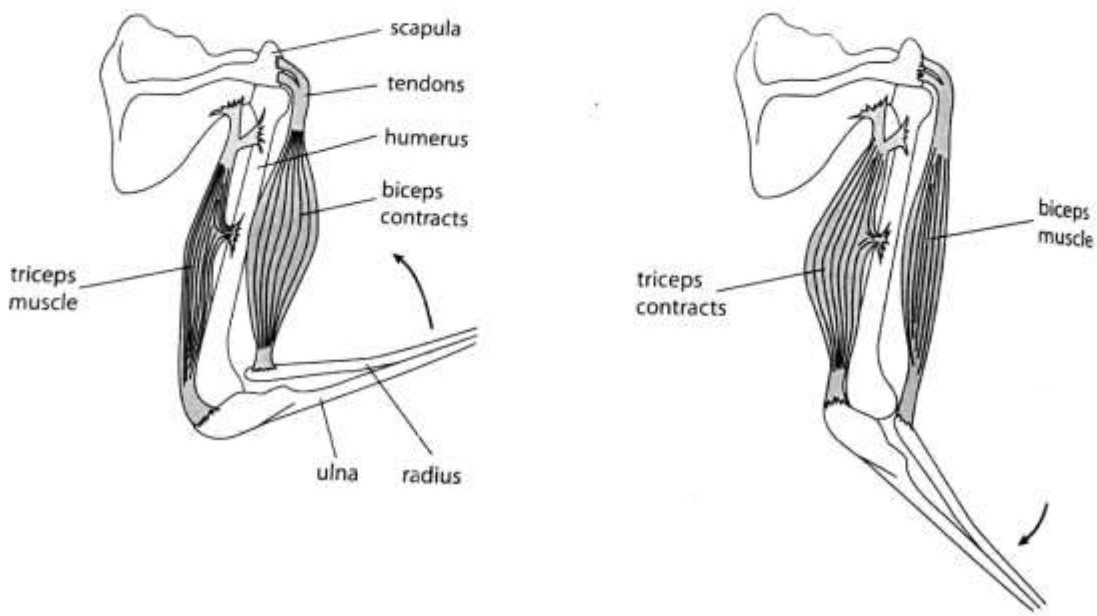


Fig. 7.12: Movement of forearm

Injuries of Bones

- Injuries of bones are called **fractures**.
- A fracture is a broken bone.

Types of Fractures

- There are two types of fractures:
  a. Simple (Closed) fracture
  b. Compound (Open) fracture

a. Simple (Closed) Fracture

- It occur when the bone breaks without causing an open wound in the skin.

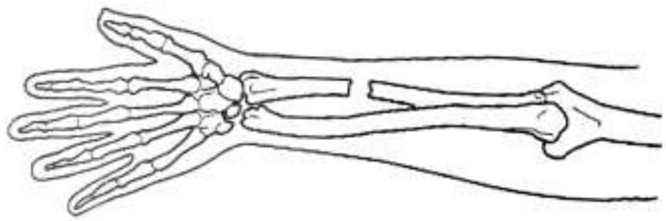


Fig. 7.13: Simple fracture

b. Compound (Open) Fracture

- An open fracture occurs when the broken bone protrudes out of the skin causing an open wound.

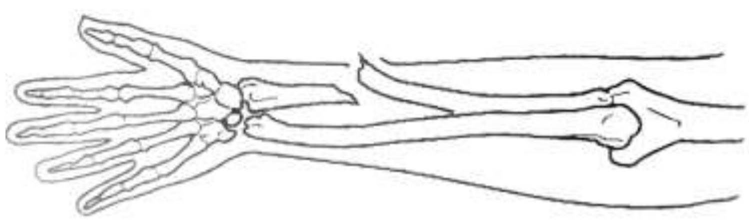


Fig. 7.14: Compound fracture

First Aid for Fractures

- Place a splinter (smooth piece of wood) on the affected part.
- Tie a clean cloth or bandage around the wound to stop bleeding and to prevent further movement of the bones which would make the wound worse.
- If it is an arm affected use a sling to hold it to the chest. A leg may be tied to another leg.
- Take the person to the nearest hospital.

Injuries to Joints

- Examples of injuries to joints include:
  a. Sprains
  b. Strains and
  c. Dislocations

a. Sprains

- A sprain is a stretching or tearing of ligaments.
- The joint is suddenly pulled or twisted
- The most common location for sprains are ankle and wrist.

First Aid for Sprains

- Apply ice or cold water on sprained area to reduce pain and swelling.
- A sprain is taken care of by carefully applying a supporting bandage at the joint and giving enough rest so that the damaged tissue can heal.

b. Strains

- A strain is a stretched or tear on a muscle or tendon.
- First aid is the same as that of the sprain.

c. Dislocations

- This is the type of injury that occurs when a bone moves out of its position at a joint.
- It usually occur at the shoulder or knee joints.

First Aid for Dislocation

- A dislocated joint is usually managed by carefully and skilfully pushing the dislocated bone back into position. It is best done by a qualified first aider.
- A sling can also be tied along the area to support the weight away from the joint.

UNIT 8: MAIN GROUPS OF ANIMALS

- Animals are classified into two groups:
  1. Invertebrates and
  2. Vertebrates

Invertebrates

- These are animals without a backbone
- They are usually small in size
- Examples of invertebrates include:

a. **Insects**

- Their body is divided into three parts: the head, the thorax and the abdomen.
- Their head has a pair of antennae and compound eyes.
- They have three pairs of legs that are attached to the thorax.
- Some insects have wings while others do not.
- Examples include bugs, beetles, butterflies, moths, flies, mosquitoes, termites, ants, bees and wasps.

Fig. 8.1: Examples of insects

b. **Arachnids**

- Their body is divided into two parts: cephalothorax and abdomen. The head and thorax are fused to form a cephalothorax.
- They have no antennae
- They have four pairs of legs that are attached to cephalothorax.
- They have simple eyes.
- Examples include spiders, ticks and scorpions.

c. **Crustaceans**

- They have many legs and two pairs of antennae.
- Their body are covered with a hard shinning material.
- Their bodies are divided into two parts.
- Examples include crabs, prawns, crayfish and shrimps

d. **Round worms (Nematodes)**

- They have cylindrical bodies which are not segmented
- Their bodies are pointed at both ends
- Examples of round worms include: *Ascaris spp*. and hookworms

e. **Segmented Worms (Annelids)**

- Their bodies is divided into segments
- They live in moist soils
- Examples of annelids include earthworms, marine worms and leeches.

f. **Molluscs**

- They have soft bodies
- They have non- segmented bodies.
- They have two pairs of tentacles.
- Examples of molluscs include: snails, slugs, octopuses and oysters.
- Many molluscs are aquatic and some of them live on land.

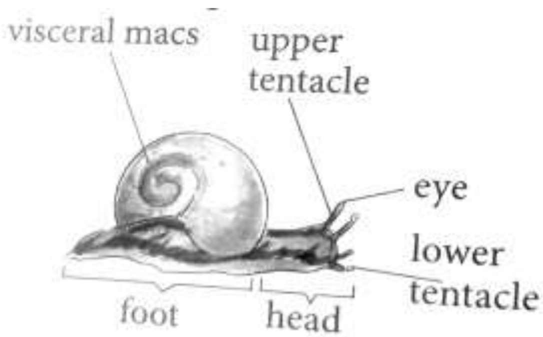


Fig. 8.2: An examples of mollusc

Vertebrates

- These are animals with backbone.
- Vertebrates are divided into five main groups: fish, amphibians, reptiles, birds and mammals.

a. Fish

- All fish live in water.
- Their bodies are covered with scales.
- They have fins for movement.
- They have gills for gaseous exchange.

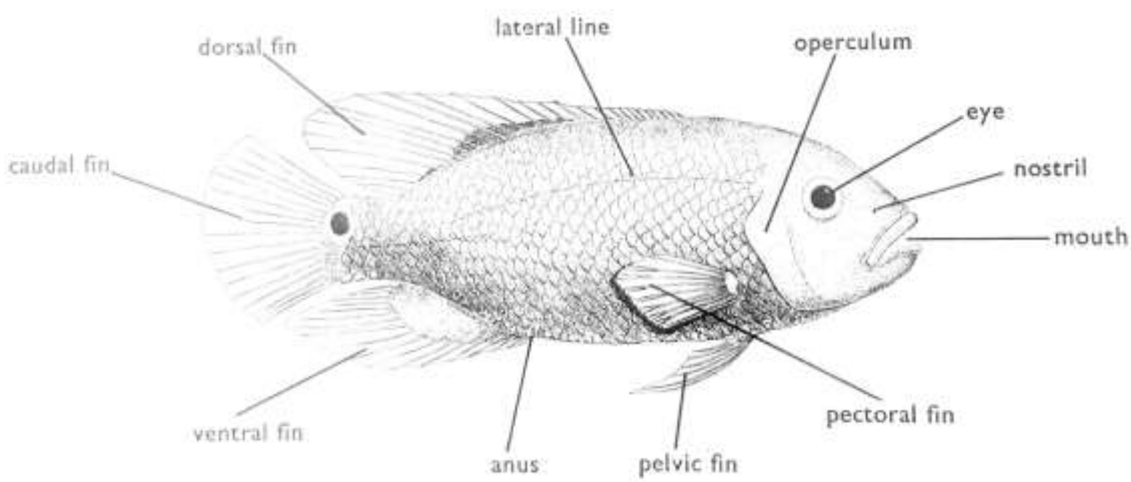


Fig. 8.3: A tilapia fish

b. Amphibians

- The word *amphibia* comes from the word “amphi” which means “dual” or two.
- They live in both land and water.
- They have moist skin.
- They breed in water and fertilization is external.
- They mucous glands under their skin to keep the skin moist.
- Young amphibians have gills and live in water, while the adults live on land and have lungs.
- Examples are frog and toads.

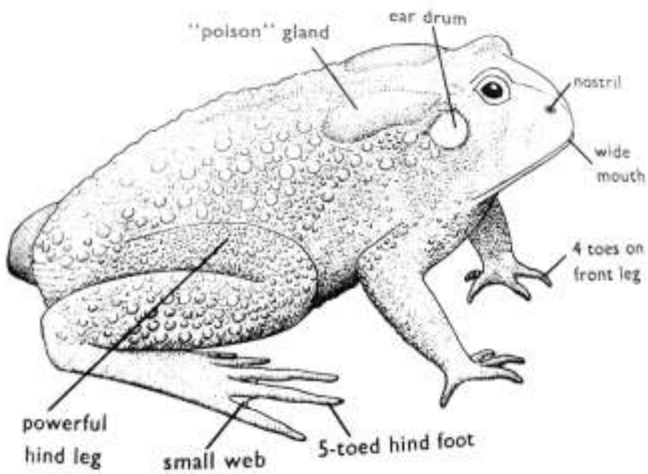


Fig. 8.4: a toad

c. Reptiles

- Reptiles move by creeping or crawling.
- Their fertilization is external
- They have well developed lungs for gaseous exchange.
- Examples are snakes, tortoise, crocodiles and lizards.

d. Birds

- Birds have bodies covered with feathers, their legs are covered with scales.
- They have wings
- They have beaks for feeding.
- Examples birds include: hawks, sparrows, eagles, chicken, ostriches and parrots.

e. Mammals

- They have fur or hair on their bodies.
- They have mammary glands
- They have teeth of different types and sizes
- They have developed lungs for gaseous exchange.
- Examples of mammals include: cats, dogs, sheep, goats, whales, man, bats and kangaroos.

Reproductive System in Vertebrates

- Vertebrates reproduce sexually. This means that an egg cell from a female animal fuses with a sperm cell from a male animal. A single cell called a **zygote** results. The zygote divides many times to produces a new animal.

a. Reproduction in Fish

- External fertilization takes place in fish. This means that the female eggs are fertilized by male sperms outside the female's body.

b. Reproduction in Amphibians

- The female lay eggs in water and these are fertilized externally. The male sperms swim to the eggs as they leave the female body. The eggs are surrounded by a jelly- like substance that protects them from drying up, or being eaten. Inside the jelly, the egg and sperm fuse.

c. Reproduction in Reptiles

- Reptiles mate and fertilization is internal.
- Reptiles reproduce by laying eggs.

d. Reproduction in Birds

- Birds reproduce by laying eggs.
- Fertilization in birds is internal.

e. Reproduction in Mammals

- Mammals produce live young that they look after for a long time.
- Fertilization is internal.

Circulatory System in Vertebrates

a. Circulatory System in Fish

- Fish have blood that flows in veins and arteries.
- They have simple heart to pump blood around the body. Their heart is divided into two chambers.

b. Circulatory System in Reptiles and Amphibians

- They have a heart with three chambers; two atrium and one ventricle.
- Some blood vessels carry mixed blood. Mixed blood is blood containing both oxygenated blood and deoxygenated blood.

c. Circulatory System in Birds and Mammals

- They have a heart with four chambers; two atria and completely two divided ventricles.

Respiratory System in Vertebrates

a. Respiratory System in Fish

- Fish have many gills containing many blood capillaries as respiratory system.
- A stream of water containing dissolved oxygen goes through the gills as a result of movement of the mouth and operculum. Oxygen diffuses out of water into the blood that flows through gills. Carbon dioxide diffuses out of the blood into the water.

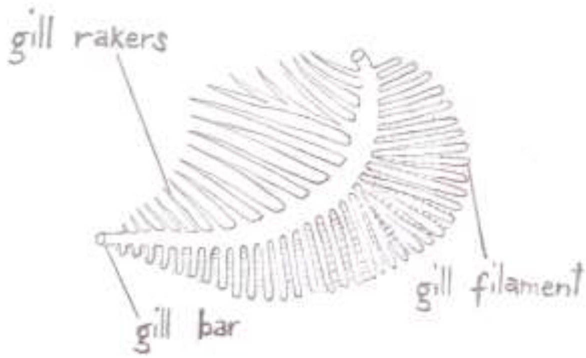


Fig. 8.5: Gills

b. Respiratory System in Amphibians

- Amphibians raise and lower the floor of their mouths so that air is taken in from the outside and forced out of the mouth. Oxygen in the air diffuses through the moist skin lining a frog's mouth and into blood capillaries. Carbon dioxide diffuses out of the blood in these capillaries and is forced out of the mouth.
- Frogs can also use lungs for breathing when they are active. Air is forced into the lungs through the mouth when the nostrils are closed.
- Some amphibians are able to use their skin as a respiratory surface. Oxygen can diffuse through the moist skin into capillaries underneath it and carbon dioxide can diffuse in opposite direction into the water.

c. Respiratory System in Reptiles

- Reptiles use lungs for breathing.
- Snakes breathe by contracting muscles between their ribs. Snakes do not have a diaphragm.

d. Respiratory System in Birds and Mammals

- Birds and mammals use lungs for breathing.
- Birds do not have a diaphragm. The change in pressure in the air sacs helps to move air in and out of the respiratory system.

Locomotion in Vertebrates

a. Locomotion in Fish

- Locomotion of fish in water is by swimming. Swimming involves forward movement and control of the body position in water as fish moves.

Functions of Fins

1. **Pectoral fins and pelvic fins**
   - They are used for changing direction.
   - They allow the fish to move up and down in the water (pitching)
   - They enable the fish to stop
   - They help the fish to prevent unnecessary pitching caused by water currents

2. **Dorsal fin and Ventral Fin**
   - They prevent yawning of the fish. Yawning refers to the tendency to move from side to side as the as the fish swims.

3. **Tail Fins**
   - It causes propulsion (forward movement).

Adaptations of Fish for Swimming

1. Fish has streamlined body so that it cuts through water rapidly.
2. The scales overlap facing backwards. This arrangement of scales allows the fish to move through water easily.
3. The body of fish is covered with mucus which reduces friction between the body of the fish and water during movement.
4. They have fins which help in controlling movements of fish in water.
5. They have swim bladder which controls buoyancy (able to float and sink) and depth at which it swims in water.
6. They have a flexible vertebral column which allows the fish's body to curve.

Locomotion in Birds

- Birds can swim, walk and fly.
- Birds have wings which enables them to fly
- Birds have legs which are used for walking or hopping.
- The most common type of locomotion in birds is flying.

Flight in Birds

- There are three types of flight movements in birds.
  1. Flapping flight and
  2. Gliding flight and
  3. Soaring flight

1. **Flapping Flight**
   - Wings are flapped up and down.
   - When wings are flapped up, the movement is called **upstroke**.
   - When wings are flapped down, it is called **downstroke**.

- The flapping of the wings is controlled by muscles that hold the bones of the wings to the pectoral girdle. These are **pectoralis minor (elevator) muscles** and **pectoralis major (depressor) muscles**.

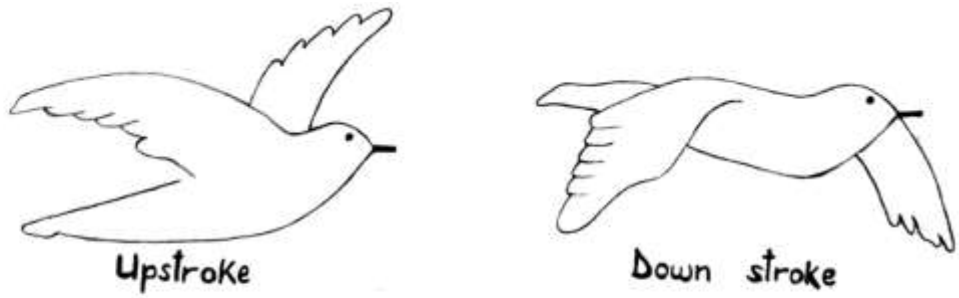


Fig. 8.6: Flapping flight of birds

What Happens During Downstroke?

- The pectoralis major muscles contract pulling the wing downwards and the pectoralis minor muscles relax.
- The flight feathers overlap in way as to trap much air so that there is more resistance below the wing to generate lift.

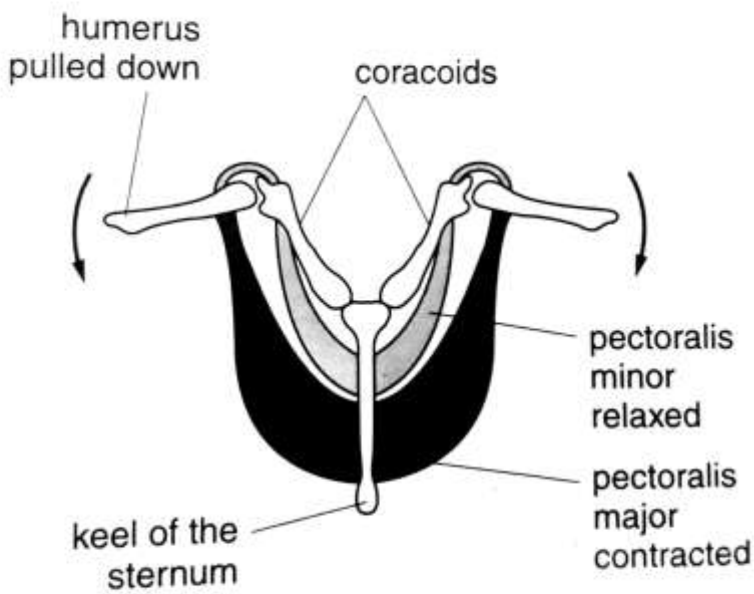


Fig. 8.7: Downstroke

What Happens During Upstroke?

- The pectoralis minor muscles contracts pulling the wing upwards and the pectoralis major muscles relax.
- The flight feathers overlap in a way as to let air pass between them so that air resistance is reduced below the wing. As a result there is no upthrust below the wing and the force of gravity pull down the bird so that it losses height.

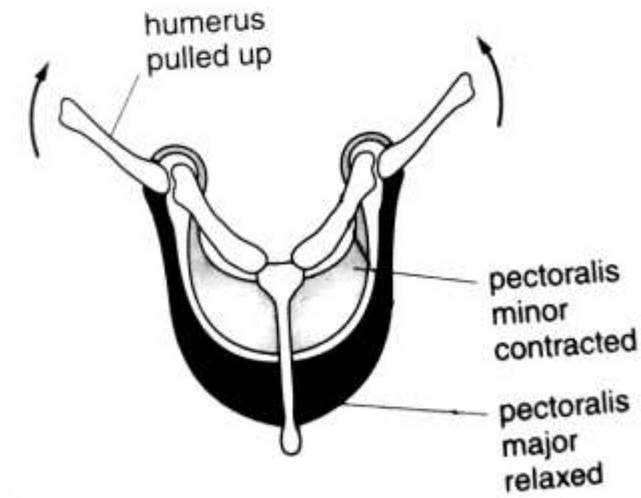


Fig. 8.8: Upstroke

2. Gliding Flight

- In gliding flight, the wings are out-spread. Spreading of wing of wings increases the surface area which creates resistance below the wing in order to generate lift.
- The wings are also used as **aerofoils**. The distance over the top of the wing is greater than the distance over the bottom of the wing so air on top move faster than the bottom. This makes the downward pressure on top of the wing less than the upward pressure on the lower surface of the wing hence there is a net upward force.

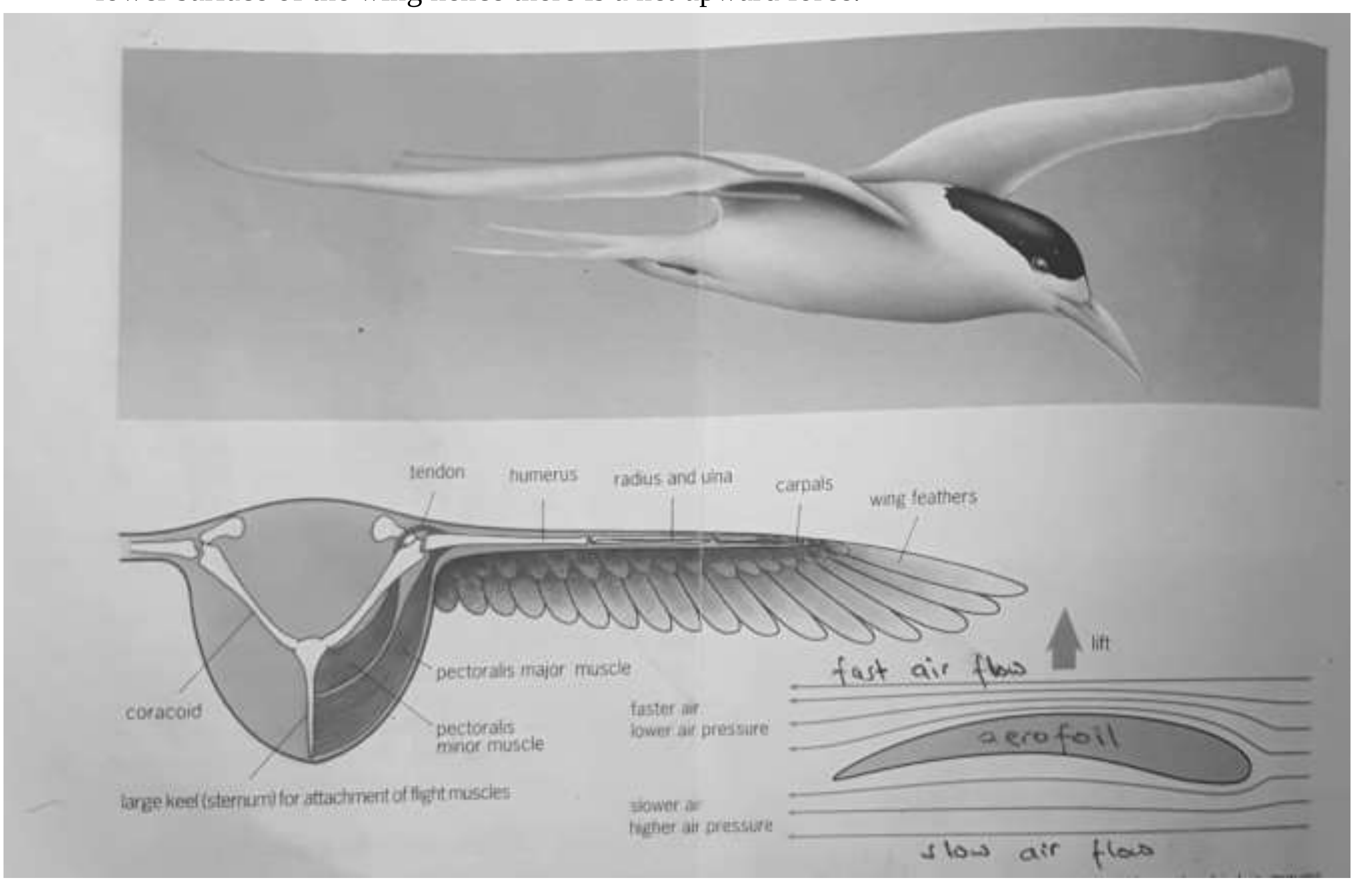


Fig. 8.9: The wing acts as an aerofoil

3. **Soaring Flight**
   - The bird spreads out its wings in soaring movement to allow upwards thermal air currents to lift the bird allowing it to gain height without moving its wings.

Flight (Quill) Feathers

- These are feathers that are attached to the wing and they help in flight of birds.
- They are large and have even margin.
- They have large quill.

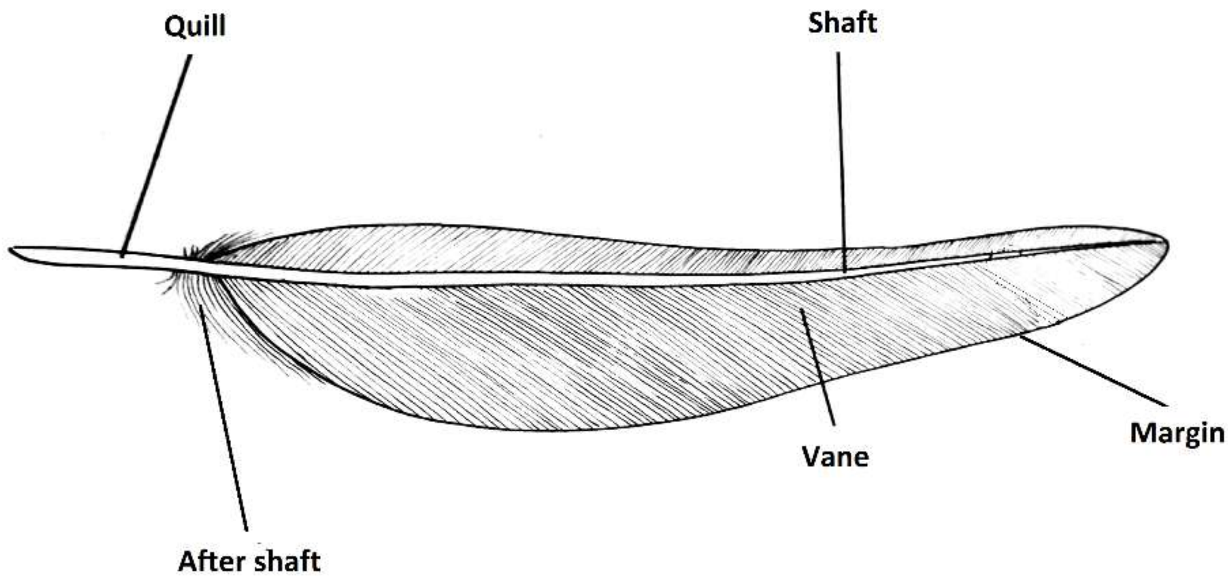


Fig. 8.10: Quill feather

Down Feathers

- These are feathers that cover the rest of the bird.
- They are small and have uneven margin.
- They have small quill.

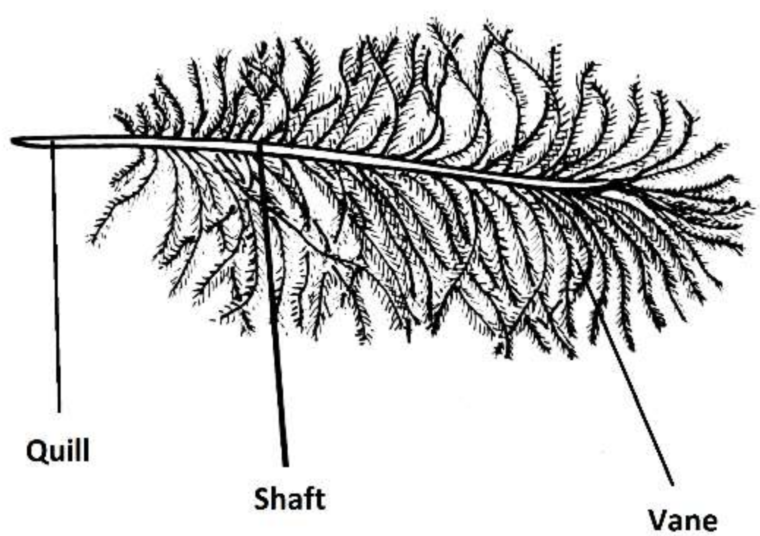


Fig. 8.11: Down feather

Adaptations of Birds for flight

1. They have streamlined body. This makes possible for them to move in air with less resistance to air currents.
2. They have large and powerful pectoral muscles that attach the wing to the body of the bird for efficient movement of the wing.
3. They have hallow bones which make them lighter while in flight.
4. They contain air sacs which make them lighter while in flight.
5. The forelimbs of birds are modified to wings. The wings have feathers which create a large surface area for flight.
6. They have a large sternum which have deep keel to which the breast muscles are attached.
7. Their body is covered with feathers which help to insulate the birds, helping them to stay warm so that they can produce enough energy for flight.
8. They have no teeth. This enables them to reduce their body weight.
9. They have no earlobes. This enables them to reduce air resistance during flight.

Locomotion in Mammals

- Mammals move by creating a propulsion force that moves the body forward. This force is provided by the contraction of muscles of the legs. As the muscles contract they move the bone back and forth. The bones cause the movement of the locomotory structures producing a propulsion force that moves the animal forward. The whole mechanism is controlled by the nervous system.

Locomotory Structures in Mammals

- Mammals have four limbs that are modified for walking, running, jumping and flying.
- The locomotory structures in mammals include:
    a. **Legs**- are found in most animals. Human beings use two limbs for movement. Horses, donkeys and cattle use four limbs.
    b. **Wings**- are found in bats
    c. **Flippers**- are found in aquatic mammals such as whales and dolphin. They are used for swimming in water.

Adaptations of Mammals for Locomotion

1. They have movable joints which allow the bone to move freely to enhance faster movement.
2. They tendons which join a muscle to a bone.
3. They have ligaments which join a bone to a bone at the joints. This makes sure that the two bones do not separate even when strong movement activity is taking place.
4. They have strong muscles which generate great force to move the bones during contraction.
5. Their hind limb is longer than the forelimb. This enables a creation of a greater force to propel the body forward during movement.

UNIT 9: HUMAN EXCRETORY SYSTEM

Excretion

- Excretion is the process by which organisms remove waste products of metabolism from their bodies.
- Metabolism refers to all processes and reactions that takes place inside a cell.
- Examples of metabolic wastes produced by cells:
  - **a. Carbon dioxide**- from the process of respiration
  - **b. Nitrogenous wastes**- these are produced by protein metabolism. They include urea, uric acid, ammonia and creatinine.
  - **c. Excess water**- absorbed in the body after taking in excess fluids and fruits.
  - **d. Bile pigments**- produced after break down of old and damaged red blood cells.

Parts of Human Excretory System

- Different organs in the human body are involved in the removal of metabolic waste products as shown in the **table 9.1**.

Table 9. 1: Summary of the Parts and Functions of Human Excretory System

Excretory Organ	Waste products removed
Skin	▪ Excess water ▪ Excess mineral salts
Lungs	▪ Carbon dioxide ▪ Excess water
Liver	▪ Bile pigments ▪ Toxins ▪ Dead cells
Kidneys	▪ Excess mineral salts ▪ Excess water ▪ Urea ▪ Uric acid ▪ Creatinine

The structure of the Human Urinary System

- The human urinary system consists of:
  - a. The kidneys
  - b. The bladder
  - c. Two tubes called ureters that transport urine from the kidneys to the bladder.
  - d. Blood vessels

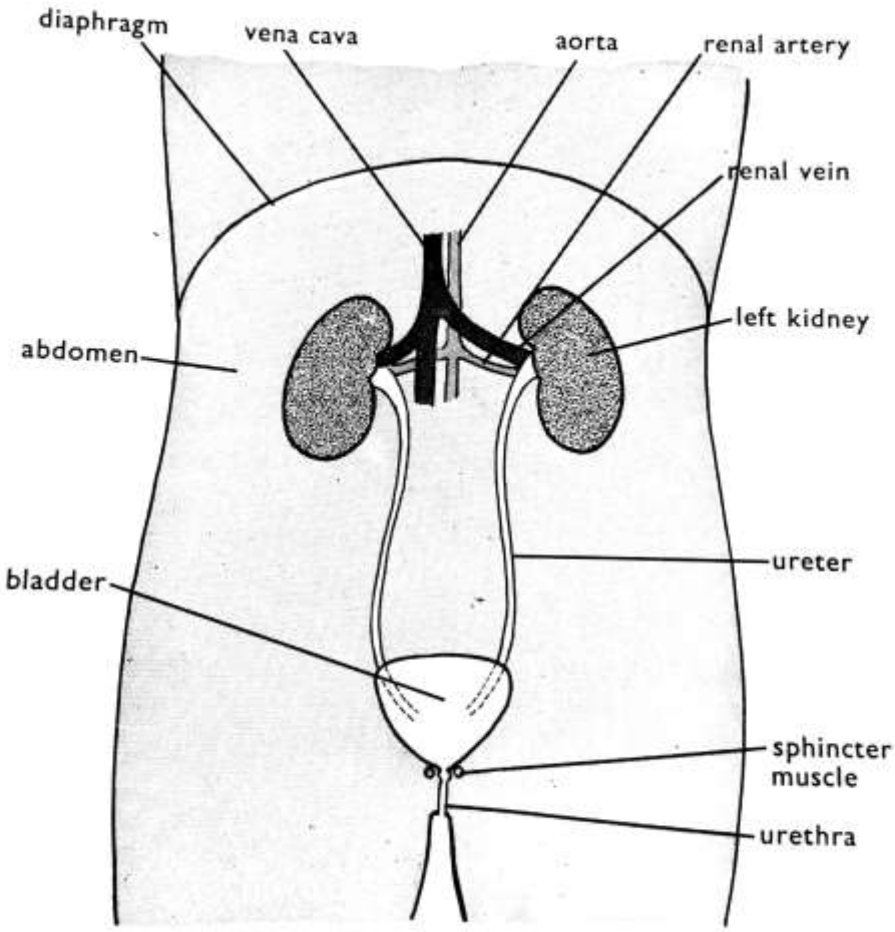


Fig. 9.1: Position of kidneys in the body

The Structure of the Kidney

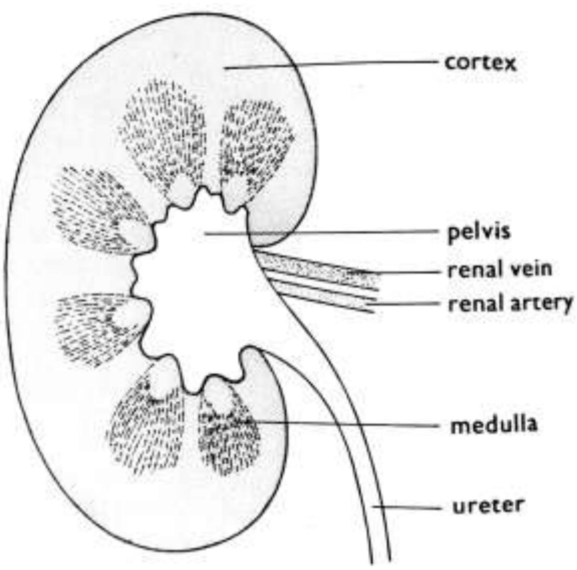


Fig. 9.2: Section through a kidney

- A kidney has a dark- coloured outer region called the **cortex**, and a lighter coloured inner region called the **medulla**.
- Each kidney is supplied with blood from **renal artery**, which splits into capillaries. These are more concentrated in the cortex of the kidney, making it darker than the medulla.
- Blood leaves the kidney in the **renal vein**.
- From where the ureter originates, there is a **pelvis** where urine collects from the cortex once formed.
- Kidneys are made up of tiny structures called **nephrons**.

Functions of the Kidneys

1. They carry out excretion.
2. They regulate water content in the blood.
3. They regulate pH of the blood.

The Nephron

- The nephron is the functional unit in the kidney.

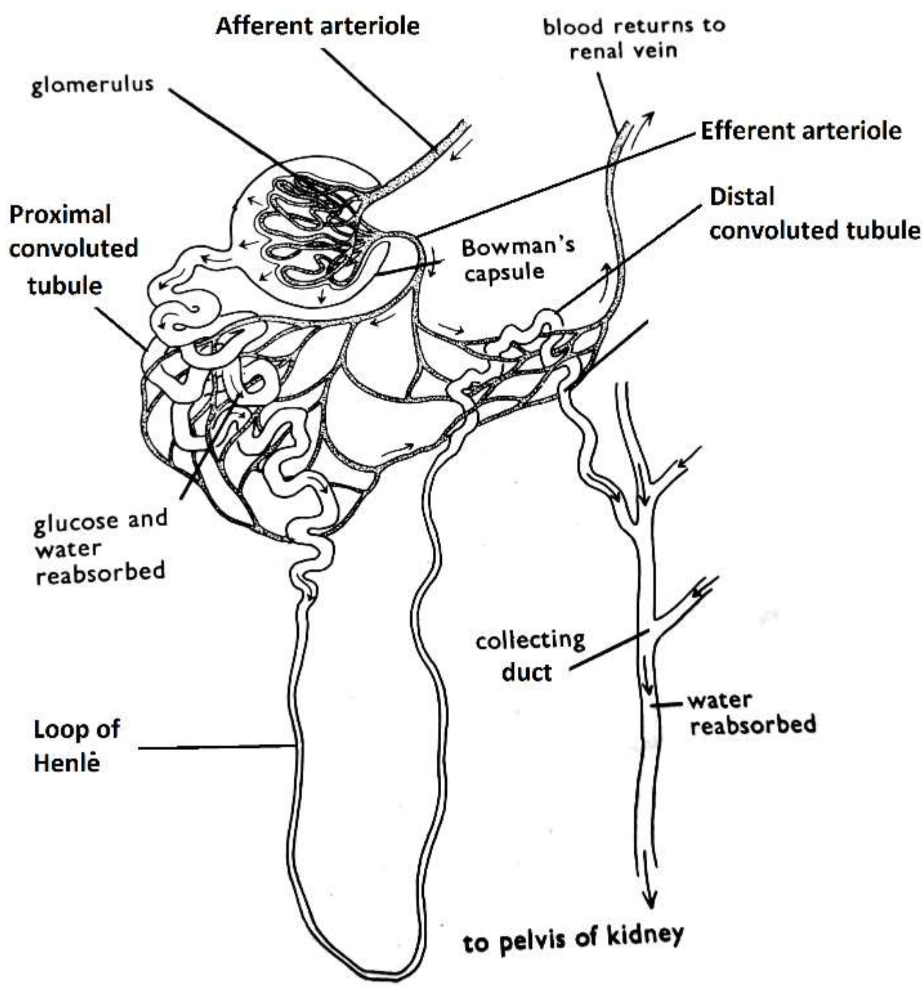


Fig. 9.3: Structure of nephron

- Urine is formed in the nephron, which consists of the following different parts:
  1. In the **cortex** of the kidney
     - Bowman's capsule- In the Bowman's capsule, the capillaries form a knot called **glomerulus** which branch from an **afferent arteriole** that originates from renal artery. The glumeruli capillaries reunite to form an **efferent arteriole** which channels blood away from the glomerulus.
     - The first, or proximal, convoluted tubule.
     - The second, or distal, convoluted tubule.
  2. In the medulla of the kidney.
     - The U-shaped tube called **loop of Henlē**.
     - The collecting ducts.

How the Kidneys Works?

- The main function of the kidneys is to excrete urea in form of urine from the body.
- Two processes are involved in urine formation in the kidneys, namely:
  1. Ultrafiltration and
  2. Selective reabsorption

1. Ultrafiltration

- Ultrafiltration is a mechanical process that takes place in the Bowman's capsule producing **glomerular filtrate**.
- Ultrafiltration occurs due to high blood pressure in the glomerulus.
- The high blood pressure develops in the glomerulus because:
  a. the afferent arteriole is wider than efferent arteriole thereby creating pressure
  b. the glomerulus has narrow lumen thereby creating resistance
  c. blood flowing to the kidney comes from renal artery which branches from aorta whose blood is at high pressure.
- The high blood pressure squeezes the blood against the walls of the capillaries of glomerulus. The walls of these capillaries are semi-permeable so that substances with small molecules are filtered out by the pressure into the tubule. This process is called **ultrafitration**.
- The following substances: water, glucose, vitamins, amino acids, urea and mineral salts are filtered out of the blood in the glomerulus into the tubule. Blood proteins, white blood cells, red blood cells and platelets are not filtered because of their large molecular size. These remain in the blood and continue to flow to the efferent arteriole.
- The liquid collection in the Bowman's capsule is called **glomerular filtrate**. The glomerular filtrate is a mixture of essential nutrients and metabolic waste products. The glomerular filtrate flows down the nephron where re-absorption will take place as it flows along.

2. **Selective Reabsorption**
   - As glomerular filtrate passes along the nephron, some substances that are useful to the body are selectively taken back or reabsorbed into the bloodstream in the capillary network.
   - Processes involved in reabsorption are osmosis (for water), diffusion and active transport.
   - Exactly the right amount of water and salts are reabsorbed to give the blood its correct composition.
   - The remaining fluid continues on its way along the tubule. By the time it reaches the collecting duct, it is mostly water with salts and urea dissolved in it. The liquid is now called **urine**.

     Note: The process is referred to as selective reabsorption because only useful substances are reabsorbed.

Table 9.2: Comparison of Composition of Urine with that of Glomerular Filtrate and Plasma

Main Substance	**Grams of substance per 100 ml of fluid**		
	Plasma	**Glomerular Filtrate**	**Urine**
Urea	0.03	0.03	2.0
Uric acid	0.005	0.005	0.05
Ammonia	0.001	0.001	0.04
Glucose	0.10	0.10	0
Amino acids	0.05	0.05	0
Mineral salts	0.70	0.70	1.50
Blood protein	8.00	0	0

- Substances such as glucose, amino acids and proteins are missing in urine. They are not excreted in urine. This is because glucose and amino acids are needed by the body. They are completely reabsorbed back into the bloodstream in the proximal convoluted tubule. Proteins on the other hand are large molecules and thus are not utra- filtered. Therefore, substances excreted by the kidneys include:
  a. Urea
  b. Uric acid
  c. Excess water
  d. Ammonia
  e. Excess mineral salts
- Kidneys also excrete toxic substances from the body. These are substances that are mainly taken into the body together with drugs or other substances. Such substances include:
  a. Remains of drugs or medicine
  b. Chemical additives used in food preservation
  c. Chemicals not useful to the body contained in some soft drinks

Comparison of Blood in Renal Artery and Renal Vein

Blood in the Renal Artery	Blood in the Renal Vein
Contains more urea	Contains less urea
Contains more glucose	Contains less glucose
Contains more water	Contains less water
Contains less carbon dioxide	Contains more carbon dioxide
Contains more oxygen	Contains less oxygen

Effects of Salt and Water Intake on Urine Production

- Taking too much water leads to production of more urine. The urine is also more diluted in concentration and it is pale in colour. This is because almost all the water taken up is absorbed into the body. This makes the blood to have low **osmotic pressure** hence less reabsorption takes place in the kidneys. As a result all the excess water taken is excreted as urine
- Osmotic pressure is the measure of how much solute is in a solution. Water moves from a region of low osmotic pressure (few solutes) to a region of high osmotic pressure (more solutes)
- When one takes a lot of salts, the osmotic pressure of blood is raised. This makes the kidneys to reabsorb more water back into the blood. This results to production of less urine that is more concentrated. The urine is dark yellow in colour.

Effects of some Eating and Drinking Habits on Kidney Function

- Habits refers to certain things that we do repeatedly for long until we get used to doing them.
- The following are some ways in which bad eating and drinking habits affects our kidneys:
  a. Excessive consumption of salt results to disorders such as **kidney stones**.
  b. Excessive intake of proteins such as lean meat causes excessive proteins to be deaminated in the liver. The deaminated proteins form urea and uric acids that are passed to the kidneys for excretion. Uric acid and other chemicals are deposited in the renal pelvis as kidney stones.
  c. Excessive intake of carbonate drinks and foods make some chemical substances to accumulate in the kidneys. These cause kidney damage.
  d. Taking alcohol affects the liver and the kidneys. Alcohol destroys the balance of ions and water in the body. These affect metabolic processes in the body.
- However, there are some good habits that enhance proper functioning of kidneys. They include:
  a. Taking adequate quantities of water every day.
  b. Minimising salt intake in food
  c. Minimising taking proteinous food such as meat.
  d. Taking a lot of vegetables. Vegetables provide vitamins that are essential in the functioning of the kidneys.
  e. Taking of fruits in diet. Fruits are also sources of vitamins.

Regulation of Water and Salts in the Body

- The kidneys regulates the balance of salts and water in the body. They do this by filtering the blood that enters the kidneys and reabsorbing the amount of water the body needs back into the blood. It is the amount of water that determines the concentration of salts and other dissolved substances.
- The water and salt concentrations in the body are controlled by **osmoregulation**. Osmoregulation is the process by which the kidneys regulate and keep the concentration of water and solutes at constant levels.
- Two hormones are responsible for maintaining the balance of water and salts in the body:
  a. Antidiuretic hormone (ADH) controls water balance
  b. Aldosterone controls the salt balance

The Role of Antidiuretic Hormonal (ADH) in Osmoregulation

- Receptors in the hypothalamus of the brain detect whether there is too much or too little water in the blood.
- If the blood passing through the brain has too little water, the hypothalamus detect this change and send a signal to the pituitary gland to secrete into the blood a hormone called antidiuretic hormone (ADH).
- When ADH reaches the nephron in the kidney, it increases the permeability of the collecting duct and distal convoluted tubule to water so that more water is absorbed from glomerular filtrate back into the blood. Thus, the urine becomes more concentrated and the quantity reduces. From then, further loss of water from the blood is reduced.
- If the blood passing through the hypothalamus has too much water, the hypothalamus detect this change and send a signal to the pituitary gland to secrete less antidiuretic hormone (ADH) into the blood. This causes the nephron to become less permeable to water so that there is a decrease in the reabsorption of water into the blood from glomerular filtrate. This causes the elimination of excess water via urine. One produces large quantities of dilute urine.

The Role of Aldosterone in Osmoregulation

- The maintenance of sodium levels in the blood is controlled by a hormone aldosterone from adrenal gland situated above the kidneys.
- If there is too little sodium in the blood, less water is reabsorbed into the blood from the kidneys and there is a drop in pressure. Receptors in the aorta detect the low blood pressure and this causes adrenal glands to release aldosterone into the blood. Aldosterone changes the salt reabsorption in the distal convoluted tubule, allowing more sodium ions to be reabsorbed into the blood.
- If there is a high concentration of sodium ions in the blood, more water is reabsorbed from the kidneys and blood pressure increases. Receptors in the aorta detect the high blood pressure and the secretion of aldosterone decreases or stops. This allows fewer sodium ions to be reabsorbed into the blood from distal convoluted tubule of the nephron.

Kidney Failure

- Kidney failure is a condition in which the kidneys lose the ability to remove waste and balance fluids.
- If one kidney fails to function, the person can still lead a normal life using the other kidney. However, if both kidneys fails, the individual will die within 8 to 14 days if not treated.

Causes of Kidney Failure

a. Exposure of kidneys to toxic substances such as heavy metals. These may include mercury, antibiotics and overdose of common medicine.
b. Drop in blood pressure due to heart failure, haemorrhage, dehydration or shock. (Haemorrhage means excessive bleeding)
c. Blockage of the urinary tract which leads to difficulties in elimination of urine. When the body cannot eliminate urine, toxins build up and overload in the kidneys leading to kidney failure.
d. Infections in the kidneys by bacteria and viruses.

Symptoms of Kidney Failure

a. Urinating much less often
b. Oedema (swelling of tissues)
c. Rise in blood pressure caused by too much salt and water in the body.

Treatment of Kidney Failure

- There are two forms of treatment for kidney failure:
  (i) Dialysis machine
  (ii) Kidney transplant

The Dialysis Machine

- A dialysis machine receives blood through a tube connected to an artery.
- Inside the machine, blood flows through dialysis tubing. The tubing has partially permeable walls and is bathed in **dialysis fluid**, which has the same concentration of substances found in health human blood plasma (except that it does not contain any waste substances). This means that:
  1. Waste products such as urea, uric acid and ammonia are more concentrated in the blood than in the dialysis fluid so they diffuse out of blood and into dialysis fluid.
  2. Excess water and mineral salts leave the blood into the dialysis fluid.
  3. Useful substances such as glucose and amino acids do not diffuse out of the blood because the concentration of these substances in dialysis fluid and blood are the same.
  4. Large molecules, such as blood proteins and blood cells, are too large to pass through the dialysis tube wall.
- The tubing inside the dialysis machine is long and narrow, providing a large surface area for efficient diffusion of substances.

- The patient's blood and dialysis fluid move to opposite directions in the dialyser in order to create a steep diffusion gradient for fast diffusion of substances.
- The dialysis fluid is also constantly replaced in order to maintain a concentration gradient for efficient diffusion of substances.
- The dialysis fluid is warmed to the same temperature as patient blood to avoid cooling the blood.
- The dialysis machine has filter and air bubble trap which prevents air bubbles from getting into the patients' blood while on the dialysis machine. The air bubbles would cause blockage in the patient's blood vessels if they get into the patient's blood and may lead to death. The air bubbles may also cause a blood clot which may interfere with supply of nutrients and oxygen.
- Blood return to the body through a vein. This is easier since blood in a vein is at low pressure.
- A patient usually has three dialysis sessions per week, each lasting 6-8 hours, which disrupts the person's life.

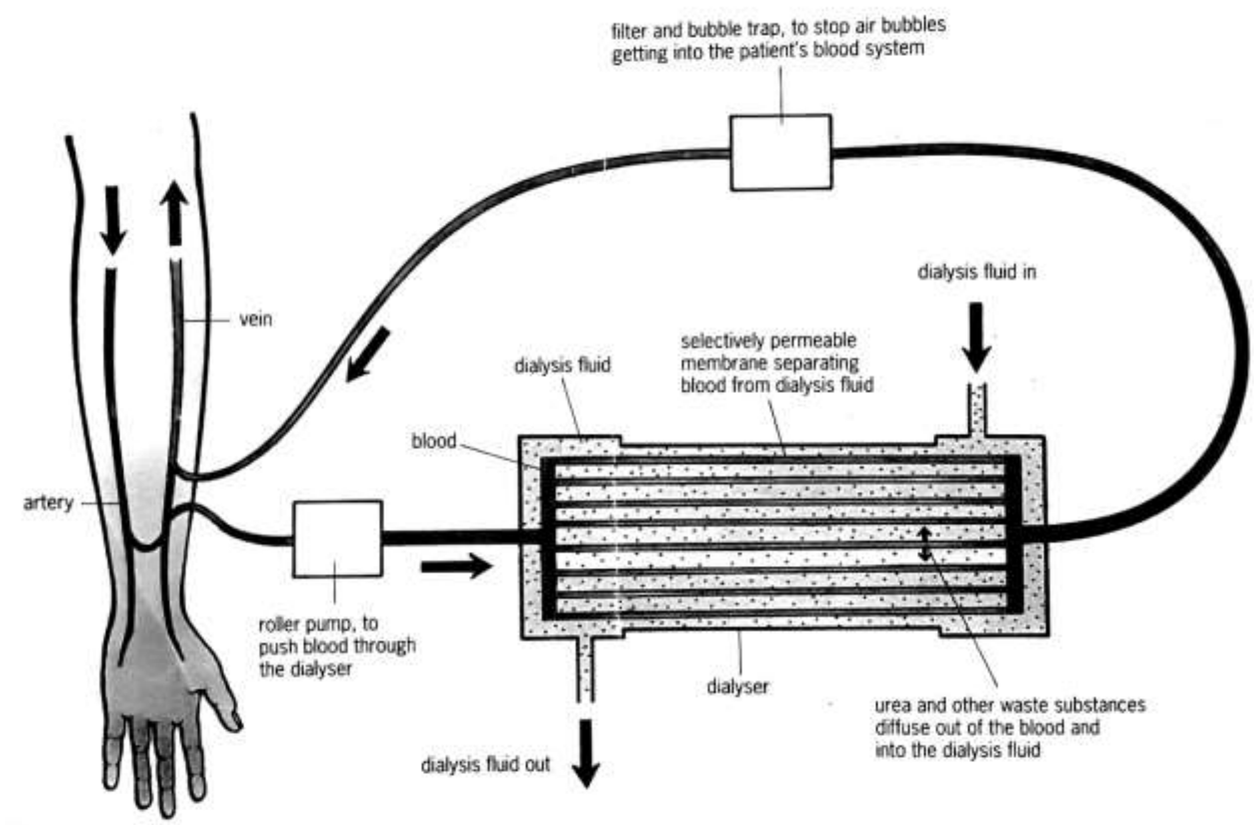


Fig. 9.4: How a dialysis machine works

Kidney Transplant

- Kidney transplant is where healthy kidney from a human donor is given to the patient.
- This is a more permanent solution for people who have lost both of their kidneys

UNIT 10: INFECTIOUS AND NON- INFECTIOUS DISEASES

- Diseases can broadly be divided into two categories:
  1. Infectious or communicable diseases
  2. Non- infectious or non- communicable diseases

1. Infectious Diseases

- An infectious disease is a disease caused by organisms such as bacteria, viruses and fungi.
- Organisms that cause diseases are called **pathogens**.
- Some infectious diseases can be passed or transmitted from one infected person to another. Some are transmitted by bites from insects or other animals. Others are acquired by eating contaminated food or drinking water that contains harmful organisms.

2. Non- Infectious Diseases

- These are diseases that are caused by factors such as **genetics**, **environment** and **lifestyle** and not by disease causing organisms.
- Non- infectious diseases do not pass from one person to another.
- Cancer is an example of non- infectious diseases.

Common Infectious Diseases

Diseases Caused by Bacteria

1. Pneumonia

- This is an inflammation of the lungs' air sacks.
- Pneumonia is caused by a bacterium called *streptococcus pneumonia*which attack and cause the inflammation of the lungs' air sacks. These air sacks may also fill with fluid and pus. The lungs become solid and have no air. This prevents exchange of gases in the lungs. Patients die by drowning.

Mode of Transmission of Pneumonia

- Pneumonia is spread by droplet infection, that is, through tiny water or mucus droplets expelled when a patient coughs without covering his mouth with a handkerchief.

Signs and Symptoms of Pneumonia

a. High fever
b. Chest pains when coughing.
c. Coughing
d. Rapid shallow breathing
e. Wheezing during breathing because of the fluid that accumulates in the lungs.
f. Sudden chills

g. Headache
h. Tiredness
i. Muscle aches

Prevention of Pneumonia

a. Avoid overcrowding
b. Live in well ventilated homes.
c. Patients should cover their mouths with handkerchief when coughing to prevent drops from getting to others.
d. Isolate the patient to prevent spread of the disease.

Treatment of Pneumonia

- Antibiotics are used to treat bacterial pneumonia.

2. Tuberculosis (T.B.)

- Tuberculosis is caused by a bacterium called *Mycobacteriumtuberculosis*.
- Tuberculosis bacteria may attack any part of the body but they usually attack the lungs causing pulmonary tuberculosis. The bacteria destroy the lung tissue making it difficult for infected person difficult to breathe.

Mode of Transmission of Tuberculosis

- It is transmitted through droplet infection.
- Drinking unboiled milk from infected cows.

Signs and Symptoms of Tuberculosis

a. Fatigue
b. Fever and chills
c. Weight loss
d. Coughing
e. Chest pains
f. Damage to the lung tissue hence causing wheezing.

Prevention of T.B.

a. Immunisation of children with B.C.G. vaccine.
b. Avoid overcrowded environments.
c. Isolate the patient to prevent spread of the disease.
d. Avoid taking raw milk. Boil all milk or drink pasteurised milk.

Treatment of T.B.

- It can be cured in early stages by treatment with antibiotics such as streptomycin.

3. **Typhoid**

- Typhoid is caused by a bacterium called *Salmonella typhi*.

Mode of Transmission of Typhoid

- Typhoid is transmitted through consumption of contaminated water and food.
- Houseflies also transmit the bacteria as they move from infected faeces to foodstuffs and food utensils.
- *Salmonella typhi* live in the intestines.

Signs and Symptoms of Typhoid

a. High fever
b. Abdominal pain
c. Severe diarrhoea followed by constipation
d. General weakness
e. Headache
f. Loss of appetite
g. Ulcers
h. Muscle aches
i. Breakdown of intestinal wall in extreme situations. This may lead to death.

Ways of Preventing and Controlling Typhoid

a. Isolate the patient to prevent spread of the disease.
b. Sterilizing clothes that the patient has used using disinfectants or by boiling to kill the bacteria.
c. Food handlers in institutions, like hospitals, schools and restaurants should go for regular check-ups and treated if found infected to avoid spread of the disease.
d. Proper disposal of faeces to prevent spread of the disease.
e. Boil or chlorinate water before you use it for drinking to kill the bacteria.
f. Maintaining proper hygiene such as washing hands properly after every toilet visit. Thorough washing of fruits and vegetables with clean water.
g. Get vaccinated against typhoid to stimulate antibody production.
h. Proper medical treatment by qualified doctor in the case of infection by the disease in order to cure the diseased person hence preventing the spread of the disease to others.
i. Proper sewage treatments should be done in towns to kill the bacteria.
j. Households and areas around them should be kept clean to prevent flies from breeding in them.

Treatment of Typhoid

- Typhoid is treated by administering antibiotics prescribed by a doctor.

Diseases Caused by Viruses

1. **Common Cold**

- Common cold is caused by a virus.
- It is transmitted through droplet infection.

- It can also be spread from hand- to- hand contact with an infected person.

Signs and Symptoms of Common Cold

a. Running nose
b. Sneezing
c. Fever
d. Sore throat
e. Coughing
f. Body aches
g. Headaches
h. Congestion

Prevention of Common Cold

a. Avoid overcrowding
b. Live in well ventilated homes.
c. Patients should cover their mouth with handkerchief when coughing to prevent drops from getting to others.

Treatment of Common Colds

a. Use of drops that lower the fever
b. Drinking of lots of fluids may help the symptoms to disappear more quickly

2. Influenza (Flu)

- It is caused by a virus called **influenza virus**.
- Flu viruses spread by droplet infection.
- It can also be spread by touching items with the virus and then touching the mouth.

Signs and Symptoms of Flu

a. Sneezing
b. Fever and chills
c. Body aches
d. Headaches
e. Lack of energy
f. Nausea and vomiting
g. Congestion
h. Dizziness
i. Sore throat
j. Fatigue
k. Cough

Ways of Preventing and Controlling Flu

a. Isolate the patient
b. Vaccine may be available

Treatment of Flu

a. Use of drugs that lower fever

b. Use of cough drops
c. Use of anti-viral drugs in severe cases.

3. Measles

- Measles is caused by viruses.
- There are two viruses that cause measles. These are:
  - (i) *Rubella virus*- causes the German measles.
  - (ii) *Rubeola virus* – cause the ordinary or red measles
- Measles is transmitted through droplet infection.

Signs and Symptoms of Measles

a. High fever
b. Running nose
c. Cough
d. Reddened eyes
e. Loss of appetite
f. Rash on the face which then spread to the rest of the body. The rashes does not itch
g. Swollen and soft lymph nodes
h. Headache
i. General body weakness

Ways of Preventing and Controlling Measles

a. Isolate the patient to prevent the spread of the disease.
b. Immunisation of children.

4. Chicken Pox

- This is a skin disease caused by a virus called *Varicella zosta*.
- It is transmitted through air droplets.
- Contact with infected person also spread the disease.

Signs and Symptoms of Chicken Pox

a. Rashes on the skin
b. A lot of itching on the skin rashes
c. Mild fever
d. Loss of appetite
e. Headache
f. Fatigue

Ways of Preventing Chicken Pox

(i) Vaccination using varicella vaccine

Treatment of Chicken Pox

(i) There is no specific treatment but individuals develop immunity once they are attacked. Seek medical attention for pregnant women to avoid birth defects.
(ii) Creams are provided to ease the itching spots.

Diseases Caused by Fungi

1. **Ringworms**
   - This is fungal diseases caused by a fungus called *Tinea corporis*. This fungus is transmitted through:
     a. Direct contact with infected areas.
     b. Using infected combs or shaving equipments
     c. Sharing hair brushes and hats

Signs and Symptoms of Ringworms

(i) Round grey patches on the head and face
(ii) Itching on the grey patches
(iii) Hair losses on the patches

Prevention of Ringworms

(i) Avoid contact with infected person or personal objects e.g. clothes, hats and sponge
(ii) Ensure personal cleanliness

Treatment of Ringworms

- Ringworm is treated using fungicide creams and tablets.

2. **Thrush (Candiasis)**
   - This disease is caused by a fungus called *Candida albicans*.
   - It can occur in the mouth, vagina, and intestines.
   - It is mainly transmitted through sexual intercourse. It may also arise due to changes in acidity in the vagina in females during pregnancy or diabetes. New born babies can be infected in the mouth at birth and through vagina canal.

Signs and Symptoms of Candiasis

(i) White patches on the affected area
(ii) Red inflamed skin under the patches
(iii) Itching of the vagina
(iv) Painful sexual intercourse
(v) Vaginal discharge

Treatment of Candiasis

- Treatment with appropriate drugs administered by a qualified doctor.

3. **Athlete's Foot**
   - This is a fungal disease that affects feet in human beings.
   - The disease is common in areas with warm wet weather.
   - The disease usually occur due:
     (i) Wearing closed shoes for so long
     (ii) Keeping the feet wet for prolonged period of time
     (iii) Excessive sweating in the feet

Mode of Transmission

- It is spread through direct contact with contaminated floors.
- Sharing socks with infected person.

Signs and Symptoms

(i) Sores in between toes.
(ii) Itching in between toes
(iii) Pains in between toes

Prevention of Athlete's Foot

(i) Change socks frequently
(ii) Use of sandals in public showers
(iii) Proper drying of feet after bath

Treatment of Athlete's Foot

- Athlete's foot is treated using antifungal drugs such as powders and creams.

Control and Preventive Measures at Household and Community Levels

- The following are ways that can be used to control diseases in our communities and households in general.

1. **Water treatment**- This is the process of removing the undesirable properties of raw water to make it safe for human consumption. Water treatment kills disease- causing organisms; for example, liver flukes and bacteria therefore preventing the spread of diseases.
2. **Personal hygiene**- it is the practice of observing cleanliness and glooming of the external body parts to reduce risk of infections. Proper personal hygiene increases immunity of the body.
3. **Pest control**- this is the management of organisms involved in spreading diseases such organisms include tsetse flies, mosquitoes and worms. Control of these vectors prevent the spread of diseases.
4. **Food treatment**- this is the practice of processing food to prevent spoilage, spread of diseases and food poisoning. The methods used for food treatment and preservation include smoking, drying, freezing, canning and pasteurisation.
5. **Health services**- this is the responsibility of the health ministry which deals with the hospital boards and medical officers. Public health inspectors check shops and restaurants that sell food to make sure that the highest standards of hygiene are maintained. This helps to reduce the spread of diseases.
6. **Proper disposal of human and domestic wastes**- this helps to prevent spread of diseases.

UNIT 11: DIARRHOEAL DISEASES

- Diarrhoea is the continual defecation of watery stools.
- Diarrhoea is a symptom of diseases that affect the alimentary canal.
- Examples of diarrhoeal diseases include:
  1. Cholera
  2. Dysentery and
  3. Typhoid

1. Cholera

- It is caused by a bacterium called *Vibrio cholera*e.

Mode of Transmission of Cholera

- It is transmitted through consumption of contaminated food and water.
- Water contamination occurs when infected persons defecate near drinking water sources such as rivers, dams and ponds. A healthy person drinking the water can become infected with the disease. Uncooked food, fruits and vegetables can easily be contaminated especially if washed in contaminated water or human excreta are used as fertilizer.
- Houseflies can also be **vectors** of these pathogens. Houseflies can carry the *Vibrio cholerae* from faeces to food that is not covered.
- A **vector** is an animal that carries disease-causing organism.
- Once contaminated food or water is ingested, the bacterium undergoes incubation period of one to six days. The bacteria then multiply rapidly in the small intestine and produce highly toxic substances that cause symptoms of cholera. **Incubation period** is the time between infection and appearance of symptoms.

Signs and Symptoms of Cholera

a. Severe diarrhoea
b. The person passes watery faeces that look like rice water.
c. The person becomes dehydrated since large quantities of water are lost from the body. Dehydration is followed by collapse, shock and may cause death.
d. Severe vomiting
e. Acute thirst
f. Muscle cramps
g. Shrinking of the body and limbs
h. Abdominal pain
i. Nausea

How can you help someone with Cholera

a. Give a person plenty of fluids, such as water and oral rehydrated solution (ORS) to prevent dehydration.
b. Immediately seek medical help for a person. A doctor can give antibiotics to kill the cholera bacteria and saline drip to replace the water that was lost from the body.

c. Do not give a person any solid food which would worsen the diarrhoea.
d. Protect yourself and the person by observing general rules of hygiene such as washing your hands with soap and water before and after touching the person.

Ways of Preventing Cholera

a. Boil or chlorinate water before you use it for drinking to kill the bacteria.
b. Get vaccinated against cholera in order to introduce immunity against cholera.
c. Isolate the patient to prevent spread of the disease.
d. Maintaining proper hygiene such as washing one's hands after going to the toilet, covering foods and washing utensils thoroughly.
e. Keep the public places clean, such as markets, bus depots and restaurants in order to prevent cholera outbreak.
f. Dispose of human and domestic wastes safely to avoid spreading the bacteria.

2. Dysentery

- It is an intestinal inflammation especially in the colon that can lead to severe diarrhoea with mucus or blood in the faeces.
- There are two types of dysentery:
  a. Bacillary dysentery
  b. Amoebic dysentery

a. Bacillary Dysentery

- It is caused by a bacterium called *Shigella*.
- It is transmitted through consumption of contaminated food and water.
- It can also be transmitted by flies.
- Direct contact from hands of infected person also transmit the disease.

Sign and Symptoms

a. Fever
b. Diarrhoea
c. Visible blood in the stools
d. Abdominal cramps
e. Rectal pain

Treatment of Bacillary Dysentery

(i) Giving the patient oral rehydrated solution.
(ii) Administering antibiotics

b. Amoebic Dysentery

- It is caused by amoeba called *Entamoeba histolytica*.
- It is transmitted through consumption of contaminated food and water.

Signs and Symptoms of Amoebic Dysentery

a. Diarrhoea with loss of blood.
b. Fever
c. Abdominal cramps
d. Vomiting

Ways of Preventing and Controlling Dysentery

a. Boil or chlorinate water before you use it for drinking to kill pathogens.
b. Thorough cooking of food to kill the disease causing microorganisms.
c. Good hygiene practices like washing hands properly after visiting the toilet. Thorough washing of fruits and vegetables with clean water.
d. Proper sewage treatments should be done in towns to kill the bacteria.
e. Proper disposal of human waste to prevent spreading the bacteria.
f. Disinfect all linen, clothes and materials surrounding the patient to kill the bacteria.
g. Proper medical treatment by a qualified doctor in the case of infection by the disease to prevent the spread of the disease to others.

Home- Made Treatment of Diarrhoea

- A patient with diarrhoea is given a solution called oral rehydrated solution (ORS). ORS enhances faster absorption of water into the body hence preventing dehydration.
- ORS should be given to the patient regularly.

How to Prepare Home- Made ORS

a. Put one litre of water in a jug
b. Add 10 teaspoonfuls of sugar.
c. Add 1 teaspoonful of salt
d. Stir the mixture till the salt and sugar dissolve.

UNIT 12: SEXUAL TRANSMITTED INFECTIONS (STI'S)

- A sexual transmitted infection is an illness that can be passed on from one person to another through sexual contact.

Common Sexual Transmitted Infections (STI's)

- common STI's include:
  1. Gonorrhoea
  2. Syphilis
  3. Genital warts
  4. Candiasis
  5. AIDS

1. Gonorrhoea

- It is caused by a bacterium called *Neisseria gonorrhoea*.
- The bacteria affects urethra in males

Mode of Transmission

- It is transmitted through sexual intercourse with infected person.

Signs and Symptoms of Gonorrhoea

(i) A burning sensation when urinating
(ii) Yellowish discharge from the genitals.
(iii) Narrowing of the urethra especially in males which can lead to difficulty in urinating
(iv) Abdominal pain in females

Treatment of Gonorrhoea

- The disease can be cured by treatment with antibiotics.

2. Syphilis

- It is caused by a bacterium called *Treponema pallidum*.
- It affects the urethra and vagina.

Mode of Transmission

- It is transmitted through sexual intercourse with infected person.

Signs and Symptoms of syphilis

a. Genital ulcers
b. Fever
c. Enlarged lymph nodes
d. Rashes on the skin
e. Sores in the mouth, nose and rectum
f. Blindness

g. Paralysis
h. Insanity
i. Heart failure
j. Damage to the brain and spinal cord hence causing blindness, paralysis and insanity.

Treatment of Syphilis

- Treat with antibiotics.

3. Genital Warts

- It is caused by a group of viruses called Human Papilloma Viruses (HPV).

Mode of Transmission

- It is transmitted through sexual intercourse with infected person.

Signs and Symptoms of Genital Warts

(i) Bump- like growths on the genitals.
(ii) Itching sensation around the genitals.
(iii) Bleeding may occur.

Treatment of Genital Warts

- Treatment with appropriate drugs.
- Removal of the warts using liquid nitrogen or chemical which is usually applied on the warts.

4. Acquired Immune Deficiency Syndrome (AIDS)

- AIDS is caused by a virus called Human Immuno-deficiency Virus (HIV).
- When the person is infected with HIV, the virus destroys the white blood cells that protect the body against infections. This makes the person vulnerable to many other diseases, such as tuberculosis, diarrhoeal and skin diseases.

Mode of Transmission of AIDS

- HIV is transmitted mainly through sexual intercourse with an infected person.
- Blood transfusion using infected blood.
- From infected mother to child during pregnancy, birth or breastfeeding.
- Sharing unsterilized surgical or piercing instruments such as syringes, razor blades and needles with an infected person.

Signs and Symptoms of AIDS

a. Loss of weight
b. Night sweats
c. Chronic fever
d. Skin rashes
e. Shingles

f. Chest infections
g. Pneumonia
h. Chronic diarrhoea
i. Multiple infections
j. Ulcers in the mouth
k. Loss of memory
l. Skin cancer
m. Chronic cough
n. Inflammation of lymph nodes
o. Persistent fatigue

- A person with these symptoms may not have AIDS, because there are many diseases that show similar symptoms. A blood test for HIV infection is the only way to be sure whether someone has AIDS.

How can People with HIV Care for themselves

a. Eating a variety of nutritious foods and drinking plenty of fluids
b. Doing physical exercises
c. Avoid smoking
d. Avoid drinking alcohol
e. Bathing themselves regularly
f. Going to the hospital when they develop any infection that can be treated
g. Avoid stressful situations
h. Maintaining a positive attitude towards their problems
i. Protect further infection or spreading the virus by having protected sexual intercourse.

Ways of Caring for People with HIV and AIDS

a. **Providing physical care**- HIV and AIDS patients are usually weak and there may be need to feed and bathe them, and take them to the hospital.
b. **Giving material support**- people with HIV and AIDS should be provided with basic needs such as clothes, food, soap, bedding and medicine.
c. **Giving emotional support**-chat with them, listen to them, share feelings and concerns, this shows that you love and care for them because during this time they may be worried, afraid, sad or depressed.
d. **Giving spiritual support**- pray with the patients, share a word and love of the creator for them as a way of bringing peace and encouragement to them.
e. **Helping them with domestic chores**- help clean their homes, wash their beddings, cook for them and their children, shopping and running errands.

Misconceptions about HIV and AIDS

- A misconception means a wrongly understood idea that looks to be so true.
- The following are misconceptions about HIV and AIDS:

a. AIDS is as a result of witchcraft. Some people think because they have no one to bewitch them then they cannot get the disease.
b. Some people believe that the virus can be spread through mosquito bites. People living in areas with no mosquitoes are deceived that they cannot contract the disease.
c. In some areas people have a misconception that use of protected sex can kill a woman or make her infertile. This has made many men to avoid use of condoms during sexual contact and in turn led to spread of the virus.
d. Some people believe that HIV is contracted by people who are not faithful and trustworthy. They tend therefore to believe so much in their partners without getting the proof that the partners are not infected. The belief of mouth only leads to greater risks of contracting HIV and AIDS.

Ways of Preventing and Controlling Sexual Transmitted Infections

a. Abstinence from sexual intercourse for unmarried people.
b. Being faithful to one sexual partner- couples should avoid multiple sexual partners, because this increases the risk of getting STI's.
c. Having protected sex by using a condom
d. Avoid using unsterilized surgical instruments/ equipment
e. Avoid sharing needles and razor blades
f. Blood screening to ensure safe blood transfusion.

UNIT 13: WORM INFECTION

- Parasitic worms which infect humans include round worms, hookworms, tapeworms, threadworms, bilharzia worms and filarial worms.

Roundworms (*Ascaris lumricoides*)

- Roundworms mainly live in the small intestine where they feed on the food that has been digested by the host.
- A roundworm grow up to 30 cm in length and is white or pink in colour.
- One person may be infested with many roundworms at a time.

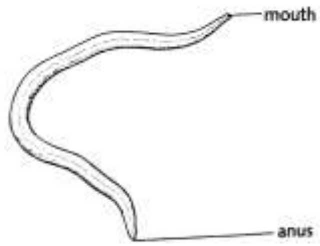


Fig. 13.1: Roundworm

Life Cycle and Transmission of Roundworms

- The eggs of roundworms are passed out with the faeces of infected person. If this person handles food with dirty hands, the food becomes contaminated.
- The eggs may be swallowed by another person eating raw food such as vegetables or fruits.
- In digestive tract the eggs hatch into larvae, which in turn pass through the wall of intestine into bloodstream and travels to the lungs.
- The larvae take about ten days to grow in the lungs, before they are coughed up from the lungs and swallowed back into the intestine, where they mature into adults. They then produce eggs which are passed out in faeces. This process is illustrated in the lifecycle of roundworm in **figure 13. 2**.

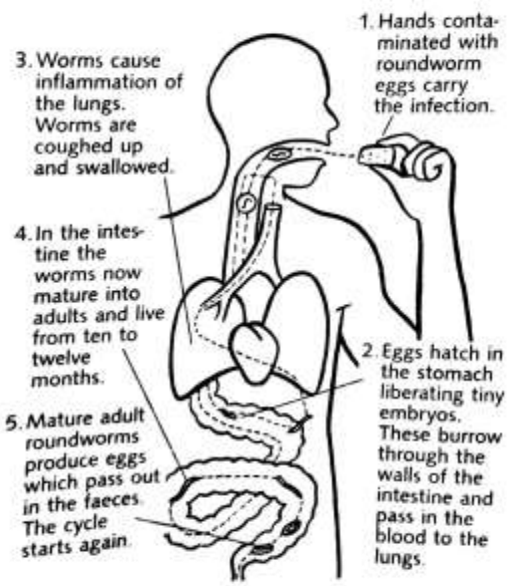


Fig. 13.2: Life cycle of roundworm

Signs and Symptoms of Roundworm Infection

1. Loss of appetite
2. General weakness
3. Dullness
4. Damage of the lungs by the larvae of the worms
5. Malnutrition
6. Stunted growth in children
7. Nausea
8. Vomiting worms
9. Abdominal discomfort
10. Obstruction of the intestine

Ways of Preventing and Controlling Roundworm

- Roundworm infection can be effectively prevented and controlled by breaking the life cycle.
- The life cycle of roundworms can be broken in the following ways:

  At the egg stage:
  1. Wash vegetables and fruits before eating.
  2. Cook vegetables to destroy eggs.
  3. Wash hands before handling food
  4. Always use proper toilet.
- At larva and adult stages, take appropriate drugs to kill larva and adult roundworms in the body.

Hookworm Infection

- Hookworms live in intestines. They attach themselves to the intestinal lining and suck blood.
- Adult hookworms are 1 cm long and red in colour.

Fig. 13.3: Hookworms

Life Cycle of the Hook Worm

- The eggs of the worm come out with faeces and hatch into larvae which can live in water or damp soil.
- If they come in contact with bare skin, the larvae burrow and bore through the flesh and make their way via the bloodstream to the lungs. From there they are coughed up into the mouth and swallowed.
- Once in the intestines, they can feed and lay eggs which are passed out in faeces.

- **Figure 13.4** shows life cycle of hookworms.

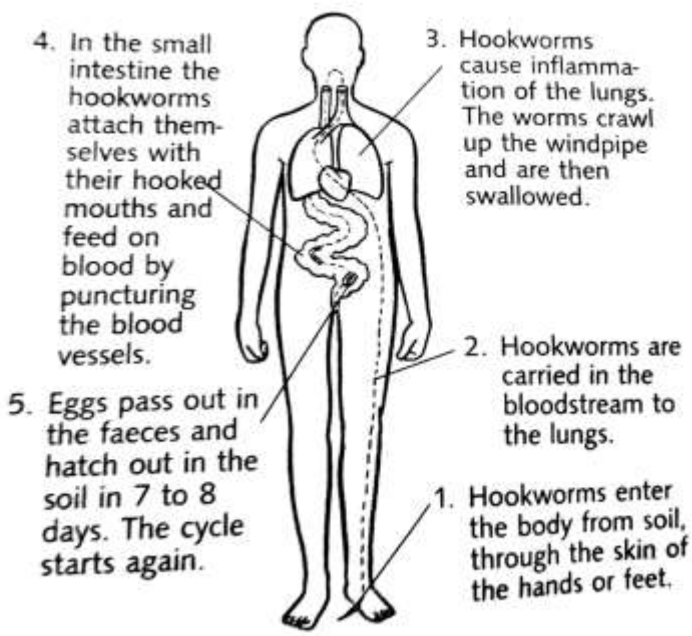


Fig. 13.4: Life cycle of hookworms

Signs and Symptoms of Hookworm Infection

1. Abdominal pain
2. Weakness
3. Fatigue
4. Weight loss
5. Anaemia
6. Diarrhoea
7. Itching of the skin at the site of penetration
8. Difficulty in breathing
9. Coughing, sore throat and blood in the sputum during the passage of the immature worms to the lungs.

Ways of Preventing and Controlling Hookworm Infection

1. Disinfect latrine floors
2. Wearing shoes
3. Proper disposal of faeces.
4. Deworming using drugs

Tapeworm Infection

- Tapeworm infest human beings and also animals such as pigs, cattle and fish.

The Structure of Tapeworm

- Tapeworm have flat, tape- like bodies which can reach a length of 3.5 cm.
- At one end of the long body is a small head called **scolex**.

- The body consists of numerous flat segments called **proglottides** which bud off from the narrow region behind the scolex.
- The tapeworm has four evenly spaced suckers on the head and some of them have a ring of hooks.
- Tapeworms live in small intestine and are attached by hooks or suckers to its lining.
- Tapeworms feeds by absorbing partly digested food of its host through the whole surface of its body. Its long and flattened shape provide a large absorptive area.
- The parasite is not digested by the host's digestive enzymes because it secretes a substance which neutralise them. Besides, the parasite is not easily passed out because it is firmly anchored by scolex to the walls of intestine.
- A large tape worm may block the intestine completely.
- Tapeworm also produces waste substances which are absorbed by the victim and over time make him ill.

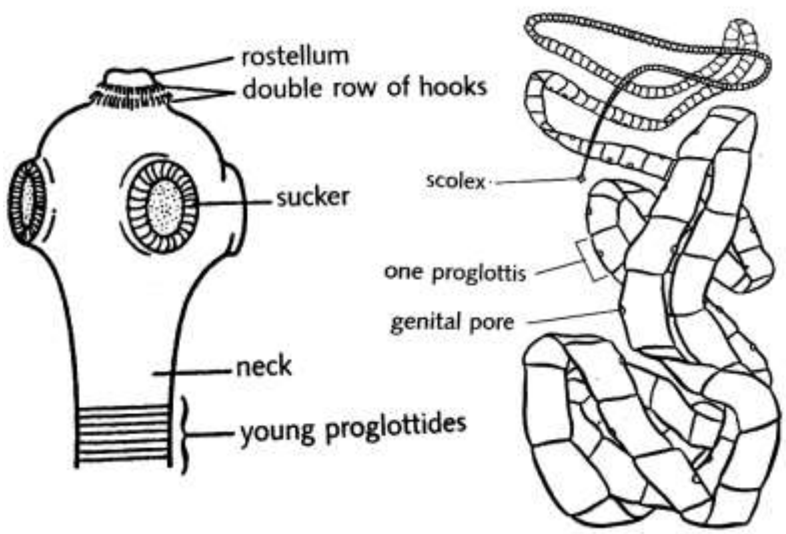


Fig. 13.5: Tapeworms

Life Cycle of Tapeworm

1. Inadequately cooked flesh of a cow, sheep or pig is eaten by human being. This may contain the larva of a tapeworm.
2. In the human intestine, the larvae develop into adult tapeworms and attach themselves to the wall of the alimentary canal by hooks.
3. Mature segments full of tapeworm eggs break off from the end of tapeworm.
4. Mature segments pass out in faeces.
5. Cattle, sheep or pigs may eat grass contaminated with human faeces.
6. In the intestines the eggs hatch into larvae which burrow through the wall of the gut and lay dominant in muscle.
7. If the animals is slaughtered for meat and eaten, the cycle start again.

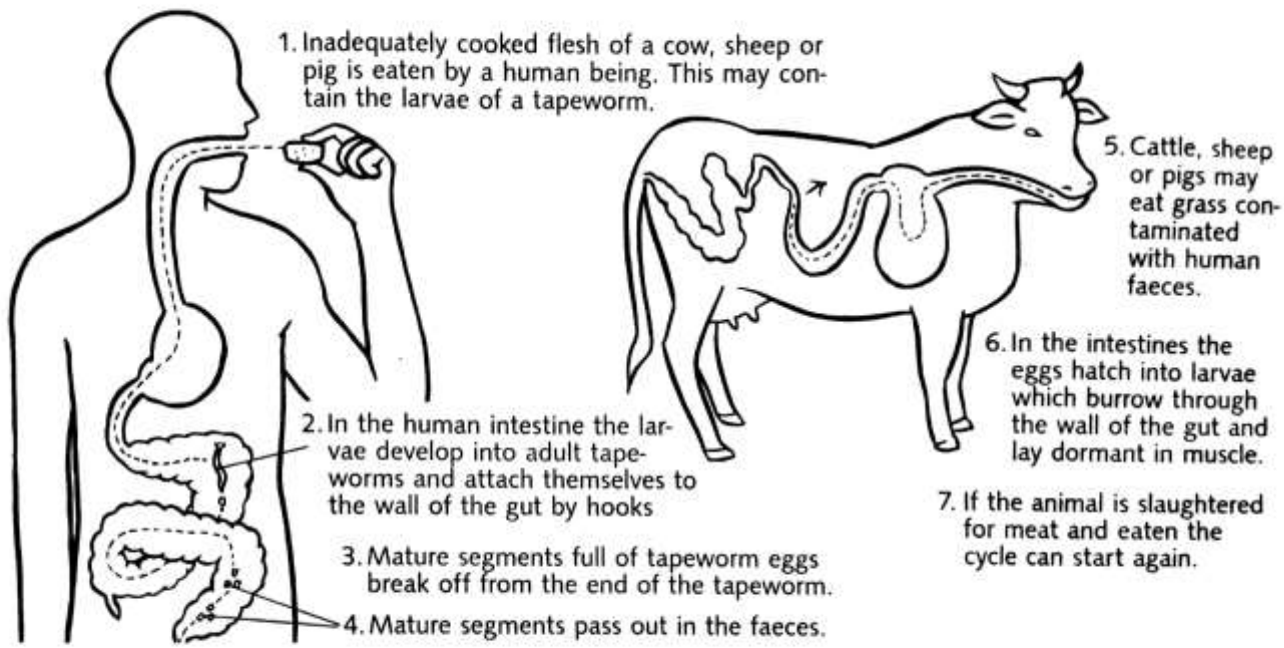


Fig. 13.6:Life cycle of tapeworm

Signs and Symptoms of Tapeworm Infection

1. Anaemia
2. Abdominal pain
3. Presence of segments of worms in faeces
4. Diarrhoea
5. Loss of body weight
6. Obstruction of intestine by large tapeworm

Ways of Preventing and Controlling Tapeworms

1. Cook the meat and fish thoroughly to kill the larvae.
2. Proper disposal of faeces by use of toilets and pit latrines to prevent spread of worms
3. Drinking boiled or treated water to kill the eggs
4. Livestock should be given anti-worm drugs to kill the worms

Threadworm Infection

- Threadworms, also called pin worms, mainly infect young children, although adults occasionally do not get infected.
- Threadworms are white and about 1 cm long.

Fig. 13.7:Threadworms

Life Cycle of Threadworms

- The worm lives in the large intestines. The female lay eggs which are passed out through faeces.
- Eggs are swallowed through contaminated food or water.
- The eggs also attach onto the fingers as children scratch the anus due to itching. They then swallow the eggs as they feed using unwashed hands.
- In the alimentary canal, the eggs hatch into larvae. Larvae migrates to the large intestine and develops into an adult worms.
- The worm feeds by absorbing food substances in the large intestine.

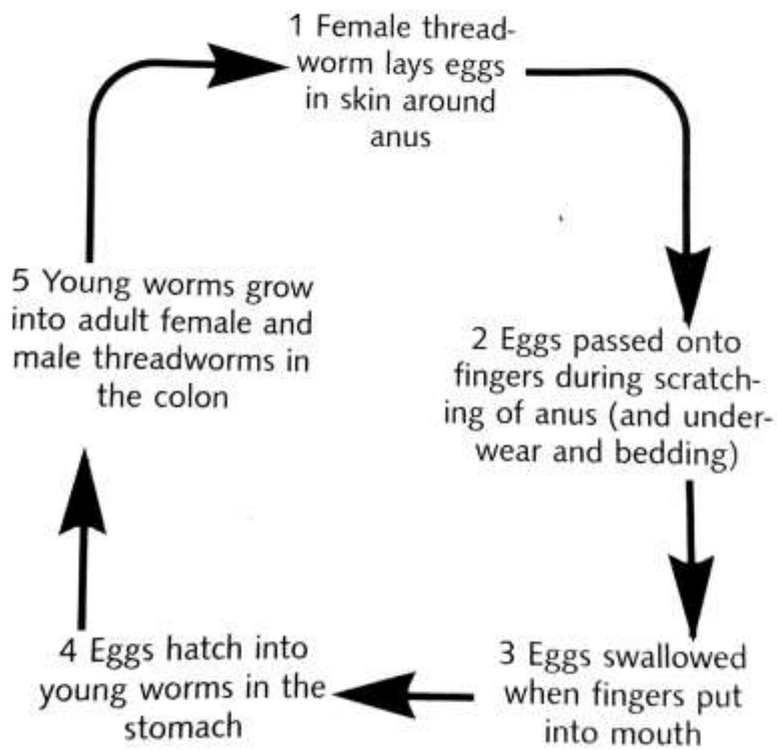


Fig. 13.8: Lifecycle of threadworms

Mode of Transmission

- Through contaminated food.
- Through contaminated water

Sign and Symptoms of Threadworm

1. Itching of the anus
2. Presence of worms in faeces
3. Small wounds around the anus
4. Swelling around the anus in heavy infestation. This because the female threadworms lay eggs around the anus.

Ways of Preventing and Controlling Threadworm Infection

1. Washing hands with soap and water before eating.
2. Proper disposal of faeces
3. Deworming using drugs.

Bilharzia Worms

- Bilharzia is a disease resulting from parasitic flat worms called bilharzia worms which live inside the body of infected people.
- The disease is also called **schistosomiasis**.

The Structure of Bilharzia Worms

- Bilharzia worms (flukes) are flat and about 1-2 cm long.
- The male worm has a groove in which the female fluke lives.
- The adult female and male flukes are always together. In this position the eggs laid by the female can easily be fertilized by the male.
- Bilharzia worms live in the blood vessels in the bladder and intestines.
- The worms feed on human blood.

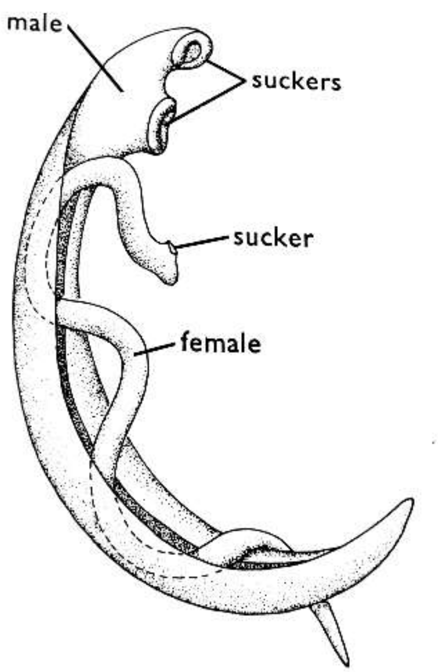


Fig. 13.9: Bilharzia worms

Life Cycle and Mode of Transmission of Bilharzia

- Eggs in urine or faeces from an infected person may get into water in rivers.
- In water, these eggs hatch out into embryos and then enter some types of water snail.
- The embryos use the snails as hosts to feed on and they reproduce, giving rise to many more embryos. The embryos reproduce asexually, and develop into different type of embryo called cercariae.

- Cercariae emerge from these snails to enter second host. The forked tail helps the cercariae to swim in search of new host. If they fail to find new host within 1-2 days, these cercariae die.
- When the new host is found, the cercariae attach to the host's skin with their suckers. This new host is either human or another animal. With the help of digestive juice from digestive gland, the cercariae burrow through the skin of the host to enter its blood stream. Itching occurs at point where the cercariae enter the skin.
- Once in the blood stream, the cercariae feed on blood and grow in size.
- From blood stream the cercariae move to the blood vessels near intestines or bladder. Here they settle down and mature through several stages into adult male and female flukes.
- The adult female flukes lives in the groove of the adult male fluke. The female lays thousands of eggs which get fertilized by the male fluke.
- When the host visit the toilet, the eggs get passed out. Often blood can be seen in urine or faeces, depending on which part is infected.
- If these eggs get passed out into fresh river water, the life cycle start all over again.

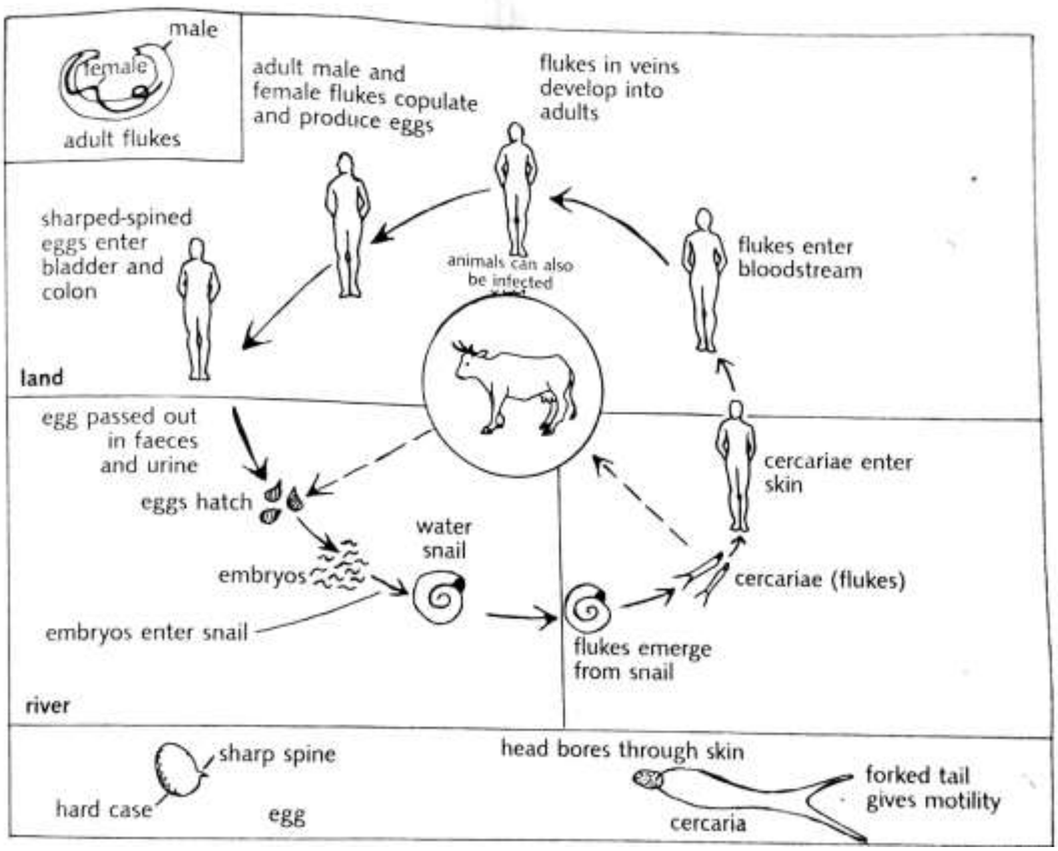


Fig. 13.10: Life cycle of bilharzia worms

Signs and Symptoms of Bilharzia

1. Cough or skin rashes for few days.
   - This is due to the presence of cercariae (young bilharzia worms) in blood stream. The body fights the cercariae that have entered the blood stream causing a cough or skin rash.

2. Anaemia
   - Cercariae feed on the blood.

Fig. 13.11: Cercaria

3. Abdominal pain
   - The adult female flukes produce thousands of eggs which have sharp spines. The spine are used to cut through walls of the intestines and other tissues.
4. Pain when urinating
   - This is due to presence of cuts in urethra.
5. Blood in urine and faeces.
   - The blood that come out of the cuts in the walls can be seen in urine and faeces, depending on an area where the tissue is cut.
6. Cancer
   - This is due to the damage of the intestine and the bladder
7. Fever

Ways of Preventing and Controlling Bilharzia

1. Proper disposal of urine and human excreta
   - This prevents the eggs from reaching fresh water.
2. Treating drinking water and washing water. Filtration followed by chlorination kills the larvae. Boiling also destroys larvae in water.
3. Destruction of water snails that serve as intermediate hosts by use of appropriate chemicals in water.
4. Wear protective clothes, e.g. boots when working in rice fields to prevent the larvae from reaching the skin.
5. Effective health education.
   - People living infected areas should be educated always to use latrines.
   - Children should be warned about the hazards of playing in snail infested water and be taught about need for hygiene behaviour. This is necessary since they often play in and out of water, exposing themselves to the risk of infection.
6. Early medical treatment to reduce the number of infected people in the area.
7. Clearing vegetation in ditches which are the feed of water snails.

Filarial worms (*Wuchereria bancrofti*)

- *Wuchereria bancrofti* is a parasitic worm which causes elephantiasis.

Life Cycle of Filarial worms

- Filarial worms produce young ones in lymph nodes, and the larvae migrate to bloodstream where they are sucked by mosquitoes. When these mosquitoes bite a person, the filarial worms are injected into the victim's bloodstream and enter the lymphatic system where they mature.

Signs and Symptoms of Filarial Worms on the Host

1. Fever
2. Pain in the testicles
3. Pain above the testicles
4. Enlarged groin
5. Blocked lymph vessels
6. Massive swollen legs, genitalia and breast
7. White urinary discharge
8. Swollen liver
9. Swollen spleen.

Prevention and Control of Filarial Worms

- Since anopheles and culex mosquitoes are vectors for filarial worms, the best way of preventing filarial worm infection is to get rid of mosquito bites. This can be done in the following ways:
    1. Spray rooms and houses with insecticides such as doom to kill mosquitoes which are vectors of filarial worms.
    2. Spray oil on stagnant water that cannot be drained. This prevents the larvae from breathing and so kills them by suffocation.
    3. Drain all stagnant water which are breeding areas of mosquitoes to reduce population of mosquitoes.
    4. Cut grass or vegetation short around homes which harbour adult mosquitoes.
    5. Breeding fish or ducks in slow running water to feed on mosquito larvae or pupae to reduce population of mosquitoes.
    6. Sleep under treated mosquito nets to avoid contracting filarial worms through mosquito bites.
    7. Administer medicine to kill microscopic worms.

UNIT 14: CANCER

- Cancers are tumours caused by abnormal and uncontrolled cell growth.

Types of Tumours
- A tumour is an abnormal growth of cells.
- Tumours are divided into two groups:
  1. Benign (non- cancerous) tumours
  2. Malignant (cancerous) tumours

Benign (Non- Cancerous) Tumours
- These are not cancerous tumours
- They stay in one place and do not spread to other parts of the body.
- They have a regular and smooth shape and have a covering called a capsule.

Malignant (Cancerous) Tumours
- These are cancerous tumours
- They (metastasize) spread to other parts of the body.
- They invade other cells of the body.

Causes of Cancer
- Cancer is caused by gene mutation which leads to uncontrolled cell growth and tumour formation.

Organs commonly affected by Cancer
- The organs commonly affected by cancer are:
  1. Liver
  2. Cervix
  3. Breast
  4. Skin
  5. Throat
  6. Prostate gland
  7. Colon
  8. Blood (leukemia)

Effects of Cancerous cells in the Body
1. They form lamps or masses of tissue called **tumours**. Tumours can grow and interfere with digestive, nervous and circulatory system.
2. They compete with normal cells for nutrients.
3. They lead to malfunctioning of the affected organs. Cancerous cells displace normal tissue, so the organ malfunction.
4. They cause unusual bleeding or discharge.
5. They cause death of the normal body cells.
6. Some cancers can release chemicals that can alter body function.

Factors that Increase the Risk of Cancer

1. **Smoking**- The tar and other chemical substances in cigarettes smoke can trigger gene mutation which can lead to cancer. Any substance that causes cancer is called **carcinogen** (literally means "cancer maker")
2. **Excessive Alcohol Consumption**- Alcohol damages liver cells making them to develop cancer. It is also converted to other chemicals that initiate cancer in the liver and the throat.
3. **Exposure to Toxic Chemicals**- Chemicals such as mercury damages DNA and hence initiates cancer in the body.
4. **Over-Exposure to Radiations**- Some radiations such as x-rays, gamma-rays, ultra-violet radiation from the sun increases the chances of development of cancer in the cells. These rays penetrate into the cells where they damage DNA.
5. **Some Viral Infections**- Some viral diseases such as hepatitis damage DNA in the liver, causing liver cancer. Human Papilloma Virus (HPV) damage DNA in the cervix, causing cervical cancer.

Ways of Preventing and Controlling Cancer

1. Eat plenty of plant foods such as fruits and vegetables.
2. Avoid smoking to reduce cancers of the lungs, mouth, oesophagus and larynx
3. Avoid exposure to toxic chemicals.
4. Avoid exposure to harmful radiations.
5. Eat a diet high in antioxidants like vitamins A, C and E. Vitamin A, C and E act as antioxidants in the body since they stop free radicals from damaging DNA. Free radicals are a group of chemicals in food which may damage DNA
6. Avoid taking alcohol.
7. Exercising regularly and maintain healthy weight.
8. Limit fat in the diet. Choose fewer high fat foods because they have high calories and may increase the risk of overweightness which in turn can increase risk of cancer attacks.
9. Get immunized for Hepatitis B to limit liver cancer and HPV (Human Papilloma Virus) that lead to cervical cancer.

Cancer Screening

- This is a process by which cancer is detected after it has formed but before any noticeable symptoms appears.
- This may involve physical examination, blood or urine tests and medical imaging such as X-ray.

Treatment of Cancer

- If cancer is detected early enough, treatment is possible. Treatment includes:-
    1. **Hormone therapy**- It is used to treat cancers that depend on hormones for growth. For example for treatment of breast cancer.
    2. **Surgery**- It is an operation to remove cancer.
    3. **Radiotherapy**- Uses high- energy radiation rays to kill cancer cells in a targeted area.

4. **Chemotherapy**- It is the use of drugs that kill cancer cells throughout the body.
5. **Gene therapy**- to repair diseased human cells.

Management of Cancer

Palliative Care

- This is a specialised medical care for people who have serious illness.
- It aims at improving the quality of life, mind and spirit for the patient.
- It is used to provide support to cancer patients and other patients with terminal illness. A terminal illness is any illness that has reached a stage where it will automatically cause death.
- In advance cancer, palliative care may help the patient to live longer and to live comfortably, even if they cannot be cured.

Benefit of Palliative Care for People with Cancer

1. It helps the patient to fully complete treatment.
2. It improves the quality of life during treatment
3. It increases ability of the patient to perform daily activities.
4. It helps the patient to live longer.
5. It improves the ability of the patient to deal with emotions
6. It increases connection to social support.

UNIT 15: FLOWERING AND NON- FLOWERING PLANTS

- Plants are classified into two main groups depending on presence of flowers or absence of flowers.
- Those without flowers are called **non- flowering plants** and those with flowers are called **flowering plants**.

Non – Flowering Plants

- Examples of non- flowering plants include algae, mosses, liverworts, ferns and conifers.

Algae

- Algae are simple plant- like organisms.
- They mainly live in water.
- They have chlorophyll and can photosynthesise
- Some are multicellular plant, such as spirogyra, other are microscopic, unicellular plants such as diatoms.

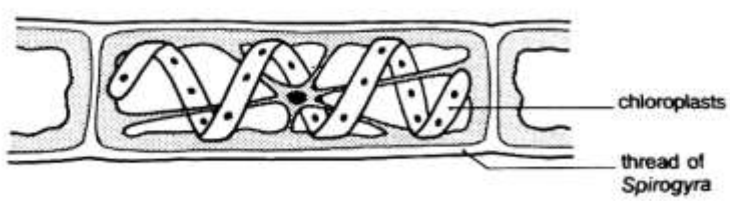


Fig. 15.1: Spirogyra

- Spirogyra reproduce asexually by fragmentation. Their bodies are not distinguishable into roots, stems and leaves.

Ferns

- Ferns are large green plants with true roots, stems and leaves.
- They have underground stem called a **rhizome** which bears adventitious roots.
- They reproduce through spores which are produced under mature leaves.
- They grow in damp, shady conditions.

Fig. 15.2: Fern

Mosses and Liverworts

- Mosses and liverworts are simple plants with simple structures.
- They do not have true roots, leaves or stems. These roots, leaves and stems are not true because they do not contain vascular bundles. Instead of true roots, mosses and liverworts have rhizoids which anchor the plant and absorb water.
- They reproduce by means of spores which are found in spore capsule.
- They are found in damp places like walls or caves.

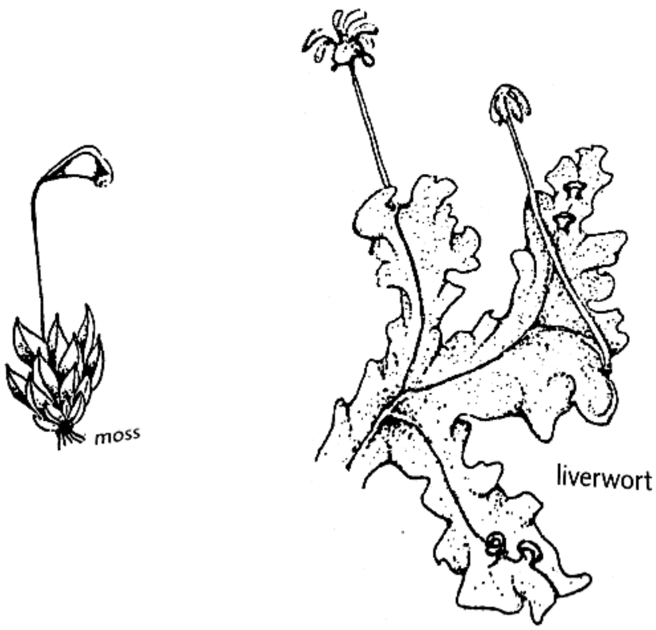


Fig. 15.3

Conifers

- Conifers are mostly found in temperate countries. Some are found at high altitudes in tropics. In Malawi, they are common at high altitude areas of Zomba Mountain and Viphya plateau.
- Examples of conifers are pine, cypress, podo and juniper.
- They have well developed roots, stems and leaves that have well developed conducting tubes (vascular bundles) for transportation of water, mineral salts and food nutrients.
- Reproduction is through seeds which are a result of fertilization of pollen grain from male cones and ovules on the female cones.

Flowering Plants

- Flowering plants are divided into two main groups: **monocotyledons** and **dicotyledons**.
- Flowering plants have true leaves. They have well developed stems and roots.

1. **Monocotyledons**
   - They have seeds which have one cotyledon
   - They have narrow leaves with parallel veins
   - They have fibrous root system.
   - Examples include grasses like maize plant, elephant grass

2. **Dicotyledons**
   - They have seeds which have two cotyledons.
   - They have broad leaves which have network veins.
   - Examples include beans, peas and mango plant.

Parts of a Flowering Plants

- Flowering plants are composed of three main organs: roots, stem and leaf.

1. **Roots**
   - There are two main types of root systems:

   a. Tap Root System
   - In tap root system, there is a very large main root known as the tap root (also called a primary root), developed directly from the radicle. In addition there are severe lateral roots (also called secondary roots) branching from the main root.
   - Tobacco, cotton, tomatoes, cabbage and legumes (beans, peas, and groundnuts) have tap root system.

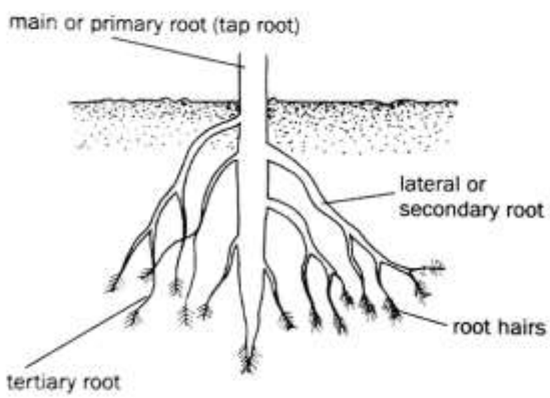


Fig. 15.4: Tap root system

   b. Fibrous Root System
   - This root system does not have a main root. All roots grow from the base of the stem.
   - Maize, millet, sorghum and elephant grass have fibrous root system.

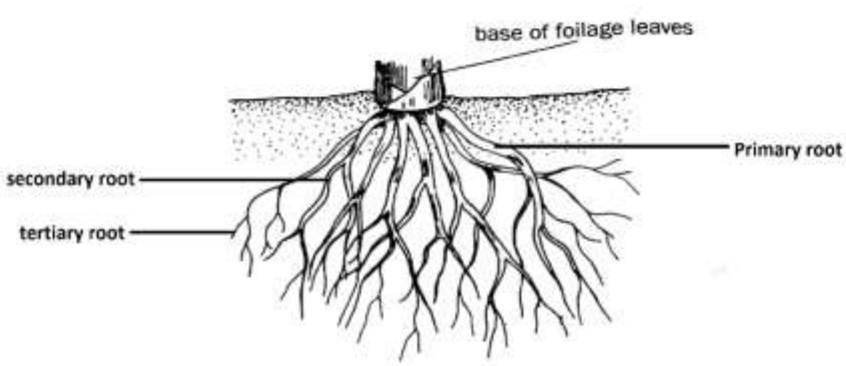


Fig. 15.5: Fibrous root system

2. **Stems**
   - Characteristics of Stems
     a. A stem has leaves at regular intervals. The region of stem from which the leaf springs out is called the node, and the length of stem between the nodes is called internode.
     b. A stem has terminal buds at the growing points.

Types of Stems

   - Types of stems include:
     a. Underground stems (e.g. reeds and potato tubers)
     b. Upright stems (e.g. maize)
     c. Climbing stems (e.g. beans)
     d. Creeping stems (e.g. sweet potatoes)

3. **Leaf**
   - A typical leaf consists of three main parts:
     a. The lamina or leaf blade
     b. The petiole or leaf stalk
     c. The leaf base (which connects the leaf to the stem in cereal crop)
   - The edge of the lamina is called the **margin**. The margin can be smooth or toothed (serrated)
   - The petiole is continued up to the centre of lamina to form the midrib or main vein.

Form of Leaves
- There are two main forms of leaves:
  1. Simple
  2. Compound

Simple Leaf
- A simple leaf has a single leaf stalk e.g. hibiscus.

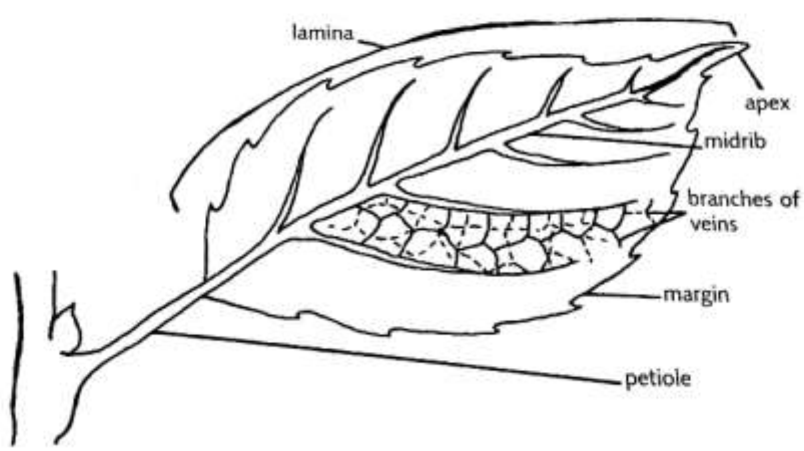


Fig. 15.6: Hibiscus leaf

Compound leaf

- A compound leaf has the leaf blade divided into several leaflets.
- The leaflets of a compound leaf may be arranged in several ways:
    a. Pinnate
    b. Bipinnate
    c. Digitate
    d. Trifoliate

a. **Pinnate**

- In pinnate arrangement the leaflets are arranged in pairs opposite one another along the main stalk e.g. cassia

Fig. 15.7: Cassia leaf

b. **Bipinnate**

- Bipinnate leaves are those in which each pinnate leaflet is itself divided into pinnate leaflets e.g. jacaranda

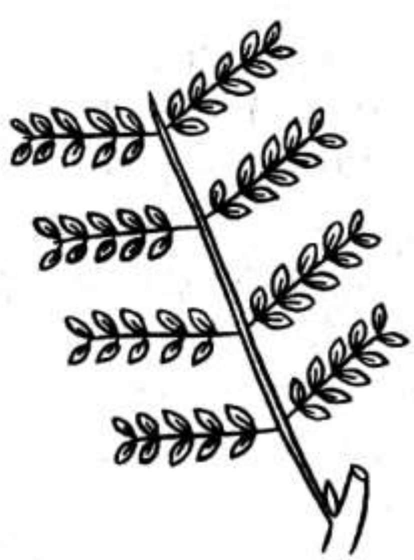


Fig. 15.8: Jacaranda leaf

c. **Digitate**

- The leaflets radiate out from the end of stalk like fingers of a hand e.g. cassava and chorisia

Fig. 15.9: Chorisia leaf

d. **Trifoliate**

- In trifoliate leaves, each leaf consist of three leaflets e.g. beans.

Fig. 15.10: Bean leaf

Leaf Venation

- It is the arrangement of veins in a leaf.
- There are two main forms of leaf venation:
  a. Reticulate venation
  b. Parallel venation

a. Reticulate Venation

- In reticulate venation, the veins are arranged in a network e.g. leaf of tomato plant.

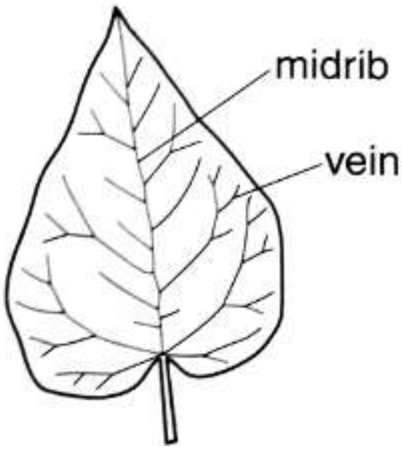


Fig. 15.11: Tomato leaf

b. Parallel Venation

- In parallel venation, there are several main veins that run parallel to one another e.g. leaf of a maize plant.

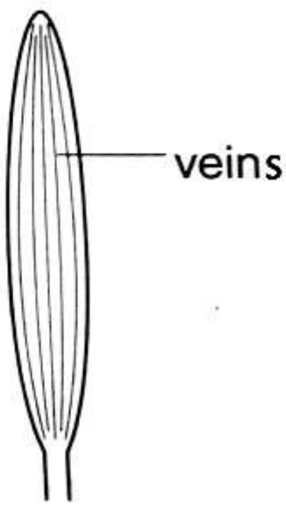


Fig. 15.12: Maize leaf

Leaf Arrangement

- Leaves may be arranged on the stem in one of three ways:

  a. Opposite

  - The leaves are directly opposite each other on a stem – there are two leaves per node on stem.

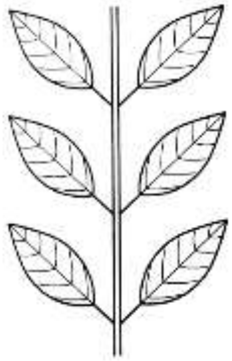


Fig. 15.13: Opposite

  b. Alternate

  - There is one leaf per node and the leaves are attached alternately on each side of the stem.

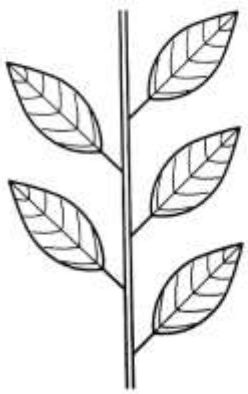


Fig. 15.14: Alternate

  c. Whorled

  - There are three or more leaves per node

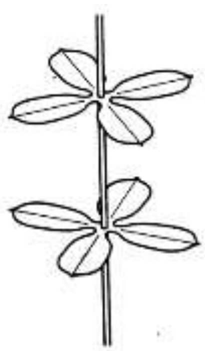


Fig. 15.15: Whorled

4. The Flower

- Reproduction in flowering plants is carried out by the flower.

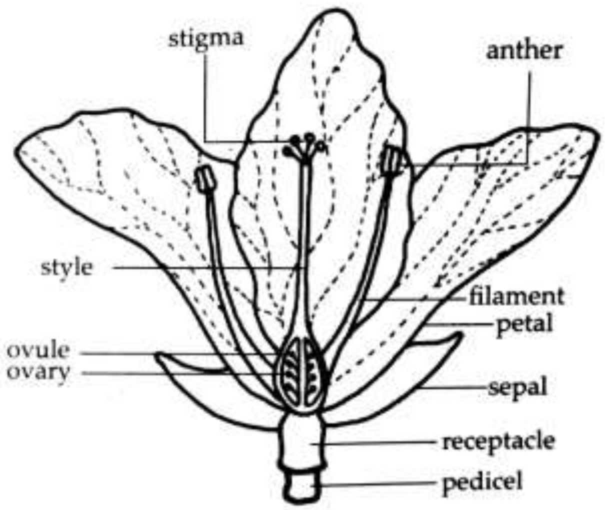


Fig. 15.16: A generalised structures of a flower

- Flower may be classified according to whether they are pollinated by wind or insects.

a. Wind- Pollinated Flowers

- Flowers that are pollinated by wind have the following characteristics:
  - (i) Petals are very small, not clearly visible or absent since they have no need to attract pollinators.
  - (ii) They do not produce nectar or scent
  - (iii) They produce large quantities of pollen to increase the chance of falling on the stigma.
  - (iv) They produce light pollen so that they can be easily carried in air
  - (v) Pollen is not sticky
  - (vi) They have large anthers, loosely attached to filaments. Filaments hang loosely outside the flower so that they can shake and shed pollen even when there is no strong wind.
  - (vii) Stigmas are wide and feathery to increase the chances of catching pollen.

b. Insect- Pollinated Flowers

(i) These flowers are brightly coloured and attractive to pollinators i.e. insects and birds
(ii) They possess nectar
(iii) The petals produce distinctive scent which attract pollinators.
(iv) Pollen grains are larger in size, hairy in some plants, smooth and sticky in others. This is important for attachment of pollen to the body of pollinators.
(v) Stigma are often sticky.

5. The Seed

- A seed is a fertilized ovum.
- The seed, which carries an embryo, must be released by the parent plant into suitable place to germinate. This is important because it reduces competition for growth resources and also helps spread the plant widely.
- The main agents for seed dispersal include wind, water, animals and explosive mechanism (self- dispersal).

a. Wind Dispersal

- Fruits and seeds dispersed by air have the following characteristics:
  - (i) They are light in order to float in air.
  - (ii) Some possess structures that enable them to float in air, e.g. hairs.

b. Dispersal by Water

- This is the method used by aquatic plants and some plants which grows close to water bodies. In this method, the seed is carried by water.
- Seeds dispersed by water have the following characteristics:
  - (i) The seed float in water
  - (ii) Mature fruit contain air space inside which makes it light enough to float in water e.g. coconut fruit.

c. Animal Dispersal

- The following are the characteristics of fruits and seeds dispersed by animals:
  - (i) Some fruits are attractive and eaten by animals. The animals either throws the seed away e.g. mango or the seed pass through digestive system e.g. guava
  - (ii) In some plants, like *Bidens pilosa*, the fruit has developed hooks which attract to the fur of animals or clothes of people.
  - (iii) In some plants, there is a presence of sticky hairs on fruit for attachment to the animal body.

d. Explosive Mechanism (Self- Dispersal)

- Some plants have developed a way to eject or release seeds away violently so they fall far from the plant. The seeds are dispersed from the fruit, which remains attached to the plant.
- Usually self- dispersal mechanism is caused by unequal drying of different layers of the outer layer of the fruit which, therefore, breaks in the line of weakness like in legumes (peas and beans).

UNIT 16: PLANT RESPONSES

Stimulus

- Stimulus refers to changes in the environment that brings about a change in the activity of an organism. Examples of stimulus include light, gravity, water, pain and rise in blood temperature.
- A stimulus is said to **unidirectional** or **unilateral** if it comes from one direction.

Response

- It is a change in activity of an organism which is initiated by a stimulus.
- Plants are capable of responding to changes in light, water, gravity, temperature and contact.
- There are two major groups of plant responses to stimulation:
  1. Tropisms and
  2. Nastic responses

Tropisms

- Tropism is a growth response towards or away from unilateral stimulus.
- If the response is towards the stimulus it is **positive response**.
- If the response is away from the stimulus, it is **negative response**.

Types of Tropisms

- Tropisms are classified according to the stimulus that produces the growth movement. They include:
  a. Phototropism
  b. Geotropism
  c. Hydrotropism

a. Phototropism

- This is a growth movement of a plant part in response to light coming from one direction (unilateral light)
- The direction of movement depends on the direction from which light originates.
- If the plant part bends towards the direction of light it is referred to as **positivephototropism** while if the curvature is away from the light it is referred to as **negative phototropism**.

b. Geotropism

- This is a growth movement in response to the stimulus of gravity.

c. Hydrotropism

- This is a growth movement in response to the stimulus of water.

Plant Hormones

- Plants produce a number of hormones, some of which influence growth.
- The growth hormones in plants are called **auxins**.

Auxins

- Auxins are a group of plant growth hormones.
- Auxins are not growth promoters, they are growth regulators since they can either increase or slow down the growth process.
- The main natural auxin that plants produce is called IAA (Indole Acetic Acid).
- Growing parts of the plant such as young leaves, tips of shoots and tips of roots produce largest amount of IAA. The auxin is then transported to other parts of the plant.
- IAA affects different parts of the plant in different ways:
  1. In stem, a higher concentration of IAA stimulates higher growth rate by encouraging cell elongation (enlargement).
  2. In roots, a higher concentration of IAA inhibits growth by preventing cell elongation.

Auxins and Phototropism

- Phototropic response of a plant is caused by unequal distribution of auxin due to illumination from unilateral light.
- When unilateral light is directed at the tip of the shoot, auxins migrate from the lighter side to the darker side. The cells on the darker side are exposed to higher concentration of auxins. Therefore these cells (on the darker side) elongate more than the cells on the lighter side hence the shoot bends towards light (positive phototropism).

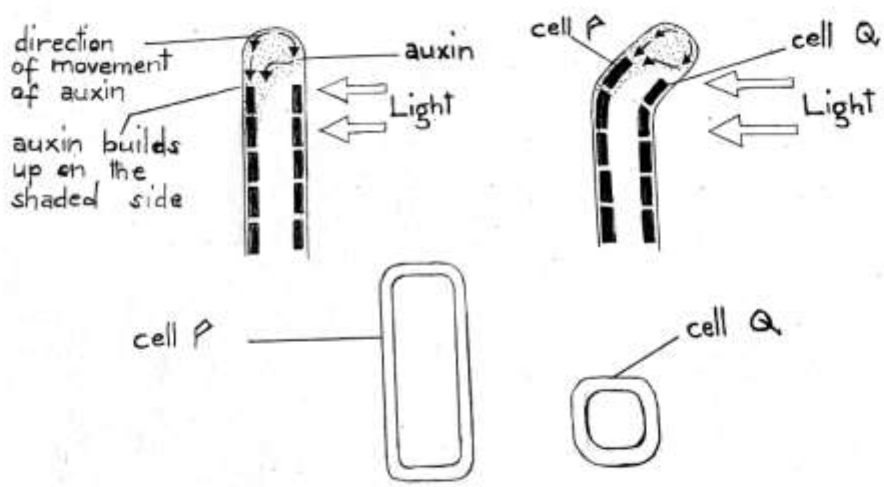


Fig. 16.1: Effects of auxin on a germinating bean seed

Auxins and Geotropism

1. In shoots

- When a potted plant is placed horizontally, gravity pulls down the auxins produced by shoot tip to the lower side of the shoot. This result into higher concentration of auxins on the lower side than on the upper side hence the cells on the lower side elongate faster than those in the upper side. Consequently, the shoot curves upwards, away from gravity (negative geotropism).

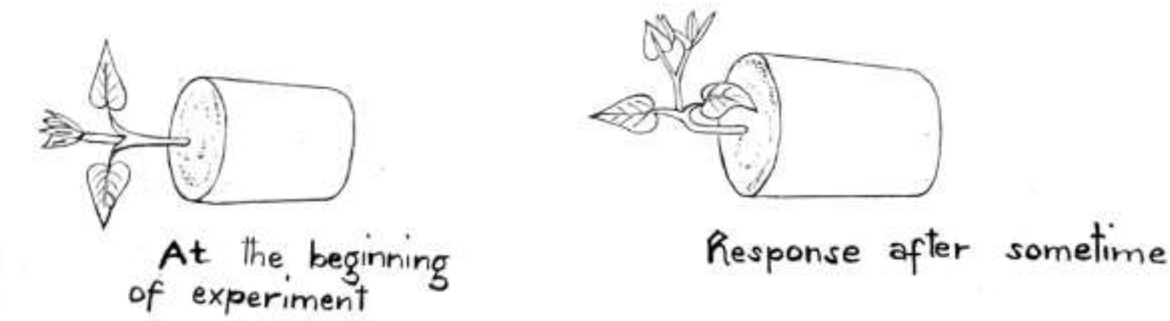


Fig. 16.2: Geotropism in shoot

2. **In Roots**
   - When a maize seedling is placed horizontally, gravity pulls the auxins produced by the radicle tip and accumulates more on the lower side of the radicle. Since in roots or radicles auxins inhibits cell elongation then the cells on the upper side of the radicle elongate faster than cells on the lower side. Consequently, the radicle bends downwards – towards gravity. This is positive geotropism.

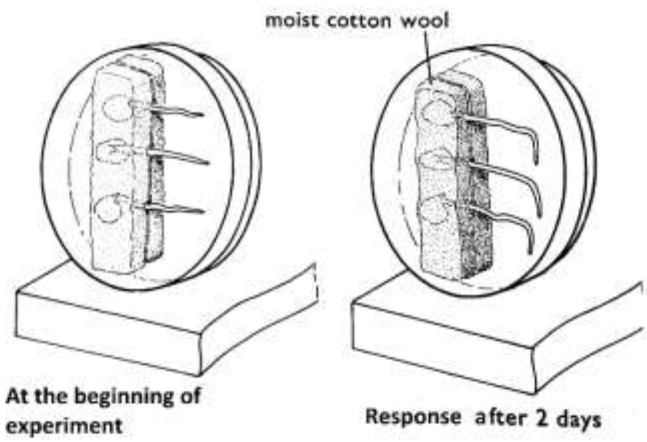


Fig. 16.3: Geotropism in roots

Auxins and Hydrotropisms

- When a plant root is exposed to unequal distribution of water in the soil, auxins produced by the tip of the root migrate and accumulate more close to the moist i.e. high water content. Cell elongation is inhibited in this side as such the root bend towards an area of high water content. This is positive hydrotropism.

Importance of Plant Tropisms

1. Enables plant shoot to grow towards light hence maximising photosynthesis.
2. Enables plant roots to grow towards the soil hence maximising anchorage and water, mineral salts absorption.

Nastic Responses

- Nastic responses occur when plants move some parts of their body due to presence of a particular stimulus.
- Unlike tropisms, these movements are not controlled by the direction of stimulus.
- Nastic responses are also reversible and can be repeated.
- Nastic movement are rapid in comparison to tropisms.

Examples of Nastic Responses

a. *Mimosa pudica*

- The *Mimosa pudica* plant is known to fold its leaves when touched. Under normal circumstances, the leaves of the plant are well spread along the midrib. However, when touched, the leaves fold rapidly as a way of preventing damage to the leaves.

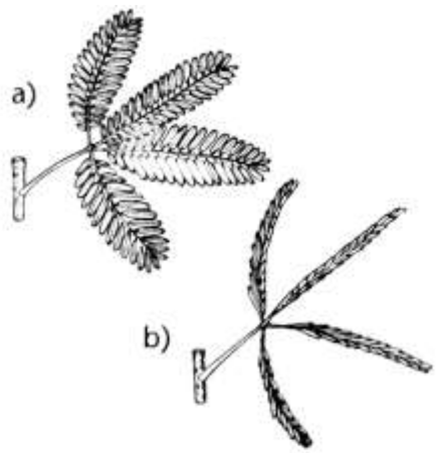


Fig. 16.4: Mimosa pudica before (a) and after (b) stimulus

b. The Venus Flytrap

- The Venus flytrap is an example of an insectivorous plant (a plant that eats insects). It closes its leaves to trap an insect that lands between the lobes of its leaves and later digest it.

Fig. 16.5: Venus flytrap plant with a trapped fly

- The leaf blades of the Venus flytrap contain hairs which are sensitive to touch. When an insect lands on the leaf blade, it is sensed by the hairs causing the leaf to rapidly fold. This encloses the insect inside the leaf and is pierced by the hairs killing it. As it decomposes, the leaves secrete enzymes which digests the insect.

c. Sleeping Movement in Plants

- This is a response to changes in light intensity during the day. It is common in leguminous plants such as groundnuts and bean plant.
  - During daytime, the leaves open flat (horizontally) to make sure that sun rays are horizontal to their surface. At night, the leaves fold or close.

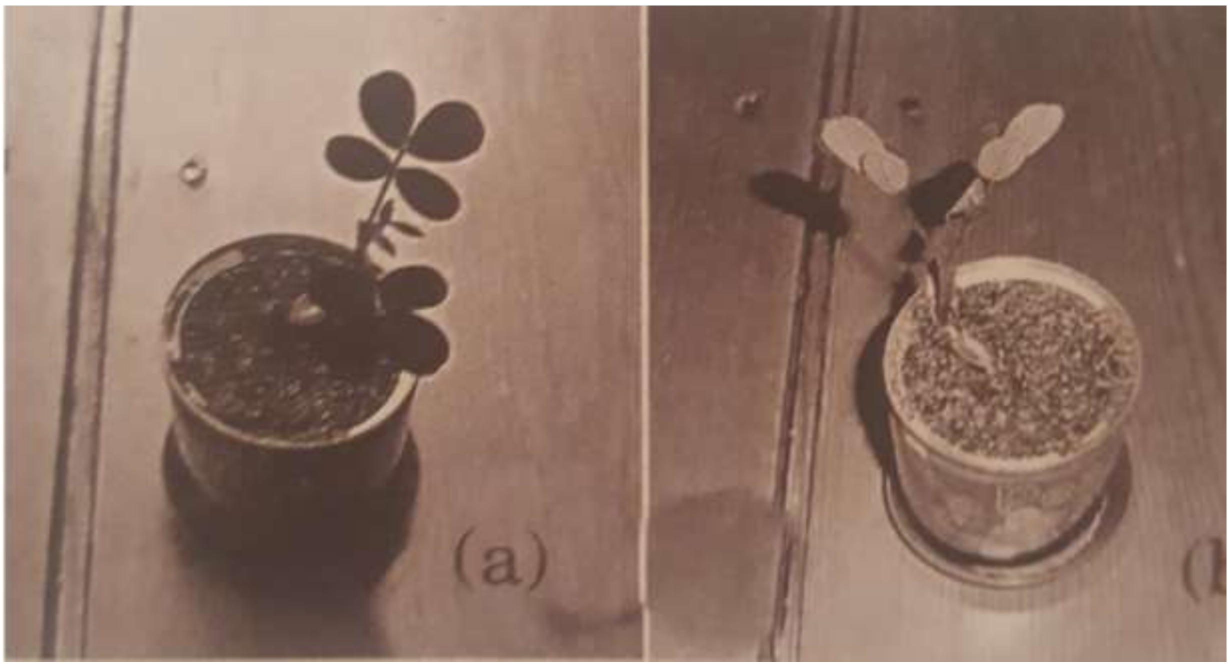


Fig. 16.6: Sleeping plants (a) during day time (b) at night

  - In hot weather, the leaves droop to minimise water loss through transpiration.